LOOKING AT INSTRUCTIONAL ANIMATIONS THROUGH THE FRAME OF VIRTUAL CAMERA

by

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ABSTRACT

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This thesis investigates the virtual camera and the function of camera movements in expository motion graphics for the purpose of instruction. Motion graphic design is a popular video production technique often employed to create instructional animations that present educational content through the persuasive presentation styles of the entertainment media industry. Adopting animation as a learning tool has distinct concerns and challenges when compared to its use in entertainment, and combining cognitive learning and emotive design aspects requires additional design considerations for each design element. The thesis will address how the camera movement-effect in supporting the narrative and aesthetic in instructional animations. It does this by investigating the virtual camera in terms of technical, semiotic and psychological level, culminating in a systematic categorization of functional camera movements on the basis of conceptual framework that describes hybrid integration of physical, cognitive and affective design aspects; and a creative work as a case study in the form of a comprehensive instructional animation that demonstrates practiced camera movements. Due to the correlation of the conceptual framework relied upon by the supplementary work with the techniques of effective instructional video production and conventional entertainment filmmaking, this thesis touches on the relationship between live action and animation in terms of directing and staging, concluding that the virtual camera as a design factor can be useful for supporting a narrative, evoking emotion and directing the audience's focus while revealing, tracking and emphasizing information.

ÖZET

EĞİTİCİ ANİMASYONLARA SANAL KAMERA KADRAJINDAN BAKMAK

ALİ CEM BATMANSUYU

GÖRSEL SANATLAR VE GÖRSEL İLETİŞİM TASARIMI YÜKSEK LİSANS TEZİ, TEMMUZ 2019

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Anahtar Kelimeler: eğitici, animasyon, işlevsel, kamera, hareket

Bu tez, anlatım amaçlı hareketli grafiklerdeki sanal kamerayı ve kamera hareketlerinin işlevini incelemektedir. Hareketli grafik tasarım, genellikle eğlence medya endüstrisinin ikna edici sunum stilleriyle eğitim içeriği sunan eğitici animasyonlar oluşturmak için kullanılan popüler bir video prodüksiyon tekniğidir. Animasyonu bir öğrenme aracı olarak benimsemek, eğlence alanındaki kullanımına kıyasla farklı kaygı ve zorluklara sahiptir ve bilişsel öğrenme ile duygusal tasarım özelliklerini birleştirmek, her tasarım öğesi için ek tasarım düşünceleri gerektirir. Bu tez, kamera hareketinin öğretim animasyonlarında anlatı ve estetiği desteklemede nasıl bir etkisi olduğunu ele almaktadır. Bunu sanal kamerayı teknik, gösterge bilimsel ve psikolojik düzey açısından inceleyerek, fiziksel, bilişsel ve duygusal tasarım özelliklerinin karma entegrasyonunu tanımlayan kavramsal çerçeveye dayanarak; fonksiyonel kamera hareketlerinin sistematik bir kategorize edilmesini ve örnek kamera hareketlerini gösteren kapsamlı bir eğitici animasyon biçiminde bir vaka çalışması olarak yaratıcı bir çalışma olarak sunar. Etkili öğretim video prodüksiyonu ve konvansiyonel eğlence film yapımı teknikleriyle tamamlayıcı çalışmalara dayanan kavramsal çerçevenin korelasyonundan dolayı, bu tez canlı kamera ile animasyon arasındaki ilişkiyi yöneten ve sahneleştiren, sanal kameranın tasarım faktörü olarak, bir anlatıyı desteklemek, duygu uyandırmak ve izleyicinin odağını yönlendirmek, bilgiyi açığa vurmak, izlemek ve vurgulamak için faydalı olabilir.

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1. INTRODUCTION

Instructional animations have received much attention in recent years due to their entertaining and informative aspects, which offer a growing number of motion graphics videos on online video sharing platforms. Motion graphic design has many possible uses in the entertainment industry and has also been investigated as a digital learning tool in the education field. However, much uncertainty still exists about the systematic classification of particular design elements or storytelling tools (Ploetzner & Lowe 2012; Berney & Bétrancourt 2016; Boucheix & Forestier 2017), such as the function of camera movements in expository animations (Fiorella & Mayer, 2018)

One way to investigate the function of camera movements is to analyze them alongside design aspects of instructional videos. There has already been extensive research regarding the design aspects of digital video learning and entertaining value of animations. For example, Morain and Swats (2012) provided a systematic classification of YouTube tutorials in terms of physical, cognitive and affective design aspects, and more recently Krasner (2017) provided comprehensive knowledge about temporal and spatial animation parameters of motion graphic design regarding entertaining/commercial animation videos. Although effective and affective design concerns as they relate to educational and entertainment value has been researched and practiced over years, little attention has been paid to camera movement effect, in other words, to the dynamic behavior of viewpoint changes in instructional animations (Lowe & Schnotz 2004).

This thesis presents a conceptual framework for analyzing camera movements in expository animations in terms of *physical*, *cognitive* and *affective* design aspects. It then describes the narrative and aesthetic functions of camera movements along with practiced creative work (see *Appendix A*) on the basis of provided framework. Ultimately, this combination of practice and research forms a taxonomy table covering the functional camera movements are provided in *Appendix C*, which can be useful guide for individual motion designers and further discussions about functional camera movements in instructional animations.

It is generally accepted that the major focus in the digital video industry is ensuring viewer retention with intriguing presentation styles and attractive contents owing to ever-growing media consumption. Whether it is for commercial interest or educative purposes, aiming to stimulate audience’s emotion and provide ongoing motivation constitute the primary function of instructional animation, which seems to be affective rather than effective at first glance (Schwan & Papenmeier 2017). However, the underlying premise of the term “instructional” does not solely rely on emotive or seductive design decisions but also supports effective learning in developing a piece of knowledge. Therefore, animation as a learning technique has raised multiple design issues that require additional consideration.

In the education field, the potential of instructional animations as a learning tool has always been a contentious method of research and artistic practice. As a result of digital media convergence, the literature on multimedia learning has interrogated the added-value of animation as design aspects, shifting the question from “does animation enhance learning?” to “when and why does animation enhance learning?” (Berney & Bétrancourt 2016). The *why* question corresponds to utilizing cognitive-perceptual systems regarding the psychology of comprehensive learning, which attempts to address the beneficial effect of animation upon audience. The *when* question deals with the design systems regarding visual representation techniques and approaches during the presentation. Having said that, the growing body of literature focuses on the “why” question, documenting merits and drawbacks of animation as a whole multimodal[1] sign system from a pure education perspective (Chalbi 2018). What is not yet clear is systematic classification of design factors (i.e. camera movements) and comprehensive characterization of educational animations to achieve designated learning objectives grounded in literature and practices in expository animations (Ploetzner & Lowe 2012; Berney & Bétrancourt 2016; Boucheix & Forestier 2017). One of the design factors is the applicability of changing point of view

[1] Multimodal refers to combination of multiple modes (audial and visual signs) to create meaning, i.e. combining animated texts with voice-over in a video.

during the presentation. Following this, as a conventional approach, most instructional animations present visual contents from a stationary-point of view, whereas little attention has been paid to the dynamic point of view during the presentation (Schwan & Papenmeier 2017). By drawing on the concept of camera animations, Richard Lowe and colleagues (Lowe & Schnotz 2004) argue that “the fixed and dynamic viewpoint approaches offer designers of educational animations different opportunities for exploring and explaining the subject matter”.

There are two main methods to break fixed point of view in digital animations. One of them is adding a virtual camera as an object into the scene while other one is that of changing motion properties of representing images in terms of scaling, position, rotation. In other words, *camera movement-effect* can be simulated without adding a secondary motion to the camera by manipulating spatial and temporal properties of the graphical entities as a reference to point of view. Thus, some fundamental camera movements such as panning, tilting, push or crave in/out shots practiced in conventional filmmaking can be imitated by these means, which may provide a multipurpose quality to achieve aesthetic and narrative functions of camera movements as an informative and persuasive storytelling tool. According to David Bordwell and Kristin Thompson's section on camera movement in Film Art, *mobile framing* is defined as “the ability of frame to be mobile as camera movement” (Bordwell & Thompson 2017). That is in fact, a broader term of camera movement including additional properties such as zooms. In the same vein, Jon Krasner (2017) complements mobile framing in his book *Motion Graphic Design: Applied History and Aesthetics;*

> “the study of movement is not just confined to how elements travel inside the frame; it also involves the perceived motion of the viewer with regard to how the content is framed over time. Frame mobility, which is achieved through actual camera movement or simulated camera movement, can breathe life into scenes and achieve various compositional framings.”

Collectively, these studies and practices highlight the need for systematic design approaches for camera movements in animation videos. Despite the fact that camera as a physical device has been practiced over years in entertainment industry as a traditional storytelling tool, in the age of digital learning, there remains a need for an inquiry focusing on the function of camera movement-effect in instructional animation videos.

1.1 Background and Literature Review

In the past several decades, incorporating design practices into digital media formats have been an inevitable consequence of mass media production and profound changes in consumer behavior. Henry Jenkins (2003), argues that the transformation of design approaches is promoted by emerging technologies as well as cultural demands, which is a collective process based on the nature of contemporary media consumption. Jenkins (2004) indicates that;

> "Media convergence is more than simply a technological shift. Convergence alters the relationship between existing technologies, industries, markets, genres, and audiences. Convergence alters the logic by which media industries operate and by which media consumers process news and entertainment."

Jerkin's argument is particularly congruent with the rising popularity of video streaming websites like YouTube, where digital content production has emerged as a profession for individuals and businesses. This phenomenon has led the audience to become the "users" who have the option to determine which video content suits their interest among numerous alternatives, in contrast to being a subject to the film by sitting in a cinema or lying on a couch while watching the television broadcasting relatively limited number of channels. Moreover, this active engagement enables the internet user to learn technological knowledge such as usage of software tools or programming languages along with audio-visual communication techniques such as filmmaking, graphic design, motion design, instruction design and eventually motivates them to develop their own video contents. Manovich (2001) takes this phenomenon referring to a notion of filmmaking and emphasizes that;

> "A hundred years after cinema's birth, cinematic ways of seeing the world, of structuring time, of narrating a story, of linking one experience to the next, have become the basic means by which computer users' access and interact with all cultural data. In this respect, the computer fulfills the promise of cinema as a visual Esperanto[2] – a goal that preoccupied many film artists and critics in the 1920s, from Griffith to Vertov. Indeed, today millions of computer users communicate with each other through the same computer

[2] "The notion of a "visual Esperanto" is an appealing concept which standardizing the advertising message across countries and benefiting from strategic consistency and economies of scale" (Michael, 1999)

> interface. And in contrast to cinema, where most "users" are able to "understand" cinematic language but not "speak" it (i.e., make films), all computer users can "speak" the language of the interface. They are active users of the interface, employing it to perform many tasks: send e-mails, organize files, run various applications, and so on."

In that sense, speaking is relatively easy comparing to reaching people and getting them to listen. In other words, keeping people's eyes on the content is harder than before due to the vast ocean of online information. Videos can no longer have stagnant, dull or lifeless visual narrative in the digital age since users are accustomed to having control by actively skipping anything that is not intriguing enough to keep their attention for long. From this argument, our perception towards animated graphics is no longer magical or novel; instead, it is one of the prerequisites of visual communication in digital-age standards. With the aid of accessible software tools and online "how-to" videos, anyone can create and edit videos effortlessly.

Until recently, producing instructional animations had been a collaborative process where skilled specialists and technicians from various domains like psychology, education, art, visual communication, had worked together especially in the educational field (Jacobs and Robin 2016). In the context of the entertainment industry, media scholars point out that the democratization[3] of production process with the aid of software tools enables desktop publishing (Kalogeras 2014; Kosner 2018). In contrast, within a purely educational context, scholars point out that the individual animation producers design their videos based on practical experience, personal aesthetics, and intuition instead of being grounded in precedent researchers or formal practices (Koning 2018, Ploetzner and Lowe 2012; Chalbi 2018; Mayer 2017). It all boils down to the fact that the production of individual and multimedia learning videos requires rigid guidelines to support designers' decisions. While the immense freedom of animation brings creativity and authenticity to the implied work, particular design aspects, such as comprehensive articulation of the content, are often overlooked (Koning, 2018). Many researchers fail to observe other design aspects of the animation for their educational inquiries, rendering the video a flavorful yet fruitless product (Ploetzner and Lowe 2012).

[3] Free or affordable technology which is more accessible to more people

In theory, a designer's primary concern should be aligned with the specified learning tasks before the persuasive design decisions such as adding extraneous graphics or irrelevant sound effects Correspondingly, comprehensive design in video making should seek to determine learning objectives explicitly, and objectives are often based on empirical studies that can be implied for general use in a learning context (Kulgemeyer, 2018). It can be argued that these studies and theoretical frameworks can guide the designer to set primary design rules during video production. Due to the versatile aspects of target goals in using animated graphics, studies and practices have provided sufficient structures to understand why and when the educational animation reaches the desired learning objectives (Berney & Bétrancourt 2016; Chalbi, 2018). Therefore, the instructional designers also need to construct a framework to ensure that the target goals are coherent with their design decisions during the production process (Lowe & Ploetzner 2017).

In practice however, designers and researchers work in distinct domains characterized by different considerations and approaches to affordability. Most publications addressing the particular practice of animation in terms of design factors are from either too general or overly scientific perspectives (Chalbi 2018). Having said that, arguably only a few works have been focused on applicability of animation properties in terms of spatial and temporal parameters (Schwan & Papenmeier 2017), yet still, design concerns are proposed for specific contexts of use. For example, John Krasner's book "Motion Graphic Design: Applied History Aesthetics" (2007) categorizes spatial and temporal parameters of animation by means of semantics and technical definitions which are supported with examples. Despite the fact that his broad technical and conceptual analysis for motion graphic design literacy provide an invaluable source for one who is eager to learn and practice motion graphic design, whereas all use cases and examples are oriented specifically to the entertainment and commercial industry rather than to the digital learning. Subsequently, due to the broad applicability of animation parameters depending on the target goal, the designer needs to refer back to a set of design aspects and understand when the animation parameters are coherent with these target goals (Lowe & Schnotz 2014; Chalbi 2018).

Finally, once the designer sets the design aspects, the production process invokes the question of "how do I achieve my appointed design aspects using motion graphic design technique?" Undoubtedly, there is no conclusive answer due to fast changing popular cultures and consumer behaviors in an ever-growing world. However, in essence, achieving these goals successfully depends primarily on what is animated and how this animation is designed. The designer needs to understand animation parameters and decide how to define them. Even mundane shapes may turn visually appealing chorography just as the animation of Viking Eggeling's *'Symphonie Diagonale'*[4] in 1963 or Ted-Ed Channel's *'What is bipolar disorder?'*[5] in 2017. In other words, defining what needs to be communicated across the frame relates to visual representation types. By referring Ploetzner and Lowe's (2012) framework for visual representation types in animated videos, the visual representation has two ingredients: *static images,* which refer to a way of presenting multimedia without adding secondary motion (e.g. illustration, typography, data charts, photographs, etc.), and *dynamic images* (e.g. animated graphics, kinetic typography, inserted video clips, etc.).

1.1.1 Learning Challenges

Mayer (2001) proposed a set of guidelines based on the theoretical frameworks of *cognitive load* theories. Cognitive load theory refers to the amount of information processed during the viewing experience (Sweller, 2005). Following that, the amount of visual clutter and irrelevant information can induce exhaustion, and eventually impede learning. In the light of Mayer and his colleagues' findings, Lowe (2003) suggests that the inclusion of the temporal dimension in a visual presentation demonstrates different information processing demands. These demands are described as the presence of too much or too little information in certain time intervals that can overwhelm or underwhelm the learner, and create adverse cognitive effects, especially in the case of changing or evolving images simultaneously in a time-based medium. Over the years, interdependent results and practices have converged in similar results, proposing that the main challenges of employing animation in education are directing viewers' attention to the relevant information, omitting irrelevant information that may overload learner's processing ability, enhancing the processing requirements in order to accommodate incoming

[4] https://www.youtube.com/watch?v=KpCI67GMe7o [Accessed 11 June 2019]
[5] https://www.youtube.com/watch?v=RrWBhVlD1H8&t=211s [Accessed 11 June 2019]

messages and assimilating knowledge from the presented audio-visual modals (Ibrahim, 2012).

Briefly, cognitive researchers have dealt with three major challenges in using animation in instructional learning (Ibrahim 2012).

1) The *transitory nature* of animation refers to the inadequate pace of presented information, and continuous replacement of one information with another;

2) The *compositional complexity* of animation refers to the simultaneous movements of many elements from one location to another, which can cause confusion related to the focus of an animation;

3) The *inclusion of extraneous content*, such as background music, decorative images, refers to visual effects which block or compete with the essential information being presented.

The learning challenges mentioned above indicate that the cognitive dimension of these learning challenges is significantly built upon designing effective learning, rather than emotional -*affective*- design aspects. Affective design or visual aesthetic features were usually seen as a by-product of seductive components which are irrelevant to the learning objectives and impedes learning outcomes (Harp & Mayer 1998; Clark 2006; Mayer 2011). Instructional content centers primarily on the design and the construction of efficient factors that engage the learner with the intent to develop intellectual or cognitive skills for long durations. Thus, the attraction or appeal of multimedia learning strategies have been viewed as an unnecessary addition to the learning process and, in fact, may create extraneous load (Clark, Nguyen, and Sweller 2006). However, Norman (2013) emphasizes the emotional qualities of design by identifying the strong connection between the affective and cognitive aspects in the design of everyday products. Even though academic researchers in educational field may be reluctant to integrate a value of emotional aspects for an appealing design, commercial industries and media businesses have found that the visual aesthetics or persuasiveness of the representations are quite determinant for the users' pleasure and motivation (Lavie & Tractinsky 2004). Moreover, in the design of multimedia learning, studies have implied that persuasive design factors can evoke some emotions and that these emotions influence the spectator's cognitive process (Kumar 2016). Consequently, studies have shown the importance of affective design as an engaging and motivating component for learners (Morain & Swarts 2012).

1.2 Conceptual Framework

Based on aforementioned learning challenges in the background and literature section, the designer must consider the learning types and seek a balance between insignificant and important depictions of representations -i.e. between effective and affective- to reach audience and, to be understood clearly with the content by audience. Considering the broad applicability of design factors in regard to different designated goals and aspects, conceptual framework is imperative in order to confine the scope.

1.2.1 Types of Knowledge Development in Instructional Videos

According to Anderson's taxonomy (2001), there are four types of knowledge for learning in videos: Factual, conceptual, procedural and metacognitive.

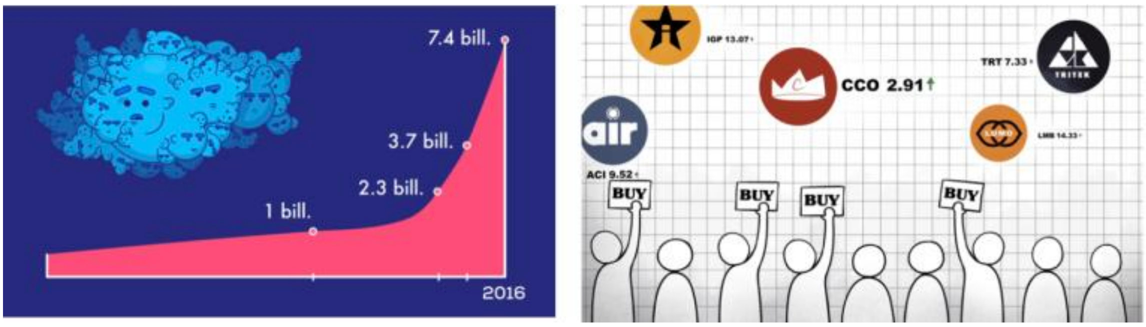
Factual knowledge development refers to the basic elements that the audience is expected to know and to learn. In other words, the factual knowledge is gained when the audience is interested to be aware of a fact or a specific detail of a whole concept such as statics, terminology, technical vocabulary, and so on. For example, biologic components of human cell structure[1], etymology of a word, historic dates of World War One[2].

Figure 1.1 - Examples from instructional animations aiming at *factual knowledge*

[1] https://www.youtube.com/watch?v=URUJD5NEXC8 [Accessed 11 June 2019]
[2] https://www.youtube.com/watch?v=PbwH1ZBnYds [Accessed 11 June 2019]

Conceptual knowledge refers to interrelationships between "the basic elements within a larger structure that enable them to function together" (ten Hove & van der Meij, 2015; Anderson et al., 2001). Learning conceptual information through audio-visual sign systems involves the understanding of concepts, principles, theories, models, classifications and so on. Most of the informative animations are enhanced with the narrator's explanation, which facilitates viewers to link audio-visual messages and events. While factual videos can be presented without audial support, conceptual videos often require an external voice-over due to multiple layers of information being linked together. Most conceptual instructive videos include factual knowledge to justify their explanation and supplement the narrative. For example, "what is overpopulation?[3]" or "How does the stock market work?"[4] videos raise awareness with factual pieces of information as well as conceptual commentary about subject matter.

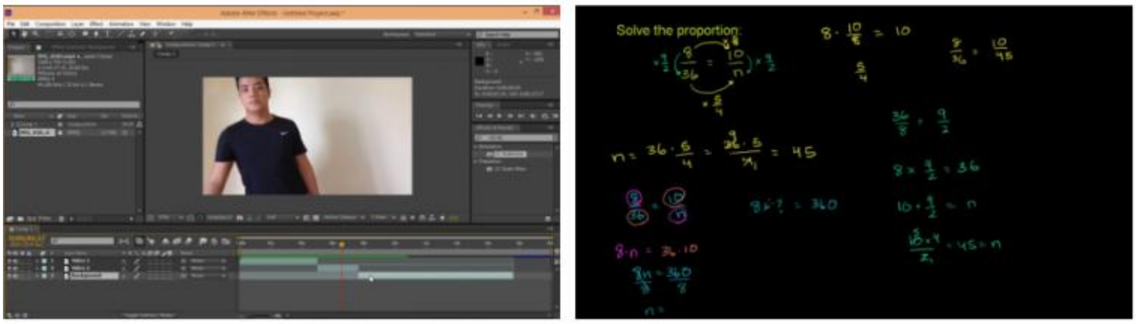
Figure 1.2 - Examples from instructional animations aiming at *conceptual knowledge*



Procedural knowledge consists of techniques, algorithms, and methods aiming to develop "know-how" skills covering "how-to" videos such as “how to use After Effects software”[5], “solving a math problem”[6], “how to cook food” and so on. These videos are mostly task-oriented and require technical documentations or set of skills to address the particular topic. "How-to” videos are dominant explainer video style among 585 million instructional videos on YouTube (Per Eriksson & Yvonne 2019).

[3] https://www.youtube.com/watch?v=QsBT5EQt348 [Accessed 11 June 2019]
[4] https://www.youtube.com/watch?v=p7HKvqRI_Bo&t=179s [Accessed 11June 2019]
[5] https://www.youtube.com/watch?v=C913enLWYxE [Accessed 11 June 2019]
[6] https://www.youtube.com/watch?v=GO5ajwbFqVQ [Accessed 11 June 2019]

Figure 1.3 - Examples from instructional animations aiming at *procedural knowledge*



Metacognitive knowledge is designed to help students increase their awareness associated with how they learn or think about their own cognition process, which are not a typical video type on online video platforms since they demand feedback-based interactivity and thereby it is beyond the concern of this thesis.

1.2.2. Design Aspects

Once the designer determines which type of an instructional animation is going to be used, design aspects need to be addressed to overcome learning challenges, as mentioned earlier. Technical communication scholars, Morain and Swarts (2012), have researched YouTube video tutorials as a part of how-to videos. In their evaluation of software video tutorials based on their user ratings, Morain and Swarts stresses the priority of affective, physical, and cognitive design aspects in order to reach target audiences efficiently. The physical design is associated to the “ability to find information”, the cognitive (intellectual) design is linked with the “ability to understand information”, and the affective (emotional) design is connected to the “ability to feel comfortable with presentation of the information” (Carliner 2000; Morain and Swarts 2012). This framework (see Appendix B), is also employed by some other researchers (Ten Hove 2014; Koster 2018; Per Eriksson & Yvonne 2019). For example, Ten Hove’s quantitative research (2014) adopts this framework and modifies it according to include other dimensions of video qualities, such as revealing which characteristics make instructive videos more popular than others. In line with this, Erik and Yvonne Eriksson’s concept design (2019) focuses on the physical design aspects of live-action videos such as visibility and resolution of a video presentation.

Although the framework built upon procedural learning style is mainly task-oriented and was conducted as a result of live-action video formats, it can be argued that each rubric echo with the general learning challenges in multimedia education discussed in the previous section. These design aspects notably establish a holistic knowledge regarding design concerns for procedural learning video formats, yet, these aspects remain pertinent in essence for conceptual animation videos. However, the framework constructed above is absent from a systematic design guideline for achieving these design goals. For instance, based on the framework provided above, design goals such as changing viewpoint during presentation do not serve *viewability* or *confidence* as such. Therefore, modification is essential and will be best achieved by taking into account individual design factors in order to define how to achieve the selected design.

Table 1 - Adapted design aspects according to the applicability of a virtual camera

Physical Design	
Timing	to make it easy for viewers to follow the content by means of camera
Cognitive Design	
Completeness	to present information in an organized superstructure with sufficient detail by means of camera
Affective Design	
Engagement	to provide enough stimulation that ensures continued interest and motivation by means of camera

1.3 Research Aims & Objectives

This thesis argues that the virtual camera, specifically the camera movement-effect, can be functional to supplement narrative and aesthetic design aspects of instructional animations. The objectives of this research are to determine whether design aspects can be achieved by means of virtual camera. For that purpose, the initial objective of this thesis is to investigate virtual camera in terms of technical, semiotic and psychological level, and is to adapt selected design considerations from each rubric to practice the function of camera movements along with documentation of creative work.

Herein, the thesis submission is comprised of multiple modes of evidence including a product (an instructional video); documentation of process (still shots from the video project); and "complementary writing" which attempts to provide a taxonomy for the function of camera movement in instructional video making by taking into account of specified design aspects.

1.5 Research Rationale & Contribution

The primary aim of this thesis is to contribute to the field of motion graphics design, and investigating the virtual camera as a purposeful design factor based on a contextualization of design aspects, with a taxonomy table and submission of a supplementary material. By this means, the examination of the camera function with respect to directing and guiding the audience's attention reinterprets the relationship between the live action and animation. Furthermore, a structured understanding of the employment, design concerns, and evaluation of camera animation would contribute a formal ground that would facilitate purposeful and constructive discussions.

Moreover, although the many design factors have been carried on specific context of use, there have been few studies attempted to investigates functional camera movements as a design factor. In that sense, looking at instructional animations through the frame of virtual camera in cooperation with creative work as a case study would shed light on choreographing the camera movement in a structured manner. Following that, defining virtual camera and a systematic characterization of functional camera movements along with a taxonomy table would contribute to the knowledge of understanding when and why an animation works. In the age of digital learning, such knowledge might be instrumental in allowing a broader audience to design and craft their own animation videos.

1.4 Research Inquiries

Based on the design aspects in the adapted framework and the learning challenges in animation, the research inquiries aim at the instructional and emotional design aspects to supplement narrative by means of the functions of the camera movement:

1) Easiness: In what ways does the virtual camera enable the audience to follow content easily?

2) Completeness: In what ways does the virtual camera direct and orient the audience's attention to particular visual information?

3) Engagement: In what ways does the virtual camera support narrative and evoke emotional reactions to stimulate and motivate audience?

1.6 Methodology and Structure of the Thesis

All inquiries aim to supplement value of storytelling narrative and information telling by means of virtual camera. Instead of coming up with a set of "answers" or "empirical results", the thesis is structured based on practice-led research, constructing its own methodology. Practice-led research involves a research project where practice is a key method of approaching the inquiries and is submitted as supplementary evidence entailed by research methods (Nelson 2013). In the book "Transmedia Storytelling", Kalogeras (2014) refers Clandinin and Connelly (2000)'s approach as defining the practice-led research as an emerging research method:

> "Framing a research puzzle is part of the process of thinking narratively. Each narrative inquiry is composed around a particular wonder and, rather than thinking about framing a research question with a precise definition or expectation of an answer, narrative inquirers frame a research puzzle that carries with it 'a sense of a search, a "research," a search again', 'a sense of continual reformulation".

In this sense, the term “inquiry” defines practical knowledge which is demonstrated in submitted practical work. Following this, in an attempt to analyze virtual camera in animations, a systematic characterization of animations provided by Schnotz and Lowe is adapted. Schnotz and Lowe (2003) provided three levels of analysis for animation videos characterized as *technical, semiotic* and *psychological*. Due to the fact that the term “virtual camera” and “camera movement-effect” is too elusive, to analyze the notion of camera and camera animation, their model is adapted to be grounded in more contextual and goal-oriented structure. The three levels formulated in their analysis gives insight to approach the notion of the camera throughout the thesis.

Technical level refers to the carriers of the signs in terms of technical devices that are used for the presentation similar to the difference between computer-generated cameras and live-action physical cameras. From the viewer’s or learner’s perspective, “these sign carriers do not directly affect the learning process but are essential to identify the transition between the physical device to the virtual device in terms of the function of the camera.” (Lowe 2003). In this regard, camera as an intermediary device between the audience and the world, the nuances between physical and virtual camera, addressed in -*Prior Stage*; explore human perception involving the way of exhibition of movement and perception towards moving images.

Semiotic level refers to sign modality as a visual or audial sensory system in human nature in the form of semiotic representations including sound, text, pictures. animated graphics, voiceover and so on. These semiotic levels concern how representations are framed with respect to temporal and spatial parameters such as changing point of view. Although, the semiotic level of animated graphics -visual representations on screen- are integral part of visual communication design, analysis of representation types or behaviors are beyond the scope of this thesis. In addition, other semiotic changes of camera, such as focal length, optical disorientation, and motion blur, are not evaluated under the behavior of camera movements. With respect to semiotic level, each subsection of Chapter 3, 4 and 5 exemplifies a technical approach where a virtual camera can manipulate time and space. Subsequently, Chapter 3, 4 and 5 does not revolve only around a functional purpose of the camera but also the technical approaches concerning spatial and temporal parameters of the camera.

Psychological level refers to the perceptual and cognitive processes involved during the viewing experience. Whether it is computer generated or physical, camera is an intermediary instrument between the spectator and (virtual) world, which implies affordance of the camera. In other words, viewing experience involve the perceptual process referring cognitive and emotive qualities of the presented video. In that sense, Chapter 3, 4 and 5 is oriented to perceptual process of viewing experience by means of camera movements.

2. PRIOR STAGE

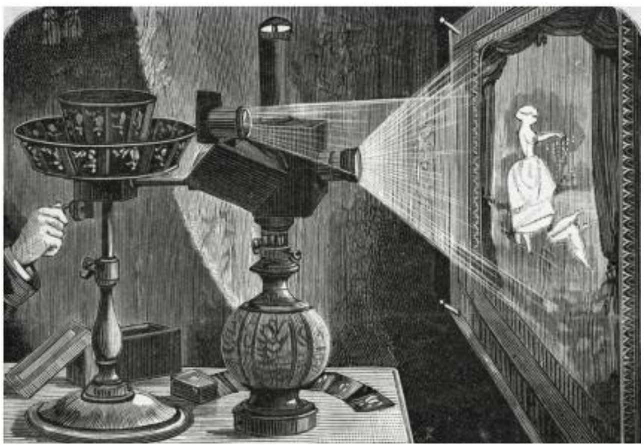
2.1 Exhibition of Movement

Humans have a long history of communication through visual stimulate. The eyes are to obtaining information in an environment, and the ability to control sight by eye or head movement greatly increases an animal's chance of survival. According to Arnheim (2004), eyesight ensures survival while movement creates the strongest visual appeal because motion expresses a change in the environment and may require possible reaction to threat, alliance or. It is widely accepted that our ancestors depicted their reactions towards events in their environments by painting on cave walls, and in these depictions, we can see how sight and movement manifested in our ancestor's interpretation of their experience. A read-through of our ancestors' sight delineates that Paleolithic artists were not only interested in representing a sequence of events but also in narratives (Azema 2005). Their visual perception and drawing capabilities pushed them to draw series of images juxtaposed as they are in motion, which to this day can be seen in animation technique, such as split action. Their representation of movement can be described as the result of two processes: The first, breaking down the movement which refers to superimposition of successive images, and the second, the juxtaposition of successive images (Azema 2012). A more recent version of this splitting action technique can be seen in Leonardo da Vinci's drawings, while a more advanced depiction style called *onion skinning technique* is scripted as a tool to assist animators in contemporary animation software.

Figure 2.1 - Some depictions of moments via *onion skin technique* in different eras

Over the years, the illusion of movement in media has been crafted via successive phases of progressive images, from shadow play to simple optical devices such as Phenakistoscope, Stroboscope, and Zoetrope. However, these items were not projected on a scene; instead, they were simple apparatuses that served to move pictures, until 1876, when Charles-Emile Reynaud invented the Paranixoscope named *The Theatre Optique* which was crafted with the same working principle of the Zoetrope which was an animation device that strips of papers presenting twelve frames of animation in a cylinder whilst Paranixcope was projected on the screen for the theatrical entertainment (Lewis 2019). Reynaud's animations, which had 300-700 transparent images drawn one by one by the artist, is the result of the animator's active engagement relying heavily on the animator's imagination and hand drawing skills. It can be argued that the artist is the source of the image where production flow is from drawn images to an illusion of movement as just our impressionist ancestries did. His scene, "The Theatre Optique," enabled animation films to be presented on broad screens in small theatres until 1892– three years before the Lumiere Brothers invented film camera (Lewis 2019). Following Reynaud's animation, cartoon animation arose, employing principally the same stop-motion graphic technique in which hand-drawn illustrations generate visual actions.

Figure 2.2 - "Theatre Optique" invented by Emile Reynaud in 1892



The techniques used to record motion changed drastically with the discovery of photographs. The scientist and physiologist Étienne-Jules Marey invented the *rifle camera, a* chromo-photographic device which was able to register twelve successive exposures; these shots were recorded on the same picture, named an "animated photograph." Marey's rifle camera was mobile and succeeded in capturing flight of doves, which led him to be pioneer of the pre-cinema period (Wells 2009). In parallel with Marey, Eadweard Muybridge became a pioneer of cinematography by showing sequential pictures depicting the movements of people and animals. His iconic serial photographs proved the exact pattern of a horse's galloping movement, which had been depicted incorrectly until then (Figure 2.3).

Figure 2.3 - A galloping depiction, Theodore Gericault, *The 1821 Derby at Epsom*

Photography as a representation of the succession of discrete snapshots that deconstruct and recompose the movement, began to create a perception of illusion which was practiced by many animation practitioners and artists afterward (Williams 2001). Although Muybridge's aim was to create a visual reference to guide motion, scientific accuracy of motion was not his main concern. (Prodger 2003). He sometimes rearranged the order of snapshots to create pictorial values and edit the sequential motion (Prodger 2003). Conversely, Marey's concern related to how movement occurred rather than what movement looked like. Marey's approach was more scientific, taking snapshots from a single point of view like a single eye observing events, and sequencing them on a single plate. For him, an *eye machine* was needed to overcome this drawback, since human perception could not detect complex and unfamiliar changes (Prodger 2003), which will be discussed in further chapters.

After the Lumière brothers' innovations, producers began to explore the possibilities of the camera in a broader sense. Through a rapid advancement of analogue camera technologies, conventional film making has evolved to today's massive digital media production, which integrates numerous computer image technologies and media technologies. Traditional animation has boomed due to the tremendous advancement in computer-generated imagery, or CGI. Conventional hand drawing has been subordinated by computer software, allowing 2D and 3D computer to be used in domains like simulation, virtual reality applications, cognitive learning, interaction design and more.

The shift of the medium from analogue to digital brought significant changes to the way the cinematic image is experienced. Manovich argues that "cinema can no longer be clearly distinguished from animation. It is no longer an indexical media technology but, rather, a sub-genre of painting" (Manovich 2001). Digital technologies have enabled animated images to be mixed with live action and create a hybrid form of visual storytelling: motion graphic or picture. Manovich defines motion graphics as "a particular case of animation which uses live action footage as one of its many elements" (Manovich 2001). It should be noticed that Manovich uses the term "animation" as a film format where computer graphic images form the material texture, rather than presenting realistic, live-action recordings. Although animation and live action can be mixed, some dualities between animation and live-action should be revised.

In a general sense, animation is a type of film where the meaning and visual effect is fabricated or generated through graphic of motion in time-based media. Bordwell and Thompson (2008) describe narrative as; "a chain of events in cause-effect relationship occurring in time and space," suggesting that interpretation is based in the relationship between figurative elements rather than the elements themselves. They continue to argue that "our engagement with story depends on our understanding of the pattern of change and stability, cause and effect, time and space". In traditional films, themes and meaning are an integral part of storytelling, since the audience interprets the subject matter from a chain of events and how they relate to them. In other words, movies mostly evolve around subject matter where the character development, environments, events and activities are quite familiar for the audience.

As animation becomes more widely used, different styles of motion graphics need to develop narrative structure using other techniques. For example, instructive motion graphic videos often deal with situations where the spectator's experiences lack prior knowledge. Viewers are therefore not able to easily link events, which can be mitigated by the use of narrative voice-over. In animation, non-figurative or non-narrative dynamic or static images construct meanings when they are combined together as such syntaxes in any language.

2.2 Perception of Movement

Since silent cinema, the camera has been examined by both film practitioners and theorists within the film industry as the primary physical cinematic device. Live action films function as an intermediary apparatus between the observer and the world, "children of a recording process that uses lenses, regular sampling of time, and photographic media." (Manovich 2001) When the camera starts recording, it records everything that is there without emphasis by registering discrete images on each frame. It can be argued that although language of film evolved over the years, our vision and cognitive-perceptual system towards narrative and motion have been remained the same (Hartson 2003). In terms of visual language, there is no difference regarding human vision in terms of the viewing experience on a flat screen or on real-transparent window. As is the case in human vision system, the ongoing visual process of the camera registers discrete images in a series of events in a projected space. In other words, we extract meaning from the visual field and then interpret it according to our "subjective experiences or intellectual property" (Andersson 2009). John Berger (1972) claims about the human vision that:

> "We never look at just one thing; we are always looking at the relation between things and ourselves. Our vision is continually active, continually moving, continually holding things in a circle around itself, constituting what is present to us as we are."

Although our eyes collect visual information with rapid - saccadic eye movements, the human brain is not able to extract the entirety of information available from the scene (Hochberg 2007). Moreover, similar to the complexity involved in drawing a horse galloping, strictly speaking, we are not able to minimalize the complexity of visual information confined deliberately to be conceived in real time. Thus, directing audience's attention has always been primary goal for most film producers along with experimental techniques for orienting the audience's eye sight.

Guiding and directing the viewers' attention during the presentation is not a criterion for all filmmakers and can essentially be considered manipulation. For instance, it goes against the Bazinian's idea of the "*democracy of vision*" suggesting that the cinema - camera- should record reality as it is in order to provide reality as we would perceive it (Nielsen 2007). Bazinian suggests that it is not the camera movement which is responsible of directing the viewer's attention, rather it is the scene which may include stylistic parameters such as visual-audial cues to lead. Each cut and camera movement disrupt spatial and temporal continuity of reality in film and thereby as production technique, discontinuity and continuity has always became a controversial topic among early film producers, who generally focused on cutting techniques. This can also be seen in the animation technique of establishing a full frame. Presenting a full frame shot doesn't dictate where the audience focus. Instead, it leaves the audience free to choose by allowing them to focus on visual entities in either the background, middle ground or foreground of the screen.

One of the most significant aspect of structuring meaning can be seen in Berger's discussion of art through the frame of a camera in his 1972 documentary named *Ways of Seeing*[7]. The documentary focuses on Berger as a narrator, either addressing the camera in a face-to-face style or speaking to the audience through a voiceover, while showing relevant dynamic and static images. He demonstrates how the meaning of an image on the screen can be manipulated by changing the viewpoint of camera. Comparing to full-frame animation, the scope of presented visual information is changed by means of expanding the visual field and orienting the camera viewpoint across each figure's faces in a narrative order. In his words, "the invention of the camera has changed not only what

[7] https://www.youtube.com/watch?v=0pDE4VX_9Kk [Accessed in 19 Jully 2019]

we see, but how we see it". Berger (2008) refers to the presented painting within a frame and narrates that;

> "And because paintings are essentially silent and still, the most obvious way of manipulating them is by using movement and sound. The camera moves in to remove a detail of a painting from the whole. Its meaning changes. […] But the difficulty is that on a screen, if you keep the whole painting in view, you don't see very much. You have been waiting impatiently for the camera to go in to examine details."

Considering the Berger's definition, the notion of camera movement relates with our perception such as illusion of movement. As mentioned above, animation adapts a great deal from 19th century optical devices in terms of depicting the illusion of movement. In contrast to the camera-user's capture of an existing scene, an animation designer shows what the artist or director sees starting with a blank wall surface, piece of paper or digital 3D space called a frame. However, whether produced by a machine or hand-drawings, the audience simply looks at a screen presenting dynamic changes. The spectator does not have a separate cognitive-perceptual mechanism for digital and real-world experience as a vision system. The on-screen effect of camera movement and depth is visible for the audience, whilst the camera is not. In other words, the audience neither sees the camera nor camera movement; they encounter only moving or changing images framed on a flat panel.

It is necessary here to clarify exactly what is meant by *camera movement.* Conventionally speaking, camera movement is a form of interaction [8]between *cinematography* and *mis-en-scene.* Cinematography refers to "what is seen" and "what is excluded" within the borders of the display screen by means of framing, which is determined by the director; while the term *mis-en-scene* refers basically anything that appears on the scene (Nielsen 2007). However, there is a degree of uncertainty around the term "camera movement". David Bordwell (1977) investigates the viewer's perception of camera movement on the screen, arguing that perceived camera movement- effect is not necessarily equivalent to actual camera movement in production, and refers to relative changes in terms of temporal and spatial parameters of visual entities on screen, which replicate actual camera

[8] suggesting to the audience what is both on and not on screen, what was in the scene and what no longer is, and what might be in the scene in the future.

movement illusion. Boardwell (1977) exemplifies this camera movement-effect as follows:

> "For the camera movement effect to occur, monocular movement parallax must be read from the entire visual field. If only a part or item in the visual field yields that differential angular velocity across time, then camera movement will not be specified – only the movement of that object will be specified."

Hence, defining camera movements with terms such as '*dolly shot'* and '*crane shot'* does not provide a clue about how these shots are established due to the camera movement-effect. For example, a dolly movement cannot depict the essence of motion that an observer can distinguish, whether it is entailed by external (physical camera in motion) or internal changes (objects in motion). What is perceived is a flat surface that displays some cues of movement. This is indicative of an understanding that such camera movement-effects e.g. panning in traditional animation process, can be achieved by moving an object in a scene that is wider than its visual field across the frame. As such, zooming can be achieved by scaling up the objects in exactly same proportion. Subsequently, instead of defining camera movement terms one by one, looking at function of camera movements would much beneficial for analyzing design aspects in instructional animations.

Today, with the development of computer technology, the hybrid medium of motion graphics gives designers substantial authority and flexibility to explore mobile framing. One popular piece of software, Adobe After Effects, enables the motion designer to create multiple camera objects, simulating the capabilities of actual camera lenses in film. Inserting "camera" as a virtual object into a scene can generate multiple perspectives and viewpoints. Here basic camera motions used in conventional filmmaking are imitated. Panning, for instance, can be achieved by simply changing the position of the virtual camera across the screen. It becomes possible to manipulate the meaning of subject matter and to direct the audience's attention whether a particular camera movement is achieved through actual or virtual camera.

3. PHYSICAL DESIGN

This chapter concerns design aspects of the spatio-temporal structure of the informational content, i.e. instructional videos. Physical design plays a central role in the communication of final product as it *helps viewers to find information of interest easily*. The spatial aspects of the design principle are highlighted in the first subchapter, and a discussion regarding the temporal elements can be found in the second.

3.1 Staging

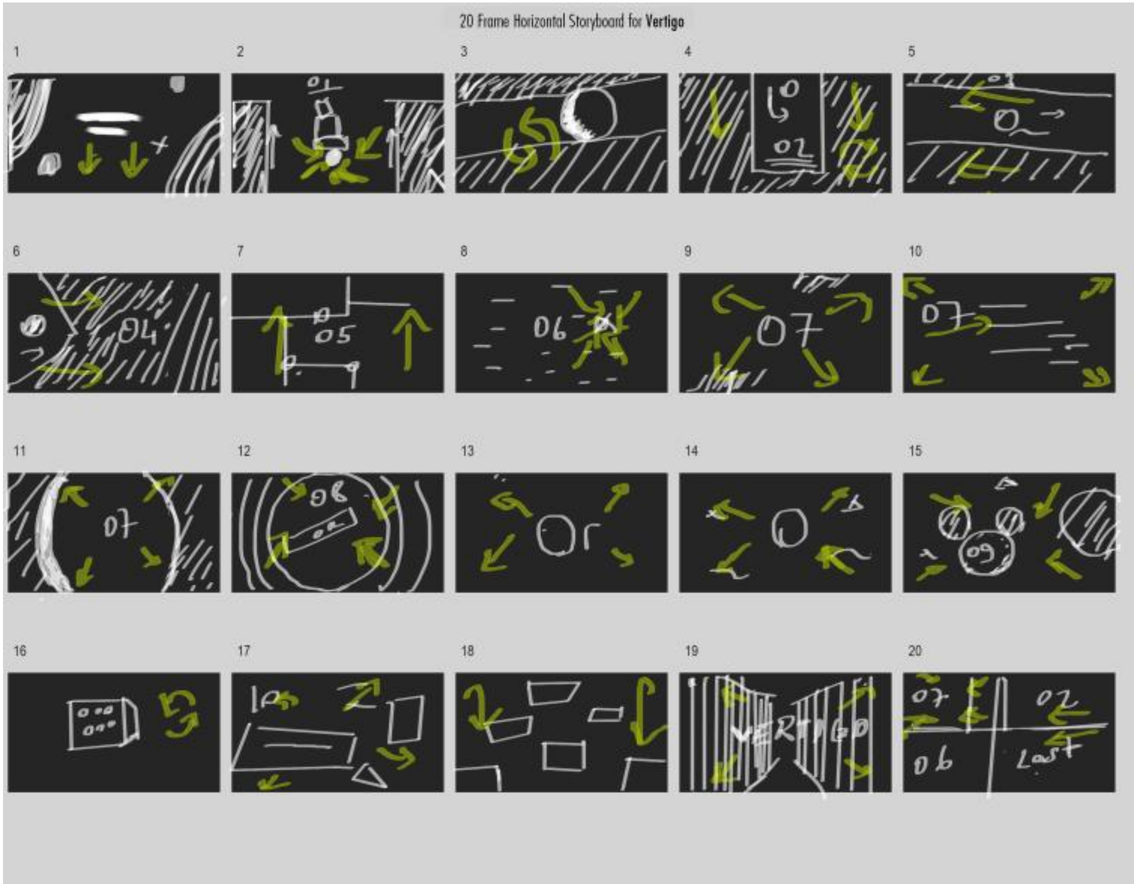
The term *staging*, derived from theatre and cinema terminology, is one of the twelve basic principles of animation in the book named *The Illusion of Life* (1981) which is written by Disney animators Ollie Johnston and Frank Thomas, and refers to directing the audience's attention to the relevant part of objects, or to the events of the narrative. It is a fragmentation of sequences that can be seen as a tacit encouragement from the director, the equivalent of them dictating: “look at this! Now look at this and now look at this!”. Strictly speaking, staging relates with storyboarding where the director decides what is going to be framed in pre-production.

In animation as well as live-action movies, most film directors and video designers endeavor to deliver their message in a particularly clear manner. To achieve this clarity, directors often collaborate with a storyboard artist, who illustrates specific shots that tell the story. In general, the primary function of the storyboard is as a planning tool that assists the production process. The director can visualize the narrative as a series of manageable shots. In order to simplify complex shots, storyboards summarize the events occurring within the frame and what sets need to be built as a mis-en-scene. The most important aspect of this is determining how much of the set is going to be visible and at what time.

During the presentation, the flow of shots composed of events and actions in an animation storyboard primarily focuses on depicting multiple dynamic images, which are designed to be placed simultaneously in a full frame-single shot. Following this, continuous animation can be considered a composition of discrete stages and therefore the audience apt to perceive stages as the composition of multiple actions or events where each element has a start and end. Thus, there is no need to insert anything that will not be visible within the frame. For example, a horse moving across the screen can be staged as a macro event, and in that case, micro event would be depicting running action of the legs. If a designer wants to emphasize only the leg movement, there is no need to draw or animate other body parts of the horse. Furthermore, the stage might also consist of multiple events, as in full-frame animation. Considering the idea of *democracy of vision* mentioned in the subchapter *Exhibition of Movement*, full-frame presentation without any guidance (arrows, text, additional visual information) forces the viewer to extract and interpret their own meaning from the representing images. It is important to recall that the designer needs to take into consideration the learning challenges posed by the amount of information presented. Multiple dynamic images being presented simultaneously on the screen could have an overwhelming effect that is exhausting for the audience's active memory during the viewing experience (Lowe & Schnotz, 2014).

In contrast to full frame animation, visually complex stages illustrated on the storyboard might be decomposed into smaller steps in order to direct the audience's attention to an essential piece of information, while extracting irrelevant information in a visual field. If the intended emphasis is conceived in discrete steps, it may be better to frame stages in discrete steps. For that purpose, a storyboard (see Figure 3.1) is created for my thesis project named *Vertigo.* Vertigo is a one-minute explanatory motion graphics video that demonstrate some functional camera movements oriented to factual knowledge development, which aim at creating balance between effective and affective design. The storyboard presents staging flow based on macro and micro events along with icons that depicts camera movements. In other words, each shift between events are specified by icons defining some particular camera movements, as shown in Appendix D.

Figure 3.1 - 20 Frame Horizontal Storyboard for *Vertigo*



In this thesis, I explore the potential of appropriate framing or staging compositions by taken into account of overwhelming effect. Following this, whilst camera moves across the frame, visual complexity of representing images are strived to reduce in order for audience to focus camera movements. By this means, general visual language of presenting images is composed of basic shapes. Staging the complex scenes and changes in the action in composition (both within one or across multiple frames) can provide adequate context while focusing the viewer's attention on the most relevant details by isolating other events, as shown in the Figure 3.2.

Figure 3.2 - Staging alternatives from *Vertigo*

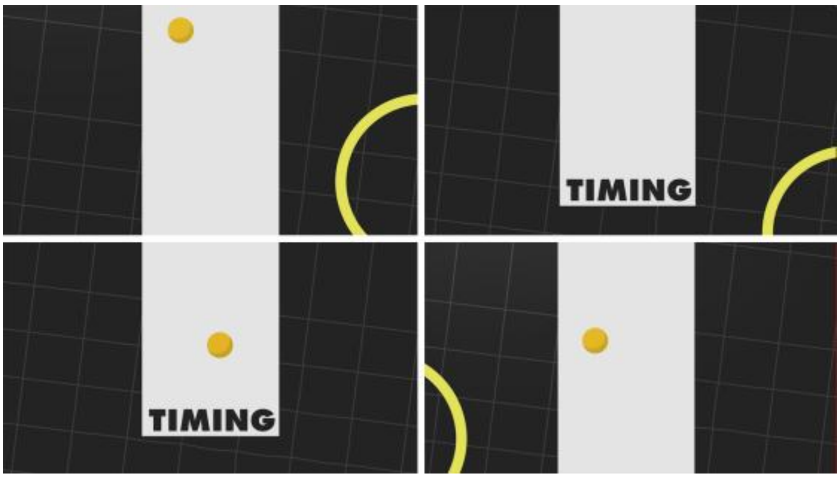
However, without adding secondary motion to a frame, the audience will perceive the images represented from a single point of view, until the next cut or transition effect creates a shift between viewpoints. Stages might consist of multiple micro and macro steps (e.g. the horse galloping) and requires multiple shots in different angles. In this case, cuts between different shots designed to portray each event or step in different point of view, could disrupt perceived temporal-spatial continuity, especially in complex scenes. Bearing in mind that if the cut rate is too high due to other design factors (e.g. the speed of voice-over, the pace of video, overabundance of cut-rate) it presents too much information in time slots that are too short, which causes cognitive overload, discussed in the section *Learning Challenges.* Consequently, staging animation is not only related to the technique of deconstructing events, but is also associated with scheduling the time between shifting events and order of the sequences.

3.2 Timing

As animation is composed of changing and unchanging visual entities in a time-based medium, all representational dimensions adhere to the time parameter. “Time is the primary component that differentiates static from sequential, or dynamic, graphic design.” (Woolman 2004). Following this, even static images presented in a scene depend on a time parameter, which determines how long a static image will stay in view; more precisely, how long a data picture will be presented until it is interfered or substituted with the next shot or image. For example, in the dynamic image of character walking across the scene, each footstep is timed so the character reaches the right place at the right time. Pardew defines this timing of individual character’s movement (i.e. timing of footsteps) as “internal timing”, as opposed to external timing (i.e character walks across scene), which refers to control of events or characters in a scene. (Pardew 2008). External timing brings attention to the staging actions where events or entities interact with each other or the environment with delay and duration. For both dynamic and static images on scene, careful arrangement of temporal parameters provides a coherent sequence that corresponds to the audio-visual narrative and thereby facilitates audiences to follow the content in logical order.

In order to address order of events regarding timing, one should understand the duration and delay properties of the animation. The reason is that together, multiple sequences of events constitute a story, which often merges with the progression of an audio narrative. When perceiving simultaneous audio-visual signs through multiple channels over a period of time, human perception attempts to order these discrete messages according to the mental structure referring to cognitive process of the viewer make sense of information as noted in the section *Perception of Movement*. Therefore, considering the visual complexity created by simultaneous actions or events that have been framed together in one shot or sequence, events or actions need to be ordered to avoid confusion or misconception caused by delay between stages. In some cases, delay creates anticipation about the what is going to be happen in next shots. As it can be seen Figure 3.3, in order to create anticipation, a ball is dropped down at the end of the shot and ball leaves after a while from visual field. After a little bit of delay, the ball falls in the tube. The delay between stages and the duration of each stage (i.e. the ball fanny around in the tube) on the screen constitute the global duration of the video. If the duration or delay is longer than pre-determined length of the video due to the multiple order of stages in time-line, then the global duration of the video would be extended. This brings up the issue of "scheduling the stages".

Figure 3.3 - Delaying stages (on top) and duration (on bottom) in *Vertigo*



Specifically, "scheduling the stages" is the phrase used to refer duration of stages. As explained above, setting the value of the external timing involves manipulating the temporal parameters of animated images, in regards to the duration of their appearance within different stages and delay between stages, determining how long the video will be. Considered in this light, it may seem that fixing the global duration of the video before production is a reasonable approach, however, this may induce a fast-paced presentation where graphic entities are difficult to follow, while slow-paced visual flow can be underwhelming and discouraging to an audience, due to the low level of stimulation. Determining the external timing is based on the specificity of the stages. It is generally accepted that designers fragment the animation from general to specific depictions in order to estimate an event or scene's length during production, though another approach is to work from the specific to the general, which provides a better appearance to each animation without the limitation of a fixed time (Pardew 2008). The reason is that animator starts with internal timing of characters (footstep animation) without concern of external timing of events. For example, as shown in Figure 3.3, the length of shot is predefined whereas internal timing of the ball is overlooked, and therefore the shot (the ball as subject) seems procrastinating in the tube.

4. COGNITIVE DESIGN

The previous chapter discussed the structure of informational content; however, in the absence of a goal-oriented, contextualized coherence, physical design aspects would prove mere outlining of sequential design rather specifying subject matter in a context. The discussion of cognitive design aspects builds on the previous chapter by introducing the importance of the context itself. Cognitive design helps *viewers to understand information* which is presented throughout the instructional videos.

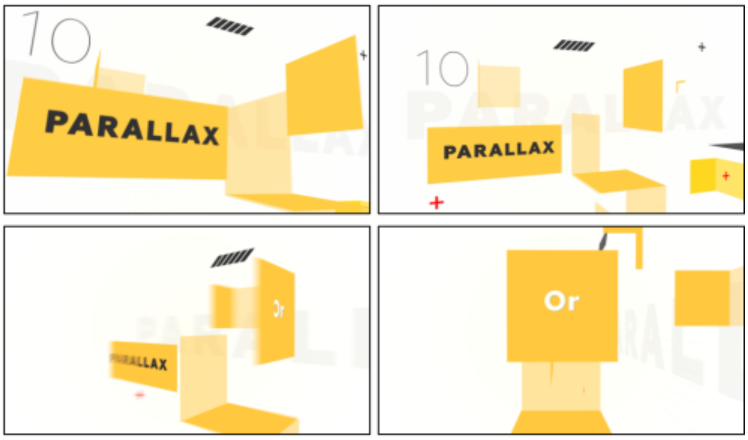
In this regard, I investigate the use of camera in three contextual categories: the first subchapter explains the effects of perspective manipulations and dimensionality on the context of the frames. The second describes the importance of directionality when panning from one part of the context to another. And, lastly, the third emphasizes the zoom effects that help highlight an element of interest on the frame.

4.1 Volume

Articulating depth and volume with the aid of camera movements such as a dolly or crane shots has been an essential aesthetic of the cinematic language over years. One possible explanation regarding aesthetics of this technique lies in the idea that when we look around from a stationary position in real world, even though our head keeps moving, our eyes don't move rapidly and continuously along the way while differentiating the volume and depth. In line with this, changing camera position in a scene provides a sense of volume, depth, or camera movement-effect to a flat environment rather than a fixed point of view, which is similar to our real-world experiences. Whether simulated or not, changing viewpoint in the spatial dimension reinforces the entities with more cues that create depth in the scene. This allows the spectator to better infer the relative distance of objects in the frame.

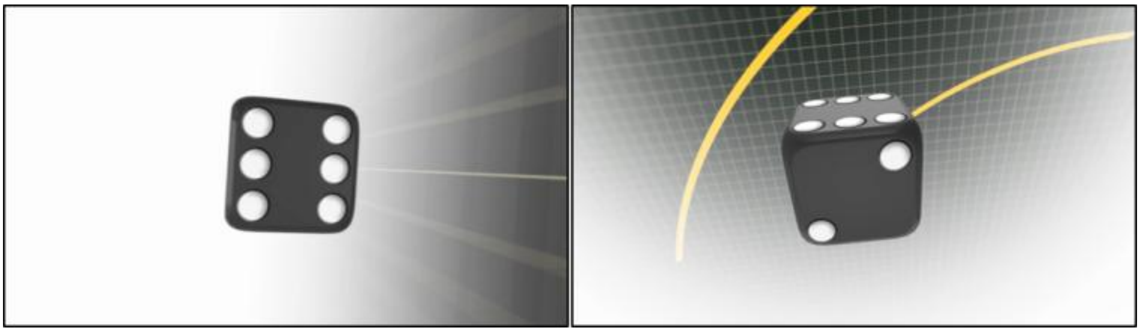
Some animation tools enable the designer to arrange placements of static objects with respect to width, height, and depth, instead of a flattened distribution in width and height (x and y axis respectively). Lowe claims that, generally, an audience will frequently search for information in the parts of the presented visual field that do not hold the information pertinent to the narrative (Lowe 2003). One possible explanation might be that most instructive motion graphics convey representations on a two-dimensional coordinate from a fixed view (Schwan 2017), and software tools are constrained from three-dimensional projection space that enables depth in a coordinate axis. In this case, the *parallax effect* presents itself as a valuable option to articulating the three-dimensional effect for effective organization and distribution of visual entities. The parallax effect refers to moving background objects relative to foreground objects in the frame on which the camera is focused. This makes use of the location and figurative image(s) relative to the centers of two different viewpoints. With visual representations that relate to two different viewpoints, a camera focused on the front will allow the user to read the visual information that is out of the frame or unreadable when it moves without losing focus (Torun 2014).

Figure 4.1 - Parallax effect to articulate depth and reveal an information *in Vertigo*



Another approach is to provide a complete viewing experience through a three-dimensional projected space, which is enabled by a carefully planned virtual camera traveling in the z-axis as an additional spatial parameter. Factual learning animations often employ three-dimensional representations for complex models, offering a complete visual field of a complex subject. As noted in *Physical Design,* inspecting the complex event from a stationary viewpoint would not adequately elucidate its facets, components and their spatial relationship with other parts. Relevant parts may be located on a hidden side or blocked by other items. To avoid these problems and allow the learner to make a comprehensive inspection of the object, an animation may present a circular movement of the camera around an object. Figure 4.2 shows the facades of a dice with circular camera movement.

Figure 4.2 - A circular movement to reveal and hide information in *Vertigo*

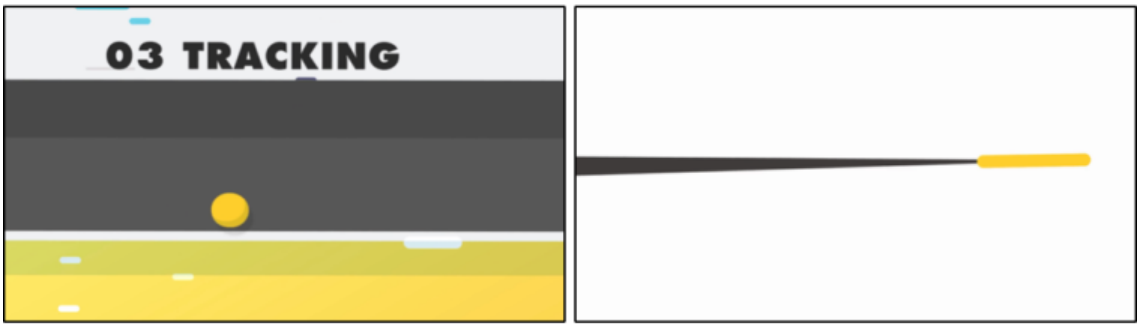


4.2 Direction

As previously noted, without adding the third dimension, a visual field might be framed from various point of views that change on the x and y-axis. For many explanatory animations with carefully planned staging, discussing visual representations of the information from a single viewpoint by juxtaposing the discrete sequences are sufficient to orient the viewer. In the case of complex scenes requiring multiple staging approaches, this would cause discontinuity and disorientation, which would impede learning. The chapter *Physical Design* discussed the fragmentation of a scene or events for staging purposes, without placing much emphasis on transitions entailed by shifts in between stages, which can now be discussed in relation to how they are used to orient the viewer.

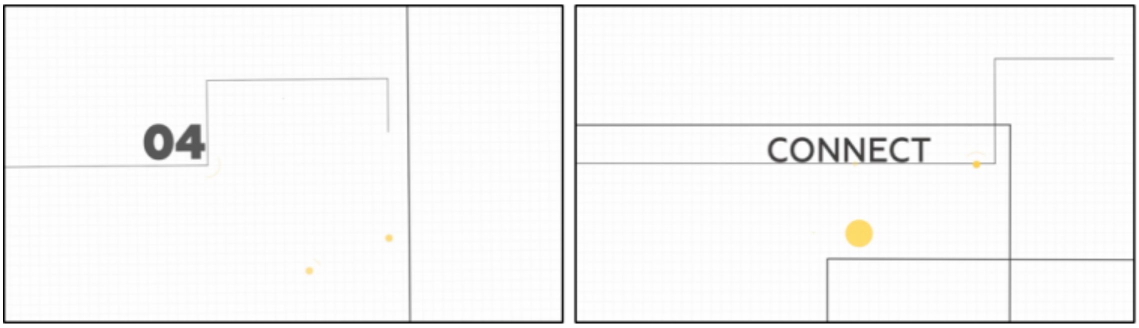
Figure 4.3 shows the camera motion that frames the ball as a subject matter. As the ball moves up or down, camera tracks the subject matter instead of tracking other elements in background. As a function of camera movement, following or re-framing the subject matter in a period of time provides completeness and clarity for the viewer since audience aware of what is currently main subject. By this means, without adding additional voice-over as such in *Vertigo*, following or tracking the action direct audience's attention on subject. Furthermore, in the same figure, when the shot connects to other stage where the tube is lied down, even though the camera is not moving, the camera movement-effect is achieved with careful positioning of the camera, and represents image in motion. As it discussed in the *Prior Stage,* understanding on-screen effect helps an animator to create camera movement-effect because the illusion of camera movement is also relating with dynamic behaviors (scaling, rotating, positioning and so forth) of representing images.

Figure 4.3 - A full-frame stage from my video demonstrating a circulation cycle



One should notice that what is tracked as shown Figure 4.3 is a single object, and therefore if there are multiple objects moving across the same direction with camera motion, audience would lose the trace of what is the subject matter. However, this paradigm might turn into an advantage for the designer and create connections that links between different entities. Moving the virtual camera along with a pre-defined path and pausing at particular points, enables the audience to connect ongoing action via the progressive viewpoint of the current step. An alternative is to change the orientation of the virtual camera in line with the timing of the presentation, which enables the viewer to keep up with the ongoing event by dictating the viewer to register and recognize each event juxtaposed along with camera movement. Moreover, in some cases full frame animation is sufficient, whereas in some progressive events, continuous actions could not be tracked or linked with other events without additional cues, such as arrows, or colors. For example, Figure 4.4 shows that after ball fades out in the second image where the different lines suggest different directions that can be anticipated by the viewer. Even though there is not any clue about where the camera keeps moving after each stop except for lines, directional camera movement pulls the audience's attention on one subject to another. In that juxtaposing visual representations by means of camera movement create planar interplay between characters and objects. Moreover, connecting stages or shots by means of directional camera movement create anticipation that have been exemplified already in *Timing* subsection (see Figure 3.3).

Figure 4.4 - Connecting stages by directional camera movement



Camera movement can be functional for the expanding visual field and reveal[9] hidden information that belongs same shots or composition. As it is discussed in *Staging* subchapter, decomposing the scenes into stages conceals representing images from the visual field. In this point, distinguishing the function of camera movements in terms of connecting and revealing need be highlighted. While connective directional movement dictates where the subject matter is placed among other possible directions as such in Figure 4.4, camera movement for revealing expands the visual field where the representing images is not introduced yet. Relatively, both connective and revealing functions of camera movements does not emphasize where the audience should focus. Considering the macro events composed of micro events as discussed in *Staging* subsection, directional movement in x and y axis does not highlight the scope of revealed macro event where the subject matter is laid down as a micro step as such in full -frame animation case. In this case, except for employing zoom-in and zoom-out function of camera, adding volume to the scene and moving the camera along with z-direction (i.e. push in shots) in order for audience to emphasis what is subject matter. Inversely, directional camera movements in z-axis can be used to hide presented information and reveal other representing images in three-dimensional space (see Figure 4.5).

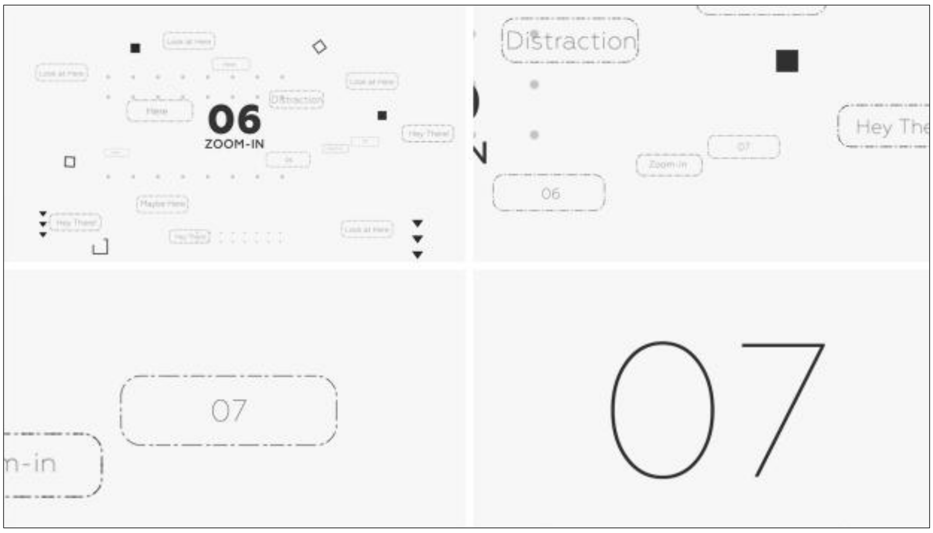
[9] Camera movement for revealing can be conceived as hiding presented images, which is not emphasized since in essence revealing or hiding are rooted in similar manner.

Figure 4.5 - Directional camera movement on z-axis to reveal hidden objects

4.3 Scope

He direction of the camera does not always signify where the audience should look, such as the case with macro steps or events consisting of multiple micro events or steps. Previous research suggests that due to the transient nature of animations, the audience tends to overlook some relevant elements because they are distracted by other salient parts of the animation (Lowe & Schnotz 2014). Visual cues such as the arrow, contrast etc., can be used to address this issue, another key tool being the virtual camera's zoom function, which can be utilized as demonstrated in Figure 4.6. Compared to three-dimensional camera movements like a crane or dolly shot, zooming is induced by the magnification of spatial layout, without distorting the perspective. Hence camera zooms in animation are not a category of camera movements, instead they are pertinent to mobile framing depending on optical properties of the lens change. In a conventional cinema there is a long tradition of zooming into and out of the action via optical flow, in order to guide the audience. Often the action is fragmented into multiple individual shots, which are scoped from separate distances and can be recognized as one of the integral parts of contemporary film making (Bordwell & Thompson 1977).

Figure 4.6 - Two shots show depicting zoom-in function to scope the information



In animation, zooming-in and out are one of the standard practices for many content creators for a practical as well as persuasive function. The zoom-in function orients the audience's attention to whatever is presented while keeping extraneous visual entities out of the frame, which would be represented in memory otherwise (cognitive load). With zoom-in, the information associated with the whole image is lost. Hence, zoom-out provides a comprehensive picture and highlights how the scope of frame is linked with the general picture of an event. In *Vertigo*, zoom in/out functions were employed to hide extraneous content by taking cognitive load into account. I use zoom to reveal the link between partial information and the space they inhabit in the whole picture, as shown in Figure 4.7.

Figure 4.7 - Two shots show depicting zoom-in function to scope the information

These approaches assist in addressing completeness in the viewing experience by presenting visual information with sufficient details to orient the audience and suggest where to focus. Consequently, directional camera movements may unveil information by establishing a visual hierarchy through emphasis and may support object tracking by overcoming the transitory nature of animation- which has been addressed in the section *learning challenges* in animation, and connect multiple elements or scenes.

5. AFFECTIVE DESIGN

Once the viewer can find and understand information, they need to develop an emotional attachment to it. Affective design deals with motivating *viewers to feel information* in the presentation. This design aspect is the most crucial, top-level component that delivers the desired message to the viewers.

The design aspect can be further divided in three main headings: the first part deals with the emotive effects of pacing on cognitive design aspects. The second subchapter discusses some suggestive effects of camera movements. And, lastly, the third talks about the persuasive function of the camera movements in combination with cognitive design aspects.

5.1 Pacing

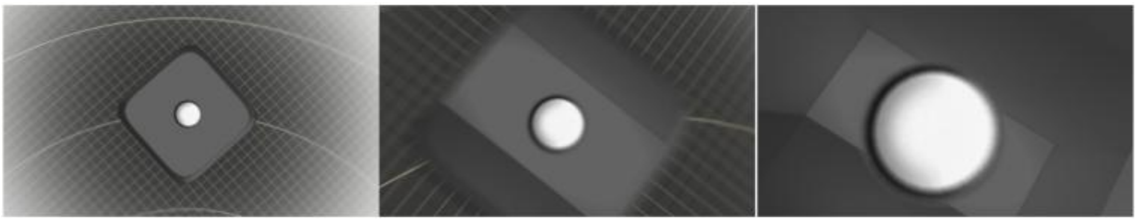
Animation parameters of camera movements are not confined only by space but also by time. I have discussed the temporal aspect of animation regarding duration and delay in the *Timing* subsection. Images can be animated in relation to both the length of time they appear on the display area, and how their spatial or visual properties (i.e. position, size, transparency, orientation, and color) are shown in time (Krasner, 2007). Alongside this, the virtual camera has internal timing properties (e.g. angle of view, movement, focal distance). In other words, in psychological level, the movement of the camera, following the action or connecting visual elements by cognitive design aspects, creates an emotive response.

Animating a camera from one point to another might be represented as a linear, robotic motion, or the camera motion may give a sense of acceleration and deceleration between stop and charge states. This temporal articulation, a sort of internal pace, determines the velocity of an object travelling between successive frames. Thus, pacing is an essential concern of most time-based media, especially motion graphic design, since the pace of motion conveys a meaning that contributes to the overall feeling of the presentation.

At first glance, the pace of the camera movement seems entirely related to the velocity of the camera. The speed of camera movement often depends on the narrative and thereby is at the editor's discretion. However, it is necessary to recognize some limits with respect to learning challenges in viewing experiences. For example, if the camera moves too fast across a scene, it might confuse or disorient the audience. At that point, motion blur helps restrict the visual information. The camera movement determines the pace at which representation transpires during the scene. Changing the pace of motion between events sustains smooth camera movement; it is possible manipulate the pace of the camera and sustain its smoothness, creating a seamless camera movement that is not noticeable for the audience. Smooth camera movement has always been one of the keystones of early filmmaking, utilized in order to maintain a point of related entities within the scene.

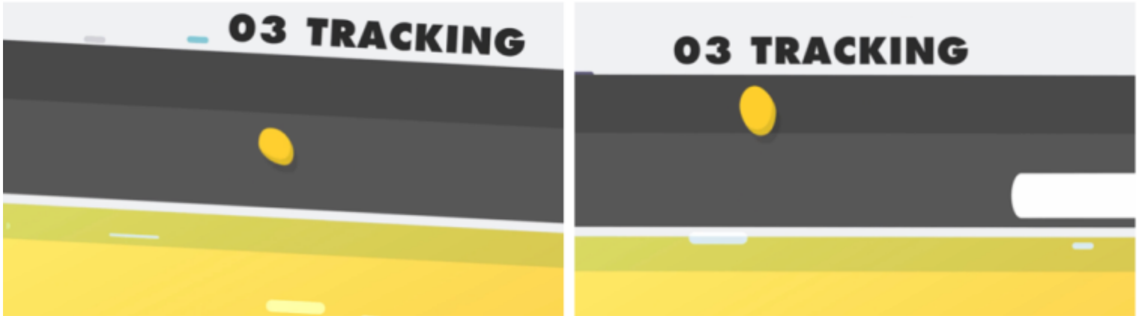
Unlike this smooth, linear movement, the velocity of camera motion can be accelerated to create anticipation about upcoming event or change in scene. Alternatively, one can decelerate the speed in the process of time, so that the camera does not pause abruptly. These are called ease-in and ease-out, which are essential motion design parameters which provide fluid motion and comfortable presentation. In my project, these properties are adapted to switch from one stage to another in relation to changes in orientation and scope of viewpoint, while providing smooth, dramatic and intense motion on stop and charge states. In Figure 5.1, I used accelerating speed function to zoom-in the subject matter in order to create fast-paced transition between scenes.

Figure 5.1 - Accelerating pace of camera towards target in *Vertigo*



Relatively, fast pace of camera by means of shaking camera movements (free moving camera), in short intervals during a stage can be used to amplify excitement or action presented, which is a common practice in action movies. As shown in Figure 5.2, tighter framing of the stage with fast paced camera movements magnify the motion of the ball and empower the narrative in terms of aesthetic manner of camera movements.

Figure 5.2 - Shaking camera to be amplify the action in *Vertigo*



5.2 Suggestive

Camera movements may also be employed to contribute to the narration in a suggestive manner. Aside from the natural outcome of pacing the camera with respect to affective impact, as discussed in the previous subchapter, the movement can have a semiotic function. For example, a fast-paced pan would suggest searching for something or mimicking head movements, giving a sense of urgency from the narrator's own field of observation. In my project (see Figure 5.3), selected texts are framed one by one via fast-paced camera movement. The fast-paced panning motion is intended to suggest searching for something and gives a feeling of anxiety. Adding motion blur between each pause enhances the dramatic effect while reducing extraneous visual information during the visual flow.

Figure 4 - A close-up shot suggesting camera searching a text in *Vertigo*

Krasner (2007) explains that “after World War I, manipulating the viewpoint allowed many experimental filmmakers to portray psychological states of mind.” Hence, using camera movement as a narrative form may vary in technique to suggest a conceptual meaning that the audience can relate to. In the closing shot of my project, while camera zooms out, previously presented clips are revealed side by side. After a quick zoom-out transition from the current stage, the camera encapsulates the all storyboards from a comprehensive picture and then continues to zoom out as presented other stages reveal into the frame set within a two dimensional until the frame ceases on the end credits, which suggests the whole clips presented in a set of stages were actually belongs the bigger picture that is storyboard. Herein, zooming out movement changes the initial meaning of the scene and suggest a different one at the end of the shot. Panning and zooming out/in shown in Figure 5.3 and 5.4, are just two examples of many different camera movements that can be used in this way, which can be further modified by the speed at which they occur, as has been previously discussed.

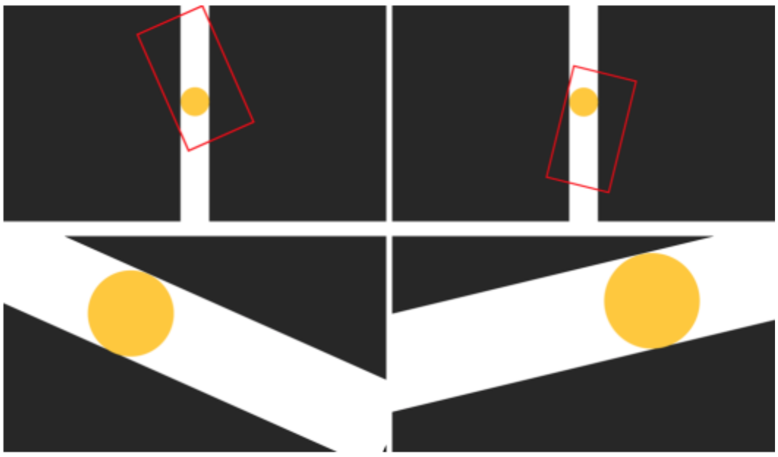
Figure 5.4 - Suggesting a meaning between shots by changing the subject in *Vertigo*

5.3 Persuasive

Another use of camera movement is to stimulate the audience with persuasive and seductive design aspects. The persuasive function of camera movement cannot be overlooked since human attention is quite sensitive to motion, both directly and indirectly. As previously mentioned, eyesight ensures survival, while movement is the strongest visual appeal to attention (Arnheim 2004). It can be argued that the slow movement applied or unnoticeable camera motion would sustain visual flow. This is often seen in movies where camera motion doesn't aim to direct attention, but rather aims to hold the audience’s attention with continuous motion. As it can be seen in Figure 5.5, in order to allow audience to read the text, motion of entities in scene is ceased except camera movement that slightly wiggles point of view. Scientifically, in motion graphics a higher rate of optical flow of motion within the frame will increase the audience’s arousal level, while slower flow of information will decrease it (Sekine and Ogawa 2013). On this basis, the pace of camera can be exaggerated by combining other spatial properties such as rotation and scale to create excitement as shown in Figure 5.6.

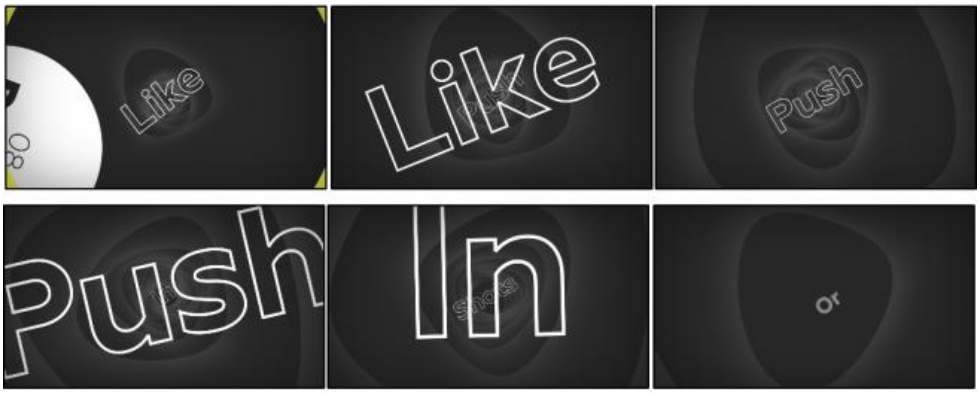
Figure 5.5 - A slight rotation movement to sustain movement to stimulate in *Vertigo*

Figure 5.6 - Changing angle of viewpoint (on top) and the representing images (on bottom) by adding ease-in and out properties



In contrast to a filmmaker with a physical camera, an animator is free to place the virtual camera almost anywhere in the digital world, as he or she is working outside physical limitations. Multiple sequences of camera movements framing subjects in various camera angles and distances can be linked together to provide continuity on an adventurous journey (Krasner 2007). Adding three-dimensional volume provides extra freedom to design a persuasive visual narrative. For example, in figure 5.7, captions through the shot together with camera movements by combining not only push-in properties in three-dimensional space but also by rotating the angle of point of view during the transition between shots. Adding other properties of camera movement, such as rotating, enhances the aspects of affective design. In this case, the camera travels across the tunnel while rotating around itself to increase exciting feeling of journey.

Figure 5.7 - Push-in the virtual camera while rotating to increase excitement in *Vertigo*



I also used alternative editing techniques to make a smooth transition between match cuts. Match cuts are one of the fundamental editing methods for seamless storytelling in conventional cinema, creating transitions between two scenes that are consistently framed, either visually or kinetically. As can be noticed in Figure 5.9, two different shots centers objects around of similar shape and size. Here, match cutting provides continuity between the previous object's movement and the next frame without breaking the momentum between two shots.

Figure 5.8 - Match cut in *2001: A Space Odyssey* (Stanley Kubrick, 1968)

Figure 5.9 - A match cut between two similar shots in *Vertigo*

It can also be argued that fixing audience's focus on a changing subject placed in the same position in space requires less saccadic eye movement. In this sense, a seamless transition between two different shots via ease-in/out parameters help to prevent cognitive-load and gives a sense of progression of time while remaining focused on the subject matter. Inversely, changing the position of the subjects after each cut would cause multiple saccadic eye movements that would catch attention and increase the stimulation of the audience during the viewing experience. Moreover, while cutting to a similar shape and zooming out to show the same event creates a smooth link between the two scenes, zooming too much or having too much camera movement with unnecessary special effects would produce a distracting rather than an adequate animated video. In other words, the established techniques used to evoke emotion and persuade an audience might be effective to raise and sustain their arousal level, however, unnecessary and/or constant visual flow could cause overload in cognition, exhausting the viewer in turn.

Lastly, I explored combining directional movement with the zoom function of camera to imitate one of the live-action cinema aesthetic by means of camera movements as shown in Figure 5.10. Here the zoom-out function is used to frame the text while the camera pushes-in towards to representing image. Following this, the effect does not contribute the narrative of the video in terms of instructional but provides aesthetic viewing experience that is not familiar for human eye in real world experiences. This technique was introduced by Alfred Hitchcock in the movie named *Vertigo*. Applicability of camera movements creates possible viewing experiences that might support narrative and aesthetic presentation.

Figure 5.10 - Mimicking the technique of vertigo in *Vertigo*

CONCLUSION

Camera movements is a fundamental property of animations in entertaining digital media industry whereas, despite its long application through the film practices, little is known about function of camera movements in instructional videos. The present thesis contests claimed that changing point of view during presentation can be functional and also emotive in order to direct audience's attention to subject and motivate them. To analysis functional camera movements, this thesis introduced the notion of virtual camera and investigated particular camera movements in conceptual learning animations based on the design aspects these movements are built on. To this end, a set of relevant design aspects were chosen, based on contextual reviews from literature findings, and an analysis of the design process through the creative work was used to embody, test and push the existing knowledge of education and entertainment media industries. In other words, in this thesis, the discussion of each aspect is supported with the documentation of my own creative work, named *Vertigo*.

In order to establish a prior knowledge and enrich the definition of camera movement-effect, the chapter named *Prior Stage* constructed a systematic overview for analyzing the notion of virtual camera and camera movements. It reviewed the perspective of both those who view a piece of animated informational design and those who create it, from a historical and contemporary perspective. In terms of being an intermediary device between the audience and the world, the nuances between physical and virtual camera is discussed in terms of technical level, semiotic and psychological level of analyses. Based on the premise that the perceived dynamic images were inquired according to the conventional film making and animation, and the investigation centered the viewing experience regarding the movement and camera movement-effect changes. In this regard, this chapter also reinterpreted the relation between live action and animation as a technique for motion depiction.

After the *Prior Stage*, chapters named *Physical Design, Cognitive Design and Affective design* was constructed according to research inquires and conceptual framework.

Physical Design discussed that careful arrangement of temporal and spatial properties of the virtual camera might be functional for provide *easiness* in order for audience to find information. These design considerations were discussed as fragmentation of the scene in terms of staging while for the temporal parameters of events or representing images were discussed with respect to ordering and scheduling the internal and external timing.

Cognitive Design discussed camera for *completeness* which refers direction and orientation of audience's attention to particular visual information in scene by taking consideration of learning challenges. In this regard, adding *volume and depth* to be used for circulation movements around the subject matter, which can be useful to reveal or block the extraneous content by changing the orientation of the viewpoint. Without adding volume or depth*, directional* camera movements in x and y axis can be useful for tracking, connecting and unveiling representing images. Lastly, zoom-in and zoom-out functions of camera can be used in order to *scoping* an action or event with respect to revealing or concealing respectively.

Affective Design discussed the *engaging* aspects referring presentation style that provide comfortable feeling for the viewer with regard to *pacing, suggesting* and *stimulating* by means of camera movements. In this sense, as a director of *Vertigo,* I endeavored to create balance between effective design (presenting chapters alongside related movements) and affective design (adding aesthetically pleasing behaviors to camera movement).

These chapters mentioned above were documented as a constructive relationship between practice and theory, and discussed the structure for a potential taxonomy for the function of camera movements in relation to specific design aspects, which can be accessed in Appendix C. A taxonomy of functions for camera movement in expository animations was proposed based on the premise that the functions of camera movement may be inherently multifaceted. Most often a camera movement-effect does not do the particular example justice by pinpointing only one function. Camera movements tend to multitask. Consequently, the movement may activate one or more of the proposed functions at any given moment. Moreover, design aspects may vary and depend on the particular demands, the taxonomy table is thus still incomplete and findings might not be transferable to each type of knowledge development. Hence, the functions of camera movement are one of the steps towards asking about why animation works for learning, when the design aspect are functional and how camera movements as a design element can articulating meaning.

Nevertheless, practicing and researching camera movements in expository animations would be useful for animation designers to deepen their knowledge about applicability of virtual camera as well as understanding of camera movement-effect while this study has gone some way toward enhancing our understanding of motion literacy and animation; and it incorporated with other design studies as discussed in *Conceptual Framework*. In future investigations, it might be possible to use a different design aspect in which camera or other design elements can provide.

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APPENDIX A: Video Format

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Online source (Vimeo): https://vimeo.com/349531814

Project File: https://www.dropbox.com/sh/6vuelmd0072euj4/AACwVxLiPnr6-4-OT12JIgMia?dl=0

Length: 01:03

Format: Aspect: 1920 x 1080

Frame Rate: 29,7 frames per second

APPENDIX B: Rubric for design aspects of tutorial videos (Morain & Swarts, 2012)

Physical Design	
Accessibility	Video allows the viewer to focus on areas of the screen that are relevant to the instruction at hand.
Viewability	Production quality (audio, video, text) is sufficient to make content tolerably watchable.
Timing	Video is paced to make it easy for viewers to follow content.
Cognitive Design	
Accuracy	Content was presented without errors of fact or execution.
Completeness	Content was presented in an organizing superstructure and with sufficient detail so as to be accurately reproduced and broadly applied.
Pertinence	Content was related to the instructional goal, and it had an instructional purpose.
Affective Design	
Confidence	Narrator inspires confidence by presenting self as knowledgeable and skilled
Self-Efficacy	Video persuades viewers that they can successfully complete the tasks that are the focus of instruction.
Engagement	Video is designed to interest and motivate users.

APPENDIX C: A Taxonomy for the function of Camera Movements

Physical Design			
Easiness	Staging	Framing an entire scene without directing point of view (mis-en-scene)	Presenting entire scene by **enforcing audience** to extract their own meaning from the motive depicted
		Framing a part of the scene with directing the point of view (cinematography)	Fragmentating scenes and shots into events and steps according **the storyboard**
	Timing	Order of the shots, i.e. changing point of view from close-shot to long-shot or vice versa.	Order of the scenes and shots accords with **visual hierarchy** regarding importance of information
		Duration of each scene or shot by means of camera framing over time	The length of shots and scenes accords with **script and voiceover.** Creating **rhythmic and dynamic** presentation
Cognitive Design			
Completeness	Volume	Using camera movement for indicating or concealing volume and depth	Changing the point of view in 3D space by **providing more information** via single shot through visual field
			Moving camera in z axis to break fixed point of view and to **reveal/block the extraneous content** in scene
	Directing	Directing and guiding the audience's attention	For **tracking** visual information
			For **connecting** events and steps together
			For **unveiling** information in visual hierarchy of a representation
	Scoping	Camera movement to scope events and steps	**Zooming-in** to focus relevant information while hiding irrelevant visual entities in the scene
			Zooming-out to reveal links between multiple events by broadening the visual field.
Affective Design			
Engagement	Pacing	Pacing the motion of camera to provide comfortable feeling for viewer	**Smoothing** the motion of camera for fluidity by means of ease-ease
			Accelerating the motion of camera for exciting flow by means of ease-out
			Decelerating the motion camera for dramatic flow by means of ease-in
	Suggesting	Emphasizing the psychological state/mood or assigning a novice meaning	**Pacing** a pan and tilt movement of camera to give a feeling of searching for something.
			Suggesting a new meaning as camera moves from one scene to another
	Stimulating	Evoking emotional activity by means of unnoticeable and noticeable camera movements.	Establishing **seamless discontinuity** between multiple shots by means of match-cut
			Sustaining visual flow with single shot instead of hard-cut

APPENDIX D: A set of signs depicting camera movement types