

A Changing Cinema: Re-conceptualizing Indexicality and Digital Technologies

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by

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A thesis submitted to the Faculty of
Graduate Studies and Research in partial fulfillment
of the requirements for the degree of
Master of Arts
in Film Studies

Carleton University

Ottawa, Ontario

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395, rue Wellington
Ottawa ON K1A 0N4
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Your file Votre référence

ISBN: 978-0-494-93555-2

Our file Notre référence

ISBN: 978-0-494-93555-2

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ABSTRACT

New digital technologies in cinema have challenged the theoretical concepts of realism and indexicality, two defining features of cinema itself. A thorough review of the concept of indexicality as originally established by Charles Sanders Peirce, emphasizing functionality and phenomenology in the process of perception and understanding the real, combined with a historical survey of related film scholarship, reveals a misappropriation of the term from the beginning. More recently, film scholarship has focused its technical analyses solely on the digital process, ignoring older technologies and perpetuating these misconceptions. This paper seeks to remedy these misunderstandings, as well as apply industry examples of digital motion capture to create a complete understanding of how these issues operate for spectators. (keywords: indexicality, CGI, movement, phenomenology, spectatorship, motion capture)

ACKNOWLEDGEMENTS

I would like to thank my supervisor Marc Furstenau for the time he has spent discussing and clarifying with me the concepts surrounding indexicality, as well as for reviewing and revising my writing so that I could more clearly convey my research and ideas.

I would also like to thank my family and friends for supporting me throughout this very busy time. I would particularly like to thank Jonathan RL Nuttall for his love and patience as well as the countless hours that he listened to me talk out and formulate my thoughts about the index or pick his brain so that I could better understand the science and physics of photography.

This research was supported by the Social Sciences and Humanities Research Council.

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INTRODUCTION

The cinema is changing, particularly its methods of production and distribution. Though most of the changes are happening in terms of distribution and access, it is the changes in production that have caused the most concern for scholars. This is due in part because changing *how* cinema is made has led film scholars to speculate or believe that this directly changes what cinema *is*. From the beginning, establishing a definition for cinema has been a matter of much debate and definitions themselves are problematic. Despite this, a recurring concept can be seen in these discussions, the index. With the advent of digital technology, there has been a renewed vigour in discussions and debates surrounding the concept of the index, particularly as it relates to visual imagery. Indexicality is a term associated with Charles S. Peirce's theory of semiotics, which sets up a system of classification for signs and describes how they convey their signification. Peirce was an American scientist, philosopher, and logician, known today for his contribution in founding pragmatics and semiotics. Peirce's theories and writings were not immediately recognized or well received by the academic community until after his death. Scholars who did write about his work initially did so in respect to pragmatics, linguistics, and philosophy. In the 1960s, Roland Barthes' *Elements of Semiology* examined some of the key aspects of Peirce's theory but in relation to the photographic image, giving rise to a school of thought that analyzes all imagery as a visual sign system.

The work by Barthes quickly prompted film scholars to apply these concepts with regards to cinematic imagery, since at the core of cinema is a photographic image that has been set in motion. Many film scholars relate the concept of the index to issues of realism

as an aesthetic, in part due to the connection the index has with the real. Films that traditionally are associated with realism have been given this quality based on their adherence to filming images with minimal manipulation, maintaining the highest degree of accuracy to what we would visually see if we had been there ourselves. Films that fit into the more formalist or fantasy category did just the opposite, especially in the early days of cinema. Indexicality was never questioned in formalist or fantasy films until the creation of digital cinema. This is due to the view on indexicality which supposes a direct relationship between the object photographed or filmed and the final media product such as a film. Since digital cinema is often used in science fiction or fantasy films that have little basis in reality, these technologies challenge the very notion of the existential bond of indexicality. As such, realism is often at the heart of debates on defining exactly what cinema is and how its representations reflect universal truths or falsities. The index, and its association with the real, has therefore long been a defining feature of cinema and part of what makes up a portion of its essence. Digital technologies for cinema production do not need a real world counterpart in order to create its images. For many film scholars then, these new technologies challenge not only the concept of the index, but by default they also challenge what was once seen as an inherent aspect of cinema's very being, causing a transformation that seems to change the essence of cinema itself.

In general, academic discussions on indexicality and digital production technologies tend to focus on only two aspects of the index. The first defining feature stems from Barthes who gave the index an attribute that he phrased as a sense of "having been there," which means that all photographs are associated with the past tense. The other aspect of the index is the idea of the index as a trace, meaning that it is directly created by the object

itself such as a footprint in the sand. In the case of photography, it is by the particles of light reflecting off the object and being captured and revealed on film stock. Chapter One of this thesis focuses on clarifying these two aspects of the index, as well as demonstrating that film scholars have misappropriated these aspects, which is not only problematic but has had larger scale ramifications for the understanding of the index and the essence of photography and cinema. Chapter One also emphasizes that there are other aspects of the index that have been omitted by scholars as they sought to make the index useable in the study of photography. These other aspects need to be remembered in order to bring about a clearer definition of the index so that it can be properly applied to new issues such as digital technologies. As such, a return to Peirce's original theory of signs and their signification, particularly the indexical aspect of the sign, alongside a thorough review of the index in film scholarship, is needed to help with establishing a definition and an understanding of the nature of the index. Furthermore, the chapter will demonstrate that years of misunderstanding the term, in combination with the status of the photograph as documentary proof, has inflated both the concept of the index and the photograph to a level beyond what they should be.

Since production is at the core of the changes brought about by digital technologies, Chapter Two applies the clearer and fuller understanding of the index to the actual technologies themselves, analyzing how the concept works alongside the technical details. The technical analysis is something which up until now has been strongly lacking in academia, in particular with respect to older camera technologies that use film stock. Instead, the focus has been on the technological changes found within digital cameras. The result is that older camera technologies are given an elevated status, one that strongly

positions it as an automatic, naturalized process instead of the photochemical process that it is. By focusing any technical analysis solely on the digital production process, scholars create too narrow a field; one that does not allow for any new technologies of photography. Indeed digital technology is often described as if it does not fit into even the same category of image representation technology, for some scholars do not view digital as the next in a successive line of image making technologies but rather as a fundamental shift or break in the history of camera technology. Furthermore, the new digital technologies are seen as being more inherently manipulatable than photographs produced using film cameras, yet another seeming change in the defining characteristics of photography and cinema. The inflated belief in photographs as truth that came about from the misappropriations of the theoretical concept of the index has been shattered by the change in production which seems to allow for greater manipulation. Chapter Two then highlights the technological discussions and how the index has been applied and theorized alongside the technical, emphasizing how the science and technical aspects have been left out with respect to older film cameras. Furthermore, Chapter Two attempts to remedy the situation, using a detailed scientific analysis of image-making for both analog cameras and digital cameras, noting the similarities, differences, and how the science connects to the concept and issues of indexicality. The chapter also uses the science of image making to help clarify the issues of manipulation and the photographic claim to tell the truth.

Having established a fuller understanding of the index and how film scholars have misinterpreted the concept, as well as gaining additional insight into the concept from the technological aspects of production, Chapter Three completes the discussion by looking closely at another new technological change and development in the film industry, digital

motion capture. In terms of indexicality, digital motion capture has already been discussed by several film scholars. Despite its status as a digital technology, many of the scholars who argue that digital imagery has a weaker indexical connection to the real world also argue that motion capture is a stronger form of the index, closer in strength to that of photographic imagery. As was seen with the index itself, due to its own connection with its real world counterpart, digital motion capture is often examined in conjunction with realism as a cinematic aesthetic. Related to issues of realism for another reason, motion capture adds a new element that also needs to be discussed, namely *movement*. The idea of movement within cinema is often associated with issues of realism, as well as being another main component for what makes cinema what it is. By examining the technology behind motion capture, issues of movement, realism, and indexicality can all be better understood and defined, particularly as they relate to changes within the cinema. As such, Chapter Three reviews scholars who discuss movement and how it relates to these overarching ideas, laying out how the concepts were viewed prior to digital technologies. The science behind motion capture is then examined, alongside industry examples, in order to further our understanding of the index and the issues surrounding it. These examples also serve to highlight how the industry needs to change (or not) its practices as it incorporates the new technologies into the production process of filmmaking.

An important element that absolutely cannot be overlooked throughout the theoretical debates, technical analyses, and industrial applications is the spectator who watches, uses, interacts with and obtains information from the sign system known as a movie. As Peirce developed his theory of a sign system, which includes defining the index and other elements of a sign, he also connects issues of phenomenology, reality, and how humans

perceive and comprehend their surroundings. The purpose of his semiotic theory is then to show how we come to interact, understand, and identify with signs and sign systems. The spectator has not often been included in film scholarship about the index, in part because Peirce's system was based on logic, not to be confused with cultural studies that developed later. However, scholars need to ask themselves how spectators perceive and understand digital imagery whether it is captured via motion capture or not, and to determine whether these perceptions and comprehensions are any different from what they perceive in films created with older camera technologies. This type of research requires studies that have not yet been conducted, but the industry and academia would greatly benefit from it. Despite this, all three chapters keep the issue of the spectator at the forefront of their debates and conclusions in order to draw out some early deductions on the nature of the digital spectator versus the photographic one. Here we find the issue of change in cinema to once again be the focus. To establish exactly how and how much the cinema itself is changing, we turn first to understanding the index and its role throughout the years since photography first began.

CHAPTER ONE

Re-defining the Index

And somewhere in the shadowy centuries that had gone before, they had invented the most essential tool of all, though it could be neither seen nor touched. They had learned to speak, and so had won their first great victory over Time. ~Arthur C. Clarke, 2001: A Space Odyssey

Indexicality has become a key concept for cinema studies. Derived from the semiotic theory of Charles Sanders Peirce, it has been and remains very attractive to film theorists, who have long sought the conceptual means to explain the relationship between a photographic image and the represented object. Indexicality is one of the main elements of these scholarly discussions, mainly due to its existential connection and association with the real world. Both the real and realism as an aesthetic composition have also been a major focus for filmmakers and academics alike. From the early days, film scholars have attempted to define and understand exactly what the cinema is, but the cinema's connections to the real and realism posed many problems and paradoxes when they tried to determine how the cinema operates as a medium. Theories of cinematic realism, as well as debates surrounding the nature of cinema are plentiful and diverse, creating the sense that no one can quite figure out exactly what the cinema is or how it expresses the real; unless one takes the stance that the cinema and realism are many things simultaneously. The one common thread that can be found in these discussions on defining cinema and realism is the concept of the index. Interestingly, the notion that the photographic image is somehow directly related to the object it represents is also the main source of some of the contentions. As the concept of indexicality has been applied to each of these multiple

perspectives on defining cinema and/or realism, the end result is a similar sense of confusion towards defining the nature of the index.

Today digital technologies in cinema have caused even more confusion for they seem to challenge the very notion of indexicality, particularly if these images are computer-generated imagery (CGI). In their attempts to understand the threat this new technology seems to pose for the index, recent film scholars have naturally turned to these earlier academic works on defining cinema or realism. Yet since these works take such a multitude of approaches and never accomplish the goal of defining cinema or realism, issues of indexicality surrounding digital technologies have become equally muddled. Furthermore, due to the complex nature of all of these topics, most scholars tend to focus solely on one aspect or another. While this may be helpful in isolating a specific issue, it does not take everything into account, making a definition or ontological nature for any of these concepts next to impossible to establish. Before one can determine a definition of the cinema and how it portrays realism to the spectator, conceptual clarity and understanding of the index itself would be of great value since it is at the heart of these debates. Returning to Charles Peirce's original definition of the term index and examining how it operates as part of a sign system can help to shed light on the concept of the index itself, its role within photographic images and cinema, as well as how it has been misappropriated in film scholarship.

To determine exactly what indexicality is, an examination of Peirce's theory and classification of signs is first required. Peirce created a system of triads; everything can be classified by a category of threes. At a general phenomenological level, everything will be experienced through its Firstness, Secondness, and Thirdness. Firstness is the most

immediate level. It is the level of feelings without cognition or contemplation. Firstness is looking at something in its entirety without delving into its substance or parts; it is the quality as a whole. As such Firstness is monadic. Firstness can only be denoted but not described by details, the same with Secondness. Secondness is best summed up by using the word "fact". A fact is something particular, it is not general. All facts have a here and now associated with them. Secondness is dyadic for it has the ability to reference a correlate by virtue of its relate. The reverse of Firstness and Secondness, Thirdness cannot be denoted, it can only be described. Thirdness is at once both a generality and a law. Much like the laws of physics, we can predict or know the outcome of an event. Thirdness is itself another triad. This is because Thirdness is where we find mediation or representation and the basis of a sign system.¹

For Peirce, a sign "stands for something to the idea which it produces".² In other words, it is the mechanism which conveys something into the mind. A sign is divided into three parts: object, meaning, and interpretant. It is important to Peirce that the sign be broken into three parts for there is a triple connection of sign, thing signified, and cognition produced in the mind. Peirce emphasizes that the sign as a representation is a series of representations, each representing the one behind it. Since each representation has its own interpretant, Peirce recognizes that it can be seen as an endless pattern of representations and interpretants. If the series breaks off at any point, the sign fails to be what Peirce considers the perfect significant character. Instead, existence is the crucial element and Peirce stresses that the interpretant does not need to exist in the present, but can exist in the future as well.

Peirce does more than discuss the nature of the sign; he creates a system of classification as well, based, not surprisingly, on a system of thirds. It is the second trichotomy of his classification that Peirce considers to be the most “fundamental” and it is here that we find the notion of indexicality.³ This second trichotomy is divided into three parts, the icon, index, and symbol. Peirce declares that the icon exhibits a similarity or analogy to the subject, that it is a “relation of reason between the sign and the thing signified”.⁴ The icon does not act as a sign itself; it simply denotes the sign by its similar characteristics. The index importantly does not describe the object but simply forces one’s attention towards it. Furthermore, the relationship between the sign and the thing signified can have a direct physical connection in order to be classified as an index. The symbol is the name or description which is used to signify its object. This name or description can be achieved by means of idea association or through the habitual connection of the name commonly used by a social group.

Here we find Peirce’s general set of thirds, namely Firstness, Secondness, and Thirdness to be important in the grander scheme of his classification. It is important to note that this general set of Thirds should not be confused with the specific categories of Thirds; they are separate sets that each contribute to the operation of a sign system. However, the general set of Thirds can help with identifying an important aspect in the nature of the index. The index as the second set in its specific trichotomy falls under the larger and broader classification of Secondness. This means that an index must be a “fact” that has a here and now element to it. As we shall see, this idea of the here and now has repeatedly been misunderstood and misused in film theory. To differentiate between the concept of a general second and a specific one, Peirce uses the term “individual second”

when referring to a specific object. If the Secondness of the index is an existential relation then the index is considered genuine. When the Secondness of the index is referential then the index is termed degenerate. A genuine index, its object and immediate interpretant whether people, things, or facts must then be existent, which can be problematic when it comes to abstract ideas such as “facts”. Since every individual second must have particular characteristics that are observable, a genuine index will therefore contain Firstness, making the iconic aspect a part of it. The same follows for the symbolic aspect, which will reside in the description or name.⁵ These three aspects of the sign are always present and connected to each other in a sign system.

For Peirce, the crucial issue behind existence and the real world is the notion of objectivity. Of extreme importance to Peirce is how our thought processes and perception works, both within signs and the real world. This is because Peirce was determined to find the ultimate truth or the reality concerning abstract concepts such as thoughts and the physical world. To demonstrate this, Christopher Hookway gives the example of a book; if the book is to be truly considered as a particular colour then there are realities that involve generality. He quotes Peirce who wrote:

It is plain that this view of reality is inevitably realistic: because general conceptions enter into all judgements, and therefore into true opinions...It is perfectly true that all white things have whiteness in them...It is a real which only exists by virtue of an act of thought knowing it, but that thought is not an arbitrary or accidental one dependent on any idiosyncrasies, but one which will hold in the final opinion.⁶

The problem here is how to be objective if the concept of colour is something that only exists inside the mind and the words used to describe colours is strictly a social convention established by a particular language.

Peirce does stress a difference between something real that exists physically, but it is the “reality” of concepts that are only thoughts that puzzle him. Peirce concludes that so long as the majority of a social group agree on a particular idea then it can be considered as existent. Hookway poses some objections to Peirce’s abstract notion of objects being real simply inside the mind. If the real is defined by referring to our mental processes, Hookway questions the objectivity behind reality or realistic images, for the thought process is one that is questionable. Hookway writes that Peirce himself doubted his own conclusions for his later writings demonstrate the difficulties he had in making a formulation of the doctrine due to the unknowable future, which has shown in the past to change truth or reality behind even scientific facts that were considered to be indisputable.⁷

The object of science is to produce a true representation of reality. In order to obtain this goal, we need to understand how thoughts and sentences can represent reality.⁸ Peirce notes that as members of a community, we use conversation and dialogue with the other members in order to arrive at these representations. Other scholars and philosophers also emphasize the importance of dialogue with other community members for people to establish what they constitute as reality, which forms the basis for their interpretation of signs. Michael Holquist explains the importance of dialogue with the following:

In dialogism, the very capacity to have consciousness is based on otherness. This otherness is not merely a dialectical alienation on its way to a sublation that will endow it with a unifying identity in higher consciousness. On the contrary: dialogism consciousness is otherness. More accurately, it is the differential relation between a center and all that is not that center.⁹

Here Holquist stresses the importance of simultaneity as people build their ideas about themselves, others, and the world around them. He insists that the differences cannot be overcome; the separateness and simultaneity co-exist as basic conditions. Dialogism contends that all meaning is a direct result of this relation between two bodies occupying simultaneous but different space and further recognizes that bodies may be considered as our own physical bodies to political bodies or even to more general bodies such as ideologies. Since this deals directly with time and space, Holquist correlates it to Einstein's theory of relativity where a third party classified as observer is necessary. Their position to what is observed is crucial for it provides more objectivity much like a mediator, since meaning is derived from the place where it is perceived. Both Peirce and Hookway are therefore correct: abstract concepts can become created by social groups but the "reality" of such concepts will change if another social group comes to a different conclusion.

Peirce acknowledges that perception is our main means of access to reality. Credibility of images does not stem from perception alone; it comes from a connection built over time through other members of the social community, like in dialogism. In terms of mediation and meaning, Hookway emphasizes the importance of Thirdness in Peirce's sign system. The sign relationship consists of the sign, its object, and the interpreting thought which is itself a sign. Importantly, a sign mediates between the interpretant and its object.¹⁰ Ideally, as a mediator, an objective sign would then act much like Einstein's third party observer. But objectivity goes deeper than this. For example, in the scientific community, perceptual reports may have initial credibility but they are still a fallible determination of reality; more tests must be performed to confirm the perception. Much like abstract concepts, only

when multiple tests have the same results can a conclusion be relatively safely drawn. The amount of knowledge by the scientists or a social group will affect the conclusions they make. The most objective methods can be used when creating a mediated product or scientific report, yet they are both limited by the knowledge of its members. Limited knowledge however, does not mean the same as arbitrary. Peirce importantly recognized that there are limits to human knowledge, but insisted that this did not mean there was no objective reality. Instead, he found it important to mention the limits, in order to prevent an establishment of an all-encompassing absolute reality that is the same for everyone.

Hookway writes that the indexical is also an important part of the Secondness of perception. The term Peirce uses for the referent of the demonstrative is individual. Peirce writes that all perceptual judgements are singular judgements that make reference to individuals or particulars, the opposite of universals. Reference to individuals must be indexical.¹¹ This works under the assumption that a subject can be denoted by a general description of it. Perceptual judgement refers to an individual or a quality and asserts that it is so. To complicate this matter, Peirce distinguishes between two modes of being, arguing that universals and laws are “real” but individuals just “exist”. As already shown, referring to items that are not “real” challenged Peirce. Yet reference must have an indexical component or we can never justify endorsing the Firstness of the subject in question. Building upon work by Immanuel Kant, Peirce emphasizes that time and space are important indices. Reference to locations in space or time must be indexical. Such a claim then points towards a connection with existence and Secondness. Thomas Goudge declares that Secondness is the representation that we associate with truth. Indexicality, as part of Secondness, contains the notion of truth within it. Thirdness is something we

know, it exists only in our thoughts. If the thought is accepted by the community, then a connection between the real and Thirdness happens. This principle works according to a third which mediates between the action of, for example, a stone falling and the knowledge by everyone that the stone will fall.¹²

To combat the problems of universals and understanding the existence of something within one's mind or the collective understanding of a community, Edward Moore uses the four answers given to this problem in the Middle Ages: extreme realism, nominalism, conceptualism, and moderate realism. Moderate realists rejected all the solutions posed by the others. They argue that there is no separate realm where universals exist, but that objects are located in space and time wherever they happen to be manifest. Furthermore, external objects are differentiated by the way the object exists. For them, an object exists in the mind as a universal, but in the real world it exists as an individual. It is important to understand this position since moderate realism is what Peirce built his position on; that the ultimate meaning of an idea is in particular experiences.¹³

Moore notes that there are some theoretical implications behind Peirce's theory of signs and signification. According to Peirce, the physiological counterpart of our thoughts and ideas is a habit. The sum of the consequences will constitute the entire meaning of the concept.¹⁴ Moore concludes that the pragmatic theory of meaning is that the meaning of an idea can be explained by describing the ways we habitually act and the experiences we can habitually expect from an object. The way that people behave can be taken as cues to their ideas and thoughts. If ideas are translated into behaviour, then Moore notes that pragmatism reduces meanings to something public and observable rather than private or personal.¹⁵

To solve this problem, Peirce attempted to define the real. Eventually, Peirce proposed two definitions for what the real is. His first definition is: “The real is that which is not whatever we happen to think, but is unaffected by what we may think of it”.¹⁶ The second definition that he gave later in his writing is: “The opinion which is fated to be ultimately agreed to by all who investigate is what we mean by the truth, and the object represented in this opinion is the real”.¹⁷ This definition states that reality does not depend upon being observed since it is unaffected by the act of observation, but if it is observed than it will be the same for all observers. This makes reality a social concept, not a personal one. Secondly, reality is defined only in terms of human experiences and rules out any realities not experienced by humans. Thirdly, to accept this definition one must be relatively accepting of phenomenology, which is a doctrine of human experience, that is both generalizable for all humans and varied for different cultures.

Interestingly, in 1905 Peirce wrote that our perception is very similar to a moving picture that is accompanied with sound or other sensation. Hookway emphasizes that this is similar to the sense datum theory which distinguishes between different kinds of sensory awareness such as audio or video, both of which can be either immediate or mediated. Yet Peirce had some problems with this notion for he struggled with the different sorts of awareness he noticed when he made observations. For example he noted that often his awareness was neither indirect nor immediate. Instead, the object could be a part of the total percept that he is aware of. He deduces from this that it is “a mistake to conclude that a percept is simply some portion of the physical world”.¹⁸ Importantly Peirce emphasizes that a percept contains two kinds of elements, Firstness and Secondness. Thirdness is not part of the empirical world. This is because Thirdness is part

of the experience and cognition of perception, something which is different from the initial perception itself. Experience and cognition are a phenomenological act, which help us make sense of our perceptions and as such is a crucial part of the process.

Peirce describes phenomenology as the observation and analysis of experience and the description of all the common features of the experience or object of study that are obtained directly or indirectly.¹⁹ It is the Secondness of signs that Goudge turns to in his explanation of phenomenology for Peirce. As noted earlier, icons, indices, and symbols are in Peirce's second category for sign systems. By definition indices correspond with fact, while symbols are simply general signs. Peirce places photography into the iconic category for while it resembles what it signifies and shows the object as it really is, it is only "like" the object because it is still just an image of it. Peirce notes a weakness to the iconic sign; it cannot convey any factual information about the object for it offers no assurance that it exists in nature. Thus we cannot know an object simply from a photograph, but we could if we were to observe the real object that was photographed to begin with.²⁰ Yet everyone still acquires knowledge from photographs and people do so because of the index. It is the main function of the index to impart knowledge about a sign to a viewer; iconicity alone cannot convey any more knowledge beyond the physical resemblance and characteristics of the represented object.

Peirce emphasizes that for an icon to be brought into a dynamic relationship with the world, it must contain an indexical quality. He writes that the index bears no resemblance to its object and it directs attention to its object only by blind compulsion. There is also an inseparable connection between index and object. The index would lose its status as a sign if its object were removed, since an index is always an existent individual, fact or thing.

Since individuals must have qualities, an index will contain a Firstness and so an icon usually constitutes a part of it.²¹ Unlike the icon and the index, the symbol has no inherent connection with its object. The symbol itself has no meaning; anything can be used provided that the community who uses it is notified in advance what the meaning of the symbol is. Gouge notes the value of the symbol is that it makes thought and conduct rational, enabling mankind to predict the future such as a social group determining physical laws or conventions. Most importantly, the icon, index, and symbol all operate together and do not function apart from one another.²²

To summarize and define the index, from Peirce we learn several important qualities. The first quality is that the index alone is not descriptive in nature, it simply forces one to make a correlation between the index and the object it is referring to. Secondly, an index has an element of truth or a factual quality to it due to its categorization of Secondness. Related to that is the third important quality which states that the index must be referring to an object that is existent, whether that existence is past, present or future, a physical object or an abstract concept that exists only within the mind or conventions of a social group. Through our perceptions and its accompanying phenomenological process, the index operating in conjunction with its related icon and symbol work toward conveying information and imparting knowledge. These qualities of the index are present regardless of if the index is part of a representation or not.

Film theory began discussing these issues of indexicality in relation to cinema after Roland Barthes related his concept of the referent to photography. An outline of these discussions starting with Barthes demonstrates some common flaws and errors in this body of scholarship. Much like the index, symbol, and icon being inseparable from each

other, when Barthes associates photography with indexicality, he writes that a specific photograph is never able to be separate from its referent.²³ He notes that it is possible to also perceive the signifier of a photograph, but that this requires an act of reflection, a cognitive recognition in order to do so. However for Barthes, the referent is forever “glued” to the object in the photograph; they will never be separated. This creates a duality to all photographs, something which he declares we “can conceive but not perceive”.²⁴ When it comes to the referent, Barthes writes:

The noeme ‘that-has-been’ was possible only on the day when a scientific circumstance (the discovery that silver halogens were sensitive to light) made it possible to recover and print directly the luminous rays emitted by a variously lighted object. The photograph is literally an emanation of the referent.²⁵

Here we see several connections with Peirce’s definition of the index. For both Barthes and Peirce, the direct connection plays an important part in a photograph for it establishes the existence of an object and it also places it in a particular time and space. Furthermore, Barthes is highly conscious of the fact that a photograph is a representation and as such contains a certain amount of manipulation to it stemming from its status as a created item. This is evident when he discusses the paradoxical nature of photographs. To demonstrate this paradoxical nature, Barthes uses an example of a person having their picture taken. The person being photographed is conscious of this fact, so they pose themselves, in essence manipulating their body and facial expression from their natural state of being. Yet once the photograph is taken, the person being photographed will either consider it to be a true likeness of themselves or not. If it is a true likeness then the photograph seems to contain some essence of their very being.²⁶ The likeness of a person however is a part of the iconicity of a photograph. Opposite to Peirce’s definition of the index, Barthes’

connection here between essence and iconicity creates a link between index and icon that is more than just inseparable, but almost as if they are one and the same.

Like Peirce, Barthes' interest leads him to make a phenomenological examination in order to understand how images communicate. However, for Barthes, it is extremely personal and he often refers to his own experiences of various photographs in order to make sense of the theory he is explaining. The image that is most personal is the photograph of his mother. While he can examine the photograph from the viewpoint of her physical body, the part that has the most direct link as a referent, the essence of his mother comes from his own experiences and memories. The image recalls her kindness; a seemingly inherent aspect of the photograph itself for it is as if it captured this part of her when it captured her physical body.²⁷ Barthes is careful to note that the photograph contains this essence of his mother only for him; no one else would have this experience unless they personally knew her like he did. Barthes emphasizes that the phenomenological process is a crucial aspect, just like Peirce did; however, Barthes' process is more personal. Peirce clearly states that for something to be real or true, it requires an act of multiple people coming to the same consensus or experience. Therefore the photograph of Barthes' mother, which contains an essence of her for him personally, will not hold the same meaning or essence to someone who did not know her. This essence then is not inherently within the photograph, but instead in the knowledge one has about the person or object in it.

Barthes' term for the referent of any photograph is the Spectrum, in part because this contains an element of the word "spectacle" which he feels plays a large part of any image due to the manipulation by either the subject or the photographer. Barthes also used this

word because of the connection it has with the dead. He describes this second connection as “terrible”, but always there, since a photograph is always of a moment that has occurred in the past.²⁸ Furthermore, the photographic process turns subjects into objects, something meant to be looked at. It is here, at the moment when the subject turns into object, that Barthes writes that the person can feel a mini-version of death.²⁹ In film studies, scholar André Bazin connected the ontology of the cinema with death. Like Bazin’s connection between photography and mummies, for Barthes the person is almost being “embalmed” at the moment the image is taken. Bazin discusses many examples of this throughout history leading up to the cinema, using examples such as death masks, fingerprints, statues, and moulds, which can all be categorized as indices. Here we find that an essence or a direct link towards an object is viewed as an inherent quality of the index, and most importantly, the past is inseparable from it. Again, this is contrary to Peirce who notes that the tense of the index is not so important as its existence.

After taking this viewpoint of photography, Barthes naturally turns to examine cinema, the basis of which is the photographic image. For Barthes, the cinematic image does not contain the same type of “completeness” as photography.³⁰ He claims that while cinematic images still contain the photographic referent, the referent continuously shifts. The result of this is that the connection with the past is lost. The idea of death that he connects to the photographic image does not apply to cinematic images because of this, which for Barthes means that the cinema cannot contain the element of the past that is so crucial to his argument.³¹ He concludes that time is not immobile in cinema but it is in photography, so while the two may technologically be created in a similar fashion, they act very different in terms of their representation and meaning for the spectator. Despite Barthes’

conclusions and that the notion of the past is contrary to Peirce, film scholars maintain that a crucial aspect of cinema and its indexical element is this connection to the past.

Film scholar Leo Charney writes about this topic in a similar manner to both Barthes and Peirce. Charney defines the modern moment as a two-part process due to the fact that any moment is fleeting and therefore constantly in motion. The first step takes place in our senses where we feel the moment. But cognitively, we only experience it after we have felt it. This is reminiscent of Peirce who emphasizes that perception and cognition are the two steps in a phenomenological process. These moments for Charney are then seen as facts by the individual experiencing them. Furthermore, Charney argues that if sensation and cognition are never in the same moment, then the “present” is never there as a part of the actual moment itself. This loss of the present holds true for both photography and cinema as both are phenomenological processes. Charney writes the result of this separation is a sense of alienation felt by the person perceiving and experiencing an object. The alienation in Charney’s perspective stems from the individual’s awareness that they are always living in the past due to this separation between perceptual emotion and cognition. But through what he refers to as “the moment of vision”, such as with images and cinema, humans can overcome this as the visual element heightens the emotion. Furthermore, the immediacy of the image serves to make it seem as if the two processes are happening simultaneously. Movement in cinema will also heighten this sensation. Today digital imagery can seem even more immediate due to the greater accessibility brought about by computers or hand-held devices. The importance of the separation between perception and cognition that Peirce emphasizes appears to be lost by the sense of the present brought about by the movement or immediacy of images.

In a similar vein as Charney, Christian Metz notes one of the major problems concerning film theory is the impression of reality experienced by the spectator. Metz argues that one of the reasons why cinema connects so strongly to the public is due to its proximity and its presence. This phenomenon is related to the impression of reality. The power lies in its ability to realize and to make real the images we see onscreen. Metz emphasizes that the division between realistic and non-realistic images is not important in this process for this power of the cinema can happen regardless. The impression of familiarity enhances the emotions experienced while watching a film, thus it doesn't matter if the images are realistic or not.³²

Metz refers many times to Roland Barthes' theory of photography and time. He stresses that for cinema, the process works slightly differently. The motion of the pictures in cinema provides the impression of the real since it creates more of a sense of the now or the current moment.³³ Barthes theory of photography argues it is the sense of the past that is the essence of the index and its proof of reality; that to be able to connect a person or object with a particular time or place in the past emphasizes the inherent indexicality of photographic images. This would cause a lot of problems for Peirce the philosopher who struggled to find proof of reality in even abstract concepts. It also contradicts Peirce's definition of index which states that existence is the crucial element of the index and existence can be past, present, or even future. But Metz takes a very practical approach and argues that while the objects and characters are only images or representations of these things, the motion is real.

Metz emphasizes, however, that the fact that these images are representations and are reconstructions created by someone is highly relevant. Here he turns to Barthes again who

says that the goal of reconstruction is not to reproduce reality for it does not attempt to recreate the same aspects and attributes, instead it is a simulation. As such, it is the result of manipulation. Turning to one of the great film directors, Sergei Eisenstein, who declares that things must be manipulated, Metz brings his argument back to semiotics. He writes that it is conceivable to distinguish between a natural meaning of things and signification, but signification occurs in the deliberate process of re-organization. Since films are to one degree or another organized and put together, they always signify meaning.³⁴

Noted earlier for his well-known work on connecting the cinema and death, André Bazin is also seen as one of the leading authorities on realism, the opposite of Eisenstein's philosophy for filmmaking. Metz notes that for Bazin, realism is not about manipulation. If one was to make a film realistic then it must be true to life and "cease to be a caricature".³⁵ Many of the great directors such as Jean Renoir and Roberto Rossellini made their films according to these principles. But Metz argues the opposite of Bazin, stating that the realistic form of the film does not matter. For the cinema he claims is not life; it is only created. Thus despite all attempts to make film appear as true to life as possible, this will not eliminate the process of signification and meaning. The film will ultimately be attempting to convey meaning through an organized method of reconstruction.³⁶ Something that Metz fails to discuss is that a film as part of a sign system will then contain the three aspects of the sign outlined by Peirce: icon, index, and symbol. These three aspects of the sign will be in any film whether it is aesthetically composed as realism or as formalism.

Instead, in his semiological analysis of film, Metz attempts to determine whether film is a language or a language system. In this discussion, Metz emphasizes that it is the

juxtaposition of two images that is a requirement for images to go from image to language. But cinema becomes language above and beyond this with the addition of narrative. Codes are also seen in cinema through the types of shots which contain what Metz considers to be learned and conventional codes of meaning.³⁷ Classifying and analyzing cinema from a traditional semiotics standpoint causes some problems for Metz as he emphasizes the differences between cinema and language, the social system first analyzed by both Peirce and de Saussure in their separate theories on semiotics. Metz concludes that the cinema is considered more like speech and never a unit of language. This is due to the fact that the image is always assertive in nature and therefore actualized. He gives the example of a close up of a revolver, which he writes does not just mean “revolver” but that it is also signifying “Here is a revolver!”³⁸ Though Metz does not outright consider this to be Peirce’s notion of indexicality, he does use some similar phrases. Metz notes that like a statement, this type of shot refers to reality or a reality containing with it an index of actualization.³⁹ Metz is careful not to come to a definitive conclusion on the matter for he emphasizes that the filmic shot is not completely like a linguistic statement, but it is not simply a word either as it contains within it the connotation of a statement, being referential in nature.

Metz uses a more Saussurian than Peircian method of semiotics in his analysis and Peter Wollen criticizes his method, declaring that his logic never allows him to resolve many of the issues he brings up. Thus Wollen is one of the first to turn back to Peirce’s original theory for his analysis of film semiotics. Of particular interest to Wollen is Peirce’s second trichotomy of signs, the icon, index, and symbol. Wollen feels that the work of Barthes and Peirce stresses the inherent connection and indexical quality of the

photograph to the object in the image due to its correspondence with nature and reality, the person or object was actually there. Furthermore, he writes, Metz builds upon their work to include the cinema but tends to see “only two modes of existence for the sign: natural and cultural”.⁴⁰ For Wollen, the main flaw behind their theories is that they only stress one or two of the three elements of the sign, when the cinema contains all three.

Wollen turns to director Josef Von Sternberg to make this point. For Von Sternberg, the mechanical apparatus for creating cinema was too limiting in its options unless one chose to manipulate and edit as much as possible. Wollen notes that Von Sternberg’s works stress the iconic image that detaches itself from the indexical in order to conjure up a dream world.⁴¹ Yet Wollen also writes that this sort of filmmaking is not the extreme opposite of realism; that belongs to animation. Still the separation between the two is not clear cut, for Von Sternberg recounts how many films have included hand painting or drawing onto their photographic images. For Wollen this demonstrates that there is a trend of prejudice within both the film industry and academic world. Furthermore, Wollen writes the indexical and iconic symbols are more predominant and powerful than the symbolic.⁴² This is problematic for it directly contradicts what both he and Peirce took such pains to emphasize, that all three aspects of the sign are inseparable and will be a part of any representation.

Wollen emphasizes that it is the combination of all three signs that creates the aesthetic richness of cinema and that Peirce himself considered the different aspects of a sign to be co-present. Interestingly, while Wollen makes a connection that the cinema as a whole contains films with all three aspect of a sign, he still separates the films aesthetically, according to whether they are dominantly iconic, indexical, or symbolic as opposed to

doing what his point was, which is to discuss the idea that all three aspects of the sign are co-present in any given film.⁴³ He concludes by declaring that the only filmmaker to create what Peirce would agree is a perfect amalgamation of all three aspects, indexical, iconic, and symbolic is Jean-Luc Godard, yet Wollen fails to provide a deep analysis of why this is so other than to say that Godard was unafraid to mix different elements from varying cinematic styles. Even so, aesthetic and cinematic styles are not enough for a proper discussion when it comes to such complexities as Peirce's icon, index, and symbol triad and the ease with which Wollen places animation into the category of the symbol ignores these complexities.

Tom Gunning addresses exactly these complexities when he stresses that indexicality and iconicity intertwine in a photograph due to the fact that the resemblance of an image must maintain a visual accuracy in order for it to refer to and be recognized for what it is.⁴⁴ Important to Gunning are the various psychological and perceptual processes involved in recognition that do not play a part in indexicality, since by Peirce's definition it is not descriptive. The power then of digital manipulation in photography is in our ability to recognize them as manipulated photographs, which rests on the fact that we can still recognize the index that is beneath the manipulation and separate it from the visual aspect that is iconic.

Gunning turns to phenomenology in order to investigate the truth claim behind photographic imagery and to understand what makes it so unique in comparison with other forms of visual representation. He uses the example of modernist photographers such as Man Ray or John Heartfield who present for Gunning a contradiction in their work that simultaneously plays with the notion of the impossible or the spectacle while also

calling upon the index or the photographic truth. Regardless of how many times this happens, Gunning feels this type of delight in the strange yet familiar will always provide a spectator with pleasure.⁴⁵ Thus Gunning posits a phenomenological fascination with photography that involves a sense of the relation between the photograph and an already pre-existing reality. Gunning feels that this is exactly what indexicality is supposed to be, yet he is still hesitant to admit that this term is the proper one for this experience.

Photography for Gunning is more than a process of signification, thus semiological terms can explain in part how photography operates but it cannot do so fully for he feels it is too complex, which does not resolve the intricate nature of the index. It is interesting that Gunning turns to a phenomenological study of photography, much like Peirce used for his study of semiotics. What Gunning fails to recognize is that Peirce also commented greatly upon the complexity of the sign system and the process of signification, emphasizing the many aspects that could be involved. Indeed, one could say that Peirce attempted to be exhaustive in his system, covering everything he could think of. That Peirce's notion of the index is much more complex is something that Gunning brings up in a separate article on indexicality. Not satisfied with his or others' accounts of indexicality, Gunning attempts to tackle this concept from another angle. First and foremost is an acknowledgement that Peirce declared there were multiple types of indices, though Peirce does not attempt to classify them. Instead, he gives a long list of what could be an index. Gunning notices that something such as a sundial has its reference strictly in the simultaneous action with the referent. Gunning stresses that Peirce declared an index could be "anything which focuses attention".⁴⁶ The crux of what Gunning argues is that discussions of the index in film theory have previously ignored many of these possibilities

and focused solely on a small range of meanings for the term. While these arguments help us understand certain aspects of the index and help to make a complicated theory more applicable, they often contradict Peirce or overemphasize and exaggerate these aspects in the process. As shown, the main ideas focused upon by film scholars are the direct connection and the past tense of photography, which Peirce emphasizes as elements of the index, but they do not define the index and there are other aspects to consider.

Turning to Bazin, Gunning returns to the connection between indexicality and realism. For Bazin, cinematic realism was dependent upon the photographic nature of the medium. Gunning emphasizes that the realism of photography for Bazin is not about its correspondence and resemblance with the physical reality of the subject, but more about the transference of reality from the subject to the reproduced image. The limitation for Bazin's indexical argument is something that Gunning feels has not been stressed enough. This limitation is that Bazin's theory attempts to discuss photography and cinema not from a semiological point of view, but from an aesthetic one.⁴⁷ Further commenting upon Bazin's aesthetic position, Gunning argues that the index is not the only way to understand realism and the changes brought about by digital technology. From a historical perspective, the cinema has its origins in both realism and fantasy. Therefore, it has never been just one thing or medium, posing a problem for those who try to define it.

Interestingly and problematically, scholarly studies of realism have also tended to focus on only one aspect of realism in the cinema. While these different studies and analyses can enhance and amplify a fuller comprehension of realism and what makes the cinema what it is, it is only when they are considered all together that these works can do so. Considered separately, there is something always lacking. Furthermore, these writings

have yet to come to any conclusions that acknowledge all of the aspects that define realism. Nor has anyone been able to combine all of these elements to say once and for all, what cinema is. Clearly the cinema and indexicality have a very complex and philosophical nature. Perhaps this is why scholars tend to focus on only one concrete manageable element, but in doing so important aspects get missed.

Gunning attempts to bring these multiple aspects about the cinema together by looking for a common denominator. The only thing that Gunning finds as the common denominator for cinema – whether it be early, modern, or digital – is movement. Gunning then proposes a theory about the movement of the images. Much like other film scholars before him, for Gunning, cinema is participatory through the act of looking, creating a sense of the present which furthers the realism of the image.⁴⁸ Since movement is inherent in all cinematic images, Gunning declares that even animation could qualify to be in the category of realism. What is most important is that this process is phenomenological since the realism stems from the experience of the spectator. Gunning emphasizes that the experience of perception feels real, so it therefore is a real experience for them.

This returns us to the objection that Moore made about Peirce and his ideas about perception and the public. The trouble with Gunning's argument is the reverse. For Gunning, reality is then a personal experience; something which Peirce stresses cannot be considered valid. A reality can only become a truth when it is experienced in the same way for everybody. It is true that in Gunning's argument, everyone who watches the cinema will experience motion in the images, but determining that motion is viewed in exactly the same way by everybody can be tricky, though some generalities can be acknowledged based on biological similarities of the eye. Additionally, the movement of

the images may not produce the same effect in everybody and this will also be difficult to determine or qualify. Gunning is completely accurate in his analysis of the index and realism when he states that film scholars need to remember that the index is more than just the direct referent between the sign and object. While this argument helps us identify a common denominator and learn more about how movement and perception operate within the cinema, as well as importantly pointing out some forgotten aspects about the index, Gunning still fails to provide a thorough description of all the elements or defining qualities of the index.

Similarly, Martin Lefebvre states that to isolate the index or even to say it is the most important property of a sign is to misread Peirce. Peirce was adamant that every sign includes elements of all three aspects, icon, symbol, and index. Furthermore, Lefebvre emphasizes the importance of what we know and learn through signs when he writes that “Peirce’s semiotic is chiefly a pragmatic theory of knowledge through signs”.⁴⁹ When it comes to the knowledge one can learn from a visual sign as a photograph, Lefebvre notes that the object in front of the camera and what is being recorded is only one of an indeterminate amount of existential connections the image has to the world.⁵⁰ Everything that can be present to the mind may be so on the basis of the three phenomenological categories of Firstness, Secondness, and Thirdness and must therefore possess monadic, dyadic and triadic properties.⁵¹ If photographs have limitless indices besides the one most commonly discussed, then Lefebvre argues that on a theoretical level this proves that CGI or anything could be an index. He emphasizes that what is truly important is the knowledge we gain from a sign.⁵²

As an example of how this works, Lefebvre asks his reader to think about paintings or CGI and the fact that they are not directly caused or created by the existence of the object they represent. They seem to lack the direct physical connection that is important to many scholars when it comes to the index. If this direct connection is not there, then he wonders where the index could be found. The answer he says lies in an object such as a historical painting, for they are seen as clear indices and objects of truth and historical fact, but they are not created the same way photographs are. This does not change the value or historical truths these paintings represent and they are seen as indices of past customs, objects, and things, which can be considered as an indirect index.⁵³ According to Peirce, every sign from the moment it stands for something is by logical necessity indexically connected to reality and it is by signs that we apprehend reality as truth.⁵⁴ Yet the index alone does not assure us of its existence, Lefebvre rightly emphasizes that we require interpretation to do this.⁵⁵ If one does not have any knowledge of who is in the photograph, then the index conveys nothing. One could certainly never have the experience such as Barthes does about the photograph of his mother without such prior knowledge. Lefebvre writes that knowledge is what adds more indexicality to photographs.⁵⁶ It is the combination of the direct physical connection along with one's knowledge that truly creates an index in a photograph and hence a film; the physical connection alone is not enough and is wrought with its own problems from a technological point of view, which will be discussed in the next chapter.

Mary Ann Doane also sees the same disconnection that Lefebvre discusses here, noting that some indices have a direct physical connection whereas others only point in reference. This perplexes her, causing her to question the exact nature of the relationship between

what she considers as two types of indices. She also questions how a word in a language, a form so strongly associated with the symbolic, can still be an index, for she seems to feel that it is almost impossible it could be so, even though Peirce was adamant it was.⁵⁷ Doane seems to miss the importance of the knowledge provided by an index when she comments that it is the lack of any resemblance to their object that makes the index a hollow sign, without description. It simply points at or designates something, directing the attention to an object by “blind compulsion”.⁵⁸ Opposite to Peirce, for Doane, one of the most crucial elements of the index is that they provide positive assurance of the reality and existence of an object, although she emphasizes this assurance has no insight into the nature of an object. Despite the differences from what Lefebvre says, Doane does note the same thing, emphasizing that the important aspect is the functionality of the index.

However, when it comes to photography and cinema, Doane emphasizes that the strength of the index comes from the fact that it is also iconic.⁵⁹ Indices such as a photograph or a footprint are signs that Doane categorizes as an indexical trace or imprint of its object. Thus the index as a trace requires a material connection between sign and object, but Doane also stresses that this makes the index as trace a signature of temporality for it is an “imprint of a once-present and unique moment”.⁶⁰ The index as trace is where Doane connects the idea of the past or the moment “that has been” that was so crucial to Barthes’ theory of photography. While the photographic or cinematic index is most definitely an indication of a past moment, Doane’s material connection between object and sign must be seriously called into question, for a photograph is not the same thing as a footprint. A photograph is not an automatic imprint with a direct connection to the

physical world; it is a highly technological, man-made device dealing with light particles and their conversion through multiple chemical processes.

Regardless of a photograph's technical aspects, other indices such as the footprint do have a direct connection with the physical object, and it is these indices that Doane feels are so different from the index as deixis – the pointing finger. With this type of index, Doane comments that the index will exhaust itself in the moment of its implementation and therefore only link to the present. This completely contradicts Peirce and his emphasis that even the index as deixis can be connected to the past, present, or future. Still, Doane continues with her argument and writes that for the deixis, the gap between sign and object is much further since it has no direct physical connection. Despite these categories that Doane creates for the index, she does acknowledge that Peirce saw the trace as simply one genre of index, nor was it the most crucial one. Indeed, Doane notes for Peirce it is the pointing finger embodied in the word “this” that represents “the very ideal of indexicality, its purest form”.⁶¹

In an effort to bring the two types of indices together and make sense of these seeming differences, Doane turns her attention to Michael Leja's theory about frames. She considers the frame around photographs to be the cinematic equivalent of the “this”. For her the difference between a footprint in the sand and a sign such as a photograph or film is that it is framed and what appears within a frame is mainly about an aesthetic activity. Its aesthetic nature is where the dialectic of Peirce's two forms of the index, trace and deixis, are brought together. For Doane, while the frame calls for the spectator to look in the here and now, the trace reconfirms that something exists to be looked at, enduring longer than the deixis it brings the element of the past into the present. The problem with

this argument is that the deictic aspect of the index also confirms that something once existed for indeed as mentioned earlier, Peirce pointed out all indices whether they be things, facts, ideas or people must be existent or have existed. Indices that fall into the deixis category may be used to point to an object in either the past or the present. More problems can also be seen in Doane's analysis. She writes that Leja's theory about the frame emphasizes that it is an aesthetic activity that has expectations which transform the index into the realm of the symbolic. Doane dismisses this possibility in relation to photographic images by saying that Michael Leja was only referring to paintings. It is problematic that she applies this concept to photographs and the cinematographic frame but does not explain how these do not get transformed into the realm of the symbol unlike paintings do. She merely uses elements of this theory and dismisses Leja's main point about the frame, that it elevates an image to a different status by placing a frame around it. Doane however continues on with her analysis noting that it is the dialectic of the past contained in the trace and the present found within the deixis that produces the conviction of the index. This conviction of the image is so strong that Doane writes, "In a way that Peirce did not anticipate, the two understandings of the index collude to buttress an almost theological faith or certitude in the image".⁶²

It is exactly this theological type of faith in the image that has created such strong beliefs about the index and the related notion of photographic truth that are not entirely accurate. The complex nature of the index has largely been forgotten in academic discussions due in part to this deeply ingrained belief that is just taken as absolute fact, making the index one of the most misunderstood aspects of the sign. Instead, it is the strength behind the combination of the iconicity of an object in a photograph and the

index, both in trace and deixis form, that has elevated the status of a photograph to an absolute truth of existence, forgetting that it is a medium which by definition is attempting to convey information that has been arranged by a person who had something very specific in mind to convey. The sheer manipulability of photographs simply by a photographer choosing what to put inside the frame can change the entire context of the reality or truth behind the person, event or idea being photographed. Thus whether the technology be digital or analog, all images should be viewed with doubt as to the reality and existence of what the sign conveys and the knowledge it imparts to a spectator. Along similar lines, analog technology has also been elevated to an almost theological type of faith in terms of its ability to capture reality faithfully and automatically, without any understanding or acknowledgement of the chemical processes involved in capturing an image with light, the lens system necessary, and even the complexity of the film stock itself, which has a long history of prior versions until it became as simplified as possible. It is here that we turn next in order to discover exactly where the index lies in a photographic image.

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56. Lefebvre, "The Art of Pointing", 232.
57. Mary Anne Doane, "Indexicality: Trace and Sign: Introduction," *Differences: A Journal of Feminist Cultural Studies* 18, no. 1 (2007), 5.

58. Mary Anne Doane, "The Indexical and the Concept of Medium Specificity," *Differences: A Journal of Feminist Cultural Studies* 18, no. 1 (2007), 133.
59. Doane, "The Indexical and the Concept of Medium Specificity", 135.
60. Mary Anne Doane, *The Emergence of Cinematic Time* (Cambridge, Massachusetts: Harvard University Press, 2002), 16.
61. Doane, "The Indexical and the Concept of Medium Specificity", 136.
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CHAPTER TWO

Comparing Analog and Digital Technologies

“Any sufficiently advanced technology is indistinguishable from magic.”

~Arthur C. Clarke's third law of science and technology

Though there have been many debates about the concept of indexicality in cinema and photography, more confusion has arisen with new digital cameras and computer software interfaces that seem to allow for greater manipulation of images as well for the creation of computer-generated imagery (CGI). Scholars such as Lev Manovich and D.N. Rodowick have attempted to come to some conclusions on the matter by taking a technical perspective and analyzing the technology alongside the concept. Interestingly, both Manovich and Rodowick take a similar position that strongly argues for an inherent loss and a weakening of the index due to digital visual technologies, though this is likely due to the fact that Rodowick builds upon the work of Manovich, citing him as the main source of technical information throughout his analysis. However, it is important to note that it is the technological changes found within digital cameras that seem to spur these two scholars into their respective technological analyses. They are particularly concerned with the supposed ability for digital images to be more inherently manipulatable than traditional photographic images and the ramifications this has on the photographic index.

While these and other scholars who take a technical perspective on this issue make important contributions to the subject, much of the work tends to focus on the technology behind digital cameras and ignores the technological aspects behind older camera technologies, which gives the impression that older cameras are not as artificial as digital

ones. The result is that older camera technologies are given an elevated status, one that strongly positions it as an automatic process. This is particularly interesting in regards to the fact that photographs also have been given an elevated status, due in part to the strong iconic and indexical elements inherent within it, as seen in Chapter One. Positioning camera technology as automatic also plays a role in elevating the status of the photograph and vice versa. This automatic characteristic given by scholars makes the technology seem naturalized, almost as if it is no longer a technology but simply an automatic process that requires no human interference in the design and creation aspect and almost none in the capturing process, save pushing a button. This automatic nature of photography has been greatly emphasized in film scholarship. Noting that scholars have positioned camera technologies in this way, Patrick Maynard wrote a book to directly address and remedy the situation. Maynard writes that his book has a simple thesis statement that declares that photography falls into the category of technology.¹ Furthermore, Maynard argues that “Almost every history of photography emphasizes its technological history, but none presents it in terms of technology”.² As a result, they are devoid of reflection upon the nature and history of technologies at a general level and never bring any insight onto the subject matter at hand, photography. Maynard sees a large flaw occurring when scholars examine a subject in such a manner. He emphasizes that it creates too narrow a field, which cannot fit in any new technologies of photography and overlooks connections to photographic processes that do not have links to photographs. This seems to be exactly what is occurring with discussions of digital technologies, for its different technology makes it seem as if it does not fit into the same category of imagery.

For Maynard, it is important to characterize photography as a *process*, something that is inherent to all technology; each invention helps us accomplish and achieve a specific goal. As such, based on Maynard's characterization, the process of photography should be categorized as a set of technologies for accomplishing the production of images on sensitized surfaces by means of light. It is evident that a technological analysis of older camera technology is lacking in regards to indexicality, particularly when it is discussed with the changes brought about by digital technology. In conducting a thorough review of some of these technological discussions in film scholarship, one should also closely examine older camera technologies and offer a direct comparison with digital technologies, to demonstrate the highly technological nature behind these optical systems and to reveal important information for the concept of indexicality as it operates in both of these types of cameras.

Scholars other than Maynard have also noticed that older camera technologies need to be more closely analyzed. Though he mentions the challenge posed by digital graphics with respect to indexicality, Greg Hainge seeks to show why indexicality also needs to be addressed in terms of pre-digital photography. Hainge writes that photography has recently fallen from grace because the analogous relationship between a photograph and its objective reality, which was previously believed to be a very strong connection, has been thrown into doubt by those who discuss the manipulability of images by digital technologies and simultaneously emphasize that film photography is just as manipulatable. Hainge discusses the indexical quality of the photograph, noting that it is deeply ingrained as a belief, yet he considers it to be a weak link; he argues it is not yet certain that the link between the photograph and the pro-photographic scene is indexical.

If the indexical nature of photography is uncertain and a key aspect defining indexicality is that it points to the existence of an object, then the medium's relationship to reality is one that he calls "fragile."

Furthermore, Hainge proposes that the indexical quality of images is in doubt due to the specifics behind the photochemical process of production, whereas most scholars argue that it is indexical because they look at the technological apparatus as a whole or as a medium.³ Here we see Maynard's earlier point about scholars needing to remember the technology behind film cameras coming into play; Hainge is able to examine the indexical nature of photography at a deeper level, by examining the technical aspects, instead of looking at the system as a whole. Hainge notes that it seems next to impossible for photography to be viewed as not having an indexical nature because scholars and critics have all used a similar ontology of the medium. They examine only the photographic product (the photograph itself) and the practices that produce the mediated reality of the photograph, but neglect to comment on the photochemical and material qualities of the process,⁴ whereas Hainge argues that analyzing the technological, mechanical process of developing film demonstrates that photographs have a strong iconographic relationship to reality, as opposed to an indexical one. This iconic relationship occurs because the photograph's visible image is produced "not in the analogue process that forms the latent image as light frees atoms of metallic silver from silver halides but, rather, in the far more arbitrary stages of development and fixing".⁵ The iconic aspect of photographs is arguably more important than the indexical aspect, at least from a spectator's point of view, for their connection to the image is usually through its iconicity or likeness to the object photographed.

As support for his argument, Hainge analyzes photographer Edward Weston's essay entitled "Seeing Photographically." In the essay, Weston makes an argument very much like Roland Barthes' in *Camera Lucida*. Weston suggests that the photographic process provides the photographer with a means of seeing the very nature of things, presenting the basic reality of his subjects. More than this, for Weston, a photographer is able to reveal the very essence of what is before the lens so that the photograph is almost more real than the actual object. The camera enables him to reveal the essence of what lies before his lens with such clear insight that the beholder may find the recreated image more real and comprehensible than the actual object.⁶ This statement about photography instantly calls into question the nature of the index and the nature of the icon, for how can a representational image be seen as more real than reality itself? It also emphasizes that spectators have an image in mind of what constitutes reality, and photography must meet these expectations in order to be seen as an accurate representation of the real.

Weston is able to capture this essence of a subject by making various technical adjustments at a number of stages in the photographic process. Hainge finds it interesting that while Weston acknowledges the manipulation of the image, it can only be done within the bounds of what he perceives to be the essence of the photograph. Thus the photographer must work within a confined set of techniques in order to obtain an image that is properly photographic and, for Weston, it is only by following such techniques that he may attain the vital essence of the subject. This is precisely Hainge's point about photography; it is the chemical fix which is the part of the process that brings the photograph from latency into the visual field that gives the essence of photography and the seeming guarantee of its indexicality. Hainge is careful to stress that the fix only arrests

certain developmental processes and it is itself a process, not the symptom of some predetermined essence.⁷

To further emphasize his point, Hainge turns to another photographer, Bill Henson, who says that the photograph is simply about suggesting something that is not clearly defined or delineated. This places photography into the performative category and not indexical and, for Hainge, reveals again that the existential nature is established in the process of the fix. Hainge emphasizes that the creativity and expressive nature of Henson's work nullifies the indexical relation of the photographic form to reality. Furthermore, Henson's work negates another important element that is associated with indexicality, that of the truth claim. By breaking the indexical bond of the photograph, its connection to the real is also broken. According to Hainge, Henson's work breaks down the ideological construct of body ideals found in the work of Leni Riefenstahl and others, helping to remove the belief that these photographs represent "ideal truths".⁸ This is because the performative nature of photography demonstrates that reality can be inaccurately represented even if the people and events in the photograph were physically present at the moment of capture. For Hainge, by attempting to define the nature of camera technology and how it is used by artists, he seeks to disprove the indexical nature of photography and the notion of an existential bond, for it can lead to false truths presented by media and other institutions.

Tom Gunning takes a slightly different approach to his work on indexicality. Gunning emphasizes that there are two points that need to be addressed in this topic. The first is Peirce's concept of indexicality and the second is the nature of the claim that photography is truth.⁹ When it comes to digital cameras, Gunning notices the similarities and

differences in the production process. Both use light sensitive emulsion to capture and then store the light. The difference in digital cameras is that it transfers data into a matrix of numbers as opposed to placing it on film. For Gunning, storage by numbers does not eliminate indexicality and he lists a slew of medical devices such as heart rate monitors that convert their information into numbers.¹⁰ Recalling words by Peirce, an index does not need to resemble the thing it represents. It is the iconic aspect of a photograph that contains the resemblance. Thus a conversion into binary code does not eliminate or weaken the indexical aspect of digital imagery such as Rodowick argues.

Moving next to his discussion of the truth claim behind photography, Gunning first stresses that the apparatus itself, whether digital or film, can neither tell the truth nor lie. The product of the apparatus, the photograph, can also neither tell the truth nor lie for they are all incapable of speech on their own. Instead, it requires a human agent to say things about it or for it. While Gunning acknowledges that photographs can be used as evidence in a court of law, it is also subjected to rigorous testing in order to prove its authenticity. Therefore Gunning declares that if a photograph is capable of telling the truth, then it is also capable of telling a lie. Furthermore, Gunning emphasizes that any claim of truth, regardless of its source, always contains within it the suspicion of falsity, even if the common belief is that the source is trustworthy. As Gunning says, “The truth implies the possibility of lying, and vice versa”.¹¹

Importantly, Thomas Elsaesser writes that the apparatus cannot be the sole criterion for defining a medium. Nor should one simply trace a historical perspective on past apparatus “to form a genealogy of cinematic apparatus”.¹² However, this does not change the fact that digital technology is not entirely new and does need to be viewed as another way to

produce illusion in cinema. Like older camera technology, digital technology still continues to use live action in either the studio or on sets. Furthermore, it also incorporates animation, robotics and mechanical special effects.¹³ What is critical to discuss in respect to digital technologies, according to Elsaesser, is that it marks the return of the artist as the creator of an image, instead of it simply being a reproduction.¹⁴ However, many people, photographers among them, would likely disagree with Elsaesser since older camera technologies are not simply achieved “just by the push of a button” as Hollis Frampton remarks; they also require a lot of artistic skill.¹⁵ Interestingly, Frampton himself, as a filmmaker and photographer, demonstrates just the opposite of his own remark, showing that a photographer or director is truly an artist and able to manipulate images, even without using special effects; it can be done by simply choosing what to put in the frame.

Elsaesser continues to take the position of digital imagery as more artistic. However, he aligns himself with Manovich who categorizes all images into a single graphic mode, where one of the many possible types of images is the photographic effect. With this classification system, digital technology then falls into the same category as painting, animation, and live action filmmaking.¹⁶ This leads Elsaesser to put out a call to let go of the truth claim of record and evidence that is so bound to the photographic image.¹⁷ He emphasizes that the problem with this truth claim is that the index is so bound up with the icon that it causes confusion, for the index is actually coming from an institution who verifies its truth claim, even if it has been manipulated.¹⁸ This is particularly so for images used in propaganda.¹⁹ For Elsaesser, the reality-effect thus comes not from iconicity, but from the here and now or the there and then of the image. This recalls Barthes’ idea of ‘having been there’; an aspect of photographs that places the spectator in both time and

language. For Barthes, the connection with the past helps to establish a photograph's truth claim and imagery must contain this past tense in order to do so.

Having established some important points, Elsaesser tackles next the issue of how digital is different from analog. Relating it to his discussion of verb tense, he tries to establish how digital technology affects the time-space and tense relation for the spectator.²⁰ He counters those who argue that digital technology loses its indexical nature when he comments that the index in cinema comes in a multitude of forms, such as the event of going out for the night or even just the smell of popcorn.²¹ Thus, he argues that the cinema is also its physical space and all that it represents, not just in the images on the screen.²² Furthermore, he adds that television and video long ago broke from the idea of the index, yet no crisis was ever provoked there. For if television can be a live event, there is no past tense of these images, yet, as he writes "there were no essentialist assumptions surrounding the apparatus for TV".²³ Since some scholars have argued that digital technology is more interactive than analog, also putting the images further into the present tense and not the past, Elsaesser examines exactly how digital cinema is interactive since "interactive" often forms the basis of the definition of digital. He notices an important paradox within the combined words "digital" and "cinema", for he wonders how narrative could be interactive.²⁴ While computers may provide viewers with a bit more control, allowing them to choose what they watch, when, and for how long, this only alters their mode of access, not the content of the film itself. For Elsaesser, true interactivity must replace the film-time narrative with a countdown, levels of difficulty and branching points which requires viewers to have new skills of cognition, vision, and sensory coordination.

Philip Rosen attempts to address some of the same issues as Elsaesser but he takes a slightly different approach. He writes that the history of filmic textuality should be seen “as an on-going, never-completed dialectical sequence of representational strategies attempting to move toward total flexibility and completeness in encountering the real”.²⁵ When it comes to the real, Rosen notes that by definition reality is temporalized, for it is always in a state of change. To understand this further, Rosen recalls Bazin’s essays on the ontology of cinema. Rosen argues that Bazin is really saying that the process is phenomenological and has been misinterpreted as a technological finality where the world is directly captured by the lens for the subject.²⁶ Subjects always search to find meaning, therefore cinema cannot be realistic. Rosen declares it is important to stress that Bazin wrote that cinema is always an illusion. Additionally, there is no point in rendering something realistically unless it is to make it more meaningful.²⁷ Since the cinema is inevitably illusory, realism is an aesthetic and thus there is no actual, unmediated access to the object.²⁸ Rosen clarifies that for Bazin, evaluation is not done through the referent. Instead, referentiality is in the processes of the subject.²⁹

Rosen agrees with Wollen’s suggestion that Bazin’s discussion on perspective was more related to Peirce’s index than Barthes’ concept of the referent, which is more Saussurian. The distinction between the two is important for understanding what Bazin says. Rosen writes that “an indexical sign indicates or attests to the existence of something” and it is our obsession with realism that makes indexicality the crucial aspect of the image for Bazin.³⁰ Importantly, indexicality implies nothing necessary about the form or what the signifier looks like. Rosen gives the example of personal pronouns and demonstratives, which are also indexical.³¹ Thus the special credibility of auto-produced

images is not the unmediated record of how reality appears, but rather markers of indexicality itself which relies on a certain prior knowledge on the part of the spectator about how such signs are generated. For Bazin however, it is the indexical trace, which always has a connection to the past.³² Yet the concreteness only exists for a subject, where it can become a pervasive ideal or privileged model. Rosen gives the example of director Roberto Rossellini, where it is not the image and the likeness to reality but the subjectivity of the artists that filters out aspects of reality.³³ For Rosen, the phenomenological process is complex, containing three co-existing levels of subjective investment in images: 1) the individual 2) the collective (which encompasses social and cultural myths as well) and 3) the fundamental preservative impulse of the subject to overcome time with the consequent desire for objective representation.³⁴

Moving away from the spectator's experience, Rosen tries to tackle the question of indexicality in digital cinema from a more technological perspective. He writes that the distinction between analog and digital is inscription, meaning that analog is continuous but digital is discontinuous.³⁵ Digital sound should be a component when considering the indexicality of cinematic images since they are always accompanied by sound. Sound has a direct physical connection to the voice, adding a layer of indexicality, for it proves that someone once existed, and this is manifested in the timber of their voice. Additionally, Rosen notices that when it comes to digital, there is a level of hybridity in the register of the digital image.³⁶ This is due to the fact that digital cameras use light but they configure the data to look like prior pictorial norms, which for Rosen does not make it indexical.³⁷ However, he argues that digital can incorporate the indexical if it manipulates analog images.³⁸ Rosen emphasizes that digital images mimic the previously known format

(photographs from a film camera), which functioned as reliable imprints of the world. But these images were 2D and on a flat plane. Rosen acknowledges that digital can produce 3D images and these are even more accurate and indexical than 2D.³⁹ But if one puts a 3D image on a 2D surface, it must then be translated into a perspective projection of the image.⁴⁰ For Rosen the problem with digital is that these images must be manipulated to fit on a flat surface. Furthermore, since interactivity presupposes infinite manipulation, it suggests one can never be certain that the image one is seeing has been fixed or finalized.⁴¹ However, to declare digital as more manipulatable and interactive is troubling, since earlier it was shown (a) how un-interactive digital really is, and (b) that photographic images are just as manipulatable.

How spectators interact with and process images is a topic that has been greatly discussed in relation to indexicality. Mary Ann Doane strongly argues that the notion of an indexical trace stems from the direct connection between object and photographic image, but she acknowledges that when it comes to cinema, it does not work in exactly the same way. This stems in part from the phenomenological processes that operate when a spectator is viewing any image, photographic or cinematographic. Doane stresses that this process within the mind and the memory is subject to personal experience and a number of other factors that make this a unique experience which inherently breaks the connection between trace and object. Quoting Jacques Derrida, she writes “memory...is not a psychical property among others; it is the very essence of the psyche: resistance, and precisely, thereby, an opening to the effraction of the trace”.⁴²

Furthermore, Doane notes that photographic images, the basis of celluloid cinema, fails to represent motion or movement due to the impression of movement created by the

after-image effect. This means that traditional celluloid-based cinema lacks any “trace” of movement when it projects a film.⁴³ Doane carefully emphasizes that it is the loss of time by the division between frames where any trace of the movement is removed.⁴⁴ Unlike celluloid-based cameras, digital technology captures all parts of the motion, capturing it so that it is not just an impression of the body, but exactly how it moves right down to the smallest detail, transferring it all into binary code to archive the details. For Doane, digital technology’s ability to archive is a key aspect to this newest of representational technologies, as well as its “desire to represent”.⁴⁵ Here Doane refers to the long tradition in painting to be able to capture the subject faithful to what they look like in real life.

One such problem with these sorts of representations is that they are being captured on a 2D flat plane, whereas real life is three dimensional. Thus issues of perspective have always been a part of visual works of art or image technology. Computer-generated imagery is much more capable of creating three dimensional images than older technologies, which relied on fill light and optical lenses, though Doane argues these never looked quite right. She emphasizes that what moving images did get right is create a sense of the present, mainly due to the motion. Doane comments that the spectator always sees movement as an indicator of the present.⁴⁶ Yet due to the false simulation of movement in celluloid based films, digital technologies are able to provide more accurate movements, thus making movement even more true-to-life than film-based cinema.

While Doane examines some of these more positive attributes given to digital technologies, Rodowick, unlike Doane, is particularly skeptical of digital imagery; he strongly argues that there cannot be any indexical aspect within them. He attributes this in part to a change in our phenomenological relationship between photographic images and

digital ones.⁴⁷ He argues that this change in our relationship is due to the uncanny nature of digital images. Furthermore, Rodowick claims that what “we find uncanny and unsettling is the similarity of digital images to photography”.⁴⁸ Rodowick’s arguments are all highly problematic, starting with this one that gets to the crux of what he is saying. The main problem is that Rodowick falls into the same trap that Maynard pointed out: Rodowick’s argument is too general and does not allow for any other opinions to be taken into consideration when in fact many people do not find digital imagery to be uncanny or unsettling. To back up his argument, Rodowick attempts to understand and analyze the technical digital process comparing older film technology with new digital technology. Almost all of his sources for technological details come from another film scholar, Lev Manovich, known for his work from a technological perspective. Though Manovich knows a great deal about technology, scientific sources would be a more direct, objective, and knowledgeable source. Furthermore, in his comparisons, he only goes into the technical aspects of digital technologies and seems to present older camera technologies almost as if they lack any technological components. This general analysis then creates a judgement about digital technology that is not entirely accurate.

In his analysis, Rodowick describes what he sees as one of the main aspects in film technology; it is an analog representation where the “basis is a transformation of substance isomorphic with an originating image”.⁴⁹ Digital technologies for him are therefore virtual representations, meaning that they are reducible to “simply numerical manipulation”.⁵⁰ This is Rodowick’s main problem with digital technologies, for he argues that the binary code makes them all identical if they are all reducible to the same computational notation. For Rodowick, mathematical abstractions that render all signs as equivalent regardless of

their output medium mean that digital media are only simulations.⁵¹ However, the functionality of the index as mentioned by Martin Lefebvre overcomes this, as well as the knowledge received by the spectator. Digital images are not all equivalent or identical for we do not read their binary code when we look at a digital ad or watch a digital movie; they are still signs and representations that we read and interpret in the same way as analog cinema.

If digital images are visual simulations, it is interesting that Rodowick seems surprised that the digital would visually try to emulate the photographic. Other scholars who have looked at cinematic technologies, such as Rosen, Elsaesser, and even Manovich, have emphasized that all visual representations are simply a long line of technologies that have all attempted to do the same thing, namely represent the world visually. Some have argued that this can include even painting. Jean Baudrillard's work on perspective, entitled *Le trompe l'oeil*, demonstrates that painting long attempted to accurately and faithfully represent the real world. Visual technologies also attempt to do this, with each line in the succession being able to do this more successfully and accurately than the previous version. Surely, digital cameras are just the next step for technology to do this even better than before. For Rodowick, the difference with digital technology lies in the fact that he sees an absence in the preservation of the image in a physical material.⁵² Furthermore, though some scholars have likened CGI to painting, he claims that they are not autographic as they are not from a physical hand nor do they have an end product since they are infinitely manipulatable.⁵³ Instead, Rodowick states that from *Jurassic Park* (1993) on, the major creative forces in the industry began to think of the photographic as an obstacle to overcome; that digital images needed to be perceptually realistic.⁵⁴ Yet

Rodowick does not seem to notice that this is the exactly the point Baudrillard was making about photography with regards to painting, that it was the culmination of a long-held desire for accurate representation. Rodowick does note that the photographic could also be manipulatable when he writes that the time of exposure affects the photographic image. Furthermore, the act of projecting may have successive variations in the quality of light of the distinct frames. Therefore in this sense, they are also inherently manipulatable like digital.⁵⁵ However, it is evident that Rodowick does not see photographic imaging as manipulatable as the digital, which he claims will be instantly seen as suspect and untrustworthy, simply because it is digital with the possibility for manipulation.

As many have, Rodowick recalls Stephen Prince and his important theory about perceptual realism with regards to digital imagery. However, Rodowick takes issue with how Prince uses cognitive and perceptual processes to define the digital and argues he forgets about cultural and phenomenological processes. Rodowick claims these are important too, which is why he adds this dimension to his argument.⁵⁶ Despite his hard-line stance about digital technologies, Rodowick does acknowledge Elsaesser's point of business as usual for digital cinema, where film may have disappeared but cinema continues.⁵⁷ Perhaps more importantly for him, Rodowick asks both us and himself,

Have computational processes changed the nature of the image as we ordinarily characterize it? Can digital cinema express duration and past-relatedness with the same force as film, or does it even want to? Is the computer a medium and thus can one make art from digitized information and computational processes?⁵⁸

Without answering his questions, Rodowick declares that all movies can be seen as animated movies in terms of motion.⁵⁹ Contrary to still images, moving images maintain a

sense of the present for spectators, despite the fact that we are not in the physical location of the image ourselves. The sense of the past is usually associated with photographic imagery; Rodowick uses a quote by Stanley Cavell to prove his point. Cavell says, “a world I know and see, but to which I am nevertheless not present is a world past”.⁶⁰ What this means to Rodowick is that our natural mode of perception (due to photography and cinema) is to view something and feel unseen.⁶¹ With digital, there is also a new ontological perplexity regarding how to place or situate ourselves in space and in time, in relation to an image that, for Rodowick, does not seem to be one. Rodowick states that the image is only an electronic screen and that on electronic screens, we are uncertain that the image is an image or that it has a stable existence to the present or the past.⁶² Once again, this is quite problematic, for people still recognize digital images as images and that they can have the same connection to the real world. CGI technology may be able to produce some fantastic effects, but it has yet to fool anyone into believing that those characters or locations are real.

Taking pictures with a digital camera has made electronic screens so commonplace and any doubt about manipulation is removed by the knowledge one has about how an image is created. As Lefebvre so clearly pointed out, knowledge of an image, how it is constructed and what it is conveying is the heart of the index. As evidence of this, many young people have recently started calling taking pictures “documenting,” as in documenting an event one is attending. This shows that the digital pictures taken are proof to them of the reality of that event. They do not instantly suspect the pictures that they have taken first-hand nor do they think the image “does not seem to be one” as Rodowick puts it, simply because they are viewing it on an electronic screen. Rodowick’s book

seems to be riddled with these sorts of grand statements, as when, for example, Rodowick writes, “one feels or intuits in digital images that the qualitative expression of duration found in photography and film is missing or sharply reduced”.⁶³ Indeed, a sense of loss and a eulogy for film, his beloved medium, and a refusal to accept that digital can also be this, pervades the entire book.

Returning to his technical analysis, Rodowick argues that analogical transcriptions record traces of events, while digital capture and synthesis produce tokens of numbers. For him, “there is something distinctly human about analogical reproduction, which is why all digital recording requires digital to analog conversion to be humanly perceptible”.⁶⁴ It is interesting that, despite being digital, Rodowick considers motion capture as analog input and that speakers and projectors as an interface are not the same as a computer. Rodowick claims that a projector must be used to see a film, yet this is not the same as needing a computer. Interestingly, a projector does not show the negative of a film; the negative must first be converted by chemicals into a positive image. The trace that Rodowick so highly values is only in the original source, an undeveloped roll of film. Rodowick does not discuss such technical processes though. He simply states that analog is continuous and indivisible as an isomorphic record, and that therefore its inputs and outputs are continuous.⁶⁵ Digital photographs function as an indexical sign and reproduce the cultural assumptions of chemical photography, but for Rodowick the transcoding of numbers removes the temporal/duration aspect. A photograph as a physical material is evidence of having been there – the kind you can hold in your hand. This appears to be a crucial aspect for Rodowick to agree that something is truly indexical.⁶⁶ Rodowick emphasizes that this is why Barthes is struck by the intensity of past/present. When the

analog capture is converted into binary code in a digital camera, “the spatial link of physical causality is broken as well as the temporal continuity of the transformation”.⁶⁷ Thus for Rodowick, the indexical link is weakened because light must be converted. Importantly, Rodowick emphasizes that transcoding introduces a temporal discontinuity in the recording process experienced as shutter lag.⁶⁸ Such an argument requires a careful examination of camera technology, both film and digital. Instead, Rodowick seems to see photographic images as an automatic process that does not require any human interference or the fact that it is also a technological invention.

Much like Doane, Rodowick also notes that movement in cinematography is 1/24 of a second. However, while Doane emphasizes the temporal loss, Rodowick claims that each unit, as well as the succession of units in a take are temporally continuous, even though some information is lost. Digital works quite differently and Rodowick compares digital sampling to scanning.⁶⁹ For Rodowick, digital images seem more like the present to us. This is very much like older academic arguments mentioned earlier where cinema has a connection with the present, while photographs are linked to the past. Multiple film scholars have emphasized that motion creates the sense of the present in cinematic images. For digital, according to Rodowick, it is the speed of capture to viewing that makes it more like the present than the photographic.⁷⁰ He argues images connected to the present lose indexicality, for it must be a past tense. If this is Rodowick’s argument, however, then indexicality would be lost from the moment a film first ran through a projector, something he does not claim. Importantly for Rodowick though, nothing moves in digital capture, it is just an impression so digital not only loses indexicality, but also movement.⁷¹ This view by Rodowick about movement appears to contradict his earlier statement about

motion capture being indexical and analog, even if it is captured digitally. It also completely contradicts Doane's work noted earlier that digital is able to be more accurate and efficient in its capture of motion. The subject of motion has been its own issue in film scholarship and a detailed discussion of it will take place in the next chapter.

In terms of digital images, Rodowick writes, "our perceptual judgements have become more spatial and less temporal and less indexical and more iconic, although this iconism is an output for symbolic notation".⁷² Therefore, he argues, we judge digital photos by the criteria of perceptual realism and have faith they are spatially similar to events we have or have not witnessed. Importantly though, for Rodowick, we fail to recognize that the criteria have changed with digital.⁷³ Rodowick makes a bold statement when he follows this by claiming that digital does not record but converts into algorithms. Thus, computers and digital visual technologies can only simulate but not represent.⁷⁴ Rodowick calls information the symbolic realm, "blind to all matters and patterns of thought that cannot be expressed in logical notation".⁷⁵ It is strange that Rodowick appears to give some sort of humanistic quality to computers with this statement, as if computers have the subjective choice to act in such a manner. Furthermore, one must ask why he does not invest these thoughts into photographic technology, for film cameras are just as much a technology as digital. Rodowick appears to take a very technologically deterministic stance but only towards new technology, much like earlier scholars exhibited their own fears when they first saw cinematic technology. Rodowick concludes that the medium of cinematography is light and the medium of videography is electricity.⁷⁶ Furthermore he says, "The excitation of phosphors traced on an electronic display removes indexicality even from analog video as it plays with our perception".⁷⁷ To back up his claim, Rodowick notes that

a computer is fragmented and never shows the whole image at once, instead we only perceive a seemingly whole image.⁷⁸ He emphasizes that electronic images are in a constant state of change, never showing the whole image at once.⁷⁹

To address these many concerns that Rodowick and others have brought up about digital technologies, it is important to understand, analyze, compare and contrast film camera technology and digital camera technology from a technical perspective about how they are both able to capture images. J.C. Dainty, former professor in the Department of Physics at the University of London, conducted a thorough analysis of the photochemical process in film cameras down to the microscopic level in order to be able to find limitations of the process and establish an ideal array of photon receptors which would improve resolution of images. Dainty emphasizes that film stock is coated with an emulsion made of silver halide grains, without which the film stock would never be able to capture any form of light or image. This is the first step of many which shows that cameras are not the naturalized or automatic system they have been made out to be, but a technological process that enables us to capture images. Silver halide grains are photon receptors and recorders of a specified light absorption, size, shape and photon threshold. When the threshold number of photons has been absorbed, the grains are activated so that after development they have a new absorption size and shape. A silver halide crystal or grain is a cubic lattice of silver ions and halide ions; a medium speed negative emulsion is typically 95% bromide by weight and 5% iodide. The crystal structure has imperfections and impurities which act as trapping sites for the photoelectrons which are produced following the absorption of light energy and which assist in the efficiency of a developable grain. A photoelectron may be raised by absorption of a photon of sufficient

energy (less than 495nm) or by thermal fluctuations such as heat. These are then trapped in the conduction band and consist of an energy level corresponding to the crystal defect. Following absorption of a sufficient number of photons, the silver halide then has a unique property that it be preferentially reduced to silver. The rate of reduction is greater if it has absorbed the threshold number of photons.⁸⁰

This increased rate of reduction is due to the latent image. The latent image is not visible to the eye or with any instrument, although some scientists have speculated that perhaps a strong electron microscope would show the electrons in their excited state. The latent image will only become visible and detectable by the process of photographic development and “consequently its existence is defined by the particular chemical reducing agent which is used”.⁸¹ The latent image is formed as a result of the arrival of photoelectrons and silver ions at specific sites in the grain, getting trapped in the conduction band. The silver ion combines with the electron to form a silver atom. At least three or four silver atoms are needed to form a developable grain, stabilizing the latent image. Not all photoelectrons produced make a contribution to the image. Once a latent image has been formed in the grain, ensuring a high probability of development, any further light absorbed is wasted and does not contribute to the image. This means that a certain amount of the light reflecting off an object does not make it into the final photograph, creating a discrepancy between the original source and its representation. For Dainty, silver halide grains are an on/off photoreceptor with a single image output level, very different from what is that of the ideal photoreceptor.⁸² Thus forming an image is a two staged process: first, the silver halides forming the latent image and next, the development. The quantum yield of the primary process is defined by the reciprocal of the

number of absorbed quanta (Q) which are necessary to make a grain developable. There is no single value for exposures to visible light, silver halide grains have a wide spread of Q values, meaning that no silver halide grain acts the same and will require different amounts of light energy to produce its portion of the image. This means that if two photographs of the same object were taken, the identical corresponding points of the object will be produced using different amounts of light energy in each of the silver halide grains. This is because basic differences in the crystal structure affect the efficiency of latent image formation. Therefore each grain is unique and it is its own single output unit.⁸³ Thus when Rodowick is concerned that digital technologies lose their indexicality since they never show the whole image at once, neither does a photograph for each element is its own fragmented capture of a specific amount of light for that point. Furthermore, Rodowick emphasizes that digital imagery also loses its indexicality due to the conversion of light into binary code. It is clear that even in photographic imagery, light is converted even down to the microscopic level as soon as its particles interact with the silver halide grains.

Kurt Jacobson notes that prepping the photographic emulsions is of vital importance or else the silver halides will not be able to capture any photons to start the chemical reaction within them. First the silver halide is precipitated by the reaction of an alkali halide and a silver salt in the presence of a protective colloid, usually a gelatin. The conditions during this stage are of paramount importance. The main factors are temperature, rate and method of addition and concentration, all of which require careful handling so that the silver halides will be able to properly absorb the light energy that will produce images. Larger crystals and thus higher sensitivity are produced when the precipitation time is extended

or if the temperature is raised.⁸⁴ This must ripen in a solvent environment, then set and be washed. Then a chemical sensitizer is used for the final stage. At this point, film stock is now ready to be used.

Graham Saxby, both a retired photographer and former professor of Modern Optics at the University of Wolverhampton, was asked to write a book on the science of imaging, which he thought must have been done many times. To his surprise, there were only six books ever written, four of which were out of print. His book details the scientific principles of photography in plain language with a target audience of photographers, thinking that understanding the theory would go a long way to helping photographers to both take better pictures and manipulate their photographs easier. Saxby writes that black and white film is coated with two layers of emulsion, one slow for low sensitivity and one fast for high sensitivity to increase the exposure latitude.⁸⁵ A plain silver halide emulsion is sensitive to only blue-violet and UV radiation. Thus improvements were made over the years that enabled the silver halide emulsion to be able to reproduce colours that are faithful to its object. In order to be sensitive to other wavelengths, the crystals are coated with dyes that absorb those frequencies of the photon and pass that into the crystal.⁸⁶ The first dye discovered allowed for a sensitivity to green light; such emulsions were called orthochromatic. Later dyes were discovered so that red light could be detected and such emulsions are called panchromatic, which is a Greek term meaning all colours.⁸⁷ Colour film has three layers of emulsion, one to absorb the green, another blue, and another red. Since all three will be sensitive to blue, a layer of yellow dye is needed in-between the layers.⁸⁸ What this means is that the photons captured in the latent image are divided up by their wavelength, so that any particular point on an object in a photograph is not

“represented” in just one grain, but in many. This again shows the fragmented state of filmic images as well as its inability to faithfully represent iconically, unless it has been adjusted by human invention.

In a developed film, the image is made up of millions of tiny grains of opaque silver. Although silver is shiny, the texture of the grains cause the light to be reflected back and forth until it has all been absorbed, making it look black. At the microscopic level, a photographic image is a binary device, just like digital, where light passes through completely unimpeded or is blocked completely.⁸⁹ The negative itself is only an intermediate stage, where the most light energy (the highlights of the subject) result in the most silver and the least energy (the shadows) results in the least silver.⁹⁰ Pure silver atoms formed with light energy meets the silver halide emulsions due to silver’s unique properties as an element. The developer hyposulphite will then dissolve any silver halides left that are not pure silver atoms, revealing the latent image.⁹¹ But a good binding medium is the most important step for it is what holds the silver atoms in place. This was discovered in 1871 by Richard Maddox, who introduced a gelatin dry plate making gelatin out of collagen found in skin.⁹² It is only through the significant discovery of this binding medium that Rodowick is able to have what is important to him; a tangible, physical material (the photograph) to hold in his hand. The substance is the defining feature of analog for Rodowick, which as stated earlier means to him that digital are virtual representations and weaker in relation to the object. Yet if photographs are simply the by-product of a desire to be able to capture and hold images, researchers and scientists could presumably find a way for digital to have a physical output as well. However, marketing stemming from computer technologies stimulated a different area of focus, one that

simplified the process even further, making it seem even more automatic and simplified. One of the goals was the exact opposite, to remove the hands on aspect of film cameras.

A developing agent is a reducing agent that turns the exposed silver into opaque grains. Developer must first get rid of non-exposed silver, and it is important that it must work slowly enough for someone to be able to stop the process before it goes too far, or else there will not be an image.⁹³ A developer must also contain alkali, a preservative, and a restrainer, each of which contribute their own unique chemical properties to allow the latent image to become visible.⁹⁴ The film's emulsion will still contain some silver halides that will be sensitive to light, so it must be fixed and washed and dried so that the negative will not absorb more light.⁹⁵ Printing is done by projecting or placing the image onto paper that also contains an emulsion; a negative of the negative produces a positive image which is on the same scale size-wise as the negative. Then the positive image is blown up to the size of the standard photograph. This is what is most interesting when it comes to Rodowick's view about the indexicality in a photograph, for the photograph itself does not actually have any direct connection with the object. Any form of direct connection lies only within the negative. The photograph that one holds, looks at, and connects with is actually just an iconic copy of a copy of the negative. Only the visual resemblance of the negative is transferred onto photographic paper, first at the same size as the negative, then the positive image is copied again as it is blown up to standard photograph size. When Rodowick argues that indexicality in digital images is weakened by its conversion from analog to digital, it is clear that the indexical link in photographic images is equally weakened from the number of steps between the negative and the actual photograph itself.

Though the lenses in a camera aid with only the iconic resemblance of an image, without their help, cameras would not be able to produce images that so strongly resemble its object; a key factor in the strength behind indexicality in photographic images as noted in Chapter One. Fritz Hershey writes that focus is the intersection of light rays to form an image and is dependent on the positional adjustment of the lens and the viewing system.⁹⁶ Furthermore, “a lens is a device whereby a large cone of light from a point may traverse a large disc and be refracted so that it is once more concentrated to a point to give a very bright sharp image”.⁹⁷ As light passes from one medium to another, such as from air into glass, the angular change in direction is called refraction. The frequency remains the same, but its speed and wavelength change.⁹⁸ Photographic lenses are made up of both negative diverging lenses, which direct light away from a central point, and positive converging lenses which direct rays toward a central point. These combine to form a compound positive lens. They converge the scattering light rays emanating from an object back into a point again. The rays of light emanating and scattering are gathered and the light is re-arranged back into the same pattern.⁹⁹ Interestingly, Hershey notes “this re-arrangement is called an image”.¹⁰⁰ Since five to eight percent of light is lost by reflection at each air/glass/air surface, lenses now are coated to help reduce this loss down to 1.5%.¹⁰¹ It is only with the help of such coatings that lenses are able to produce such accurate and faithful representations. Furthermore, lenses have aberrations, particularly when it comes to colour. Lenses for motion picture photography are quite different: they are grouped according to their purpose, such as if they are meant to address low light, versatility, coverage or power. Therefore these lenses are all significantly different with varying strong and weak points.¹⁰² Such technology would not allow photographic or digital

images to resemble the object photographed and demonstrates that neither technology is automatic, but a highly complex system that allows it to capture and create images.

Digital camera technology has some similarities to film camera technology and some differences. The main difference is that digital images are the electronic measurement of the luminance of the optical image at a closely set mosaic of points. The key difference being that it is electronic; film technology is also just a set mosaic of points (the grains). Each point in a digital camera sees the luminous level of its own area as a continuous function, and therefore it is analog in itself. These light levels are then digitised at the storage stage after it has been received by the photoreceptors. Semiconductors, the basis for modern electronic components, have their electrons bound up within their structure, but these bonds can be shaken up with sufficient electrical energy so that the material can carry an electric current and so the electrons are free to move. Silicon is the most commonly used material in the form of a single crystal. The structure is that of atoms with four outer electrons locked with the adjacent atoms. A charge-coupled device (CCD) is strictly a capacitor which stores an electric charge, nothing new or applicable only to digital technologies. Saxby writes the earliest capacitor was a glass jar lined with metal foil.¹⁰³ Application of a voltage causes the electrons to flow into one side and out of the other. When the voltage is removed, the charge remains for some time. CCD's have a very thin dielectric layer and a large area of foil which can store a large number of electrons in a small space. When light falls on the device, the photon's energy transfers electrons into the substrate where they remain as a surface charge.¹⁰⁴ Each capacitor represents a single picture element (pixel) of the photosensitive array in the focal plane of a digital camera. Each pixel records the light intensity of the optical image (the exposure) at that point of

the focal plane and holds it in the form of an electric charge. This needs to be read and stored before it can be shown on screen or printed on paper.

Though film cameras and digital cameras have some differences, mainly with respect to how the images are processed, they are also quite similar. For example Ben Long notes that a film camera has a piece of film sitting on the focal plane and a digital camera has an image sensor mounted on the focal plane. Currently, there are two major types of image sensors available. The first type created is the CCD, and the Complementary Metal Oxide Semiconductor (CMOS) is more recent and not as commonplace though the role of both is the same. When one takes a picture, the light falling on the image sensor is sampled and then converted into electrical signals. After the image sensor receives the light, these are boosted by an amplifier and sent to an analog-to-digital converter that turns the signals into digits. The camera's computer will be able to process a set amount of data based on its memory size until the card is full and the data needs to be transferred to a computer.¹⁰⁵

The image sensor in digital cameras is a chip made from silicon and it is covered with a grid of small photosensitive electrodes called photosites. There is one photosite for each pixel. Before a picture can be taken, the camera charges the surface of the CCD with electrons. Due to the photoelectric effect, when light hits a particular photosite, the silicon, a metal, releases some of its electrons. Each photosite is also bounded by a non-conducting metal, so that the electrons remain trapped. Recalling the process where the silver halides electrons become excited (and therefore starting the process for it to create silver atoms that get trapped in the conduction band), there is not much difference between the two technologies except the type of material used; film technology uses silver halides and digital technology uses silicon. Photosites in digital technology can be compared to

very shallow wells, each storing up more and more electrons as more and more photons strike them, also similar to film technology. Once the CCD has been exposed to light, the camera simply has to measure the voltage at each site to determine how many electrons are there and, thus by extension, how much light has hit that particular site. This measurement is then converted into a number by an analog-to-digital converter.¹⁰⁶ The number is thus simply a representation of how many electrons and how much light struck that particular region.

To take colour pictures, a digital camera performs a variation of the same type of RGB filtering Maxwell used in 1869.¹⁰⁷ In fact, the system used in digital cameras to capture colour is not much different than that of a film camera. While film cameras use dyes to allow the silver halide to capture red and green, and the silver without dye to capture blue, each photosite on a digital camera's image sensor is covered by a filter that is either red, green, or blue. This combination of filters is called a *color filter array*, and most image sensors use a filter pattern called the *Bayer Pattern*.¹⁰⁸ One of the main differences between digital cameras and film cameras is the efficiency of a CCD regardless of colour or wavelength. CCD's usually respond to 70 percent of the incident light, meaning a quantum efficiency of about 70 percent. This makes a digital camera far more efficient than photographic film, which captures only about 2 percent of the incident light. Though Rodowick calls a film camera the medium of light and digital cameras the medium of electricity, perhaps it is the digital cameras that should be considered as the medium of light given that it is so much more efficient at light capture.

By analyzing the components that make up the technology behind film cameras and digital cameras, it is clear that they are actually rather alike. Both contain a photosensitive

region that is highly complex, and neither of them just naturally captures light to form an image. This region would look quite similar at the microscopic level; they both contain electrons that become excited when light strikes the region. The silver halide grains form a crystal structure much like the silicon photosite in a digital camera, so that the layout of each site looks like a layout of points or pixels lined up to correspond to each amount of light that has hit it. Each silver halide grain or pixel is a single output containing a set amount of light, which makes both technologies continuous and thus analog. As noted earlier, they are also both binary.

This analysis poses some important philosophical questions. Theorists such as Doane or Rodowick consider a film camera to be capable of having a direct physical connection with the object. When cameras are deconstructed into their parts, does this mean that the indexical trace is simply a registering of the light levels bouncing off of us and being captured on celluloid? Is this what they mean by trace? If so, then our indexical trace is bounced off of everything we come into contact with, buildings, trees, and more. How much of our trace do these things capture albeit invisibly, for light is energy that by physical laws can only be converted and not destroyed. Furthermore, is our trace really as microscopic as photons and electrons? An index by definition does not need to resemble its object. But a photograph does, and it is the iconicity that seems to substantiate the indexicality in photography. If one is to assume that there is an indexical trace in photographic images, then the photographic index is not natural in the way that a footprint in the sand is or like that of a weather-vane, the most commonly cited examples. It is man-made, and only by technology is the film even capable of any sort of capture. If there is an index, only a minute fraction of the light is held within each crystal grain of silver halide

depending on its wavelength, which is just like each digital pixel. Digital images can therefore only be as indexical as photographic ones.

As Lefebvre points out, indexicality is about trust in how the image was made; people will not consider images where digital capture looks like celluloid to be less indexical or trustworthy based on the fact that the light gets converted into binary code. In fact, due to the efficiency of digital photography which captures the body and its surroundings more accurately, people may actually trust it as a more accurate and therefore an indexical reflection of the object. This, along with the cultural belief of the most recent technology being better than the old, would allow digital images to be seen as more indexical. The body is still captured via light, using even more light, in fact, than the old cameras. Therefore the physical connection and the certainty of the object's presence is all the more confirmed. Rodowick calls for an important formation of a new ontology of the digital. But so long as digital images look the same as photographs and celluloid films, the digital process must fit into, relate to and expand upon these issues of perception, spectatorship and sign systems.

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CHAPTER THREE

Digital Motion Capture: The Next Phase in Cinema's Development

“Every new development added to the cinema must, paradoxically, take it nearer and nearer to its origins. In short, cinema has not yet been invented.” ~André Bazin

As Peirce develops his logic of a sign system, which includes defining the index and other elements of a sign, he also connects issues of phenomenology, reality and perception. An important point from Peirce is that we build our knowledge of reality using our social peers and environment, which impacts how each individual will perceive, comprehend, and process the different elements of a sign. Today, we apply this theory to understand how spectators come to interact, understand, and identify with signs. In the previous chapters, the main issue at hand has been better understanding the indexical relationship within digital imagery both at the theoretical level, as well as at the scientific level. Another important part of the discussion of digital imagery, which is strongly linked to issues of perception and reality, is another new technological development in the film industry, digital motion capture. This is not an entirely new subject in cinema studies; many scholars and philosophers from both the pre-digital age to today connect these issues to what makes cinema so fundamentally different from photography, movement. With the change to digital methods of capture, the issue of movement in cinema needs to be re-examined in light of these technological changes. Furthermore, movement, particularly motion capture, is connected to the index, complicating scholarly claims about a loss of the index from digital technology. It is important to further our understanding of

how movement operates within digital modes of capture and how this new technology helps to define the nature of the index and its related issues such as spectator methods of perception and realism.

Motion capture has been compared to an early technology used in animation called rotoscoping. Here again we see that issues surrounding motion capture are not new, only this time for the film industry. Computer technology in the 1980s and 1990s allowed for motion capture as we know it today to be developed. Like the Internet and other well-known modern technologies we use in everyday life, motion capture was initially created by the military. The military designed it to help train pilots to make the correct head movements to fly a plane in combat scenarios before they even stepped in a plane. Though different kinds of motion capture exist today, the output for all systems is the same for all computer programs; it is a binary code that must be read by a software system that has been programmed with the correct algorithms so that it can display the motion correctly onscreen. The final product of a motion capture data set is digital imagery put into motion.

In terms of indexicality, motion capture fits right in to the argument of whether digital outputs maintain their indexical relationship. Many of the main theorists who argue that digital imagery loses some or all of its indexicality, see motion capture as a stronger form of index due to the direct connection with the recording of the body. This would label motion capture as an indexical trace. Since indexicality is so strongly connected with an existent object, a main issue surrounding motion capture is how it works with the concept of realism as a cinematic aesthetic. Furthermore, motion capture connects strongly within the body of film scholarship that discusses movement and how this operates. Movement within the cinema has stimulated many discussions separate from indexicality, although it

is often connected to issues of realism. Realism is an aesthetic aspect of filmmaking that uses the basics of how a spectator naturally perceives and understands imagery, alongside industry editing conventions, to produce images that seem to accurately and faithfully mimic the real world. Motion capture ties together these three issues, since it directly involves all of them. By examining the technology behind motion capture combined with industry applications, these issues of movement, realism, and indexicality can all be better understood and defined.

Many early twentieth-century scholars and philosophers were interested in evaluating the effects of movement in cinema. Movement is an inherent part of the technology; it was a part of the wonder and spectacle in the days when it was new. Manovich emphasizes that the original names for cinema, such as kinetoscope, cinematograph, moving pictures, demonstrate that the cinema can therefore be understood from its birth as the art of motion. Cinema, writes Manovich, is the “art that finally succeeded in creating a convincing illusion of dynamic reality”.¹ It is interesting that cinema is so often defined as illusory in nature, yet so connected to reality through the index. Along these lines one must then ask, is cinema also the art of creating the illusion of an indexical trace or at least the illusion of a stronger index than what is really there? Since movement is part of the illusion of cinema, to better comprehend the index, an examination of how technology captures movement is therefore critical. When it comes to movement, Manovich sees a shift that happens throughout the history of cinema. Everything that characterized moving pictures before the 20th century, notably movement, got relegated to the background in the form of animation. What is different about animation is that it highlights its artificial character, “admitting the images are mere representations”.² Classical cinema is just the

opposite of this, for it works hard to erase any traces of its own production process. In the early days, special effects that allowed filmmakers to alter and construct moving images were pushed to cinema's periphery, particularly through the style of continuity editing and the narrative structure. These editing conventions were developed in the early days of cinema, based mainly on how spectators responded to and understood the images they saw. From the early 1900s then, cinema sought to create and edit moving images that were best perceived by spectators.

Henri Bergson sought to understand movement from a more philosophical position. He uses movement in the cinema as a way to better analyze human perception and nature.

Bergson writes in his introduction:

If the intellectual form of the living being has been gradually modeled on the reciprocal actions and reactions of certain bodies and their material environment, how should it not reveal to us something of the very essence of which these bodies are made? Action cannot move in the unreal.³

Here Bergson immediately identifies movement with the real. Since he is an early scholar, his work is one of the first to connect movement and realism in cinema. Additionally, in terms of the photographic index, Bergson makes a very insightful remark when he connects the very essence of ourselves with our bodies. The essence, which we usually consider to reside in our mind, is an abstract concept that we connect to our physical selves, as its outwardly proof of existence. This is similar to the photographic index, which we can describe as the outward evidence of our physical bodies, but more than this we connect our very essence to the body and therefore to the photograph. Furthermore Bergson emphasizes that movement of the body is one of the ways we define whether a creature is living or not.

Bergson relates this right down to our cellular structure. He notes that each cell evolves in its own specific way, which importantly acts as a register where time is being inscribed.⁴ The present state depends exclusively on what happened in the previous instant, which extends back to the instant before that and so on until the starting point. Bergson relates this to a mathematical equation where time is an independent variable; however, he emphasizes that organic life should not be subject to mathematical treatment.⁵ More important to Bergson is the continuity of change, the preservation of the past in the present, the real duration inside of a living being which seems to share these attributes with consciousness.⁶ Life then seems to evolve as a continuous creation of unforeseeable form, where our senses can view a history that could be divided into a series of successive states.⁷ The conclusion of this analysis is that duration is an important aspect of reality, even if duration is often expressed in logical or mathematical formats which are non-temporal. Thinking non-temporally does have its advances; for Bergson, it allows one to see the whole picture, and in this way even into the future.⁸ Both types of thought concepts have their own purposes.

Bergson notices that humans have a stable view of what we term a form, which he emphasizes is in fact not stable. It is only when the change has become large enough that it enters into our perception when we will say that the body has changed its form. However, the body is actually changing form at every moment in our cellular structure. Bergson declares that what we should say is that there is no form, since form is immobile and where the reality truly lies is in movement. He says, "What is real is the continual change of form: form is only a snapshot view of a transition".⁹ The result is that our perception finds a way to divide and stabilize into separate images, what is really a fluid

continuity. Importantly, Bergson says that if the successive images do not differ from each other too much, then we consider them to be a waxing or waning of a single entity. But it is when the form changes significantly that we also indicate, often by a change in name, that the essence of the thing itself has changed. Furthermore, action then appears to us in the form of movement. Bergson notes that usually we turn away from the movement and focus on the plan of the movement, such as where it is going. It is in the direction or the position of its end point that we represent it. What this means to Bergson is that it is only when the movement is finalized that we consider the complex act to be defined.¹⁰ This is problematic when all living organisms are in a constant state of change, as Bergson emphasized earlier.

Trying to characterize our natural attitude towards our very being, or Becoming as Bergson calls it, is a challenge for it is infinitely varied. There are different evolutionary movements, and there are profoundly different types of movements which we might group into a larger category of action. What we must accomplish by using our perception is a single representation, which for Bergson is a general concept, undefined, and simply an abstraction that does not really say anything. Our mind will string together a series of images of the entity, which represents different states and serves to distinguish the different stages from each other. It is only when we string together these images and view them moving successively from the beginning to the end that we can form an understanding of the entirety of the object all at once.

Bergson relates these concepts to the cinematograph, for it does exactly that, string together a series of still photographs to view the successive stages of each movement. The process consists of extracting from the movement of images, an impersonal idea of

movement in general, which gets reconstituted by combining the impersonal movement with personal attitudes and attributes that we learn from the image as a sign system. Bergson declares, “such is the contrivance of the cinematograph”.¹¹ For Bergson, this process is flawed, but he emphasizes that it is the same process we use to build knowledge. Instead of looking at the inner movement or becoming of things, we distance ourselves in order to recompose them artificially. He writes that it is almost like we take snapshots of the passing reality, but forget to remember that these are just characteristics of the reality, just a fragment of the complete picture. Bergson concludes that the mechanism of our knowledge is of a cinematographical kind, which is illusionary in nature. Importantly for him, movement plays a role in fragmenting and dividing concepts, instead of analyzing them as a whole. For Bergson then, we need to put aside the cinematographic mechanism we use for gaining knowledge and create a method that allows us to view a concept in its entirety.

Another early scholar, Hugo Münsterberg, also sought to understand how movement in cinema affects the perception of spectators. He writes that the problem with movement in cinema is that movement forces itself on every spectator. Importantly for Münsterberg, we know that every frame is really fixed, immovable. Yet we do not see the passing of the long strip of film. Neither is the movement from picture to picture visible. The reason we do not see the broken image is because if the movement is quick enough, the positive afterimage is still effective in our eyes. In his attempt at understanding perception and movement, Münsterberg asks, much like Bergson, “What else is the perception of movement but the seeing of a long series of different positions?”.¹² However, Münsterberg answers by emphasizing that it has been discovered that this is too simple an answer and

perception is more complicated than this. He notes that studies show perception of movement is an independent experience, more than a series of different positions. Importantly, consciousness must also be added.¹³ Additionally, illusions of movement, such as the perception that a train is moving even though it isn't, are examples of how consciousness plays a key role in our perception. In this example, motion appears to be true motion, yet it is only created in the mind. The essential condition is the inner mental activity, not the successive movement or different positions.¹⁴ What Münsterberg feels is so important in terms of cinema, is that we know films operate like this, yet we see the movement anyway. Therefore, even though mental activity or consciousness plays the most crucial role in terms of perception, we can still ignore this and allow the perception of the afterimage to fool us into believing the illusion of movement is real.

As noted earlier, the reality or existence of an object is a key part of the definition of an index. Recently, Tom Gunning returned to the question of movement in cinema and its relationship to indexicality. To clarify what the index is, Gunning recalls a number of indices mentioned by Peirce, such as the weather vane, which perform their references simultaneously to the action or movement of their referents. This shows that the association of the photographic index with the past tense, such as many scholars do, is actually not a characteristic of all indices.¹⁵ Gunning notes that although the usual viewpoint is that the index positions the photographic image in the past tense, motion, such as is created by the cinema, brings the imagery into the present tense. However, in terms of movement, Gunning searches to look beyond the idea of index in terms of tense in order to help define what makes the cinema what it is. To start this discussion, Gunning quotes Germaine Dulac who declared in 1925 that cinema is the art of movement and

light.¹⁶ To further answer his question, Gunning ponders if there are other aspects of cinema that can be indexical and therefore connected to the world it portrays. Gunning emphasizes that the concerns that preoccupied both the French Impressionist filmmaker and the Soviet Montage theorists of the 1920s, such as cinematic rhythm as a product of editing, camera movement and composition; the physical and emotional reactions of film spectators as shaped by visual rhythms; even the visual portrayal of mental states and emotions; were all linked to the cinema's ability both to record and create motion.¹⁷ Motion, as Eisenstein's analysis of the methods of montage makes clear, can shape and trigger the process of both emotional involvement and intellectual engagement. An important question to determine in terms of digital cinema, is that if digital captures movement more accurately, how and/or will this affect our emotional and intellectual responses? We should presume that motion in digital cinema affects our responses at least as much as movement in traditional analog cinema. This affection combined with the greater access of digital images perhaps explains in part the fact that images of ourselves and of others are only becoming more prevalent and prolific in today's society.

Gunning continues to turn to early film scholars who also sought to understand motion in cinema. He notes that Sigfried Kracauer and André Bazin both saw motion as contributing to cinema's impression of reality. Gunning emphasizes that for Metz it is even more than this, it is the cornerstone of the impression. The important aspect to take from Metz for Gunning, is that he locates the realistic effect of cinematic motion in its participatory effect. In terms of cinema, participation is both affective and perceptual. Metz declares it is movement that produces the strong impression of reality. There is a general law of psychology that movement is always perceived as real. Metz writes that

there is usually a strict distinction between object and copy; however, this dissolves on the threshold of motion. This leads to an important point in terms of digital: if celluloid cinema is only the illusion of motion and digital motion capture is actual motion, these effects would likely be amplified. Perhaps what is most important in Gunning's analysis is his emphasis that motion involves two things; it contains both *transformation* and *continuity*. Here we can see a blending of ideas from Bergson and others. By noting that motion involves both transformation and continuity, we can see Bergson's idea to look at the whole of the picture (the continuity), as opposed to just the successive images (the transformation). This can also be linked to Münsterberg's notion that recognizing the illusionary nature and the conscious act of movement are important for understanding the effects of movement in cinema, for the illusion here is that something is transforming, when our consciousness can visualize that it is also remaining the same.

Like others, Metz declares that one of the most important problems in cinema is the impression of reality experienced by the spectator. A large part of this problem is that films have the appeal of a presence and a proximity for the spectator, which play a role in heightening this illusionary nature of the cinematic medium. For Metz, it is important to stress that this impression of reality is both aesthetic and psychological. He notes that fantasy is fantastic only as it convinces us; the spectacle is in the moment when the unreal seems to be realized.¹⁸ Furthermore, Metz writes that cinema creates a new category of space-time: place-present but time-past. This means that in still photography there is an illogical conjunction of here and then, a combination of both past and present. This explains the quality of "real unreality". The impact of this combination of both the real and unreal, alongside the past and the present, is that spectators insist upon the magical

aspect of the photographic image, but never completely experience it as total illusion. The difference between cinematic images as compared to the photographic for Metz is that the illusion is stronger in cinematic images due to their movement. He emphasizes that movement brings volume, and volume suggests life. Importantly, motion imparts corporality to objects. Indeed, bringing abstract concepts into a sort of corporality so that they can be captured and viewed is an important part of many films.

Corporeality plays a crucial role in our perceptions of what is real. Metz notes it is often the criterion of touch that divides the world into objects and copies, and thus how we can conceive of something real and unreal. To demonstrate this, Metz stresses the difference in corporality between a stage production and a film.¹⁹ He writes that it is precisely because the real world does not intrude upon the fiction and deny its claim to reality, as in a stage production, that a film's diegesis can yield its stronger impression of reality. Stage performances take place in the real world, and we constantly see the corporality of it around us as we watch the performance. On the other hand, films take place on a screen and spectators are always aware that no matter how real a film feels, the actors are not physically there performing. This means that films rely on a low degree of existence in order for us to be able to project and identify with its characters. Importantly, Metz realizes it does not logically follow that the further one is removed from reality, the stronger the impression. Still photography proves this point for Metz, for it also has a low connection to existence but it does not convey the same sense of reality as cinema. Again, Metz notes that motion is needed to convey this impression. The key then is a balance between a format with a low existence and an actual connection with the real to be able to achieve the impression of reality that cinema does.

More recently, Mary Ann Doane sought to combine and further many of these discussions about motion and the index. Doane first returns to Bergson who states that to produce the illusion of movement, there must first be real movement. Doane emphasizes that, for Bergson, the real movement for celluloid cinema is found in the projector. Importantly, she notes that it is a device separate from capturing the image. Doane stresses that not everyone agrees with this; Deleuze argues the movement is found in the spectator, who only sees it as movement. This recalls the fact that Metz emphasizes the psychological aspect to the perception. Most importantly for Doane, movement is often represented as the embodiment of time. Time is equal to change, a recurring theme amongst all scholars when it comes to motion. Furthermore, Doane declares that cinematography made possible a synthesis through projection of such moments, but nevertheless depended upon their spacing and separate articulation. In other words, it depends upon the changes and differences, as well as knowing the exact frame rate to achieve the afterimage effect. In terms of the index, Doane notes there is a loss of time by the division between frames, which in turn is also a loss in the capture of the index. She writes that the spectator has an unperceived darkness for almost forty percent of the running time, meaning that there is a forty percent loss in the capture of the index.²⁰ Though scholars such as Rodowick argue that the defining feature of analog is its continuity whereas digital is fragmented, here we see that in terms of motion and index, analog is also fragmented.

What we can see with all of these bodies of work are reoccurring themes when it comes to motion in the cinema. One of the most important themes is the fragmented nature of motion, both within our perception and in the production process of movie-making, as

well as how these fragments contribute as a whole to our understanding of the world around us and in the movies. The combination of an illusionary nature and a reality effect produced by the cinema are all attributed in part to the movement perceived in the images onscreen. As Doane notes, there is a large loss of index, image, and continuity of movement in celluloid cinema. Yet this did not stop the effects noted by scholars such as Metz. Today with the new form of movement in cinema via digital motion capture, these issues of index, realism, and the effects on the spectators must be re-examined.

The Science and Industry Applications of Motion Capture

Before one can understand the effects of motion capture, it is important to understand the technology and how it is capable of recording motion. Maureen Furniss outlines the many different forms that motion capture can fall into, each with its own strengths and weaknesses. Mechanical capture consists of a performer wearing a human-shaped set of straight metal pieces hooked onto the performer's back. As the performer moves, the metal exoskeleton must move as well and sensors are placed in each joint to feel the movement of the metal. This form of motion capture works well because it has no interference from light or magnetic fields. However, the technology has no sense of ground level, which prevents any jumping or knowledge of which way the performer's body is pointing. Optical capture is perhaps one of the more well-known formats today, where the performer wears reflective dots known as markers while being recorded by multiple cameras. The information is then triangulated between the cameras. Optical capture allows the performer to move freely without cables connecting the body to any equipment. It can also capture more than one performer at a time and provides very clean data. Optical capture is prone to light interference and the reflective dots can be obscured

by the performer's movements or by other performers or any other object in the camera's field of vision. This loss of data must be compensated for with a software program.²¹

Electromagnetic capture is obtained by a performer wearing an array of magnetic receivers which track location and movement via a static magnetic transmitter. What magnetic capture does well is to capture absolute positions and rotations, as well as orientation in space. It can also be viewed in real-time where performers can receive instantaneous feedback from a director. However, magnetic distortion can occur as distance to the transmitter increases. The data can also be quite noisy, meaning it is not as accurate as optical capture. This is due to the system being prone to interference from magnetic fields from surrounding metal objects, though this interference can be minimized by constructing sets without metal parts. Part of the challenge behind motion capture technology is the speed at which everything works. In real-time motion capture, motion must be sampled, data must be applied to a digital scene, and the scene must be rendered into a digital image, all within 1/30th of a second. This creates a bigger challenge depending upon the system used, since some systems are more prone to interference which prevents an accurate collection of data.²²

Furniss explains that motion capture involves measuring an object's position and orientation in physical space, then recording the measurements in a form that is understood by a computer program. Objects may include human or non-human bodies, facial expressions, camera positions or any other element in a scene. Much like traditional animation, motion capture is actually created using a number of phases. Here we see a connection once again to seeing movement as a series of stages. These phases for motion capture include setting up the studio, calibrating the capture area, capturing the movement,

cleaning up the data to correct for errors and then the post-production phase that creates the imagery for the final product. Furniss notes that many people have debated whether motion capture is animation or not. Yet for her this debate is not important and she would rather explore the way that spectators respond to figures based on motion capture data. She also finds it interesting that motion capture does not yet have a respectable standing within the mass art of animation or film production, but that areas such as dance, music, or the sciences have great respect for its process. Importantly for Furniss, this usually is the other way around when it comes to new technologies in cinema.

Furniss emphasizes that while film industry professionals argue about whether motion capture is animation or not, ethnographic researchers are able to use motion capture to record ceremonial dances that are on the verge of extinction. Software programs have been created by incorporating dance notation into the motion capture process. The benefits of using motion capture over another form of notation is that it allows analysis from any point of view and that it can then be visualized in 3D form. These recordings of almost extinct dances are not only an index of movement because it has been captured directly using a body, but they are also seen as an index and embodiment of the traditions of an almost extinct culture. What is crucial to stress is the inherent connection the captured movement has to the real, which is only achievable through the technological process. This inherent connection is not just about the successive movements, but also includes the traditions of the culture. An index is therefore more than just the direct recording of movement, but the larger picture of what those movements mean and represent.

No matter what one captures, one of the most important aspects for motion capture is the markers, for it is these that provide the ability for the camera to see and record. Guerra

writes that there are two kinds of markers, passive or active. Passive markers are the reflective kind, which bounce light back at the cameras for detection. Alternatively, active markers use LED's that shine their own light directly towards the camera. Active markers have their own unique frequency that makes keeping track of markers easier. However, active markers require the actor to wear a suit of wires to control each of the LED's. Passive markers therefore allow for more freedom and range of movement. Tight fitting clothing is required to be worn by the actor. For full body motion, approximately fifty markers are required.²³ Regardless of the type of marker, markers are put where the skin is close to the bone and near joints so that it can reproduce the most accurate movement.

Richard Roesler writes that by the late 1980s and early 1990s, new methods of capturing a subject's motion digitally were being created. Optical motion capture is the subject of his focus, which he defines as a method for turning real-life movement into digital data. It uses a number of cameras to film a subject from different views, which are then used to reconstruct the movement in 3D. The 3D object can then be placed into a computer model. One of the most important features of optical motion capture is that it can be used to capture the nuances of a performance and then transfer these to an animated character. The animated characters then have a greater sense of life and realism compared with traditional hand animation. For the film *Avatar* (2009), most of the landscapes were completely computer generated. By using optical motion capture, James Cameron was able to better visualize what the scenes would look like so that he could better direct the movement of the actors, which provides for a more realistic effect. Furthermore, Roesler notes this also gives a director a larger amount of creative control in the imagery.²⁴

Importantly, Roesler emphasizes that in order to better mimic the binocular vision that allows humans to see the world in three dimensions, optical motion capture uses a number of cameras in the capturing process. Here we see a direct connection between motion capture and creating a realistic effect. Roesler emphasizes that a number of considerations need to be made in order to guarantee the best results. Though the stage where the motion capture takes place does not actively engage with the capture process, the size of the area must first be decided. The size of the area is then a function of how much detailed data needs to be captured, along with the quality and quantity of cameras available.²⁵ If the capture area is very large, then the space can be split up into multiple zones of capture. Each zone would then need a number of dedicated cameras that only capture markers within that zone. To complete the picture for this sort of scenario, the data sets must then all be compiled together so that it visually reflects one area. Roesler also emphasizes that the amount of light in the capture area must also be controlled carefully. Diffusing the light reduces the effect of random reflections during the capture process. Since the cameras are programmed to pick up any bright reflections in the room as a marker, any points of light that may be reflected off any other surface than the markers can be misconstrued as part of the data set. This would create an inaccurate reflection of the motion captured. Uniform lighting, as well as background colour, across the entire capture area is best, so that markers appear the same throughout the entire area.

Roesler writes that it is important that specially made cameras be used for high-end special effects that will use optical motion capture as a baseline. These cameras must have a perfect balance between high resolution and fast shutter speeds. What this means for Roesler is that the choice of camera is driven by the movement that needs to be captured.

Guerra emphasizes that high resolution cameras are better in larger capture areas and with fine details, such as small gestures, but it does so at a loss of shutter speed. Cameras with a faster shutter speed can reduce the amount of blur caused by a fast moving object, but it does so at the expense of the clarity of the image details.²⁶ The result of this is that movements like walking or fighting require cameras with a faster shutter speed, while smaller movements such as facial gestures need the accuracy of high resolution cameras. Vicon, an Academy Award-Winning motion capture specialist, produces some of the best cameras for motion capture in the industry. Their top of the line model is capable of 16 megapixels at 120 frames per second. If a faster shutter is needed, the resolution can be lowered to get up to 2,000 frames per second.²⁷ This can be directly compared to the 24 frames per second that is the usual rate for a film that was created using non-digital technology. When Doane emphasizes the loss of time, index, and movement in the standard 24 frames per second, with digital motion capture and the cameras they use, there is a significant increase resulting in only minute losses. The Vicon cameras also have special strobe lights attached that reflect off the markers for easier visibility. Originally these strobe lights were using visible spectrum light, the same as those in studio photography, but it has become more common today to use infrared lights instead. This is because the amount of interference in the infrared spectrum is significantly less than that in the visible spectrum. In order to capture accurate data, it is important that the camera be able to easily identify the difference between the markers and its surroundings.

In the film industry, motion capture can be used in a variety of different ways. Furniss writes this can include being captured in real-time or not and with or without secondary animation of hands and face in the post-production stage. The captured data can also be

transformed into a character that looks just like the original actor that was captured or it could be modified completely. She notes that sometimes motion capture is used only as reference material. She turns to Richard Cray, founding director of the Performance Animation Society, who says that often animators rehearse a character's moves themselves prior to keyframing or hand positioning the different elements. Motion capture allows animators to use the data later to create reference points so that the movements drawn will be accurate. Other industry professionals use motion capture more directly. Seth Rosenthal at Industrial Light and Magic (ILM) states that motion capture is the basis for all animation created at ILM. Rosenthal says that they use magnetic capture for animatic work because it is fast and inexpensive, but that they use optical capture for feature work because of its accuracy.²⁸

Freedman recognizes that motion capture occupies a unique and disputed place among film technologies. He notes that by capturing live movement as raw computer data, it exists as an unprecedented amalgam of both recorded and synthetic cinema. Freedman cautions that these debates distract from other possibilities being presented. One such possibility is the one advanced primarily by director and producer Robert Zemeckis. For Freedman, Zemeckis demonstrates that motion capture represents a wholly new form of filmmaking, "one that cannot and should not be limited by our previously held definitions of synthetic versus recorded cinema".²⁹ In his film *Beowulf* (2007), Zemeckis strove to create a completely photorealistic film. Not only were the characters designed to facially resemble the actors, but the settings and props were all digitally created as well in order to allow for virtual camera movements that are impossible to create otherwise. However, Freedman emphasizes that not all people in the effects industry feel the way Zemeckis

does. As an example of this, Jerome Chen, Zemeckis' senior visual effects supervisor for *Beowulf*, downplays the effectiveness of motion capture in conveying human expressions. Chen says, "It won't record volume, meaning if the actor squints or purses his lips, it tells you when they did it, but it won't tell you how much they actually moved".³⁰ What this means is that in every shot, the animators must decide how to interpret the timing cues that is part of the data collected by the sensors. Chen also stresses that there may be cases where animators may use almost none of the data. The most important part for Chen is when he says, "There's not a single frame of the movie that didn't need to be touched by animators".³¹ Motion capture captures 360 degrees of data that in post-production can either be ignored or it can be used. It can also allow for camera angles that previously would have been impossible. In addition, Freedman notes that some animators actually indicate a certain pride in the imperfections and interventions of animation, showing an appreciation for the unrealism of their art. In fact, they view themselves as creators of a medium that specializes in plasticity, caricature, and exaggeration. Here we see that realism is positioned as the enemy of artistry. Writer and Director of *Ratatouille* (2007), Brad Bird states that "animators are not technicians. They're artists".³² Motion capture then has a unique connection to the reality effect discussed by so many film scholars; not only is it physically connected to the real, but visually it can either be operating under a realistic aesthetic or it can be completely unrealistic, or any combination of the two.

Freedman views the widespread acceptance of motion capture, seen in both the industry and at the box office with films such as *Avatar* and *The Curious Case of Benjamin Button* (2008), as an illustration of how motion capture has seemingly bridged the theoretical gap known as the uncanny valley. The theory of the uncanny valley states

that the closer we approach to making something artificially human, then the higher the level of revulsion occurs in the human observing.³³ For Freedman, *Avatar* and *Benjamin Button* overcame this struggle by emphasizing the contributions of its actors. This emphasis is partially done onscreen, where spectators can visually compare the actual physical body of actors Brad Pitt, Sam Worthington, and Sigourney Weaver alongside their digital counterparts. In the case of *Benjamin Button*, it was only the face that was digitally altered, which required a lot of work to keep it consistent with the rest of the body captured only using traditional live-action filmmaking. Freedman notes that their marketing campaigns also contributed to overcoming the feeling of revulsion. David Fincher took pains to position the performance as the sole work of actor Brad Pitt, despite the clear special effects team and motion capture system that was used. Fincher was successful in creating a breakthrough for motion capture with the Academy Awards; Brad Pitt became the first actor to receive an Academy Award nomination for a largely synthetic performance.

Freedman is quick to note that the same process of motion capture, in the hands of others, becomes a tool for creating animation. As an example of this, months before the release of Steven Spielberg's 2011 *The Adventures of Tintin: Secret of the Unicorn*, the director stated his intentions to submit the film in the Animated Feature category of the Academy Awards. Though a breakthrough had occurred in the Academy Awards with the nomination of Brad Pitt in *Benjamin Button*, the Academy Awards seemed to struggle with where to put motion capture in terms of the animation category. This can be seen by the Academy's 2007 amendment stating that animation is determined by the method of creating character performance. In 2010 they further declared that motion capture is not an

animation technique. This is quite problematic for currently motion capture technology requires additional frame-by-frame animation in the post-production process. The problem seems to arise from the fact that animators who draw by hand place themselves into a more artistic and purely creative category, whereas motion capture animation or CGI is looked down upon for being less original and creative. Based on a comic book, *Tintin* sought to mimic the look of its source material and did not intend to approach the concept of the uncanny valley. Yet despite this, Freedman notes how Spielberg marketed *Tintin* as a motion-capture film that is a direct descendant of Cameron's *Avatar*. Spielberg says, "Every person who animated every frame of this, animated every frame of *Avatar*".³⁴ Freedman posits that this demonstrates that the appeal of motion capture is twofold: it can transmit a live performance onto a synthetic character, but it also frees the filmmaker to experiment with visuals, camera movement and shot placement. According to Freedman, motion capture for Spielberg is "a much more direct-to-canvas art form".³⁵ These two contradictory forms of motion capture, one which attempts to be photorealistic and the other which attempts to avoid it, muddles for Freedman the preconceived notions of what constitutes synthetic cinema. For if identical technology can be used to create both live action and animation, then for those who choose to make their visuals more animated, the work should be seen as an aesthetic choice rather than a strictly production or technological technique.

Effects Specialist Remington Scott was asked to contribute to *Computer Graphics* about his experiences working with motion capture for *The Lord of the Rings: The Two Towers* (2002). Scott emphasizes that it is only recently that computing processor power, scanning, modeling, simulations and physique techniques as well as image based

rendering have been able to provide computer artists with multiple solutions for the creation of realistic humans that rival the photogenic quality of reality. For Scott, perhaps what is more important besides the computer generated visuals is the qualitative and quantitative measures of the spark of life. This includes creating “a look in the eyes that portrays intelligence, facial expressions that communicate subtleties and believability of performance, motion that occurs within the reality of gravity, and a weight and mass of the specific character that is truthful to the physics of life in motion”.³⁶ In essence, Scott sees performance capture as the soul of a realistic digital character’s emotion. He emphasizes that there is a deep unconscious level of bonding that humans invest into another human or any creature with human emotions. Through the act of viewing, as well as our social bonds, humans are trained to read each other’s actions. Any inconsistency in a character’s performance often means the end of the connection that a spectator has created and maintained with an emotionally realistic digital character.³⁷

It is interesting that an effects artist for director Peter Jackson would make such statements. Allison Tanine argues that the promotional and auxilliary materials put out by Jackson for *Lord of the Rings* does more than just promote the film in its theatrical and DVD releases. For Tanine, they also introduce discourses of realism and authenticity that directly influence how viewers respond to and judge the value of the film. She notes that since he produced at least ninety production and postproduction diaries that total more than six hours, “Jackson is perhaps the most extreme case of a director who believes that revealing the filmmaking process can only enhance, and not detract from, the viewer’s experience of the film”.³⁸ Furthermore, Tanine also argues that it is only by breaking with older notions of realism that sought to keep the production apparatus invisible that

Jackson and his team were able to frame motion capture in terms of authenticity and reference to the real world. Tanine first notes that living actors are able to bring their own experiences, desires, and emotions—viewed psychoanalytically as their Unconscious—to their characters. She wonders how these sorts of things could be provided for a computer-generated character through the artistic work of the animators. Furthermore, she questions whether spectators would be able to connect emotionally with a visual effect.

As a case study, Tanine examines Peter Jackson's work in the film *King Kong* (2005). Although Kong is a giant ape and not likely to be viewed as a virtual actor the way they are in other films, Tanine says that Jackson and his team still made the attempt to overcome the typical limitations that are outlined for any synthespian. What she feels is key to Jackson's effort to enhance emotional identification with Kong were his strategies of photorealism. At the top of Jackson's agenda was to make Kong look as real as the human characters in the film, so that Kong blends seamlessly into the shots with them. Proprietary software was designed to digitally model fur and skin. Not only did Kong have top of the line systems for designing fur and skin, but Jackson had his team pay just as close attention to the internal structure. Thus the model for Kong included a digital skeleton that had a complete set of digital muscles. Though the skeleton was never going to be shown in the film, it is built simply so that they could first attach the muscles, and then the external layers of hair and skin so that each body part would move realistically. Digital stunt doubles were also created for all the major characters in *King Kong* for when they needed to interact with digital creatures in such a way that it was easier to use digital characters than blend in live action shots or if the action shot was impossible to take with live-action filming. A 3D laser scanner was used to scan the faces of the actors in various

positions, with different facial expressions. The scans made it easy to add realistic detail to the digital stunt doubles.

Instead of drawing a divide between analog and digital forms of representation, or between indexical and iconic media, Tanine emphasizes the need to be attuned to how these various techniques and technologies overlap, influence each other, and intermix. Motion capture uses both optical and digital technologies to record the movements of a performer and then they are translated into a digital model. Andy Serkis who performed Kong's actions, was surrounded by an array of fifty-two small digital cameras for his body and an additional twenty for facial motion capture. Tanine writes, "The cameras recorded the arrangements of the reflective dots in space and transmitted those images to the motion capture software, which used the visual data recorded by each camera to track the movements of the markers—and thus the performer—in three-dimensional space".³⁹ She emphasizes that much artistic freedom was necessary particularly with the facial motion capture. Gorillas can open their mouths and curl their lips in ways that humans cannot, so a computer program was designed to read a particular expression on Serkis' face to be displayed as a specific ape expression. To help with this, Serkis had to learn both how gorillas move their face and how to move his face in such a way that the computer could recognize it as a specific gorilla expression.⁴⁰

Tanine writes that since Kong is a nonexistent beast, it must therefore be created as a special effect for the film. This knowledge is imparted to a spectator immediately when they start watching the film. Unfortunately, for Tanine, visually Kong does not live up to Jackson's wish for a photorealistic look. Instead, she writes that he is discernibly computer-generated and that he differs visibly from the living actors. The anxiety

surrounding the emergence of synthesians then “derives from its invisibility, that is, the extent to which it cannot be distinguished from living actors”.⁴¹ It is only when digital cinema achieves this goal of completely photorealistic actors and settings that we need to re-evaluate the participatory affect noted by Metz and later by Gunning. The perceptual recognition of movement can add to the reality effect, and the human eye is clearly capable of detecting the subtleties of distinguishing between what is real and what is not. If digital technologies were capable of completely re-creating photographic imagery and cinema, there may be no change in how spectators respond to the imagery, or it could change significantly.

However, Jackson does the exact opposite of keeping his visual effects invisible; something which Tanine writes departs from the normal point of view for the industry when it comes to special effects. As evidence, she lists a number of movies that did their best to hide from audiences the fact that special effects were used in order to convey a more realistic viewing for the spectator. To be different, Tanine emphasizes that Jackson features Andy Serkis and motion capture in the fourth postproduction diary and in another diary that focuses on motion capture. For Tanine, this demonstrates that Serkis’ role in the film was one of the most important aspects that filmmakers wanted to showcase. The diary features Serkis on the motion capture stage, showing the camera set-up and the software interface, while Serkis and other professionals explain how motion capture works. Importantly, Serkis always uses wording such as acting or character when he refers to Kong; showing that Serkis does not view motion capture as any different from conventional live-action filmmaking. Instead, Serkis applauds motion capture as a way to

learn more about your character and “tap into your emotional memory”, which recalls terms that are normally associated with the technique of Method acting.⁴²

For *Tanine*, the purpose of the film and the production diaries is to show that a digital double can provide more than a human actor can. It can perform dangerous stunts, work around the clock, interact with computer-generated creatures and their performance and look can be changed indefinitely. But Jackson and Serkis emphasize its continuity with traditional cinematic acting. Furthermore, the production diaries familiarize audience with motion capture technology. For the spectators who are unfamiliar with motion capture, the diaries position the experience using discourses that a spectator would recognize, such as acting, emotional connections, celebrity status, and realism in movement. Jackson and Serkis both acknowledge the digital exterior of the character, but insist that Serkis' performance carries over through the technology. For them, motion capture is not only a record of Serkis' movements, but a great way to also record Serkis' emotion and the psychological aspect of his performance.⁴³ *Tanine* feels these diaries are to help emphasize the direct connection that motion capture has to a live actor in order for the spectator to see the digital character with a greater realistic aesthetic. This idea can be related back to Metz who emphasizes that motion and just the right balance of a low connection to reality for the cinema to reach the highest potential for its reality effect.

Importantly, digital motion capture has a key role for understanding cinema's indexical status, which many scholars see as its status as a medium of providing a direct impression of events happening in front of the camera lens. Since motion capture is a direct recording of movement, it not only can be considered as an index, but also as an indexical trace. It is important to distinguish between the two, for an index does not require a direct

connection, it is simply one example of an index. We must then ask ourselves how motion capture compares with photography in terms of the concept of indexicality. First and foremost, a photograph is usually seen in terms of its status as both an index and an icon, where its iconicity comes from its resemblance of the object photographed. Motion capture data does not resemble the object that was recorded, but it does “correspond point by point to nature,” the way that Charles Peirce defined the index.⁴⁴ For Tanine, Doane, and Rodowick, motion capture demonstrates the ability for digital to still maintain a degree of indexicality due to its record of movement and physical connection to the object. They all recognize that Peirce declares that an index does not need to visually resemble its referent in order for it to be an index yet continue to feel that the indexical trace has a higher value or is a stronger form of index. Interestingly, for Peirce the truest form of an index was referential, not directly connected to a physical object. What is most important about the index is the knowledge that we receive from the sign and the knowledge that we have about how the sign was created.

Since the beginning, photography has long had an elevated status of its claim for telling the truth and that it is strongly linked through a direct physical connection with any object within the photograph. Yet unlike most direct indices stated by Peirce, such as the weather vane, photography does not come into direct, physical contact with its referent, except through reflecting particles of light. Peirce himself declared that photography was more iconic than indexical. Any weakened form of index is the fact that the image is only captured via particles of light; this is not exactly a direct connection. As Tanine emphasizes, “perhaps the realist claim of photography stems not so much from its indexical trace, but by the unrivaled ability of the photograph, more than any other form of

visual art, to create pictures with uncanny resemblances to the real world".⁴⁵ Motion capture data is also collected by particles of light; it does not have as much a direct connection as does a footprint in the sand. Often the complete opposite of the photographic icon due to the artistic iconicity of images created using motion capture, motion capture can be looked at as a hybrid. When it comes to movement however, there is no technology today that can rival the accuracy of its ability to capture each successive stage on every part of the body, so that movement and motion within cinema is more realistic than ever, and not just aesthetically. Importantly for the index, theorists seem to have sought to create a system of indexicality based on the strength of the index, with the deciding factor being how direct a connection to the physical world an object has. Other factors such as interference by computer technology are often part of the analysis of strength. As such motion capture is considered as a stronger index than digital imagery. But since a direct connection is not in fact what makes an index an index, motion capture and digital imagery share the same indexical relationship as each other and as traditional photographic images.

As Gunning notes, movement is the combination of both transformation and continuity. Digital motion capture is exactly those two things, not just in its relation to movement and the successive positions it records, but also in how it symbolically represents what digital cinema is. The synthesis of new digital technologies alongside an indexical trace, live action filmmaking, and the spectator effects that all made up a part of the definition of cinema is both transforming and staying the same. Technologically the cinema as a whole is transforming, but how it displays the imagery is relatively the same, building upon how spectators naturally understand moving imagery and how they have learned over time

through industry editing standards. Since aesthetically digital imagery, combined with motion capture or not, can be as photorealistic or creatively artistic as the director wants it to be, understanding how spectators relate and identify to the different types of imagery is an important next step. Perhaps a good starting point for the next step is with a return to Bergson. He emphasizes that dividing and fragmenting motion prevents us from being able to see the essence of something, from seeing the object in its entirety. Motion capture enables us to see the entirety of the movement, from multiple angles, with a point of view that visually resembles our own eyesight. It is also a combination of both the older technologies of filmmaking and the new, right on the cusp of transformation and continuity. Perhaps we can apply the concept of seeing it as a whole to learning more about where cinema is going in the future, and how these changes affect spectators.

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CONCLUSION

There is no doubt that due to digital technologies, in certain ways the cinema as it was known is changing. The predominant scholarly thought to date is that if the cinema is changing, then so too must the theory and anything else that the technology impacts. However, before these changes can be accurately analyzed, certain theoretical concepts need to be clarified first. From Chapter One we can make several conclusions as to the nature and definition of the indexical aspect of a sign system. By returning to Peirce, it is clear that he emphasized several important qualities of the index that must be remembered. The first quality is that the index itself is not descriptive by any means; instead it focuses one's attention so that a correlation can be made between the index and the object it is referring to. The second quality we learn is that an index has an element of truth or a factual quality to it due to its general categorization of Secondness. This particular quality of the index is where film scholarship or those who study visual sign systems see a strong existential bond between the object photographed and the photograph itself. Related to this is a third important quality which states that though the index must be referring to an object that is existent, the existence can occur in either the past, present, or future. Furthermore, the existence can either be a tangible physical object or simply an abstract concept that exists only within the mind, particularly if it is an established convention of a social group. Through our perceptions and its accompanying phenomenological process, the index operating in conjunction with its related icon and symbol has an important role: to convey information and impart knowledge. All of these

qualities of the index are present regardless of whether the index is part of a representation or not.

After establishing the nature of the index, it becomes clear that there are two common errors in film academia. The first misconception is that there are two types of indices, the indexical trace and the deixis, the pointing finger that is purely referential. While both of these are indices, they were not divided into different “types” by Peirce. As a part of this misconception is the fact that many scholars view the indexical trace and its more direct connection to an object as a stronger form of index, creating a hierarchy that Peirce did not intend. In fact, Peirce saw the word “this”, the deixis form of index, as the purest form, since it is knowledge and how the index functions that are the key elements for the indexical sign. The other main misappropriation by scholars is the notion that photographic or cinematic images must maintain a sense of the past tense. This stems mostly from Roland Barthes who importantly noted the connection that a photograph has with the past; it is a moment captured that is not occurring in the present. This is an important piece of information that someone may retrieve from a photograph they are viewing, but it does not define the index. Furthermore, in terms of creating a fuller understanding of the index and a sign system as a whole, to date film scholars have tended to separate the three aspects of the sign, icon, index, and symbol in their film analyses and to view a film as if it is only one of the three. Peirce emphasized that the three aspects of the sign as co-present with each other. While a film may emphasize one aspect or the other, an analysis of a film that highlights all three aspects of the sign would be highly beneficial, particularly as it relates to understanding our perception and spectatorship.

At a larger level, from Chapter One it can be concluded that a significant part of the strength of the photographic index comes from the fact that it is also so strongly iconic, having a faithful and accurate iconicity to the object that has been photographed. Almost from the beginning of photography, this strong bond between the icon and the index has elevated the status of the photograph so that it is considered to be concrete evidence and inherently truthful. This elevated status has been called into question with the recent changes in filmic production using digital technology. Since it was such a strong cultural belief, it has also played a role in the perception of digital imagery as more inherently manipulatable than photographic imagery. Though the index is the aspect of the sign that is related to the existence of an object, it appears that it is mainly through the iconicity of the photograph that we feel or connect to the object. For example, if we look at a photograph and feel that it visually and accurately represents the likeness of a person we know, then we determine that in some manner the camera has captured the essence of the person. The existential bond should be coming from the indexical relationship, but in fact, in the case of photography, our connection is primarily to the iconic aspect.

This is also seen to a lesser degree for any imagery. In the film *Cave of Forgotten Dreams* (2010) we can see how this works. At one point in the movie, they are examining the hand prints that were put on the walls by the people who painted the cave. In one hand print, a finger was slightly crooked so that they could identify every hand print as having belonged to a specific individual so long as the finger was angled in the same way. These hand prints would normally be seen as a strong index that points to the existence of someone in the past who painted the caves. Interestingly it is only the hand print that iconically resembles the person's hand that we view as an index. The cave paintings

themselves that the person painted with their fingers carry within them multiple finger prints, another strong index. However, for those paintings that iconically resemble animals, the finger prints have been smudged beyond recognition. If the crooked finger was used at all to create some of the paintings, perhaps an expert would be able to identify a defining feature of the painting so that it could be viewed more as an index of the person's hand. However, these paintings are not viewed as a strong index of someone due to a lack in resemblance and iconicity. An index by definition however, is not descriptive and does not need to resemble its referent in any way. Yet due to established conventions and our natural mode of perception, an index that has a faithful and accurate visual iconicity to its referent is seen as a stronger and better form of index. This has important ramifications for our understanding of a sign system. First it emphasizes the conclusion that Peirce already made, that the three aspects of a sign cannot be separated from each other. Our understanding and knowledge about a sign, which importantly comes in part from the index, is also conveyed through the icon. When the icon and index convey the same information, such as that of an existential bond to a particular referent, it creates a belief that iconically accurate representations convey the sense of a stronger index. We also can see that our perceptions naturally play an important role in the information that we gather from a sign. This would be heightened even more when the sign is a visual one, such as a film. In terms of a change towards digital production practices, CGI graphics that accurately depict an object so faithfully that it is imperceptible from a photograph would then convey the exact same information as the photograph itself. Only knowledge about the production process would change our view of the indexical trace and whether or not there was a direct connection to the physical object.

The direct connection between the representation and the real world counterpart is the main focus for Chapter Two. Here it was demonstrated that many scholars have analyzed digital imagery from a technological perspective, but their work, as well as historical discussions of pre-digital cameras tends to position digital cameras as a technology, but older cameras as a natural, automatic process. This naturalization of older camera technology helps to strengthen the elevated status of the photograph noted earlier, that it has an inherent claim to tell the truth. However, this truth claim of the photograph must be questioned by examining the production processes for both analog and digital technologies. Chapter Two provides a detailed description of both technologies in part to determine if one or the other is more inherently manipulatable. It can be concluded that although the processes are slightly different in terms of the technology itself, both formats are easily manipulatable and neither one is inherently so. It must be remembered that all photographs, digital or not, are mediated representations, particularly if the final product is a film. All mediated representations have a source, whether it is a corporation, institution, or artist, and all of these representations are trying to convey a particular impression or message to someone else. Knowing the source of the message is important for understanding whether or not the message itself can be considered as truthful.

Additionally, by examining the technologies behind analog and digital cameras, it becomes apparent that there are many similarities between the two. First, they are both fragmented into tiny pixels of light, each containing an analog representation of the amount of light, or data, so that when the pixels or grains are assembled, they form a coherent image that resembles the object that was photographed. They are also both binary; digital in terms of its code and analog in terms of its electron structure.

Furthermore, they both have a photo-sensitive surface for capturing the light reflected off an object. In terms of capturing colour, both technologies use a similar process of layering in order for the pixel or grain to accurately contain the correct wavelength of light that represents that particular colour.

From the scientific analysis of both production techniques, we can also form some more conclusions about the index as a direct connection. For some film scholars, an important part of the photographic indexical trace is the fact that there is a tangible, physical output from the process; the photograph one holds in their hand. The lack of a permanent output such as a photograph plays an important role for these scholars in the loss of the indices created by digital technology. Additionally, the seemingly fragmented nature of digital technologies that is emphasized when scholars do a technical analysis of just digital cameras, contributes to the argument that the index is weakened. The third major point that scholars emphasize in their digital technical analyses is that the conversion process from light to binary code inherently breaks the indexical direct connection. Analyzing digital and non-digital camera technologies side by side, as was done in Chapter Two, demonstrates some important conclusions about these concerns. First, while it is true that digital technologies create a fragmented image that only visually seems to resemble a photographic image, the production process for photographs is such that it is equally fragmented in nature. Both forms are merely pinpoints of light that carry separated data about the light that entered into the lens. If the fragmented nature of digital technologies means a loss of the index for digital cameras, then there is an equal loss of the index for photographic imagery. For the second concern, in photographic imagery, light is converted down to the microscopic level as soon as its particles interact with the

silver halide grains. Again, if there is a loss of the index due to the conversion of light into binary code, there is an equal loss by the conversion of light into the silver atoms found in a negative. It is important to emphasize that it is only by the discovery of a binding medium that the silver atoms are able to bond to the negative and create the physical, tangible output that is so important for these scholars. Furthermore, it is interesting that it is the output of non-digital cameras, the photograph itself, is seen as containing the direct connection or indexical trace. Analyzing the production process shows that the only place one could find any direct connection or direct output is in the negative. The photograph itself is a copy, meaning that it is only the visual resemblance, once it has been reversed, that gets transferred onto the photographic paper. There is no direct output by a camera other than the negative, making a photograph from older camera technologies or a print out of a digital photograph equally removed from the direct connection. Again, neither one can claim to have more of an indexical trace than the other one.

Chapter Three also addresses the issue of the indexical trace, but it does so by analyzing another new technology used in the filmmaking production process. Digital motion capture, although digital, is usually seen as having a stronger indexical trace than simply by shooting with a digital camera. The usual rationale for this change in view towards a digital technology is due to the relationship between the person being filmed and the point by point capture of their bodily movements. Related to this argument is the issue of movement, which has long been a topic of interest for film scholars. The illusion of movement in traditional analog cinema has been greatly analyzed over the years, particularly when it is combined with how it affects the impression of reality given by cinematic images. Here we see that the issue of realism is once again connected with the

index, only this time it is not a static image but one that contains movement. The change between static images and moving images was stressed by Roland Barthes who strongly felt that the importance of the past tense in a static image was removed by the motion in cinema which conveyed a sense of the present tense. Since the film scholars of the time strongly argued that the index must have this past tense connection, it is important to note that from this point on, the motion in cinema conveying a sense of the present tense should have been seen as a loss in the index. However, a loss of the index in terms of motion was not mentioned until more recently and it did not address the issue of grammatical tense. Instead, it was noted by Mary Ann Doane that the loss of movement and the loss of index due to the illusionary motion in analog cinema stems from the loss in time. There are significant portions in the succession of movements that did not get captured at all with analog cinema. This loss in capturing movement breaks the direct connection of the indexical trace resulting in a direct loss of the index as well.

The loss in the capture of movement as well as in the capture of the index appears to be remedied by digital motion capture. It is even argued by some as having a unique and unprecedented position among film technologies. This is because capturing live movement in the form of raw computer data puts motion capture into both categories of recorded and synthetic cinema. With this data, special effects technicians can either maintain a faithful visual accuracy towards the actor captured or it can alter their looks completely so that the actors are not visually much more than animated characters. This has created a problem for industry professionals and academics alike, for the production process allows for two previously separate formats for film to either be realistic or formalist, whatever the director chooses. Should the director choose a more animated look

or simply needs to visually depict creatures that do not exist, issues of realism are never far away. Directors and effects technicians realize that audiences will connect more with characters that have a sense of life to them. This sense of life can come in a variety of ways, from a sparkle in the eye, to facial expressions, to the movement of the characters itself that contains an adherence to the physical laws of motion. It has been noted many times by effects artists and the scientists behind creating the technology that digital motion capture of an actor who is very slim does not convey the physical laws of motion if the character on screen is altered to a large, heavysset person. Again, issues of realism seem to be connected to accurate and faithful representations on screen. Audiences' eyes have time and again demonstrated that they can catch the subtle perceptual clues that indicate whether or not an image has a basis in reality. As a result, directors will use a variety of marketing approaches, as well as large sums of money to create CGI that contains a sense of life.

The subtle clues that audiences detect as real or not are difficult and complex. Digital motion capture demonstrates another of these complex issues, the alteration from 3D to 2D. Digital motion capture data is initially in a 3D format, but due to the fact that all screens (including computers) are a two dimensional surface, some changes need to happen. Using data from established perceptual conventions created by photographic imagery as well as perceptions created from earlier imagery such as painting, an algorithm is applied to digital motion capture imagery so that it transforms the image to a 2D version. Many scholars find this to be problematic and consider these images to be less true to life, but there is no real difference for photographic imagery must also be 2D. The problem seems to arise from the fact that digital motion capture must program itself in

order to be able to make this change, as opposed to the fact that the photographic technology does this automatically as a result of the way it was designed. Furthermore, digital technology is seen as almost villainous in the fact that it attempts to create imagery that conforms to established conventions, when it is not the technology making those choices.

The film industry has not yet managed to perfect 3D movies, although it has gotten closer in recent years. More time and technology will be needed if the shift is to occur from 2D imagery to 3D. Furthermore, mankind has had less than two hundred years of photographs and thousands of years of paintings that have formed our perceptions and judgments of reality. Despite these issues, it has already been shown that audiences have preconceived notions of what looks real and what doesn't. Even if digital technology was completely capable of rendering its images into 3D and displaying them in 3D without any outside help such as the coloured glasses, the audience may not feel it looks real. Although the 3D experience is more immersive for the audience, the effects at the moment tend to lessen the sense of realism due to the large distance involved between the screen and where the audience members sit, with 3D effects coming right towards their eyes.

When it comes to capturing movement in cinema, there is no technology today that can rival the accuracy of the ability of motion capture to record each successive stage on every part of the body. The result is that movement and motion within cinema is more realistic than ever, and not just aesthetically. Whereas analog cinema was just the illusion of movement created in part from the afterimage effect in our perception, a film that uses digital motion capture is actual movement. The end result is a combination of iconicity, index, and motion that produces a strong impression of reality in cinema. The same can

equally be said of digital cameras, for they are also capable of capturing a significant amount more of the actual movement of the actors. The problem that remains for both digital motion capture and for digital cameras is the issue of manipulation. CGI artists are working all the time to create more and more photorealistic images.

However, it is not until CGI creates such convincing images as to be indistinguishable from photographic images that we need to be concerned about the knowledge aspect of the index. The main function of the index is to impart knowledge, one of which will be the source of the imagery for spectators to make a definitive conclusion on whether or not an image is a depiction of an actual event or not. Scholars have spent a large amount of time arguing whether the index as trace or the index as deixis is stronger, better, weakened or outright removed from digital cinema. But deciding whether or not an index is stronger than another index does not help us to learn more about how spectators understand and interact with imagery, no matter the type. Issues of perception are also always a key factor in any of these discussions for they will directly influence how a spectator understands imagery. The inflated status of the photograph and its direct connection to the real world, along with the automatic, naturalized view of photographic technology, have only stifled academic discussions of the index pertaining to the changes stemming from digital production technologies. This will be true with scholarship pertaining to issues connected with indexicality as well, such as realism, movement, and spectatorship. Perhaps these misconceptions about photography which have been perpetuated by both film scholars and cultural beliefs about technology can once and for all be laid to rest, allowing for a deeper analysis and understanding about sign systems and spectators to develop. This will be necessary to analyze any changes occurring within cinema, particularly those happening

with technology. For just like the cinema, technology will continue to change and evolve, perhaps one day changing the cinema into something entirely new. Though any definition for cinema has been varied and debatable, it can be said that two of its most important features are light and movement. Digital technology simply allows for even more light and a more accurate capture of objects and their movement. Digital cinema then operates exactly as a technology is supposed to, as defined by Maynard; it helps humans accomplish their goal of capturing images even better and easier. Technology is where the change has happened in cinema. Though the technology has changed, the form remains the same. Indeed, digital cinema can be considered as the perfect representative of change; it is both transformation and continuity. It is only when cinema changes its form into something completely new when scholars will need to establish a new definition for cinema and the impact this has on film theory and for those who watch them.

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