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A machine's idea of sight: the technico-sensory divide in the human use of imaging devices

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A machine's idea of sight: the technico-sensory divide in the human use of imaging devices

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University.

by

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Abstract

A MACHINE'S IDEA OF SIGHT: THE TECHNICO-SENSORY DIVIDE IN THE HUMAN USE OF IMAGING DEVICES

By Adam Dean, M.A.

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University.

Virginia Commonwealth University, 2013.

Major Director: Dr. David Golumbia, Assistant Professor, Department of English

This study explores the human and technical limitations of looking and seeing. It proposes a model for design that expands technical sight toward harmony with our human notion. This study is guided by the phenomenological experience of being expressed primarily by Heidegger as well as neuro-physiological research on the mind and body relationship by Ramachandran, Sacks Nicolelis and Damasio. It examines, in two paths, the technical developments that seek to alter or enhance our ways of looking and seeing. The first path is an assessment of ways of looking with optics-based cameras that includes how cameras might be set to look, how they behave in looking and how they translate that look into an image on display. The second path is an assessment of the image in varying states of readiness which include the capture state, state of rendering (for view) and state of display. The study uncovers the various ways that images are translated to be seen, and how *sight* and *ocular vision* might be detached in the process of imprinting what is seen in the imagination. It includes key

examples of modern image device capabilities, makes suggestions about how the framework of this study can be applied in specific cases and predicts the state of image devices in the future.

Chapter 1

Technical knowing: sensing, feeling, interacting

In Heidegger's work on the essence of technology, he calls it a mode of revealing—something that can give us access to boundaries beyond our own means. He calls this act of revealing *unconcealment*, and it is this process that expands our knowledge of what was previously known into that which is newly revealed. In Heidegger's view we are compelled toward using technology by some force, and while Heidegger and phenomenologists before him have guided our understanding of the process of making meaning of the exterior world, we are still discovering how we realize the technology associated with that force. Indeed, Heidegger's wider argument is of *enframing* and a general human perception that the world is at our disposal.[1] While Heidegger's work on the essence of technology informs this research in defining a *need-to* that compels us into the making of and using imaging devices, the current study in applications of human and technical notions of looking and seeing are grounded in Heidegger's experience of being. This study explores the nature of specific technologies that derive from our *need-to-reveal* and assesses in their application the extent of their service to this cause. In this approach we uncover that technical tools emerge as *prescriptions for* or as *interpretations of* use. As prescriptions for use, technical tools, even by their very appearance, are designed with cues for their operator on how to access some portion of the world. For example, the high definition

[1] Defined in Heidegger, Martin. "The Question Concerning Technology." In *The Question*

video cable that connects to a computer seeks only its matching connector. An operator takes a deductive approach to determining where and how to connect this device, regardless of whether or not the use is understood. Such a use—connecting a cable to its matching hub—is stripped of a complex notion of *needing-to-reveal* because our expectation is not clearly defined. One can plug in the video cable with no understanding that the monitor will spring to life with images, and indeed this is the first step for many of us when making a tool work. We unpack it and examine our pieces, determining what goes where without relating that knowledge to the outcome. On the other hand, when a tool is an interpretation of use its appearance might only exhibit its cues through directed action. A hammer does not in its appearance cue the use of nails, but only the use of our hand. This lets us know it is a tool, but for what? Maslow, who said "it is tempting, if the only tool you have is a hammer, to treat everything as if it were a nail", summarizes the consequences of this question in the law of the instrument.[2] The nail in this example is defined when the tool is put to use, and while Maslow and many others recognize this as a limitation of sorts, it also suggests that the *need-to* can derive from a sense of harmony between the user and the tool through some mutual familiarity. This is separate from Heidegger's points on the essence of technology, and more closely relates to our interactions with things through their general *readiness*—our experience of dealing with and wielding things toward some use. As will become clear in the following chapters, *readiness* is the key to assessing and improving complementary human-machine interaction.

[2] Maslow, Abraham H. *The Psychology of Science: A Reconnaissance.* Maurice Basset, 2004, page 15.

We can begin to understand from Heidegger's work that when we apply technology in *bringing forth* the concealed, we are responding to a general human feeling of access to the world, but what is most important for the current study is the interaction that occurs between the human and technology, in the "technological activity." Heidegger is more concerned with the need itself. He writes

> Enframing means the way of revealing that holds sway in the essence of modern technology and that is itself nothing technological. On the other hand, all those things that are so familiar to us and are standard parts of assembly, such as rods, pistons, and chassis, belong to the technological. The assembly itself, however, together with the aforementioned stockparts, fall within the sphere of technological activity. Such activity always merely responds to the challenge of enframing, but it never comprises enframing itself or brings it about.[3]

This enframing is what compels us into using technology, and that is its essence, but there is much more to learn about how the technological activity grants access to the world and how we align our idea—our expectation of the unconcealed—with the designing of the technology. We may have a vision of our screen springing forth with bright images when we connect it, but we do not have alignment between our expectation and the outcome that is realized. Probably, most of us have come to be surprised when technology "works" because we have learned that our expectation is not representative of the outcome. We have a firm grasp on our idea of what the

[3] Heidegger. "The Question Concerning Technology," page 13.

“working” should be, but we cannot know the unconcealed until it enters the realm of truth, thus the moment of alignment is also the moment if misalignment. This is not to say that we put technology to use without consideration for its effects, but rather, we cannot know its effects until we are privy to what it unconceals. We simply cannot imagine what is concealed, and moreover the technology at hand has its own traits (apart from our craftsmanship) to influence the unconcealing. Even if we invent something new, purely from an idea and envisioned for a specific need-to, when it comes into the realm of truth it loses its connection to our idea. Franz Brentano makes this distinction in a correlate pair—the idea is an object of thought while the invention that is realized is the thing in the world (explained more in later parts of this chapter). Such a correlation suggests these objects are tied to one another, though we should understand them as separate. They can never come into direct contact but their relationship is mediated by the senses. By questioning our sensory experience in this manner, we will pursue the use of technology as Heidegger has, but we will expand the framework so that we might apply it in specific areas. This study is concerned primarily with vision and sight, but the framework could be applied to other modes of experience as well. We will look at image devices that are based on our own faculties for sight and we will determine how they serve to unconceal—a process we will continue to call, as Heidegger has, the *revealing.* We set out to determine the revealing because it not only shapes how we know those things that are unconcealed, but also determines absolutely our degree of access to each thing. Considering technical characteristics that mold our perceptions will uncover the nature of technologies that image.

This chapter introduces the foundations of this discussion, working across interaction design, phenomenology and neuroscience to build a framework for analysis. Chapter two reviews selected literature from these disciplines and explains the significance of each one for the current study. Chapter three is the first of two chapters of the analysis. It focuses primarily on the physical characteristics associated with looking in order to discover how a mechanical apparatus that looks ultimately serves our use. Chapter four is the second chapter of the analysis. It carries the discoveries of chapter three (looking) into the mechanical and cognitive relationships that make possible our notion of sight as it relates to machine-generated images. Chapter five draws conclusions from the discoveries in chapters three and four. It returns to the foundations in phenomenology, neuroscience and interaction design to assess the current state of image devices as they are known to us through use. Chapter five includes key examples of modern image device capabilities, makes suggestions about how the framework of this study can be applied in specific cases and predicts the state of image devices in a future of integration.

Neuroscience as clinical phenomenology

When Brentano developed what he called "psychognosy," he did so in order to develop an exact science wherein the objects of thought would be defined clearly, in contrast to an interpretive observational approach that had become the standard method for psychoanalysis.[4] Brentano's method is based on René Descartes

[4] Summary of "Psychognosy as Precondition for Genetic Psychology" in Brentano, Franz. *Descriptive Psychology (International Library of Philosophy).* London: Routledge, 1995, page 78.

Meditations on First Philosophy, which raised questions, as Kant did, about how we might actually know the world outside of ourselves if we are bound to a body through which we experience it. Husserl continued Brentano's work in *Cartesian Meditations,* into what we now term phenomenology—the study of human experience in terms of sensory-cogito representation, feedback and making meaning of the world. Like Brentano, Husserl points at the underlying issue with conventional scientific models of *observation*, whereby, rather than *doubting* the contents of evidence as its method, these "positive sciences" instead build upon *objective* judgments that precede their own observations. Husserl challenges these methods directly, favoring a "genuine science" based on a return to the method suggested by Descartes. Husserl writes

> Doubt is raised at least by the fact that the positive sciences, which were to experience an absolutely rational grounding by these [Cartesian] meditations, have paid so little attention to them.[5]

The phenomenological method that Husserl develops is based on evidence as an

> …"*experiencing"* of something that is, and is thus; it is precisely a mental seeking of something itself. Conflict with what evidence shows, with what "experience" shows, yields the negative of evidence (or negative evidence)–put in the form of a judgment: positive evidence of the affair's

[5] Husserl, Edmund. *Cartesian Meditations.* Translated by Dorion Cairns. Dordrecht: Kluwer Academic Publishers, 1999, page 4.

> non-being. In other words, negative evidence has as its content evident falsity.[6]

There is hope for phenomenology as a widely embraced scientific approach, though it occurs not because science as a whole has come to reject the notion of an objective human observer. Instead, it has emerged as the most practical and productive method for understanding neurological ambiguities that might otherwise find no explanation. Phenomonology seems to succeed in cases where positive sciences repeatedly fail even to diagnose, let alone treat, a condition that disrupts the senses or cognition in some way. This study includes a number of neurological cases that, through a phenomonological approach to diagnosis, reveal not only how the brain functions, but how the mind functions. Clinical phenomenologists like Oliver Sacks, V.S. Ramachandran, Antonio Damascio and Miguel Nicolelis provide valuable insight into the mind-body problem, and through their clinical experiences we can better understand how our understanding of *sight,* might include much more than our eyes, and how our *body* might reach far beyond our fingers and toes. Like the patients that we will come to know through their unique conditions that challenge a universal perception of "the world," neuroscientific application of phenomenology will help us understand how our minds and bodies work together to create unique (for each individual person and for each individual moment) sensory-cogito experiences.

[6] Husserl. *Cartesian Meditations*, page 12.

The phenomenological experience of the moment

Why does this study require a phenomenological approach? As we will come to understand through the review of the literature in the following chapter, we are wholly dependent upon each of our means for sensing and our ability to process those senses in order to make *sense* of the world. In accepting this simple fact we must begin every analysis with an interest in how we experience the world, not just an interest in those things in the world that we experience. It is not too much to say that there is no other way to examine the effects of technology than with a phenomenological method because technology is the consequence of a human need—the *in order to*—at the moment of inception.[7] All technology exists first in the need, where the concealed has whispered that *the revealing* is possible.

This study does not represent a discovery of the benefits of the phenomenological method for technical design, and several thinkers have already indicated a way toward successful application. Interaction designers have especially depended on this method in recent decades because it allows them to inquire, step-by-step, into the processes through which a user's needs can become known to others. When these processes are analyzed ethnomethedologically as individual components toward some end-goal, designers can unlock the technology from its directed use and uncover precisely how it can help or how it may hinder the results of that pursuit. Such a way of analyzing is not restricted to technologies that exist already in a positive scientific structure, rather the phenomenological method makes it possible to identify

[7] *In-order-to:* Heidegger's definition of equipment, in contrast to a tool that is not understood through an intentioning. For example, a hammer on the table becomes equipment when a nail generates the need.

technological need itself. This need is not synonymous with the *in-order-to*, but they are correlates. The *need-to* is something we know directly, and it sparks in us the application of the equipment to satisfy. Determining the degree of satisfaction is of primary concern for interaction designers and that is the reason for a phenomenological approach. We have all lived the experiences of *needing-to* only to find dissatisfaction with the *in-order-to.* A large subset of the research in computing industries addresses the problem of rapid diversification of users' needs relative to the consumer demand for user-friendliness, which in design terms suggests a restriction on the situation of use. We will consider this challenge for interaction designers in some detail in later chapters, but to illustrate this point generally we can point to the mouse and keyboard, which have remained remarkably intact since their early designs into their adoption in mass consumer desktop computing. When Douglas Engelbart and Bill English first patented the mouse on behalf of the Stanford Research Institute in 1970 (Figure 1.1), it was then what it is now, the equipment to satisfy the most general needs of the screen user: translate physical directives to those that are visual.

The success of its design can be attributed to a fundamental simplicity in the need itself: navigate to any area on any screen and access any visual item with tactile movements. Arriving at a point in which this need became known was not a small achievement, as it required a

Figure 1.1: Image of the Stanford Research Institute's first computer mouse prototype, taken by Mark Richards, September 1, 2005, used in accordance with the terms of the GNU Free Documentation License.

complete re-thinking of the entire computing experience. Prior to the development of the conceptual design model termed "situated action" pioneered by Lucy Suchman, computing was ad hoc. A user was not motivated into use through a *need-to*, but rather the computer determined the *need-to* through its design. As designers began to understand the *situational need-to* of the everyday user, a new generation of computers emerged and ultimately surpassed the specified task managers that came before. With the *need-to* left open to the user, the designers had to resolve a new problem of *predicting* a user's *need-to* action sequence toward his or her own *need-to*, rather than *prescribing* it. The ambiguity and diversity of the *need-to* is one of two primary reasons for the difficulty designers have, in computing and beyond, in aligning equipment (*in-order-to)* with user (*need-to)*. The second reason for difficulty is the conventional (but limited) conception of the mind-body relationship, a problem multiplied by the unique minds and bodies of billions of potential users. Winograd and Flores explain this problem a bit more colorfully, noting "it has long been recognized

that it is much easier to write a program to carry out abstruse formal operations than to capture the common sense of a dog."[8]

We will examine the joint responsibilities of the mind and body in the achievement of sight as we know it in Chapters 3 and 4, but in order to translate this highly individualized "problem" into an industry directive, we need to review the very nature of our impact on the world and what it means to have a body. Heidegger termed this impact "thrownness," and it is a unique phenomenon of Dasein (*being-in-the-world)*. It is helpful to consider Dasein as a state of being, while thrownness is a quality. Our thrownness is the effect or feeling of the constant, inescapable and individually distinct worldly presence that is based primarily on our having a body and feeling its influence on an exterior world. Thrownness encompasses an awareness that relates to indirect and direct actions that have consequences for the individual, others and the world at large. Linking thrownness to interaction design, Winograd and Flores note

> What really *is* is not defined by an objective omniscient observer, nor is it defined by an individual—the writer or computer designer—but rather by a space of potential for human concern and action.[9]

Heidegger makes a clear distinction between *being* and *Dasein (being-in-the-world*) in thrownness. Dasein has an openness to the world that *being* experiences phenomenologically. We might say that *being* accesses the world *through* Dasein, and

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[8] Winograd, Terry, and Fernando Flores. *Understanding Computers and Cognition: A New Foundation for Design.* Boston: Addison-Wesley Professional, 1987, page 99.

[9] Winograd and Flores. *Understanding Computers and Cognition,* pages 35-36.

this is the reason we will focus primarily on Dasein in this study, as we develop further the relationship between the mind and the body and how we interact with the world.

Winograd and Flores provide a scenario that puts the phenomenon of thrownness into an everyday context, where having a presence alone has impact. In their scenario—a board meeting for which you are the chair—they outline at least six characteristics of thrownness. First, you cannot avoid acting. Even if you do nothing, your presence will affect the situation. Second, you cannot step back and reflect on your actions in the moment. The arena of action has any number of potentials, each with their own effects. You cannot know the moment, as you are immersed in it. Third, you cannot predict the effects of your actions. The arena has actions, as do you in your responses, as do those responses. Fourth, you do not have a stable representation of the situation. This is because you are situated yourself. Your point-of-view is exactly that. Fifth, every representation is an interpretation. You cannot know the arena beyond your interpreting, which is a process of applying from your own canon of experience. Sixth, language is action. Moreover, everything related to your presence contains messages that are communicated at every moment in the arena.[10]

Thrownness suggests a *relationship with* technology rather than a simple *act upon* technology. Understanding thrownness through interaction with technology reveals it as an extension of Brentano's intentionality. Just as there is an intentioning thing and that which is intentioned, there is also the reverse. This study at times chooses the terms *operator* or *user* in reference to Dasein but it is with the

[10] Winograd and Flores. *Understanding Computers and Cognition*, summarized from Chapter 3, section 3.3.

understanding that intentionality is not unilateral. We are so deeply connected in correlate pairs to our world, as Brentano described, that we do not seem to have an everyday consciousness of any other mode of *being-with*. Brentano defines three types of intentional phenomena: presenting, judging and emotive, which are acts of thinking for the being, and by attempting to apply them to *operator* and *user* we are met with the distinction between objects of thought, which is the duty of Dasein. The correlates of the intentional relationship, as Brentano has classified it, would be stated as "presenting and what is presented, loving and what is loved, willing and what is willed and denying and what is denied."[11] But for the operator that is Dasein, the correlate is *operating and what is operated in-order-to.* For the user it is *using and what is used in-order-to*. As noted briefly already, *in-order-to* comes from Heidegger's definition of *equipment,* which is a state of a tool when it is put to use, and in contrast to that tool as it exists when it has no intention applied to it. Much of the existence of equipment is demonstrated beyond the being, although we maintain that the effects that are known remain so only through the feedback of the body's devices for knowing. Technology therefore exists between the pair of correlates in the intentional relationship. Take for instance another of these pairs of correlates: "seeing and what is seen."[12] This intentional relationship is only possible through that which sees technically. The psychical phenomenon of seeing must be achieved not only through a cognitive process, but also a physical one of looking at, toward, for and through *in-order-to* take in and measure light among all other captured looks in the canon of seeing. In

[11] Brentano. *Descriptive Psychology*, from the introduction by Benito Müller page xix.

[12] Brentano. *Descriptive Psychology*, page xix.

operating and *using,* we might also have a *touching and what is touched* correlation that demonstrates immediately our thrownness, breaching the boundary of the psychical act of *feeling that which is felt* by *moving that which is moved*.

Heidegger recognized that our presence in and access to the world gives us and the world its shape. The act of looking at a mountain, for instance, still has some impact even if we choose not to scale it. We choose not to lay footprints in the snowy upward path, not to plant a flag at the pinnacle and perhaps these choices will compel us to scale the next peak instead. A negative action has effects, as would a positive action. The correlate regarding *operator* and *user* heightens this challenge of separating actions of thought and those acts-in-the-world that contrast natural forces because they are assigned to the intentioning *for.* We might *use* a rope to scale the mountain, but the correlate remains as a pair. The correlate action pair is scaling and what is scaled: *I scale the mountain*, but what of the rope? The rope is *how* in the same manner that Dasein is *who: I (by a rope) scale the mountain.*

Translating the haptic

Any endeavor to describe the experience of sense is met with the greatest challenge we know—that of translation. We can never truly share how we experience through sense because it is uniquely our own, but it is our greatest desire to do that which is impossible. We plunge into this study fully aware of this burden, and like so many scholars before us we will constantly reach out for the proper tool of language to convey something close to our meaning. The irony of attempting to do this for devices

that are tasked with that burden in the visual field is not lost on us, as we will explore, especially in chapter 4 where we attempt to see by way of an image, that experience of the looker. Laura Marks describes her process of navigating the terrain of experience as haptic criticism—a phenomonological alternative to theorizing as an observer.

> Haptic criticism is mimetic: it presses up to the object and takes it shape. Mimesis is a form of representation based on getting close enough to the other thing to become it. Again, the point is not to utterly replace symbolization, a form of representation that requires distance, with mimesis. Rather it is to maintain a robust flow between sensuous closeness and symbolic distance…[13]

The *haptic* is a term borrowed from Deleuze and Guattarri, who described it as a smooth space that must be navigated through constant re-referencing, as we would in an open field of tall grass. We step forward and find our footing. With each step we can know a little more about how we might pass through the field, hidden under tall grass. From the edge the field might look soft and flat, but we might find it quite jagged and bumpy in one area or another as we walk. Rather than being pushed toward an individualized interpretation of such an experience, as is often the way of criticism, this study moves along the surface of the matter. Such a resistance to content analysis immediately resolves some of the key issues that emerge in translations of feelings tied to embodiment, especially. For example, in *The Address of the Eye: Phenomonology Film Experience*, Vivian Sobchack explores how the experience of viewing a film might

[13] Marks, Laura U. *Touch: Sensuous Theory And Multisensory Media.* Minneapolis: University of Minnesota Press, 2002, page xiii.

be an embodying experience because the viewer is privy to the captured perspective of another. Sobchack's point is simple and her critique is convincing (from an interpretive critical perspective), but it does not scratch the surface of what it means to embody through the sensory experience. Rather than taking one giant leap over the field, then turning to survey what we saw below us, we will dwell in the field and consider its qualities as an entity. We will step on the divots and imagine the dimples of the invisible ground beneath the grass. We will seek to discover how we know it and how it knows us. Marks provides a vivid description from quantum physics of how we perceive. It is her own interpretation of Maurice Merleau-Ponty's phrase, "perception is a fold in the flesh of the world." Marks writes

> …the universe is like a great surface that has been infinitely folded together, until points that were unfathomably distant in space-time come to touch each other. I once watched someone make a strudel, beginning with a pliant sheet of dough, so thin it was translucent, that covered the top of a large table, and then folding and folding it until those thin layers pressed close together in a dense roll (with apples and raisins). The universe is like a strudel. Each time we perceive something, we acknowledge the continuity between its many layers. Expressing these perceptions, we actualize the virtual events enfolded in those layers.[14]

If we think back to any one moment in our memory, it contains in it the essence of our embodied experience. I (my self) can *know* the moment through its full-bodied

[14] Marks. *Touch*, pages x-xi.

impression, which may contain smells, tastes, textures that invoke feelings of joy, fear, sorrow…. Such a memory is thus embodied, as are all experiences. It is when the term *embodied* is applied to interactions beyond our self that it gets lost in translation. We might find appropriate description in our words, but the senses that we wish would permeate those words are muted, pronounced differently and alien. For others, our descriptions are *derealized* through the disassociation of our own experience and the rebuilding in another's own sensual context. Derealization is inevitable when attempting to translate sensory experience for another, and to be disembodied would mean that this sensory experience is also not understood cognitively—from within. Such cases exist in patients with Cotard Delusion, or "Walking Corpse Syndrome," who have a neurological disconnect between the self and the world. They are emotionally detached, which leaves them feeling dead. This is what disembodiment is for the self—a first-person perspective that is not associated with a sensory, whole-bodied experience. While critics of film, virtual reality and interaction design may discuss *embodiment* in relation to a shared experience, we will resist that usage. *Embody* is a precise term for our purposes in this study because it is the essence of how the self experiences Dasein. To seek embodiment beyond Dasein is futile, at least for now, because of the still unknown depths of the sensory experience and how it finds its way into the objects of thought: imagination. We will sometimes use the term "whole-bodied" when referring to experience, but this is not to be confused with embodiment. A "whole-bodied" experience refers to the application of the senses in the doing, not necessarily in the feeling through the self. To embody is the job of the self, as entrusted in Dasein's whole-bodied collection of sensory data. In this study there's a

great deal uncovered about how our minds and bodies relate to one another, and to *embody* our own—to access the direct and full (whole-bodied) experience is itself a challenge, so we must be careful to focus on it and question it before seeking to share what we do not experience whole-bodiedly with another. Here we will explore precisely what those qualities within our self are that may or may not *embody*, and we will go much deeper into the technology that forms the visual medium and vantage point for accessing the world.

Because we are examining devices pertaining to a *human notion* of sight, examples are bound to those things that look and see in ways that follow our own understanding of looking and seeing. This is a necessity because the design of things that look and see must, at some point, facilitate the objective, which is to be *seen* by a human user. There are many ways that technologies look and see in their own manner, but this discussion focuses on those that remain bound to our primary mode for achieving sight: the identification and measurement of reflected light as it passes through a lens system into a capturing medium. In short, we will focus our attention on conventional cameras that do this along with the images that they produce. Since we are interested in cameras that *look* much in the same way as we do, and images that facilitate sight as we know it, our primary examples derive from the uses of these things, some of which are in the designs and uses in personal photography and others in those of the industry of visual stories, namely Hollywood studio settings. Some work exists already on phenomenology and the visual-tactile experiences of cinema, including work already mentioned by Vivian Sobchack. Laura U. Marks and Jennifer M. Barker also write on this subject, though without addressing imaging devices

technically. While Marks expands Deleuze's theories that sought to develop a culturally-bound taxonomoy of film's way of conveying a sensory message, Barker is concerned with how the visual and aural experience is translated to one that is largely tactile in the viewer, arguing for a whole-bodied understanding of viewership. While both of these authors present useful arguments about how a *viewer* experiences film, it is worth repeating that the present discussion is unique in its technical considerations and focus on operators and users, rather than those audience members detached from the capturing process. Though cinema plays a major part in illustrating precisely *how* a camera is utilized, this study questions that use as it relates to the *need-to* that motivates and connects the human use of imaging devices. We will not take for granted the devices that look and facilitate seeing, nor will we focus entirely on how a filmmaker seeks to embody the viewer in an image on screen. By assessing the use of imaging devices primarily through a phenomenological method, we can determine, to a precise degree, the nature of technical looking and seeing.

The realness of photons

The pervasiveness of screen technologies have caused a shift in thinking about sight as a "grasp *with* the eyes."[15] Merleau-Ponty asks the important question: "how could we have believed that we saw with our own eyes what we had in fact grasped through an inspection of the mind?"[16] This question is worth revisiting in discussions of

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[15] Merleau-Ponty, Maurice. *Phenomenology of Perception.* Abingdon, Oxon: Routledge, 2012, page 28.

[16] Merleau-Ponty. *Phenomenology of Perception*, page 252.

digital imaging, as inexpensive cameras and memory, paired with a culture of sharing photos on the internet, contribute to the increasing distance between real, embodied experience and their captured representation in images. Our ability to recall is not so clearly bound to our experience with our body. We *see* but we do not *know* through our eyes what we see because our distance apart from that upon which we look has increased through the indirect nature of our interactions. Items that exist for us on screens alter our ability to interact, through theater seats, keyboards, mice and tablets in pixels of lit reds, greens and blues instead of setting eyes, hands, noses, ears, mouths upon a canvas or visage in non-digital media. We are removed physically form the image in these ways, and also we have learned through the screen the technical manipulation of images by the camera itself (trick photography) and in the rendering itself (post-editing). The result returns us to Merleau-Ponty's question, in the spirit of the negative science, where doubting the evidence becomes the method for understanding: how can we trust what we see as real? This cautionary tale is one told through the history of visual evidence—from the illusionist filmmaker Georges Méliès disappearing magically on film to the degraded "home movies" depicting UFOs, Bigfoot and the Loch Ness Monster.

We will not argue the reality of images culturally in this study because that is something left to critics concerned with observing the "big picture" that is the field of tall grass, from afar. Instead, we will learn from the experience in the trenches. Just as a camera operator might note the discomfort of a lens piece held to the eye during a long day of shooting, we will press against the technology and overcome the problem of visual evidence and subsequent interpreting by concentrating attention on the devices

that give us the image itself. Thus, we can know the reality of an image because it exists, unrelated to what we see. A large subset of digital humanities devotes itself to tackling the challenges of the "ephemeral" digital media, and some, including Matthew Kirschenbaum, have written about the tangible nature of hard drives and memory caches. Kirschenbaum's method is forensic, returning to the "scene of the crime" where the *mechanism* leaves its trace.

> Crystallizing at the nexus of storage, inscription, and instrumentation, the forensic imagination stands in contrast to the medial ideology and screen essentialism that has held sway in the theoretical conversation's critical formative years for new media as a field.[17]

Kirshenbaum outlines in his argument the traces of media held within a computer system, which includes the screen. While an LCD screen might translate everything in varying shades of red, green and blue, the graphic interface that is designed for our eyes is only the humanized front of the images within the computer. Kirshenbaum adds that the computer sees all data in the same light.

> The same properties that allow electrons to "paint" a phosphorescent coating and project an image on a screen can also be used to store and represent binary numbers, as was done in several early computing

[17] Kirschenbaum, Matthew G. *Mechanisms: New Media and the Forensic Imagination.* Cambridge, MA: The MIT Press, 2008, page 254.

> systems, most notably the Mark I developed by F. C. “Freddie” Williams and Alan Turing at the University of Manchester.[18]

Those who study media forensics recognize that all things, even those that are digital, have a body which leaves its prints. Discovering that body is the first step toward revealing its essence. While the cultural shift away from an absolute trust in visual evidence has increased our global understanding of what images actually are, we are only now being confronted with the challenges of what is visible versus what is invisible (to us). We still maintain a trust in what we see to the degree that if we do not see it, it is not there. The digital image persists in states of invisibility, and these states are the subject of chapter four, but only when we lay eyes upon it (on display) do we acknowledge its existence.

At the Media Lab at Massachusetts Institute of Technology, several researchers have developed a way of imaging that actually sees the photons that make an image as they travel. This type of design model indicates that cameras can and should see more than humans, so that we might gain a better understanding of the invisible. The Media Lab ”Trillion Frames Per Second Camera” is designed to record at trillions of frames per second, thus allowing the photons, which are always seen in their imprint, also to be visible as they move through space. Media Lab researcher Ramesh Raskar compares photons to bullets, which illustrates how we might think about a bullet, even though it is traveling quite fast, to be visible, while photons might be considered invisible to us. For photons it is not simply that they are traveling too fast for us to see,

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[18] Kirschenbaum. *Mechanisms,* page 254.

but also that our notion of sight responds to their reflection. Photons themselves must come in contact with an object to reveal some *thing.* This remains true even for the Trillion Frames Per Second Camera, which *sees* the reflection of photons as they inside of a bottle. Rasker says, "photons travel about a million times faster than bullets, so a camera can see these photons, or bullets of light, traveling through space."[19] Figure 1.2 illustrates photons traveling through a soda bottle, as captured by the Trillion Frames Per Second Camera.

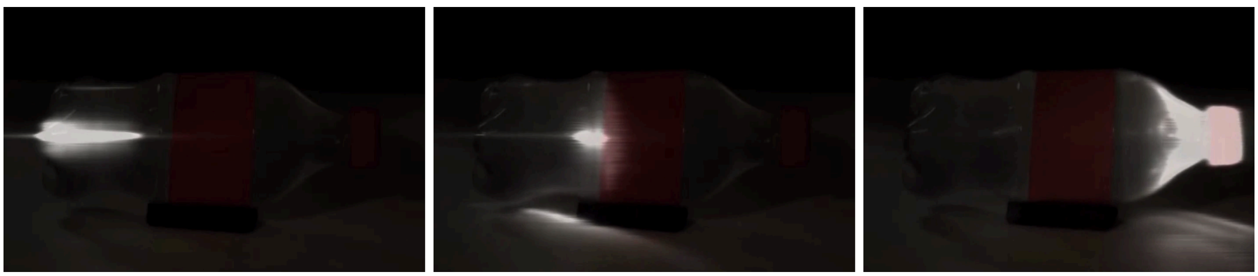

Figure 1.2: Photons passing through a soda bottle, captured by the Media Lab at MIT by Ramesh Rasker and Andreas Veltan on December 12, 2011.

In this study we will use the term *real* with the same care as we will with the term *embody.* Each term is specific to the experience captured or recalled and can only pertain to the self that applies the term. Indeed, we look at images and we see photons, which we call evidence, but we raise doubt by the method for imaging itself. It is irrelevant whether or not we see *real* photons, because of course we do not, since the camera that captured them for our gaze has done so shot-by-shot, which have been stacked up in slow-motion and re-created from color and other property data stored in pixels. Such an alteration adheres to our needs as viewers, while ignoring the

[19] Hardesty, Larry. "Trillion-frame-per-second video." *MIT News Office.* December 13, 2011. http://web.mit.edu/newsoffice/2011/trillion-fps-camera-1213.html (accessed October 24, 2012).

properties of the photons, whose speed and impact cannot be experienced this way at all. I can embody a memory, and that memory is real. It is real in the neural impulse that produces it, just as an image is real in the photons that produced it. The ambiguity in the matter of an image is comparable to the ambiguity in the matter of though in this way. Such matter is invisible to us, and comes to be known in the form of an action rather than through an observable process. In other words, we cannot see the matter that makes an image. We can only see these things in their consequences—in their thrownness. Figure 1.3 illustrates the neural impulse itself—the *real* substance of thought. We can say that it is real in the way that an event is real, not just in reference to the observation of that event. Certainly, we cannot overcome Merleau-Ponty's questioning of how we know, through our minds, what our eyes have seen, but what we can know is that there is a footprint of such a process. Figure 1.3 illustrates neurotransmitters as the small dots within the white circles (synaptic vesicles) so that we might be able to visualize the activity that is being translated for us in the drawing. What is *real* is that this action occurs—not that it resembles the depiction. For whatever the means that contributes to the effect, there is an imprint that is real, which we can reveal forensically. This is the reality of thrownness.

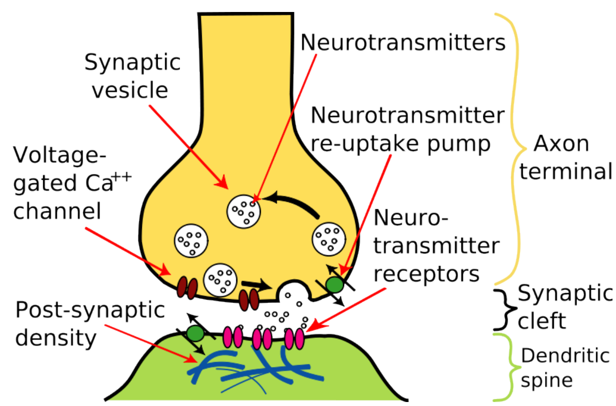

Figure 1.3: The action of thought. Illustration of the release of neurotransmitters caused by a neural impulse in the axon (yellow) to the dendrite (green), generated May 6, 2008 by Delldot, licensed freely under the GNU Free Documentation License.

The content of a neural impulse might be elusive, but it is not invisible. It loses its quantum traits through description, just as the content of any image is subject to the reaction of photon-sensitive media, where the color purple might be generated by the specific compounding of a particular silver halide, for example. Still, the existence—that the silver halide reacted at all—is how we understand that our image is real. We still cannot trust that our eyes correctly show us this reaction, and ultimately we can never know that the change occurred if we remain true to the negative, "genuine" science (toward apodictic knowledge) that Husserl describes for us. This is because we are reduced to haptic knowledge, wherein we trust our sensory experience as the real one. Attempting to know quanta also re-affirms Husserl's dismissal of the positive, "observational" scientific method because of the "observer effect" uncovered by Heisenberg in 1927.[20] A photon must interact with an electron to make it visible, but that interaction changes the path of the electron. Schommers explains it succinctly,

> It is well known that a measurement in quantum theory not only informs the observer but also modifies the quantum system under observation.[21]

All we can say of the realness of these actions is that they are not ephemeral. They do not flee when we design entire imaging systems around them and apply the same language for description when seeking to share them with one another. The digital sensor records a single pixel as 1010001…, as a response to a very specific photon,

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[20] Not to be confused with Heisenberg's uncertainty principle, referenced in Marks. *Touch*, pages 163-168.

[21] Schommers, Wolfram, B. D'Espagnat, P. Eberhard, and F. Selleri. *Quantum Theory and Pictures of Reality: Foundations, Interpretations, and New Aspects.* Edited by Wolfram Schommers. New York: Springer-Verlag, 1989, page 50.

and whether or not we *see* in any way that resembles its properties as they exist outside of our minds, these properties demonstrate that even without consciousness, there is a kind of *thrownness* that is given each time we lay our eyes or cameras upon them and when we say “look at that” to others.

Thinking digitally

Throughout the study we will pursue the *need-to* as it applies to capturing and rendering images in personal and professional film and photography, especially. The self knows this need, and it is rooted in experience. It is, in practical terms, but we will not attempt to translate it beyond acknowledging its realness. We seem to need find the readiness of things and for whatever reasons we do not trust that our memory of such an experience can stand alone in grasping such monumental moments. A photograph is a way of readying a moment. It is a tool to assist us in managing our experiences. We look to make ready all things in such a way, keeping souvenirs to trigger our memory and telling elaborate stories through filmmaking, treating it like a vehicle to make real for others our own objects of thought. It is no wonder we do this, since we are constantly thrown into the moment where we manage and adjust our perceptions anew. Each moment changes our idea of those that came before, and each prepares us for those that are ahead.

While we will not attempt to define the overarching need that results in readying a camera in the moment, it is clear that it exists and is increasingly pervasive. We are saturated in imaging technologies, from cameras built into our phones to pictures on most street corners and interior walls. But even with cameras and images everywhere

being put to use in almost every corner of the world for some particular reason, our need for imaging devices to aid us as we navigate and catalog the world has not hindered (and perhaps it has heightened) a global sensitivity to the accountability of recordings. We have already noted the historical problem of visual evidence, but we also contend with the special quality of hidden observation in police states. The existence of single and two-party consent laws show that we do not take kindly to having a technical recording made of us without our knowledge, as though we weren't being recorded by one another's memories anyway (which are even more malleable in the editing). We do, in our own way attempt to record in our memory what happens, but the memory changes each time we recall, as it is washed with new sensory data each time it emerges as reminiscence. It is not that we prefer this over recalling through a technical recording, as we are often not too certain of our own memory, but that we are not acutely aware of one another's memory impression. It is locked away, safe in another's mind, where it can never be rendered (neurologically) for an audience, only translated through language and symbols. This results in vivid stories told on behalf of drama or social preservation, but it does not result in truth. Even if we credit phenomenologists with an accurate categorization and arsenal for measuring the varying experiences brought in by the senses, we cannot account for them in recall, and we are faced with verbal or other clumsy re-enactments that are so far from an embodied experience that they themselves become the event they sought to recall. A memory is not actually something locked away, but shaped through the moment it is accessed. Each re-telling of a happening re-submits it as told/experienced anew. So why should we confront our global fear of pervasive imaging? There are a number of

benefits, beyond the most obvious opportunity to truly share, through neuro-interfaces, what is actually seen.

Science writer Michael Chorost is a cyborg—"a human being whose body has been taken over in whole or in part by electromechanical devices."[22] Chorost fits this definition because he has a cochlear implant that allows him to hear, through a computer embedded in his head. Cochlear implants are not uncommon, and like prostheses such devices do not just aid humans in accessing the world in a way that mimics the conventional *sensing,* rather they also become part of our self. Chorost describes the implant,

> It really *is* a computer. It's cold, angular, and digital, yet it's going to be embedded in my flesh, which is warm, squishy, and wet—how is that even *possible?* How can a joining like that not obscurely but permanently *hurt,* the body and brain outraged by the alien language of 0 and 1?[23]

Unlike the cochlear implant, ocular implants (intraocular lens) do not yet bypass the ocular principles that are bound to looking with the eye, which is explained more thoroughly in Chapter 4.

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[22] WordNet definition cited in Chorost, Michael. *Rebuilt: My Journey Back to the Hearing World.* New York: First Mariner Books, 2006, page 7.

[23] Chorist. *Rebuit*, page 8.

Ocular implants like the one in Figure 1.5 do not access the mind through neurological impulses, rather they are like many prostheses that substitute organic matter for inorganic matter, in this case the crystalline lens with silicon or acrylic. But unlike many prostheses, including artificial eyes, the cochlear and ocular implants are not cosmetic—they are neuro and bio cybernetic prostheses, respectively.

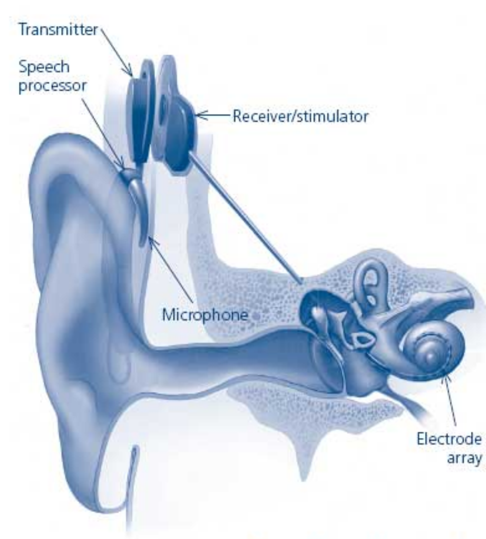

Figure 1.4: Image of cochlear implant, generated/updated March, 2011 by NIH Medical Arts. Licensed freely.

Rather than an implant that restores access to the world through the eyes, consider an imaging mechanism that, like the cochlear implant, bypasses the body's immediate parts for seeing and goes right for the mind. That is the primary distinction between a neuro-cybernetic and bio-cybernetic prosthesis. Give this mechanism a second and third capability of capturing that look and playing it back through neuro-impulses and it is a visual aid for those that suffer from memory loss. Ideas for integration of this type are the subject of chapter 5, but for now we will conclude by

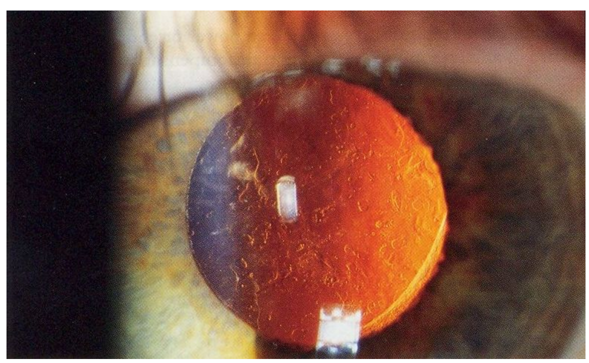

Figure 1.5: Photograph of Pseudophakia (synthetic lens replacement) to resolve cataracts, made September 30, 2006 by EyeMD and used in accordance with accordance with the terms of the Creative Commons Attribution-Share Alike 2.5 Generic license.

identifying the general limitations of *sight-based* imaging devices.[24]

First, sight-based imaging devices are mechanisms for mimesis of a human sense. This mechanical mimesis introduces an additional interpretive layer between the world, Dasein and one's self. In addition, the nature of this mimesis is always a product of its own physical design, and not necessarily a product of the sense that it is designed to mimic. A camera takes on a number of different forms, depending on the intentioning correlation that defines its role. If it is to go underwater, it needs to swim. If it is to go climbing, it needs to be tough. If it is to look deep into space, it needs to magnify. In attempting to achieve what we think of as sight in these environments, the camera takes on elaborate and often cumbersome bodies. These bodies, above all else, determine what can be seen.

Second, sight-based imaging devices are detached from the processes they emulate: *looking* and *being seen*. They cannot show anything to us without processing a captured image in a number of interfaces. The interfaces must translate what will become an image, as we know it, for both the mechanism and for our visual process. For every image there must be at least two interfaces: 1) the interface that translates the environment into captured data and 2) the interface that translates captured data into what is *seeable*. What is seeable should resemble for us the environment that is familiar to our notion of seeing the world.

Third, sight-based imaging devices have their own perspective. Regardless of the design of the body, both the camera and the image *seek to* embody Dasein's thrownness. These perspectives are not shared by the person holding the camera nor

[24] *Sight-based* refers to those designs that rely on a model of *sight* through the identification and processing of photons.

the person who sees the image. The camera that looks, and the image that is seen, have their effect on the moment, which is their content. In the looking and being seen there is an impact that cannot be granted to the operator or seer because it derives from the camera's and image's unique perspectives. Nor do the camera and image share their perspectives with one another because of the interfaces that separate them, as noted in the previous paragraph.

Fourth, sight-based imaging devices can only *seek to* embody, but they cannot truly embody. We have explored the *need-to* image, which is pervasive and contains a *for-other* quality. We share images for ourselves and to convey our sense of *being-there*, but it is never so. There is no possibility of showing an image to another and achieving mutual sight of that moment because an image does not contain whole-body information. It can only be *seen* in a reduced sense of the word, in the experience of laying eyes upon it. Further, and related to the third limitation above, even the camera's operator does not share the perspective of the camera in the moment.

What this study reveals overall is that imaging devices cause *blindness*, which becomes inescapable in their use. Blindness is not a medical diagnosis specifically reserved for the loss of ocular vision, but a phenomenon of being unable to see. This study examines blindness as a condition of limited sight. For humans, such a condition relates to Heidegger's explanation of readiness-to-hand and breaking down—the process of making the objectness of the tool apparent and pulling our attention toward it directly, thus away from its purpose. Winograd and Flores explain breaking down in an example familiar to most of us: word-processing.

> If we turn to computer systems, we see that for different people, engaged in different activities, the existence of objects and properties emerges in different kinds of breaking down. As I sit here typing a draft on a word processor, I am in the same situation as the hammerer. I think of words and they appear on my screen. There is a network of equipment that includes my arms and hands, a keyboard, and many complex devices that mediate between it and a screen. None of this equipment is present for me except when there is a breaking down. If a letter fails to appear on the screen, the keyboard may emerge with properties such as 'stuck keys.' …For me, the writer, this network of objects and properties did not exist previously. The typing was part of my world, but not the structure that emerges as I try to cope with the breakdown.[25]

This last line touches on the difference between equipment that is ready-to-hand (as it is in use) and how that object loses its *in-order-to*, which makes it equipment, by drawing our attention to it directly rather than through it toward the work. When this occurs for the user, it is the condition of blindness. This study demonstrates this condition as one that is fixed in imaging devices today.

[25] Winograd and Flores. *Understanding Computers and Cognition,* pages 36-37.

Chapter 2

Review of the literature

This study links two disciplines—interaction design and neurophysiology—through their common ground in phenomenology. Both disciplines together build a framework for understanding the human notion of sight and the varying ways that technology might align with it. These two disciplines are closely related in many ways, though their goals might differ. The interaction design principles that contribute to the base of this study deal especially with embodiment and conveying physical action in digital space. While this includes physical design principles, such as the social and tangible metaphors that establish ground rules for human-machine interaction, this study pays closer attention to the varying forms of the interface between the human user and imaging devices like cameras and screens. Research from Paul Dourish, Malcolm McCullough, Sean Zehnder, Barbara O'Keefe, Eugénie Shinkle, Lev Manovich and Hubert Dreyfus establish the visual-tactile relationship as a guiding principle in interaction design, relating it to keys, buttons and screens especially. Dourish and Dreyfus, in particular, set clear directives for the field toward an appropriate understanding of user embodiment, setting it against parallel research in artificial intelligence that seeks to augment or even supplant a physical reality with one that is digital.

The clinical neurophysiological cases cited in this study represent the wider scope of neuroscience as a field in pursuit of connecting brain activity to behavior.

More specifically, the neuroscientists that contribute most directly to this study demonstrate, through clinical trial, the connection between the physical and the metaphysical through cognition. V.S. Ramachandran, Miguel Nicolelis, Oliver Sacks and Antonio Damasio each pursue certain phenomena related to perception and the senses and in their pursuits they present compelling evidence of how cognition *looks* to an observer. What separates these clinicians from other practicing neurophysicians is their unique method, which is a phenomenological one. Each demonstrates in their case reports a path toward understanding, thus diagnosing and treating, conditions that might seem to defy the conventional scientific understanding of cognition and perception. The phenomenological methods follow what Brentano introduced as *psychognosy*, or *descriptive psychology*, which, as noted in the first chapter, sought to define empirically the objects of thought, just as a hard science is based on ascertaining concrete facts. This type of method does not conjecture to determine the causes of certain mental phenomena, but instead seeks to identify and classify them. The clinicians selected for this study do not necessarily follow phenomenological classifications in their diagnoses, as their discoveries might be better understood as neurological explanation for metaphysical experiences, but their method for discovery is through an analysis of the patient's sensory experience. Ramachandran and Sacks, especially, describe with great detail their way of understanding the metaphysical experience of their patient, through innovative and unorthodox mind tricks, such as attempting to alter a patient's visual perception in order to disconnect, through confusion, a patient's ability to accurately sense with their body. But before going further in reviewing specific neurophysiological cases through a phenomenological lens

it is necessary to establish the phenomenological base itself.

Experience and Perception

The notions of *experience* and *perception* in this study are rooted in a post-Cartesian metaphysical perspective, where the mind and body are in unity through sensation, and thus are/have a Being and a Dasein (Being-in-the-world) at once. In this framework, according to Marleau-Ponty, perception and observation serve as fundamental and exact tools for how one might measure *experience*. The unification between Being and Dasein have been established most thoroughly by Heidegger in his explanation of our openness to the world and its openness to us as we encounter it and it encounters us.[26] This kind of thinking about experience has guided researchers interested in cognition, neuroscience and metaphysics toward discoveries and inventions that reveal how the brain and body work together in sensing the world and responding in the form of behavior*.* The readings selected for this study are focused especially on two types of sensory experiences—tactile and visual. In addition to the neurophysicians, who offer case studies that literally pinpoint objects of thought with less concern on their causes and more concern for their connections, this chapter consults research that challenges traditional rationalist thinking and the persistent subject-(experimenting on an)-object dichotomy that guides conventional scientific discovery. For this discussion, the term *mind* is considered unique, but it does not inherently exist outside of the brain as it might in Cartesian dualism. Moreover, the

[26] Heidegger, Martin. *Being and Time.* Translated by John Macquarrie and Edward Robinson. New York: Harper, 1962, differentiating *Being* (the thing that knows) and *Being-in-the-world,* that exists alongside objects, or "outside" pages 79-90.

brain cannot exist outside of the body and is implied as part of the body in this discussion.

Being and Dasein

Winograd and Flores, who look at objective reality as it is tied to cognition, seek to change the ways that we understand experience as well, but look at it on a biological and social level instead. They make a strong argument for unity, even on a biological level where the mind and body have been shown, through the above cases, to act independently. Citing Humberto Maturana's work on how biological processes relate to cognition and language, a model for a consensual domain takes the place of the traditional behaviorist's observations of an independent "organism" responding to stimuli in an independent "environment." Maturana introduces the term "coupling" to suggest a pattern or network of "mutually orienting behavior" that is arbitrary and contextual. They are called arbitrary because they can take any form and are not defined by their form (you cannot point to the behavior as a cause or effect itself) and they are call contextual because the behavior can only be defined in its consensual domain (it has no place or definition beyond it).[27] Coupling is the thing that exists with the organism and environment at once. Maturana's work serves to ground Winograd's and Flores' thesis toward a unified understanding of Dasein by stripping away the inclination to analyze environments and organisms separately.

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[27] Maturana, Humberto R. Biology of Language: The Epistemology of Reality in G. Miller & E. Lenneberg (Eds.) Psychology and Biology of Language and Thought New York: Academic Press, 1978, cited in Winograd and Flores, *Understanding Computers and Cognition,* pages 48-49.

Perhaps the most straightforward example of how Being and Dasein maintain unity in and with the world is an illustration of Heidegger's idea of *thrownness*, which was explained in Chapter 1. *Thrownness* puts the division, however slight, between the two entities into terms that we can understand by our own experience. *Thrownness* makes the division clear at any moment we might choose to notice it, as we are constantly confronted with our physical presence and the effects that it has as a part of the world—a connection that Being only can know through Dasein.

Neurophysiology

Though there is some debate about whether the mind and body are forever unified with one another and the world, there is a consensus (at least from the neurophysical perspectives in the research) that the mind exists in the brain. Contrary to Descartes' thinking, Neurophysiologist Miguel Nicolelis presents a grand vision for interstellar travel that relies on a literal transport of electrical signals from a living brain to a remote body. His Brain-Machine-Interface (BMI) and Brain-Machine-Brain-Interface will make it possible to question the unity between our mind, body and the world altogether. The need for measurement tools that can observe the mind has given way to a more direct method for observing thinking in the brain as it exists on a synaptic level (though not yet on a neuro-chemical level). Nicolelis' contribution to the current research is largely to demonstrate the fluidity of the mind and its ability to act, free from the body. Nicolelis' BMI and BMBI puts the division between Being and Dasein to a clinical test. While Nicolelis does not actively pursue, nor make reference to, a phenomenological method, the path that results in these interfaces suggests that

the only way to truly unlock the sensory connection between Being and Dasein is to interpret metaphysical experience as scientific data. Nicolelis does this by translating neurological commands into computer algorithms. While this is a short but sufficient explanation of Nicolelis' method, his greater vision is dependent upon a different series of phenomena altogether: the mind's malleable image of the body.

The theme of the *body schema* is primary to Nicolelis' and Ramachandran's research especially because it sheds light on how the body might also be understood in comparison to a tool—a tool that both clinicians tend to treat as augmentable. Nicolelis cites a 1911 work by Henry Head and Gordon Holmes to illustrate that the body schema, with its fluidity, plays an intricate role in understanding precisely how a tool that is ready-to-hand might exist in the mind's body map. Head and Holmes explain the body Schema as follows

> It is to the existence of these "schemata" that we owe the power of projecting our recognition of posture, movement and locality beyond the limits of our own bodies to the end of some instrument held in the hand. Without them we could not probe with a stick, nor use a spoon unless our eyes were fixed upon the plate. Anything which participates in the conscious movement of our bodies is added to the [mind] model of ourselves and becomes part of these schemata: a woman's power of localization may extend to the feather in her hat.[28]

[28] Head, Henry, and Gordon Holmes. "Sensory disturbances from cerebral lesion." *Brain,* 34 (1911), quoted in Nicolelis, Miguel. *Beyond Boundaries: The New Neuroscience of*

Nicolelis also takes aim at the body's evolutionary limits across the senses more directly by tracing the progress toward isolating and understanding action potentials in the neuromatrix.[29] Specifically, Nicolelis sets out to prove his thesis that the activities invoked by the brain cannot be isolated to a single neuron, as previously understood in the general neuroscientific community. Instead, Nicolelis' experiments indicate that a population of neurons, often called *neural ensembles* or *cell assemblies,* together invoke actions of thought and physical activity. This distributive perspective of multi-tasking neurons guided Nicolelis' experiments and the development of the brain-machine-interface. To follow Nicolelis' vision for a mind that is freed from the limitations of its body (and ultimately the earth), it is necessary to conceive of the mind as a simulator of the real world. This view is parallel to Marleau-Ponty's in many ways. Nicolelis proposes that "the main business of our brains is to produce a large variety of behaviors that are vital for our existence as human beings" but some of the behaviors suggest the body as merely a utility (with limits) for experience. These are

(a) Maintaining our bodies in working order through the global physiological process called homeostasis;

(b) Building and storing very detailed models of the external world, of our lives, and of the continuous encounters between the two; and

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Connecting Brains with Machines--and How It Will Change Our Lives. New York: Times Books , 2011.

[29] "neuromatrix" attributed to Melzack, defined as "the somatosensory cortex, located at the surface of the brain on the top of the head, and its associated regions of the parietal lobe. In addition, it encompasses multiple neural pathways, including one that conveys tactile information from the periphery of the body to the thalamus, a sensory relay station deep in the brain whose neurons send information to the somatosensory cortex, and another that traverses the brain's limbic system, a group of buried brain structures that governs emotions such as those associated with phantom limbs." In "Nicolelis, *Beyond Boundaries*, page 60.

(c) Actively and continuously exploring the surrounding environment in search of new information to test and update these internal models. This includes learning from experience and predicting future events and their payoffs by generating potential expectations for their outcomes, costs, and benefits.[30]

In stating these behaviors Nicolelis means to point out the limitations in reductionist brain experiments, which often probe individual neurons in states of rest, thus gathering inadequate data on the environmental variables that generally influence consciousness (when awake), and how such variables relate neurons to one another rather than in isolation.

For this study the most relevant part of Nicolelis' research is the expansion of pre-existing models and applications of the BMI (into the BMBI). For Nicolelis' experiments, the intention of the BMI was to displace the action potentials of neural ensembles from the body, and instead transport their electrical information through an amplifier where the mind's commands could be interpreted and transmitted for robotic action. The most notable of Nicolelis' experiments involved a rhesus monkey named Aurora, who played a video game using a joystick. Through training, Aurora learned to control the game through the BMI, first by controlling a robotic arm by thinking in the same manner about the movements that she needed to implement in her own arm and hand with the joystick. The results showed that action potentials (the thinking in synaptic form) in the brain can indeed be liberated from the body and further, can be

[30] Nicolelis. *Beyond Boundaries*, page 28.

amplified and interpreted into robotic action.[31] The implications of this experiment put Nicolelis on a path toward universal displacement, with visions of placing the human mind on Mars in such a way.

Building on this success Nicolelis identifies a missing piece—the feedforward-feedback loop, proprioception. With Aurora, Nicolelis accomplished a unidirectional command link with the robotic arm, but the need for *tactile feedback* gave way to the brain-machine-brain-interface. Tactile feedback is an important term in HCI as well. It can be seen in simple forms like in mobile phones with touch-screen sensitivity that respond to touch with a vibration. The vibration, in that case, sends tactile feedback to confirm (beyond visual or aural cues) that an action has taken place. The BMBI, then, allows bidirectional communication between the brain and a virtual or otherwise foreign body. Through the BMBI Aurora no longer controls a mysterious motorized arm in addition to her own, but instead can control the game directly. In the experiment Aurora "presses" buttons and receives tactile feedback that they've "been pressed," while sitting perfectly still. The BMI and BMBI make it possible to bypass the body and translate thought commands, which are seen as electrical synapses, to objects in the world. Certainly, freeing the mind from the body has other effects, but such human interface devices challenge previous limits of *experience* that might not extend past the physical space that Dasein has. It is important, though, to remain committed to the *notion* of Dasein without regressing to dualistic thinking that might suggest that our entire mind and consciousness are ultimately portable and that *experience* does not still rely on mind-body unity. Though Nicolelis does not address the consequences of

[31] Nicolelis. *Beyond Boundaries*, "Freeing Aurora's Brain," pages 125-155.

freeing the mind from the body (and therefore risk the loss of association in our world), a holistic approach to Being is in line with the distributive perspective of neuroscience, which seeks to understand consciousness through observation of neuromatrices as they behave in the lived world. Ramachandran and Blakeslee warn against thinking about opposing poles as mutually exclusive routes to observation, and suggest borrowing from each, which they refer to as—*modularity* (reductionist) and *holism* (distributive). For neuroscientists modularity implies that different parts of the brain act as specialists, handling precise functions like language or memory, and do so exclusively. Holism, on the other hand, supposes that different parts of the brain have similar capabilities and "that any one part is as good as any other part."[32] Ramachandran and Blakeslee seat their arguments between these two poles, because each extreme form endangers the possibility of full understanding.

Ramachandran and Blakeslee seek to uncover the ways in which the mind and body "talk to" each other and have devised a relatively simple, but effective device that can intercept the visual communication between the two. Taking a case study approach to phantoms bodies (as in limbs and organs), the research traces how specific actions, such as movement, and neural feedback, such as pain can be experienced in a human being that has lost an appendage. Using the Penfield homunculus brain map as a model, Ramachandran and Blakeslee explain that regions of the body have corresponding, highly localized neurological regions in the cerebral

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[32] Ramachandran, V. S., and Sandra Blakeslee. *Phantoms in the Brain: Probing the Mysteries of the Human Mind.* New York: Harper Perennial, 1999, page 10.

cortex that *feel*.[33] Through experimentation Ramachandran discovered that patients that receive sensory feedback from phantom limbs are receiving overlapping stimulation from neighboring locales in the map and thus experiencing very real sensation in the missing appendage. For example, Ramachandran's patient, Tom Sorenson, described sensations in his fingers of his amputated left arm when receiving stimulation on his cheek and lips because according to the Penfield brain map (among others) the locale for the hand and fingers is directly adjacent to the face and lips.[34] This discovery has helped answer longstanding questions about sensory feedback from phantom limbs, but also about the mind's role in adapting to changes in the physical body (nerve fibers sprout and/or activate in neighboring territories that have become vacant, essentially taking over the area for the hand, in this case, with additional receptors for the face).

Ramachandran and Blakeslee make a strong case to suggest that the mind can adapt its body schema over time, but another case illustrates that a general, complete human body is probably "hard-wired" as well. In a case with a patient named Mirabelle, the issue was that she had never acquired visual or proprioceptive feedback associated with having arms and hands, as she was born without them. However she possessed an inherent, "hard-wired image of the body and limbs at birth—an image that can survive indefinitely, even in the face of contradictory information from the

[33] Ramachandran and Blakeslee. *Phantoms in the Brain*, pages 25-26, more precisely describe the Penfield map as a region that receives sensations on the surface of the skin, but because of the complexity of the sensations, I use the word *feel*.

[34] Ramachandran and Blakeslee. *Phantoms in the Brain*, pages 26-30.

senses."[35] A practical way of understanding Mirabelle's situation is to consider her arms and hands in existence and functional on a neural and muscular level, but invisible to her and extremely "present-at-hand" when acting with an object—so much so that she cannot get them to influence the object at all. Such a radical shift in thinking about limbs stretches Heidegger's concept of technology into the realm of neuroscience, where a term like "present-at-hand" takes on an ominous but more literal meaning. In Ramachandran's description of Mirabelle's case, words like "reach out," "grab," "point," "wave," "throw," "shake" and "maneuver" illustrate the need for thinking about limbs in parallel with Heidegger's observations about being-in-the-world and thrownness.

Brentano, then Husserl, rightly noted a need to depart from "objective" scientific study when attempting to *observe* subjective metaphysical phenomena. Ramachandran's case studies tend to follow this principle as well, because in each case it is only the patient's experience of *feeling* that is "measured." Ramachandran's scientific evidence is the patient's own observations paired with an exploratory approach to answering metaphysical questions of experience. The result of this non-traditional scientific approach are a few revelations that point back to a fluid body schema and the power that tactile and visual learning can have on what we think of as the self. Ramachandran describes his invention, the "virtual reality box," which is a simple device that uses a mirror of the opposite arm within a box to trick the mind into *seeing* the phantom appendage move. In a case that involves a patient with a painful, paralyzed phantom arm, Ramachandran found that the mirrored image of the opposite

[35] Ramachandran and Blakeslee. *Phantoms in the Brain*, page 42.

working arm tricked the patient's mind into believing that the phantom arm regained motor skills. What's more, this eventually frustrated the parietal lobe, which continued to receive flawed feedback from the homunculus that the appendage was paralyzed, to disembody the arm and acknowledge the arm is missing.[36]

To look closer at how the mind *feels*, Ramachandran and Blakeslee notes that the virtual reality box experiments work some of the time in abating pain by, say, unclenching a painful and uncontrollable phantom fist by offering mirrored visual feedback with the opposite working hand. But Ramachandran and Blakeslee report this as a placebo effect with limited success. Ramachandran approaches cases with different experiments to combat the complex pain illusion, and offers a succinct but powerful example of how phantom pain is not reserved for amputees, but rather," *your own body* is a phantom, one that your brain has temporarily constructed purely for convenience." An experiment to test this is laid out as follows

> To experience the full illusion, you'll need two helpers. (I will call them Julie and Mina.) Sit in a chair, blindfolded, and ask Julie to sit on another chair in front of you, facing the same direction as you are. Have Mina stand on your right side and give her the following instructions: "Take my right hand and guide my index finger to Julia's nose. Move my hand in a rhythmic manner so that my index finger repeatedly strokes and taps her nose in a random sequence like a Morse code. At the same time, use

[36] Summarized from Ramachandran and Blakeslee. *Phantoms in the Brain*, page 46-50, noting the case of Philip Martinez, who reported, through treatment with the virtual reality box, his phantom arm disappearing except for his finger tips.

> your left hand to stroke my nose with the same rhythm and timing. The stroking and tapping of my nose and Julia's nose should be perfect synchrony."[37]

The experiment usually results in the perception that you're touching your own nose or that it has been dislocated and stretched to the location in front of you. The question such an experiment answers is that the body schema is malleable, and though Ramachandran's research supplies evidence that there is a "hard-wired," natured image embedded in each of us, it competes with the nurtured image—the physical, personal image that is constantly under scrutiny by the parietal lobe and other parts of the brain. Further, other experiments reveal that the human body part can be projected onto an inanimate object as well, such as a table. Ramachandran goes so far as to call the body image "a shell that you've temporarily created for successfully passing on your genes to your offspring."[38] Such a bold statement implies that the body is merely a utility—an external mechanism that relies on an external-internal interface that lets us be and act in the physical world.

Ramachandran and Blakeslee also discuss two key ways that the mind *sees* through the eyes before going further into other senses that *see*.[39] The mind receives vision in the visual cortex and divides it into two main pathways. The first is the "what" pathway, which is sent to the temporal lobe and gives us the catalog and intuition to

[37] Ramachandran and Blakeslee. *Phantoms in the Brain*, pages 58-59.

[38] Ramachandran and Blakeslee. *Phantoms in the Brain*, page 62.

[39] Ramachandran and Blakeslee. *Phantoms in the Brain*, "The Zombie in the Brain," pages 63-84.

identify objects categorically and uniquely (sometimes called "face cells"). The second and more relevant pathway for the current question is the "how" pathway, which is also called the "vision for action" pathway. The "how" pathway equally involves sight as we know it, but concerns itself with spatial vision—"the ability of organisms to walk around the world, negotiate uneven terrain and avoid bumping into objects or falling into black pits."[40] This pathway is sent to the parietal lobe. What is left to the imagination in this chapter is the role of the eyes in the "how" pathway. In most of the examples it is not clear if the eyes are actually *seeing* in order to determine spatial vision. Some examples include a baseball outfielder beginning to run to catch the ball at the crack of the bat before locating with their eyes where the ball would land, or how basketball players can actually close their eyes and make a basket from a practiced location.[41] Such examples call for further scrutiny on how proprioception contributes to the "how" pathway and *sight*, and suggests that spatial *seeing* is spatial *feeling* too.

To continue on this path is to reveal a long-established theoretical understanding of *perception* that has, in recent years, been reinforced in scientific communities. Phenomenologists since Kant have taken on the challenge of determining the *essence of consciousness* that can only be understood through observation of the sensing and sensed, most notably the made use of sight, sound and general feel (qualia) in the lived world.[42] A work most directed at this challenge is Marleau-Ponty's *Phenomenology of Perception*. Its relevance here, in particular, is in

[40] Ramachandran and Blakeslee. *Phantoms in the Brain*, page 77.

[41] Ramachandran and Blakeslee. *Phantoms in the Brain*, page 83.

[42] Merleau-Ponty. *Phenomenology of Perception*, page xxix.

its description of how we are "caught up in the world" and thus our own consciousness does not account for the consciousness of the world. If we were able to do so, we would have a firmer grasp on the *quality* of the object that exists outside of our transporting of it into our consciousness. In short, Marleau-Ponty's notion of *quality* is something that is never directly experienced, and is reduced, in fact, by our belief that "this sense and this object, at the level of quality, are full and determinate."[43]

Another of Marleau-Ponty's observations that contributes to the current research involves sensation itself, most notably seeing. Seeing, in particular, is observed as a literal *grasping* of images, thus it gains special privilege among the senses for allowing us to grasp objects from afar, and also segregate the field and pull the object into consciousness where it can be assembled.[44] In this way, assigning conventional thinking about *physical* activity to *seeing* serves to level the sensory field and can build a bridge between the phenomenology of perception to the somatosensory experience as it is understood in neuroscience.

A clinical understanding of the sensory-cogito experience offers a great deal for the current study, which will apply similar methods to revealing the effects of a techno-sensory experience of looking and seeing with imaging devices. However, it must be noted that there is one additional consideration that Nicolelis, especially leaves out, and that is the intersection of emotion and reason. Damasio focuses especially on this, citing a flaw in the rationalist model. Damasio presents compelling evidence to suggest

[43] Marleau-Ponty. *Phenomenology of Perception*, "Sensation" page 5.

[44] Marleau-Ponty. *Phenomenology of Perception*, "Association" and the "Projection of Memories," page 19.

that emotional reasoning is at least as important as logical reasoning in determining a cognitive directive for action. Damasio traces the neuro-chemical and hormonal processes that flood the neural synapses with *feelings* in chemical form. There is no account for these processes in the BMI or BMBI, which suggests that a mind free from the body will lack emotional reasoning. Dasein's immediacy offers a degree of sensory data related to emotion, not just spatial reasoning, including feelings that represent fear of bodily harm, pleasure, sickness or health to name a few. Sacks and Ramachandran seem to consider this in their practice but make very little separation between this specific class of sensation and those that are more conventional, such sound, taste, smell, touch and especially sight. Damasio, Sacks and Ramachandran each focus a great deal of research on *seeing*, citing cases that explore what the result is in the mind. Some patients that have suffered from stroke see hallucinations in their visual field, even while they're awake and *seeing* the world perfectly well. Sacks explores a number of cases that reveal blindness in the eyes, but argues that *sight* still exists in the mind. Each case challenges an ongoing paradox between sight as an *experience* and sight as a *visual description*, which for Sacks is heavily reliant on language.[45] The key question that Sacks raises is about *seeing* as it exists in the mind, and how it can be seen through descriptive language. Sacks uses Wittgenstein's distinction between communication and representation, using the words "saying" and "showing" and Kosslyn's words "descriptive" and "depictive" to draw connections in how the brain adapts language when perceiving an image.[46] Aphasia, which means "a loss of

[45] Sacks, Oliver. *The Mind's Eye.* New York: Vintage, 2011, page 240.

[46] Sacks. *The Mind's Eye,* page 46.

speech," is a condition generally occurring from stroke that renders the patient unable to interpret the meaning of language. Sacks concentrates primarily on aphasia, taking a similar non-scientific, exploratory approach that relies on a patient's own observations to define the thought and behavior that cause the experience.

Apart from Nicolelis the authors show particular concern for cases that demonstrate a separation between a physical ability to sense and the neurological process that interprets it. In other words, Sacks, Ramachandran and Damasio share an interest in preserving or augmenting the mind-body connection, rather than pushing them apart further. While it is not their thesis, these authors tend to agree that there is a real danger in freeing the mind from the body, because without a body one cannot completely *feel*. But what does this mean? The current study shares the same limitations in the use of this term. To *feel* in the current study is most closely related to the conventional senses and the neuro-electrical experience that connects the brain and body. It is equally important to consider the neuro-chemical experience, though, but this is left for another study. In making feeling a primary tool for observation, this issue will concern the phenomenologist above all others. On this final note, Damasio writes

> …the comprehensive understanding of the human mind requires an organismic perspective; that not only must the mind move from a nonphysical cogitum to the realm of biological tissue, but it must also be related to a whole organism possessed of integrated body proper and

brain and fully interactive with a physical and social environment.[47]

Embodiment and Interaction Design

The research selected from interaction design (and closely related disciplines) confronts similar issues established by the previous neurophysiological cases, however the approach is highly theoretical. The meaning and extent of embodiment in the readings is shaped widely by metaphysics, calling mostly on Heidegger with a general contrast to the metaphysical revolution of Galileo and Descartes. Dreyfus, Dourish, McCullough, Zehnder and O'Keefe address the tensions of this term explicitly in digital space and offer theories to propose and interpret the results of human-machine interaction design models in computing and game environments especially.

Dourish's research is certainly the most devoted to a phenomenological understanding of embodiment, thus it is the most relevant source from this field for the current study. Dourish proposes that to achieve embodiment through a physical-digital interface is not merely a technological challenge but also a metaphysical one, requiring a deep understanding of the sensory-cogito relationship and an overall goal of giving meaning to the interaction itself. Dourish surveys the history of social and tangible computing to their roots in our culture and attempts to link our physical and social self to the design metaphors that are already in place in digital space. Dourish provides a fairly straightforward explanation of the term both in digital space and in the real world.

[47] Damasio, Antonio. *Descartes' Error: Emotion, Reason, and the Human Brain.* New York: Penguin, 2005, page 252.

He proposes that *embodiment* underlies tangible and social computing in the same way "in which we encounter physical and social reality in the everyday world." More precisely, our physical body and our actions are not abstract or separated but rather they are "embodied elements of the everyday world"[48] and "embodied phenomena are those that by their very nature occur in real time and real space."[49]

Tangible computing focuses on the physical environment and essentially defines what we perceive as its physical boundaries (such as dragging and dropping things on the desktop). Social computing focuses on intentionality and context *through* the system (such as the workflow and organizational habits). Ultimately Dourish's contribution to the questions of embodiment is in building the most direct link between interaction design and a phenomenological and sociological history of being. It may be an oversimplification to attribute tangible computing to phenomenology and social computing to sociology, but this does ultimately serve Dourish's goal of bringing the fields together in order to inform a culture of design that must distance itself from a dependence on representational software (the desktop metaphor, for example) and move toward "a much more questionable representationalist stance toward action and interaction."[50] Dourish's brings together models of social computing and tangible computing to strengthen the direction of interaction design for the future, accounting for both a physical and social embodiment at once. The embodiment quality accounts for

[48] Dourish, Paul. *Where the Action Is: The Foundations of Embodied Interaction.* Cambridge: MIT Press, 2004, page 100.

[49] Dourish. *Where the Action Is,* page 101.

[50] Dourish. *Where the Action Is,* page 208.

not just the physical representation of the user's actions in space, but the full experience of being in *place*.[51]

While Dourish focuses on software, Manovich takes a similar approach to the screen, in particular, as it relates to the human body. A key point comes from Barthes's "Diderot, Brecht, Eisenstein," which points out the "dual foundation" of representation, not just imitation, that is

> the sovereignty of the act of cutting out [*decoupage*] and the unity of the subject of action….The scene, the picture, the shot, the cut-out rectangle, here we have the very *condition* that allows us to conceive theater, painting, cinema, literature, all those arts, that is, other than music and which could be called *dioptric arts*.[52]

This is to say that the act of viewing/reading/etc. has several requirements, namely that we must view the cut-out, with its clearly defined edges, as all-inclusive and so we must be first immobile and then willing/able to allow the screen to exist as the locale for action. Considering Dourish's notion of embodiment, this suggests that immobility is a prerequisite for any variation of screen embodiment. The link can be found in Manovich's definition of screen, which is given in the context of *representation-simulation:*

[51] Dourish. *Where the Action Is,* pages 87-92 differentiate *space* and *place* by exploring the physical and social exclusivity of each term, respectively.

[52] Barthes, Roland. "Diderot, Brecht, Eisenstein," In *Image/Music/Text*, by Roland Barthes, translated by Stephen Heath, 69-78. New York: Farrar, Straus, and Giroux, 1977, 69-70, quote in Manovich, Lev. *The Language of New Media.* Cambridge: MIT Press, 2002, page 103.

> I define *screen* as a rectangular surface that frames a virtual world and that exists within the physical world of a viewer without completely blocking her visual field. *Simulation* refers to technologies that aim to immerse the viewer completely within a virtual universe—Baroque Jesuit churches, nineteenth-century panorama, twentieth-century movies theaters.[53]

Manovich notes also Alberti's perspectival window and Norman Bryson's logic of the Gaze, which presents to us the world as a singular "visual take" that is "static, unblinking, and fixated." Bryson wrote that this Gaze is "…eternalized, reduced to one 'point of view' and disembodied."[54] This may seem like a contradiction, but when considering the qualities of embodiment—the mental and physical transportation that must occur—the disembodiment that Bryson writes about is an inherent requirement when attempting to embody through a screen. The result, then, is that the seemingly immobile viewer acts visually—perceives—and thus the representation, as Barthes calls it, relies on the same tools of visual interpretation that are already required in reality. The point of connection to the camera apparatus, then, is the choosing of point-of-view and its subsequent positioning in virtual space.

McCullough is concerned with the issue of mobility also, adding an architectural backdrop to combat fears against ubiquitous computing and help define its role toward

[53] Manovich. *The Language of New Media,* page 16.

[54] Martin Jay's summary in "Scopid Regimes of Modernity," in *Vision and Visuality,"* ed. Hal Foster (Seattle: Bay Press, 1988), 7, quoted in Manovich, *The Language of New Media,* page 105.

embodiment. McCullough explores the notion of *priori* space as well, and observes Descartes' dualism having affected the world view of culture and nature as well. McCullough offers perspective on embodiment in the real world, but the real world includes computers, and so a discussion of space, place (and ecosystem) depends on the role of how ubiquitous computers can work with us in a world that facilitates our mobility and interaction. McCullough acknowledges context and intentionality as the main factors in achieving embodiment. McCullough cites Marleau-Ponty to illustrate these qualities in the world, and how they shape perception and culture:

> The body is our general medium for having a world. Sometimes it is restricted to the actions necessary for the conservation of life, and accordingly it posits around us a biological world; at other times, elaborating upon these primary actions and moving from their literal to a figurative meaning, it manifests through them a core of new significance: this is true of motor habits such as dancing. Sometimes, finally, the meaning aimed at cannot be achieved by the body's natural means; it must then build itself an instrument, and it projects thereby around itself a cultural world.[55]

It is clear at this point that the authors generally ground discussions of embodiment in phenomenology and ways that we act in the world (with our physical bodies and through technology). McCullough, like Dourish, also seeks to change the philosophy of

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[55] Marleau-Ponty. *Phenomenology of Perception*, page 440, quoted in McCullough, Malcolm. *Digital Ground: Architecture, Pervasive Computing, and Environmental Knowing.* Cambridge: MIT Press, 2005, page 34.

design toward one that favors context and intentionality of the user over the computer. One thing in particular that McCullough does to articulate the way that *place* and *placeness* contribute to a sense of embodiment, is to explain the dangers and causes of disembodiment. He cites M. Christine Boyer's three ways that it happens. First, people retreat into their private homes to avoid the public "squalor." Then, the city takes on a commercialized strategy to lure the people back outside. Third, as these urban spaces spread, the mental "mappability of the city" fades and with it too the identity and association of the body.[56] McCullough calls for a shift in design that will combat what he sees as a design model that favors convenience for the computer over the user, which has an impact on how users can find embodiment through technology that is constantly presenting itself as an outspoken player. McCullough notes the Windows computer error "The computer was not shut down properly!"[57] This message reminds us of the computer's needs and how they might constrain rather than mobilize users.

Though McCullough in particular is focused on building computers into our daily lives in a way that is invisible and quietly assistive, the idea for embodiment is quite different if we look at gaming, where constraints are imposed precisely to give the game meaning. When framed as a "conversation of gestures" between humans and machines, the term *dialogue* becomes a useful description. O'Keefe and Zehnder apply this term in the context of gaming and in the process determine states of gesture-to perform and opportunity to respond to the gestures of other agents, upon which this

[56] McCullough, *Digital Ground,* page 179.

[57] McCullough, *Digital Ground,* page 152.

conversation depends.[58] The result of this framework is an analysis of gaming and its effectiveness in skill development through the measure of appropriate (and inappropriate) resistance that challenge the human user toward mastery. The analysis also depends on an understanding of *agency*, which is viewed as performative. It is the "doing, guided by purpose."[59] O'Keefe and Zehnder attribute this perspective of agency to Pickering, who rooted it in Heidegger's idea of readiness-to-hand. In the case of games, embodiment seems more like a challenge of the game, where mastery comes with transforming the controls into ready-to-hand. O'Keefe's and Zehnder's suggest that resistance requires that either the agent or computer adapt, saying that "resistance is overcome by accommodation, either by the human or instrumental agencies involved in a performance."[60]

O'Keefe and Zehnder also look at the human agent's perspective (not as much with the screen, but within the virtual world itself) and how the game genre provides a model for development through resistance and accommodation. Section 3.2, "Action, embodiment, and point-of-view" is a brief but insightful review of how advancements in visual cues attempt to compensate for the absence of proprioceptive cues in even the most sophisticated games. They provide a good summary of proprioception and a helpful example. They write that proprioception

[58] O'Keefe, Barbara J., and Sean Zehnder. "Understanding media development: A framework and case study." *Applied Developmental Psychology*, no. 25 (2004): 730-731.

[59] O'Keefe and Zehnder. "Understanding media development," page 732.

[60] O'Keefe and Zehnder. "Understanding media development," page 732.

> …describes the sense of body orientation and movement that is made possible by stretch receptors in the joints and muscles which relay positional information to our brains. This sense endows human beings with the ability to do such things as walk without looking at our feet and touch our nose with our eyes closed.[61]

A common interaction design technique employed to compensate for the absence of proprioceptive mimesis is to move away from the popular first-person point-of-view (POV) visual perspective and provide one that is either third-person omniscient—a wide, typically overhead visual angle of all action in the human agent's purview, or third-person trailing POV—a position that imitates the view of a follower behind the agent's avatar.[62] Either of these allows the sense of vision to accommodate for the absence of proprioception, where a simulated body movement, such as a spin or flip, could be seen from a less restrictive (than first-person POV) angle. These two angles give the agent compensating faculties for situational actions that require precise simulated body movements in virtual space. O'Keefe and Zehnder point out that in addition to the designer's relentless task of enhancing the "reality effect" of virtual body behavior and its relationship to virtual space, graphical and aural improvements in game design also improve the human agent's opportunity and ability to replace absent proprioceptive cues with those that are visual.[63] The irony, of course, is that third-person omniscient and trailing POV compromise the reality effect in every way

[61] O'Keefe and Zehnder. "Understanding media development," page 736.

[62] O'Keefe and Zehnder. "Understanding media development," page 737.

[63] O'Keefe and Zehnder. "Understanding media development," page 738. "Reality effect" refers to Manovich, 2001.

imaginable, namely the inhuman ability to see beyond our own first-person perspective and to require exclusively a visual sense of body. O'Keefe and Zehnder point out embodiment characteristics that are available in some advanced games, such as cues for injury, which slow the character's movements and give visual cues to signify the location and severity of injury. However, this is arguably not a quality of embodiment because the injury cannot signify real harm (to the body), thus risk to the avatar in digital space does not translate to the Being-in-the-world.

It might appear that the natural path for interaction designers working in game industries would move toward models that allow more direct actions to transfer from the body to the virtual body. However, the joystick, key and button-press model still holds sway because it can more closely accommodate the computer's need for complex translations of commands. In other words, using motion sensing technologies to replace these existing command models introduces challenges when translating widely varying body movements rather than complex key combinations that always result in the same action.[64] Shinkle points out the consequence of such designs that favor the needs of the game over agent.

> For casual and neophyte gamers, however, the button-based controller can act as a hindrance to good gameplay. A series of complex and often counter-intuitive button or keystroke combinations stands in for a range of widely varied real-world skills. Rather than reducing the need for skillful engagement and the potential for error, such control systems demand

[64] Shinkle, Eugénie. "Video games, emotion and the six senses." *Media, Culture & Society* (SAGE Publications) 30(6) (2008), page 910.

> their own highly specific skill set. Perhaps more importantly, they limit the player's ability to invest themselves physically in the game. It's not uncommon for gamers to gesticulate wildly with the controller during gameplay, but standard controllers don't recognize such movements as meaningful, and they have no effect on events in the gameworld. Conventional game controllers have little to offer when it comes to the physical and gestural aspects of play, restricting, rather than supporting, this category of individual expressive response.[65]

Up to this point, each of the frameworks that have been developed to address the tensions of embodiment in digital space have outwardly stated a reliance on the human agent's ability to strive for transparency and tool mastery through practice and adaptation. The resistance is even intentional when it comes to the game experience. Even if the resistance caused by the interface is part of the overall challenge for agent mastery, Shinkle notes that it still favors vision in particular, paying little to no regard for physical senses. In describing an "ideal interface," Shinkle describes one that is transparent, intuitive, does not reduce human actions and gestures to just yes/no/on/off, and allows creativity—the human agent should be able to "find her/his own way of doing things, rather than simply following a set of established protocols and narrative events."[66] Proprioception is a major factor in the embodiment that Shinkle describes, as it accounts for the precision of movement, speed and power—all

[65] Shinkle. "Video games, emotion and the six senses, page 909.

[66] Shinkle. "Video games, emotion and the six senses, page 912.

measurable physical gestures that barely translate in the key, button and joystick models.

By way of concluding Shinkle acknowledges that in the two primary cases in the study, the Ninteno Wii and Sony EyeToy, physical gestures are not yet representative of the human agent, but merely they incorporate and create games around the concept. Since Shinkle's study there have been some advances in physical gaming but to call these games embodying is ambitious. It is also important to note that they have not replaced, nor do they intersect genres with first-person POV games that rely on complex button and joystick combinations to be successful in the game. This is largely due to social perceptions of game dynamics, purpose, and constitution of technology. The result is an emerging genre of physical games (fitness, sport or dance/music-centered) that are being developed in parallel to first-person POV games (military mission-centered, racing, flying and other games that invoke a sense of *piloting*).

Perhaps the best overview of the overarching challenge embodiment offers in digital space is given by Dreyfus. Dreyfus states outright that artificial intelligence, as a discipline, has overlooked cultural factors that a successful embodied experience depends on, thus he virtually rules out advancements in this field. His attention is primarily on human-computer-human-interaction, where users do not just seek embodiment in digital space, but through it with another human. He cites a Carnegie Mellon University research project that attempted to measure satisfaction and fulfillment of users participating in on-line friendships. From a *New York Times* report on this study, Dreyfus includes:

> On-line friendships are likely to be more limited than friendships supported by physical proximity…. Because on-line friends are not embedded in the same day-to-day environment, they will be less likely to understand the context for conversation, making discussion more difficult and rendering support less applicable.[67]

Essentially, for Dreyfus the heart of the embodiment issue is in its irreplaceable need for physical presence, proximity and context. His research is thus devoted to explaining these challenges and their consequences in three focal points in digital space: 1) hyperlinks, 2) distance learning and 3) telepresence, including anonymity and nihilism (namely the virtual environment *Second Life*).

Dreyfus's tie between hyperlinks and embodiment is in our ability to recognize relevance and find information through indirect and direct association. Dreyfus warns against creating linking structures without conscious awareness of their reliance on our ability to recognize relevance within a context of real-life meaning and physical body. This argument is even stronger when it extends to distance learning. Starting with the conclusion that distance learning is already a known failure, Dreyfus explains a hierarchy of learning that exposes the way that physical (face-to-face) limitations render higher learning impossible. Dreyfus says that it is possible to acquire, in a distance learning environment, "Stage 1: Novice," "Stage 2: Advanced Beginner" and "Stage 3: Competence." Dreyfus explains each of these stages in knowledge

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[67] Dreyfus, Hubert L. *On the Internet (Thinking in Action).* New York: Routledge, 2009, page 3.

acquisitions as possible in the absence of face-to-face learning, but the next three stages demonstrate “the Net’s limitations where embodiment is concerned” which “may well leave students stuck at competence.”[68] “Stage 4: Proficiency” describes a student that “sees the problem that needs to be solved but has to figure out what the answer is.”[69] This marks the first stage that requires an experience that puts intuitive reaction in place of reasoned responses. In other words, this stage marks a student’s ability to put what he or she has learned into action in the world. Dreyfus’s includes an example that involves the body directly, and one that involves it indirectly. The first is driving. In his example he involves a slippery turn and the need to *feel* the car’s speed and then *decide* the level of braking and turning that will ultimately succeed the turn. The second is chess, and the example illustrates that a proficient student must, if shown a “meaningful chess position,” identify the “salient forces inherent in the situation” and then calculate the best move.[70]

The stakes increase at the top two levels: “Stage 5: Expertise” and “Stage 6: Master” because at stage 5, the expert no longer needs to calculate the correct action. Instead “what must be done, simply is done.” At Stage 6, the Master knowingly breaks away from what might be considered the right move, and instead tries to develop a new move that may or may not be successful. The key is that the master is aware of

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[68] Dreyfus. *On the Internet,* stages from Chapter 2, quote on page 34.

[69-70] Dreyfus. *On the Internet,* page 35.

the moments of diversion from the path, and knowingly fails at the original path to seek discovery of a new, (one's own) path. Apprenticeship is a key factor for Dreyfus in the higher levels of learning, as he believes one must follow in the steps of an existing master in order to reach that level for one's self. The most important factor in these later stages is that they depend on a student's level of investment. In other words, the activity must matter. Unlike the flight simulator, the student must have emotional involvement and direct and personal consequences in the outcome. This is consistent with Dreyfus's theme, and transitions into his most pointed argument that intensifies the embodiment discussion—telepresence.

Using the online virtual world *Second Life* as his primary case, Dreyfus explains that the ultimate draw is the ability to experiment and invent one's self free from real-world consequences and under the cloak of anonymity. The idea of a telepresence challenges the entire notion of embodiment, as it suggests a constant disconnect that makes transparency possible, but not to the extent that the digital experience as a whole is ready-to-hand. The notion of distance, anonymity and nihilism are the root of Dreyfus's argument against the hope of a direct presence:

> Then, as in laproscopic-surgery, for example, the doctor feels himself present at the robot site, the way blind people feel themselves present at the end of their cane. But even though interactive control and feedback may give us a sense of being directly in touch with the objects we manipulate, it may still leave us with a vague sense that we are not in

> touch with reality. Something about the distance still undermines our sense of direct presence.[71]

Dreyfus cites Marleau-Ponty's *Urdoxa* (primordial belief) as the source of this vague sense of being out of touch with reality. If *Second Life* and online chat rooms offer the opportunity to "play" real, then, as Dreyfus points out, they will inevitably be unable to embody primordial risks and rewards, like danger and sex as we know them. Dreyfus returns throughout to the Platonic term "vulnerable body" and poses an affirmation of it rather than a resistance to it. Anonymity and nihilism are also consequences of the type of embodiment that the net currently affords, and this is because telepresence exists to us is in opposition to our physical self. This fundamental issue is what fuels Dreyfus's own pessimism toward artificial intelligence and the inherent flaw in programming explicit knowledge that has little to no relation to the implicit day-to-day concerns that pervade our world and thus go unnoticed.

These authors, as well as those that write about situated action design, are keenly aware of the major tensions that surround the quest for embodiment in digital space. Lucy Suchman wrote about face-to-face communication, and shared knowledge as the depth that eludes interaction design.

> What is unspoken and relevant to what is said is assumed to reside in the speaker's and listener's common stock of background knowledge, the existence of which is proven by the fact that an

[71] Dreyfus. *On the Internet,* page 53.

> account of what is said always requires reference to further facts
> that, though unspoken, are clearly relevant.[72]

The failure to address this overwhelming challenge is precisely Dreyfus's criticism of artificial intelligence and paints a bleak picture for designers that do not associate the primary factors that have been identified here as the key pieces to the embodiment puzzle. Those that stand out are mobility, intentionality, context and place. Each of these characteristics push us physically and socially into Being-in-the-world, but they are rarely accounted for in digital space. If the existing model of embodiment is telepresence, then certainly the idea of play and agency prevail. In such a model the challenge of embodiment becomes the game itself. But, when the interaction involves people, the challenges noted in face-to-face communication emerge once more, and the absence of physical presence still lies at the heart of the challenge.

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[72] Suchman, Lucy A. *Plans and Situated Actions, The problem of human-machine communication.* Cambridge: Cambridge University Press, 1987, pages 56-57.

Chapter 3

The experience of looking through technology

In his book *What Technology Wants* Kevin Kelly offers a way of thinking about technology as an autonomous force—something that is not just ubiquitous, but also independent of the human network it is supposed to serve. For Kelly technology is not merely a series of tools, nor does he frame it as a series of tools put to use as *equipment*, as Heidegger might say. Instead Kelly advocates that this vast, independent network, the *technium*, has wants and these wants drive the technium into our daily lives where their use gives them meaning. Kelly's method for assessing this meaning is through a cultural study of the evolution of the technium, observing general trajectories that it has taken to distinguish itself among and in opposition to us, the users, and our culture. This is an argument that lends itself especially to imaging devices, which have come to find their role defined by a global conception of experiencing sight—a *seeing is believing* phenomenon that favors this particular sense as one that is trusted to discover, measure and assess the physical world in front of us. Such trust is revealed in the fragmentation of the senses through varying visual technologies, where sound, touch, taste and smell tend to fade away because the device cannot embody them.

This study is on the same quest as Kelly, but the method laid out in this chapter is very different. Here we seek to reveal the behavior of image devices that *look* and *see* in ways that go beyond human notions of sight and we will do so through a step-

by-step assessment of their experience of *use*. Isolating imaging devices allows us to carve these two distinct paths for how they behave in an arena of use—*looking* and *seeing*. Looking pertains specifically to the means through which such a device might be able to see. This is largely the design of the lens system, but it is much more than that. The *looking* is all that relates the mechanism to the human notion of acquiring sight, but not actually pertaining to *seeing* the image that will result. The points of a camera that look can be defined by characteristics distinct to their own physical design, independent of how their captured images go out and express themselves after the glimpse, the gaze, the *look* from which they came. The *looking* concerns itself with the parts of the mechanism that act much as our eyes and bodies might, if they were not connected in the visual system to our mind. The *looking* device is that which enables sight through its physical and outward notion of vision. The second path, *seeing*, is directed toward the content of what is looked upon, through its recognition as an image. This is not specifically related to the means of acquiring, framing, focusing and stabilizing a look through a lens, but actually interpreting through some circuitry and drawing in a medium, an image.

Certainly, there are looking and seeing devices that challenge the human notions of both, and even enhance them in ways that overcome our reliance on light. Radar, sonar and thermographs might do their own type of *looking* with dishes, transponders or heat sensors in conditions without light, just as an EEG or a polygraph machine might *see* things differently, in digital pulses and waves or jagged lines. But it is precisely because the design principles of such imaging devices exceed the human notions that they are not the focus of this chapter. Instead, this chapter limits itself to

imaging devices that, when they look, can render an image for sight by means of a lens and iris opening up to lay light on a sensor or simple storage medium (such as film). Observing imaging device traits within these limits serves to isolate the qualities of *image devices* as they relate to the human experiences of *looking* and *seeing.*

Beyond our notion of looking: finding the camera in the image

When we think of a camera, we tend to think of it as Kelly does—through its cultural impact, where the product that is seen (the image) represents the technology that looks (the camera). To assess how a camera behaves begins with a distinction between the device and the image. A skilled photographer can often determine, by studying an image, from what *type* of camera (and in what circumstance) it has been made. Just like a drawing at the hand of a fellow artist, each camera and lens type offers its own style that is discernable to the trained eye. But we can say that if we take a photograph of a sunset on the horizon we will not actually see the camera when we study the composition of the image. Even with evidence from the traits of the lens and the capturing process embedded in an image (shutter speed, lens and sensor type, etc.), we cannot view the camera without a mirror in the image. In this way the camera looks as we do in our daily lives. When we look upon the world we do not in a literal sense see our own physical form, rather we must adjust our viewpoint to look at our feet as we walk, or shift our attention to our finger pointing in front of us. Likewise the camera's physical form is at the edge of the image, just beyond its gaze, but unlike us it has no body that can intersect that gaze. Apart from that handicap these are very human notions of looking and seeing. The camera looks at the world beyond itself, and

though the image that it sees may be designed to be stored inside of the device, we can only imagine it until it is displayed on a screen. We have many cameras that are designed to prove to us, through viewfinders and screens, that an image exists within the camera but these are based on playback from storage media, whether internal or external. Such interfaces built into cameras allow us to see a past look from the camera. There are a range of these components built onto a camera to give representation of a particular look, but that look might only exist in pixels assembled to display for the human eye, or on a quarter-second snapshot drawn in light on film. The *looking* is what most of the camera apparatus is concerned with, and it is a sensor and storage media that are then concerned with *seeing.*

The cultural perspective that a camera and its image are one-and-the-same is what leads us here, and this short discussion on their difference should allow us to depart from a critical discussion on the behavior of images. Instead, the path to determining the behavior of the camera in human experience is one that must re-evaluate the relationship between the user and the device, moving it away from a conventional subject-object relationship toward a model of coupling, where the operator and that which is operated can look and see together. The early Soviet documentarian Dziga Vertov theorizes this more precisely toward image devices with Cine-Eye, a concept of looking that is beyond the human notion. Vertov said his Cine-Eye technique would empower the camera as an extension, or even transcendence of the human eye that could record and later reveal profound truths to enlighten humankind. An excerpt from Vertov's diary reads

There's sometimes a need

to show a new plane of reality,

free from banality.

Upside down, juvenile.

Human and Soviet-style.

Cine-Eye is not the aim. Cine-Eye is a means.

To show without masks.[73]

As we will soon uncover, Heidegger's notion of readiness-to-hand can easily be applied to the person who operates (behind) a camera, and that is also the case for Vertov's Cine-Eye. Both suggest a notion of sight that goes beyond the human notion, which is revealed by peering through a camera, but in applying such notions strictly to the equipment—the *in-order-to*, we can reveal not just how the operator wields the camera (from behind) but also how the camera participates in the very actions it captures (in front of). This is the camera in the image.

Ways of looking with the camera

In Martin Scorsese's 2004 biopic *The Aviator*, Howard Hughes (played by Leonardo DiCaprio) approaches the famous Hollywood motion picture producer, head of Metro Goldwyn Mayer, Louis B. Mayer (played by Stanley DeSantis) to ask for a few

[73] Hicks, Jeremy. *Dziga Vertov: Defining Documentary Film.* London: I.B. Tauris., 2007, page 32.

extra cameras. Hughes is preparing production for an aerial fight scene in his own motion picture production, *Hell's Angels.*

Hughes: I need a few cameras.

Mayer: Yea…

Hughes: Yea two to be exact. I already bought every camera I could find but we're shooting our big dog fight sequence this weekend and I need two more, desperately. Think MGM could help me out?

Mayer: With what?

Hughes: Cameras.

Mayer: Oh, the uh, the actual cameras…well we're not usually in the practice of helping out the competition.

Hughes: Oh.

Mayer's associate: How many cameras do you have now?

Hughes: 24

Mayer: (laughing) You have 24 cameras?

Hughes: That's right.

Mayer: And you need two more?

Hughes: Yea.

Mayer: You don't think you got it with 24?

Hughes: No, no sir.

Mayer: Ya know, I think… I think we've got them all… (to his associates) don't we have them all… they're all used right? All 26 of them. Jesus Christ son…

Hughes: (correcting) Howard.

Mayer: Howard, let me give you a little advice. Why don't you take your oil money…

Hughes: (correcting) Drill bits.

Mayer: …All right take your drill bit money, and why don't you put it in the bank, because if you continue making the movie the way that you are, there isn't going to be a distributor that wants to distribute it, you're not going to find anybody that wants to see the movie, and you're not going to have any more oil money. So, welcome to Hollywood.

Hughes: I'll be sure to remember that. Thank you Mr. Mayer.[74]

This conversation between Howard Hughes and Louis B. Mayer is scripted to illustrate how Hughes's method of film production (which is symbolic of his way of doing business) clashed with conventional Hollywood wisdom. The conversation also illustrates how cameras are considered within the two opposing production philosophies. On one side, we have Mayer and the standard studio-centered model

[74] *The Aviator.* Directed by Martin Scorsese. Produced by IMF Internationale Medien und Film GmbH & Co. 3. Produktions KG. Miramax, 2004.

that favors a three-wall set and finite action within those boundaries, serving at the pleasure of the camera. In such a setting the camera shoots at one spot beyond the set and then is moved to shoot at another spot, always ensuring that the action in front of it is properly set within its frame. The mise-en-scène—all that is set, lit and decorated before the camera's gaze—is all that exists in the series of images that will be generated in this model of filmmaking. Hughes's production model, on the other hand, is one that thrusts the camera(s) forward into the action to confront and participate in the action. The camera is not merely an observer peering in at the subjects within the scene. It too is a member of the cast. In a scene that follows in *The Aviator*, Hughes is shown in the midst of shooting the dazzling mid-air dog fight he previously described to Mayer. We see Hughes as a passenger on a large airplane with two cameras fixed to the wings. He is shouting directions to his pilot, gesturing to get even closer to the spectacular nose dives and loop-the-loops ahead. They move into the action but they get too close and a camera on the wing gets clipped by a stunt plane in the scene. Hughes sees this and pulls out a handheld film camera and continues shooting. Experiencing Hughes's shooting method makes it clear that Mayer had misunderstood his request for 26, not 24 cameras. Mayer must have thought it sloppy or hasty—an issue of shooting without setting the scene specifically for each of those 26 viewpoints separately. What Mayer did not understand was that Hughes intended to *realize* the action, and could not do so by adhering to the typical boundaries within which Hollywood studio production models are based. Hughes could not capture the action by posing it within the keen but limited gaze of just one, or even two cameras that are safely removed, looking at and toward the action rather than

within. That would require re-shooting the scene from all angles to capture every specific shot that Hughes envisioned and more importantly it would not include the close-ups that ultimately caused the destruction of one of Hughes's cameras. It wasn't time or money that prevented Hughes from following the sequential shooting model. In fact he even delayed the production for months at his own expense waiting for clouds (a rare sight in Southern California) so that the planes would have a backdrop to convey their speed in the sky. Put simply, the mise-en-scène in the aerial dogfight was far too wild and vast for Hughes to contain with 24, let alone 1 camera, and above all Hughes wished to convey a look associated with being *in* the action, not just watching it as an observer.

Such a contrast between ways of looking with the camera helps to explain how the behavior of the looking device can differ in the studio and out in the world, and subsequently how this is reflected in its form. The physical form of the camera lends itself to looking and seeing in a certain way, and this way is not historically well-aligned with the human notions under the same environmental conditions. Studying the most basic and widespread points of intersection between the human user and the mechanism can explain how it behaves physically when it is looking and how these contrast with our own notion. These points are the basic interface—the intermediary that lends the workings of the camera to Dasein to achieve looking. As we'll uncover later in the chapter, these points are highly adaptable and their adaptation reflects the different ways of looking, thus they are the basis for how a camera makes itself ready-to-hand. It is not possible to look at each camera design individually, nor would that yield results that can be analyzed within the scope of this study, but it is possible to

identify design trends at key contact points, where the human being and the mechanism meet.

The shooter interface

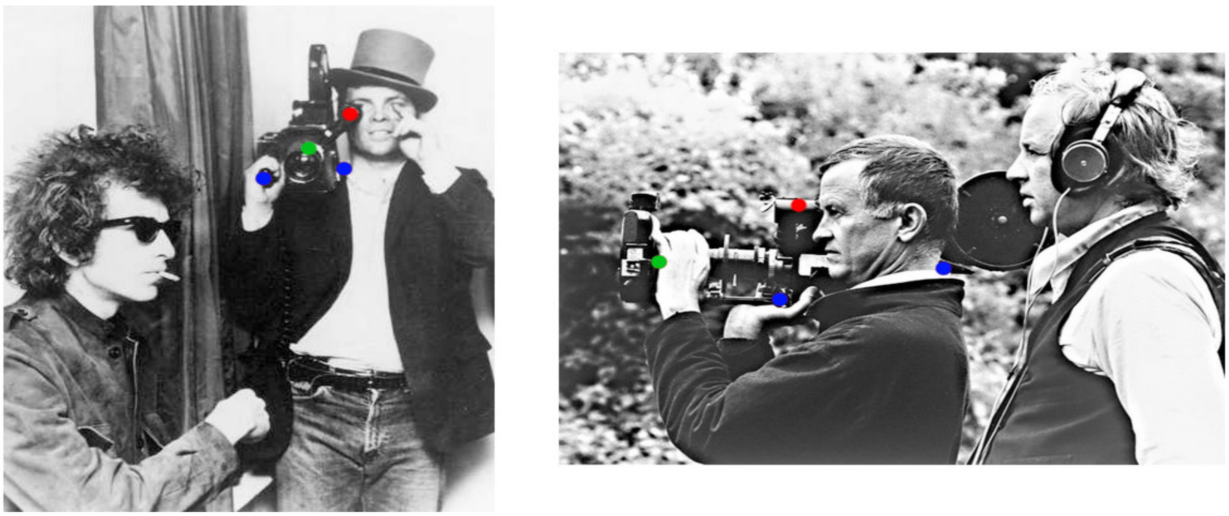

Figure 3.1: General contact points of a camera (red: eyepiece, green: focus ring, blue: stabilizing points). (Left) Image of Bob Dylan and D.A. Pennebaker, during the film *Don't Look Back* (1967), from New Orleans Film Society, October 17, 2012. (Right) Image of Albert and David Maysles, during the film *Grey Gardens* (1975), from Getty Images, date unknown. Used in accordance with the Report of the Ad Hoc Committee of the Society For Cinema Studies, "Fair Usage Publication of Film Stills."

The cameras in Figure 3.1 are fixed on the operators' shoulders, tracking targets, and looking like they might be getting ready to take down enemy aircraft. They have stabilizing locations (in blue), an aiming scope (red) and focus ring (green) to give the marksman adjustment control at varying distances. Of course there are other contact points on newer cameras that differ with intended function, such as external monitors, handle zooms, various buttons and the GUI, but the three contact locations isolated above have been standardized for general operation and their relatively universal presence serve to define for us the most fundamental camera interface that has been available through its history. Put simply, the colored dots in Figure 3.1 represent the

interfaces between us and the apparatus, and like a gun, they reflect a “point-and-shoot” design. But to make an image is to do more than to “point-and-shoot.” This is not merely an industry description of how to operate a camera, but it has become a category of cameras on the market, also known as Digital Compact cameras. The phrase and name is a common reference to image making which likens the camera to a gun, and for good reason. The camera can be used like a gun—it can be aimed at a target and it has a trigger to fire. Like a gun, the camera reveals itself at the moment the trigger is pulled, and if it is properly aimed it will hit its target and the image will be generated. But unlike a gun, the camera’s shot is received, rather than sent. When you “shoot” there is nothing that the camera projects, but rather it opens to absorb light. A companion flash might throw light, but the camera acts like a black hole, pulling light into its peering eye. The longer it looks (with the shutter open) the more light it grabs. A camera that is given the opportunity to see for more than a quick blink is capable of turning even the most dimly lit room into one filled with blinding light.

The eyepiece (red dot), as its name suggests, lets the human eye look. In Figure 3.1 these are film cameras, which is notable because the function of an eyepiece differs greatly in a digital device where the operator might be given a digital rendering of the look (an image, really) rather than a look that is reflected in a mirror system (Figure 3.2). This is particularly relevant when we consider that an interface is designed to mediate the information between, in this case, the camera and the operator. In digital cameras the information sometimes must be translated from the sensor and depicted on a screen in the viewfinder (such as in a Digital Compact

camera), while in film cameras it must only be displaced by reflection to make its way to the eyepiece.[75]

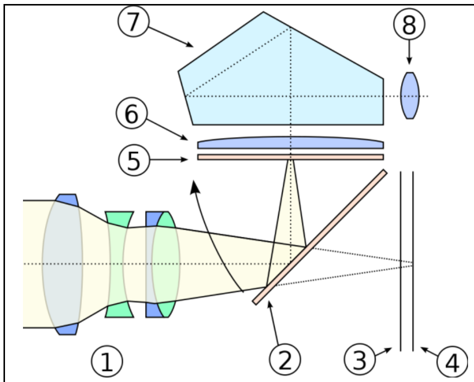	Lens assembly Mirror in down position (image visible in viewfinder) Focal-plane shutter Sensor/Film Focusing screen Condensing lens Pentaprism or Pentamirror Eyepiece

Figure 3.2: Cross-section of SLR, Image and key from Wikimedia Commons, licensed freely.

The eyepiece and the focus ring (Figure 3.1, green) take precedence because they are the interface through which we can look while determining what the camera might render to see in different degrees of clarity and distance. While the blue dots represent the stabilization of the camera with our body and ultimately determine where the camera looks, the eyepiece (red) and focus ring (green) directly impact the lens action together; they determine, through our looking or perhaps through some automatization in the focusing system, the precise frame and fineness of what will be seen. If with our own eye we verify the adjustments made by the focus ring, then a "clear" image will be seen.

[75] Digital Compact cameras refer to those that automate most functions in favor of convenience of use and compactness. These are the most notable "point-and-shoot" cameras because of their simple, automated designs. They are detailed in this chapter under the section title "Image clarity and environmental looking."

Image clarity and situational looking

Declaring that an image is "clear" is tricky because it can lead to critical analysis of that image. For instance, if a portion of an image in the foreground is clearer than something in the background, we might begin to weigh and measure the content of the image, leading to a dissection of its composition rather than an analysis of its form. But without dissecting composition we can say simply that it is discernable to the human eye: it is generally in focus and it is not over or underexposed. The clarity of an image is dependent on any number of details, but in terms of design it is fundamentally a relationship between focal ratio and shutter speed. Of course, the operator can evaluate each look independently and arrive at his/her own measure of clarity, but in a point-and-shoot state of use, it is the automatization of this relationship that matters most. Though camera design has evolved for a number of applications, from scientific observation to security protection, it is the automatization of looking that has guided imaging device design toward the pointing-and-shooting model as a whole. A fitting term for this model is "situational looking," and it does not specifically limit itself to sightseeing and leisure, though these are primary venues for use. Rather, it represents the entire scope of use, as we know it, for a mobile person encountering a range of environments with one camera. Since the camera and the way that it is used are not likely to change, the environmental variables (changes in distance and light) dictate the automatization. Thinking about the user and camera as stationary, and the looking itself as mobile, determines the appropriate automatization. Digital Compact cameras—those lightweight, relatively inconspicuous pocket cameras meant for snapping a quick landscape or portrait in front of the Eiffel tower—are perhaps the best

example of the situational looking model. Automatization concerns itself with enabling the camera's sight in many environments, trusting that the operator will follow Louis B. Mayer's scene-by-scene shooting model. But what if the user wishes to capture snapshots of real-world actions as they spontaneously transpire, rather than composing the stillness required for an automatized photograph? The easiest answer is to shoot many images (motion photography) instead of a single snapshot, but this only gives more weight to the question. What if the notices a hummingbird in flight and wishes to capture it? This is a moment filled with many degrees of movement, some beyond the seeing abilities of the human notion. The hummingbird flaps its wings up to 80 times per second, We might look and fix our gaze at the right moment at a fine detail, but in its spontaneity and fleetingness we cannot process all that is there to see beyond that detail. After all, is not this a moment that provokes the camera's in-order-to? What is its need if not to extend our notion of sight? This is a moment that should, in Vertov's words, show a "new plane of reality."

The image of the hummingbird in flight is one that requires a great deal of setting the camera to look. Where the point-and-shoot model offers automatization, an operator finds a need to manually set the camera's way of looking situationally so

Figure 3.3: Green Violetear Hummingbird seen by a Canon EOS 1D Mark III at 1/320 sec, f/11, ISO 400, taken by Mdf, January 30, 2008 used in accordance with Creative Commons Attribution-Share Alike 3.0 Unported.

that it can see the details in a hummingbird's wings in flight. The image in Figure 3.3 reflects a carefully crafted shot with a camera that is not intended for automatized pointing-and-shooting. Instead the camera that took the image in Figure 3.3 is designed to favor an operator's adjustments and measurements to optimize its ability to see. Note that the wings are almost clearly focused without a significant loss in light that would otherwise limit sight of the fine detail in the shaded areas. Conversely in automatization a camera sets its own look in accordance with preset situations. Figure 3.4 shows a list of automatizations from the user guide of a 2012 model Digital Compact consumer camera. It asks the simple question, "What Do You Want to Do?" If you want simply to "Shoot, leaving it to the camera to make settings," you might struggle to find the preset for "hummingbird." So instead we might look for a preset that increases the shutter speed to minimize blur. We would probably choose "Kids and pets," because it lets you capture subjects that move around, such as children and pets, without missing photo opportunities.

You will be able to focus on subjects that are approx. 1 meter (3.3 feet) or more away from the end of the lens.[76]

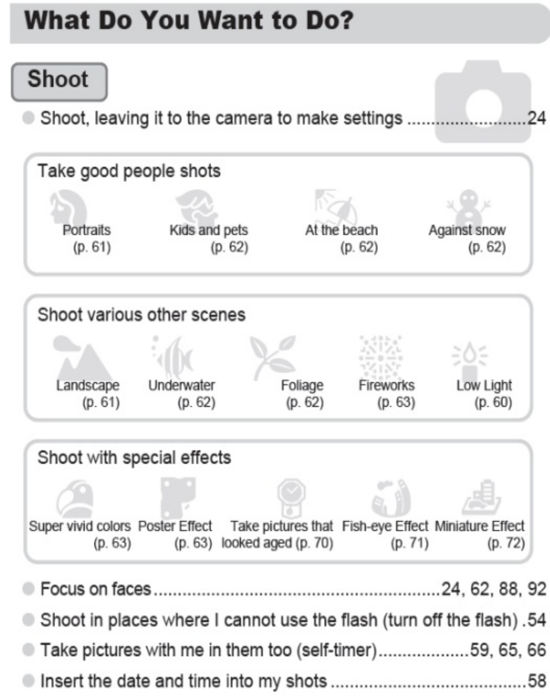

Figure 3.4: Automatization as presets in a Digital Compact Camera, from *PowerShot S95 Camera User Guide*, page 4.

We might consider "Portraits" or "Foliage" too but in learning about these features we would see that they emphasize color tones and contrasts for relatively still subjects, rather than spontaneous movement. Figure 3.5 shows another image of a Green Violetear Hummingbird in flight, but this is seen by a Compact Digital camera that, by its point-and-shoot design, favors automatization in looking. In this point-and-shoot setting the camera looks with a higher degree of spontaneity, but it comes at the cost of its own sight, which has deep, dark shadows at such a high shutter speed and very few intricate details revealed in the fluttering wings. This particular camera has 14 presets for looking, including "FIREWORKS," "SNOW," "BABY," "FOOD," and "NIGHT SCENERY."[77] But even if these few categories of shooting environments could encompass, in the camera's ability to see, all of the varying situations we might set our camera to look upon, we cannot see the moment that set in motion our use of equipment because we must first

[76] Canon, Inc. *PowerShot S95 Camera User Guide*. Manual, Canon, Inc., 2010, page 62.

[77] Leica Camera AG. *Leica D-LUX 2 Operatoing Instructions*. Solms, Germany: Leica, page 67.

set the camera to look. While it may possess the ability to see beyond our human notion, in its natural state the camera requires that we set it to look, which makes it quite un-ready-to-hand. Heidegger describes this state as follows.

> In our concernful dealings, however, we not only come up against unusable things *within* what is ready-to-hand already: we also find things which are missing—which not only are not 'handy' ["handlich"] but are not 'to hand' ["zur Hand"] at all. Again, to miss something in this way amounts to coming across something un-ready-to-hand. When we notice what is un-ready-to-hand, that which is ready-to-hand enters the mode of *obtrusiveness*….[78]

Figure 3.5: Green Violetear Hummingbird seen by a Leica D-LUX2 at 1/800 sec, f/4, ISO 100, taken by Jimfbleak, February 11, 2006 used in accordance with Creative Commons Attribution-Share Alike 3.0 Unported.

Usability and readiness-to-hand

What is usability in the physical realm? What transforms something that is present-at-hand into something that is ready-to-hand? In practical terms Donald Norman offers a definition of usability in the design of everyday objects, such as doors, lamps and light switches. In dealing with such two-function items, usability and understandability rely

[78] Heidegger. *Being and Time*, page 103.

primarily on 1) a conceptual model that “allows us to predict the effects of our actions” and 2) visibility.[79] Norman lays out a model for measuring these in “Gulfs,” which refer to the separation space between the mental and physical—the degree of understanding between the intended user actions and the system of control in place in a mechanism. In essence, Gulfs are the area of interpretation between a user and the mechanism’s interface. A more successful design would lead to a smaller Gulf, and a performed operation that provides an outcome that is in line with the user’s expectation. Norman specifies two: 1) a Gulf of Execution that refers to the degree of separation between a user’s intended action and the relating of this action to the appropriate command in the interface and 2) a Gulf of Evaluation that refers to the degree of user understanding, through feedback from the mechanism, that the intended action was performed correctly. [80] Norman’s “Gulfs” are to some degree a measureable method for readiness-to-hand for practicing designers, though Norman does not mention Heidegger’s deeper, more relationship-centered concept of readiness-to-hand. Readiness-to-hand is not directly relatable to usability and understandability because it is only measurable through its experiential application, the in-order-to, where it should fade into the work, within which it is conceived. Unlike Gulfs, which are helpful to the designer seeking some degree of measurable feedback on how a user might understand and adopt a tool for use, Heidegger explains the concept of ready-to-hand as a relationship. He explains that when a tool is put to use there is a notable change to both the user and the tool, when it becomes equipment

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[79] Norman, Donald A. *The Design of Everyday Thing*s, 34-63. New York: Basic Books, 2002, page 13.

[80] Norman. The *Design of Everyday Things*, page 51.

(in-order-to). This change is from a state of presence-at-hand from which it is merely observed.[81] He writes

> To lay bare what is just present-at-hand and no more, cognition must first penetrate beyond what is ready-to-hand in our concern. *Readiness-to-hand is the way in which entities as they are 'in themselves' are defined ontologico-categorically.* Yet only by reason of something present-at-hand 'is there' anything ready-to-hand.[82]

Heidegger also frames the terms around our intention to emphasize the withdrawing that must occur when a tool is put to use. Heidegger explains that the work itself defines the tool as equipment.

> The peculiarity of what is proximally ready-to-hand is that, in order to be ready-to-hand, it must, as it were, withdraw [*zurückzuziehen*] in order to be ready-to-hand quite authentically. That with which our everyday dealings proximally dwell is not the tools themselves. On the contrary, that with which we concern ourselves primarily is the work—that which is to be produced at the time; and this is accordingly ready-to-hand too.[83]

Norman concerns himself with usability in the design sense, where the ad hoc intentionality (readiness-to-hand) is established prior, and the focus is turned toward measuring the successfulness of actions of use. Gulfs serve only to quantify the

[81] Refers to Heidegger's use of *tool* as the thing, which becomes *equipment* when assigned "in-order-to" by Dasein, from Heidegger. *Being and Time*, page 98.

[82] Heidegger. *Being and Time*, page 101.

[83] Heidegger. *Being and Time*, page 99.

degree of effectiveness of interaction between the human operator and the interface that takes in the command and provides feedback. Heidegger, in contrast, is concerned with how we perceive the tool in its various states, and it is only through our intended use of the tool that we can know its role as equipment and evaluate its effectiveness. Heidegger's way of evaluating delves much deeper into the ontological relationship with objects and the idea of use itself. This fuller description of the essence of *usability* is at the heart of Heidegger's concept of readiness-to-hand. Consider the camera once again, in its physical state, unwielded (present-at-hand) which is to become equipment (ready-to-hand). It is the use that defines it as equipment, and the most general use of a camera is to capture an image. But that does not account for the user, who does not consider the image but the things that motivate the use. The experience stirs in the user a need to capture and keep, to study and to scrutinize. This need is what draws out the camera from pockets, bags and cases and sets it to looking in very specific ways.

Norman's explanation of the design principles that define usability and understandability cannot fully explain what is required for an operator to find a tool ready-to-hand because it is concerned primarily with two-state functioning objects, such as doors and light switches. Tools that become equipment require something more than an on/off capacity—they must offer a degree of control that aligns them as extensions of some ability we already possess but for which we have found its limit. To be ready-to-hand, a tool must not only be understood to Dasein as something "in-order-to," but also something that can *withdraw* when put to use. A light switch cannot *withdraw* in its use because it is stationary and unto itself on the wall, and it possesses

its own state of “on” or “off.” A flashlight, on the other hand, is grasped and wielded, subject to the malleable qualities already available in the body, now extended. Point it here and there, and the light will fill and you can see. The light continues to reach beyond the tool, allowing the operator to move and adjust the tool to accommodate the action of running through the woods at night, or finding the light switch in a dark basement hallway. Obviously a fixed, two-function light switch and a flashlight are scarcely comparable. Likewise, setting a video camera on a tripod and pressing “record” fails to satisfy the *use* associated with its way of looking. To be ready-to-hand suggests more than activating a function of a tool. It suggests the *equipment withdrawing* into the intention of Dasein, allowing them to become intentioned users behind, in front of and around the device that is to capture, manipulating their own bodies with the device as an extension, to achieve the looking that is beyond their own.

Looking with technology: the tactile gap and point-of-view

Indeed, the camera has proven that it has the potential to extend our notions of looking and seeing, but it has also proven that it requires us to set it for looking, and its ability to see is contingent on our own ability to carry out that setting. That setting-to-look relies on a station, a mount, a perch from which to gaze. Louis B. Mayer might scoff if that is something unsteady, like a plane, or perhaps our shoulder, but situational looking is often inspired by that spontaneous need to capture, as described above. It is only fitting that the station—the body that the camera is perched upon—should offer a sense of viewer embodiment, especially if the looking is meant to convey a human perspective. Before delving into point-of-view as it pertains to the looking with a

camera, we first need to evaluate how the body might convey itself to us as a constant in our own notion of looking.

In interaction design, the term *transparency* refers to something similar to readiness-to-hand, where the degree of control of tactile commands (like typing on a keyboard or performing a move with a combination of buttons on a Playstation controller) is not something that can be built, but rather it is achieved through “skill automatization.”[84] This is the “practice makes perfect,” and “hand-eye coordination” idea, and it refers directly to the factor that allows readiness-to-hand—our sense of the body in relation to the equipment that we wield as an extension. Consider the “conversation of gestures” that takes place in a complicated video game. O’Keefe and Zhender call this a *dialogue* because it includes a number of states of gesture-to perform and opportunity to respond to the gestures of other agents, upon which this conversation depends.[85] The “achievement” of transparency, as it is described here, explains the essence of readiness-to-hand. Equipment can *withdraw* when an operator can concern him/herself with use, and this requires that the equipment finds undisrupted control from the operator’s mind and body. If we think of the typical video game controller, it relies on our hands and fingers to hold it and press its buttons. We rely on tactile and visual feedback to determine that the “x” button indeed makes our character on the screen “jump,” and that moving the joystick left makes our character on screen also “move” left. The *withdrawing* arrives through the familiarizing of how the controller feels to us, and how we feel to it (because it must measure our movements).

[84] Kaptelinin and Nardi. *Acting with Technology*, page 79, citing Bardram and Bertelsen (1995) and Kaptelinin (1991).

[85] O’Keefe and Zehnder. "Understanding media development," 730-731.

When our tactile actions begin to translate our intentions into the game and we can evaluate visually the correctness of that translation, we can say that the controller is *withdrawing* and the equipment is ready-to-hand. As the controller *withdraws* further and further through our "skill automatization" we no longer can see the functions of the controller in themselves, and instead see it as an extension of our body.

The term "skill automatization" is vague in this explanation, because even in describing the process of *withdrawing* there is no clear link to tell us what is actually happening to make this possible. If "skill automatization" is simply the learning of *use* in the mind and body, through practice and repetition, then it is the process of learning the body. This type of sensory knowledge is called *proprioception*. Proprioception is sometimes called the sixth sense and rightly so, for it is the word for our ability to know our body in reference to the world. O'Keefe and Zehnder provide a good summary of proprioception and a helpful example. They write that proprioception

> describes the sense of body orientation and movement that is made possible by stretch receptors in the joints and muscles which relay positional information to our brains. This sense endows human beings with the ability to do such things as walk without looking at our feet and touch our nose with our eyes closed.[86]

Because interaction platforms such as games are subjugated to the tactile action-visual feedback requirement in screen environments, translations of physical to metaphorical activity are employed to convey a sense of where-in-the-world. This is particularly

[86] O'Keefe and Zehnder. "Understanding media development," page 736.

widespread in video games and movies, but it must happen in any environment that receives input in the form of physical activity and projects the feedback visually.

A common way for games and movies to substitute visual feedback for what we generally would experience physically, in the form of proprioception, is to move away from the popular first-person point-of-view (POV) visual perspective, where our body is not seen in motion around us, but rather movements are felt and measured through proprioception. Consider first-person POV in a cave where there is no light—we must navigate by a constant re-orientation of where our feet are, for example, as we take each step in the dark. When we have the privilege of light, we still do not have to look at our feet and body to ensure we are moving forward with the proper speed, balance and posture because we constantly receive proprioceptive cues that allow us to adjust naturally as we navigate our environment. Without this feedback channel in games and movies, we need a perspective that presents our representative body visually. This is usually third-person omniscient—a wide, typically overhead visual angle of all action in the human agent’s purview, or third-person trailing POV—a position that imitates the view of a follower behind the agent’s avatar.[87] These perspectives have been popularized in video games and films alike. Either of these allows the looking to accommodate for the absence of proprioception, where a simulated body movement, such as a spin or flip, could be looked at from a less restrictive (than first-person POV) angle. These two angles give the agent compensating faculties for actions that require precise simulated body movements in virtual space. For game designers these concepts require a precise controller-screen (hand-eye) command-feedback loop, but

[87] O’Keefe and Zehnder. "Understanding media development," page 737.

for a person capturing an image it is a look-see (eyepiece-image) loop, often with the seeing coming separately, later in the dark room or on the upload of a digital image. What's more, the camera needs the human body to set it to looking, but it needs the hands rather than the eyes. One can take photographs without every consulting the eyepiece. The essence of the tactile gap is the translation of the look, in the way of the camera, which is embodied by the photographer, and the disembodiment of what is seen. It is the limit of proprioceptive feedback to the wielding of the camera in setting it to look, and its absence in what is seen.

If the camera is intended to look and see beyond our own notions, we need to fully understand what can possibly be experienced through this disembodied sight. Without acknowledging the tactile gap in the visual experience the mind and body are given unity unduly, and by extension, this unity is given unduly to us with equipment. In describing the process in which children learn arithmetic, Kaptelinin and Nardi account for the social arena which includes the teacher and friends, but also the fingers as objects for counting before it is learned without the external reference.[88] What relation, then, do our bodies have with the equipment that we use to further extend our abilities? More precisely, what is the role of our mind and body in setting the camera to look?

Neuroscientists V.S. Ramachandran and Blakeslee offer several cases that illustrate how the mind might perceive the body and its extension into the equipment. Their research specifically seeks to uncover the ways in which the brain and body "talk to" each other by tracing how specific command-feedback loops, such as body

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[88] Kaptelinin and Nardi. *Acting with Technology*, pages 8-9.

movement and neural feedback are experienced in a human being that has lost an appendage. Through experimentation Ramachandran discovered that patients that receive sensory feedback from phantom limbs are receiving overlapping stimulation from neighboring locales in a region of the primary motor and primary somatosensory cortex referred to as the "Penfield homunculus," which takes the name of the neurosurgeon that first theorized it in the mid-20th century. The Penfield homunculus is a region that is best understood as the brain's "map" of the body in the cerebral cortex—the area where we *feel* the body.[89] For example, Ramachandran's patient, Tom Sorenson, described sensations in his fingers of his amputated left arm when receiving stimulation on his cheek and lips because according to the Penfield and other comparable brain maps, the region for feeling the hand and fingers is directly adjacent to the face and lips.[90] This discovery has helped answer longstanding questions about sensory feedback from phantom limbs, but also about the brain's role in adapting to changes in the physical body (nerve fibers sprout and/or activate in neighboring territories that have become vacant, essentially taking over the area for the hand, in this case, with additional receptors for the face).

In another case that helps to explain how the mind perceives the body, Ramachandran describes the case of Mirabelle Kumar—a young woman born without arms. The peculiarity of the case, for Ramachandran, was that Mirabelle had phantom arms that gesticulated when she talked and she could move them voluntarily. She also

[89] Ramachandran and Blakeslee. *Phantoms in the Brain*, pages 25-26, more precisely describe the Penfield map as a region that receives sensations on the surface of the skin, but due to the complex descriptions of the sensations, I use the word *feel*.

[90] Ramachandran and Blakeslee. *Phantoms in the Brain*, pages 26-30.

demonstrated full awareness of their location, size and physical behavioral qualities that are associated with proprioception (Ramachandran calls it "kinesthetic feedback"). In short, Mirabelle, having never acquired visual or proprioceptive feedback associated with having arms and hands, possessed an inherent, "hard-wired image of the body and limbs at birth—an image that can survive indefinitely, even in the face of contradictory information from the senses."[91] Mirabelle seemed to be able to *feel* with her arms, though she never had any.

This is not all there is to phantom limbs though, and there is also reason to believe that the mind's image of the body is not malleable. Feeling the presence of a limb in proprioceptive terms does not account for pain, nor does it account for Ramachandran's report of a patient's experience in feeling objects *with* a phantom appendage. In a case similar to Mirabelle's, Ramachandran describes how he pulled a very real cup across the table and apparently out of the phantom hand of another patient named John. John said, "Ow!... I had just got my fingers around the cup handle when you pulled it. That really hurts!"[92]

A practical way to understand Tom's, Mirabelle's and John's situations is to consider their arms and hands in existence and functional on a motor level, but they are invisible and ineffective in the world around them. When Mirabelle and John attempted to act with an object—their arms, which they can command and receives proprioceptive feedback from, have no impact at all on an object. Such a radical shift in thinking about limbs stretches Heidegger's concept of technology a bit, and we must

[91] Ramachandran and Blakeslee. *Phantoms in the Brain*, page 42.

[92] Ramachandran and Blakeslee. *Phantoms in the Brain*, page 43.

consider the body as our most suitable equipment that is to each of us, the definition of readiness-to-hand (until it is not). It is the impression of the body that gives the term any meaning at all. Since this non-functioning equipment is otherwise simply known as our body, we can say that this is the most precise experience of un-readiness-to-hand. In Ramachandran's description of Mirabelle's case, words like "reach out," "grab," "point," "wave," "throw," "shake" and "maneuver" illustrate the need for thinking about the body this way. Such terms come about only in the proprioceptive command-feedback experience between the body and mind, and it is for precisely this reason that the use of things can only be understood experientially through the body. Heidegger observes this in the *withdrawing* that takes place when the equipment finds its use (*in-order-to*), noting "the ready-to-hand is not grasped theoretically at all, nor is it itself the sort of thing that circumspection taxes proximally as a circumspective theme."[93] The problem then, is that equipment can only ever be as ready-to-hand as our own body, for which there is a distinct impression of intentioned use in the mind. Whether or not we succeed in extending our body into the equipment, our use is limited to our first understanding of ready-to-hand between the mind and body. Considering the impression of the body as the source for any understanding of ready-to-hand allows for the assessment of equipment in use. *Looking* and *seeing* represent the nature of the image capture device, and only in use (rather than through circumspection) can an image capturing device reveal its nature because of its varying states of readiness-to-hand in relation to the body and mind.

[93] Heidegger. *Being and Time*, page 99.

The role of the camera in sequential shooting

In a conventional motion picture studio setting the camera takes on a strange and fluid role, staring at the action that is manufactured in front of it and moving only when it is ready to position its gaze at a different static viewing point. These varying, static perspectives result in a sequence of looks, which takes on the industry term "shot" once again in this model. In the studio the camera might move to capture the scene from many points in the room, and in the strictest scene environment this means that each shot is carefully crafted and the scene is renewed with any change in camera station. In this setting the camera can be quite still when it is used in a studio, at most it might pan or tilt on a tripod at a station, or it might move on a track from point A to point B. The action is taken, re-taken, again and again to accommodate the varying points-of-view that the camera must see (shoot). This is the structure of narrative filmmaking for the camera. Just as the actors carefully study their lines and take cues from the director between takes, so too does the cinematographer meticulously work with the director to develop and implement proper camera blocking. Figure 3.6 is an example of how a blocking diagram might be drawn. It is drawn from overhead so that people and things can be accounted for relative to the studio space. A blocking diagram like this one assumes that the camera is relatively stationary, on a tripod, pedestal or dolly. Each station represents a shot, and each shot will be taken any number of times.

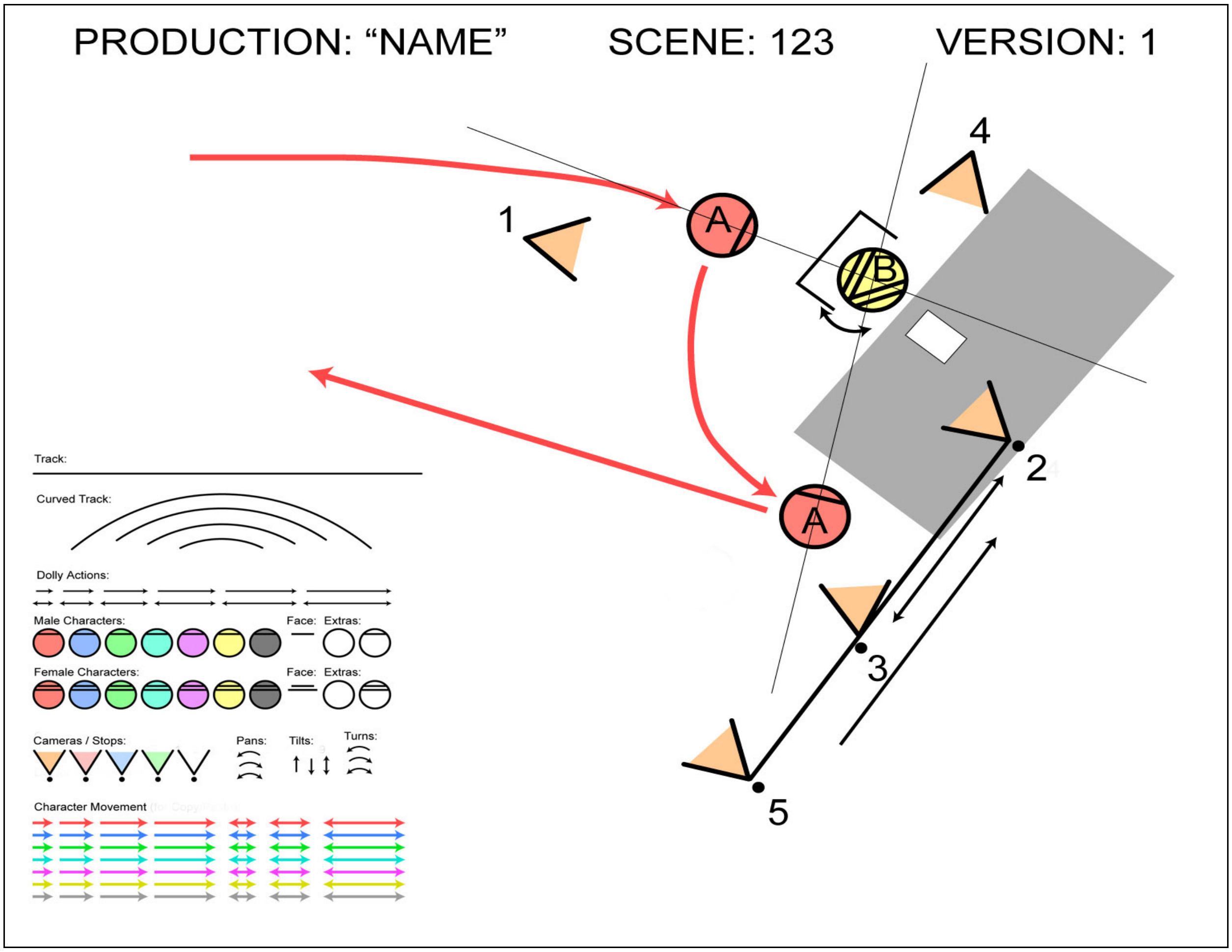
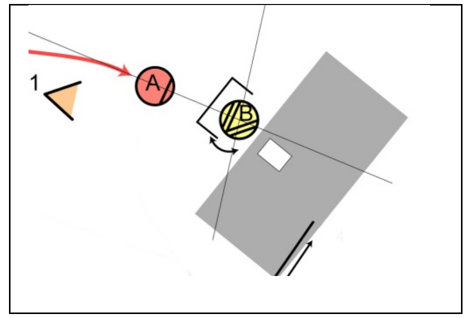


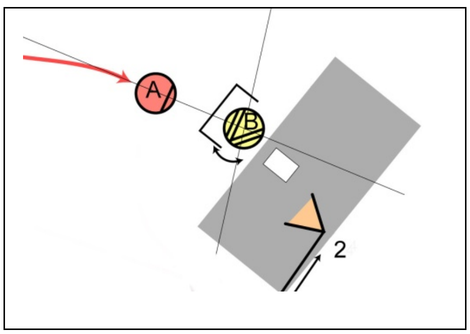
Figure 3.6: Sample Blocking Diagram and key, used with permission from Hollywood Camera Work.

The figure illustrates how cinematographers manage their shots for each scene. The triangular shape representing the camera contains a few pieces of information that indicate the shot type, stops and angle. The characters, indicated by circles, have movement within the scene, and the movement is anticipated in the blocking. There are a total of five shots depicted, with the bottom three as a series of dolly shots. This indicates that the shot itself moves across the scene and could actually be one continuous shot with angle changes. Note that if these were multiple cameras, shots 4 and 5 would see shots 2 and 3, and vice versa. Also note that in a multi-camera setting not all cameras would see all character movement as drawn. But this diagram

represents just one camera, and so it is free to look at the “same” action around the studio, take after take. The scene would be shot like this:

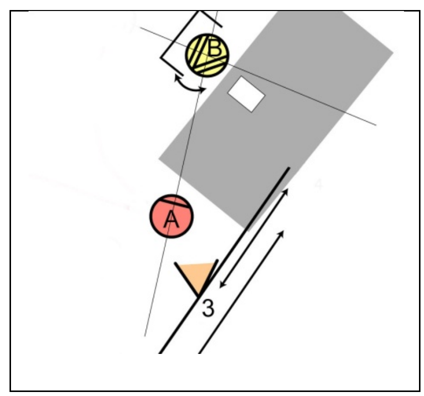


Character A enters from top left. Shot 1 picks up Character B over the right shoulder of Character A. The more horizontal line is the plane of action.[94]

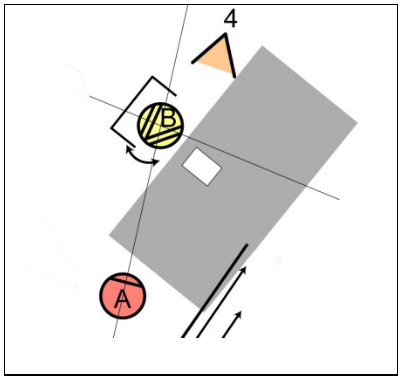


Shot 2 picks up Character A over the left shoulder of Character B.

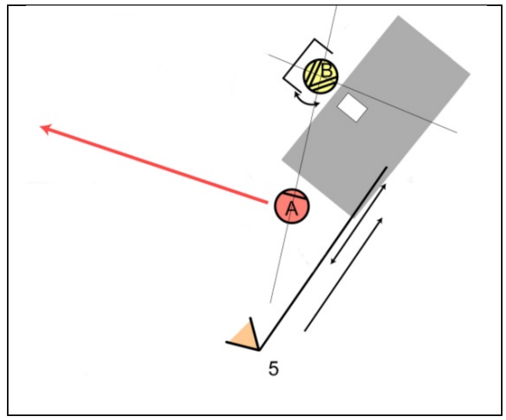
Character A moves to the next mark and shot 3 picks up Character B over the right shoulder of Character A. The more vertical line is now the plane of action.



[94] The plane of action represents an imaginary line through the center of the action as if it takes place in a circle. If the camera crosses the plane (180° of the circle) the result is a continuity error. The action, when cut together, will abruptly appear to have switched sides. Consider watching a sporting event from the grandstand, then abruptly experiencing a change in perspective to the complete opposite side of the field. The players will appear to have switched directions, now running toward the opposing goal. As the mark changes for Character A, we see the plane of action must also change to a more vertical line.



Shot 4 picks up Character A over the left shoulder of Character B.



Shot 5 sees Character A exit.

As shown in this single camera setting, five separate versions of a single scene are needed to create one continuous shot sequence. The various angles and tracking symbols indicate that there will be even more shots captured. This is quite different from situational looking because it is the staged action that must adapt to the camera in this model, rather than the camera adapting to varying environments. Between the shooting of each version of this scene, the camera moves around the room to its next station, and the mise-en-scène is reset and re-composed to adapt the scene for the new shot before the director calls action once again. In this staged scene the camera stations follow specific rules of perspective, with third-person-trailing (over-the-shoulder) looks for both characters at each mark. It is this observational, third-person POV that creates the problem of the 180° rule, as the shot is never truly parallel to the action because it is not a part of it. If we instead consider the camera's ability to look as

we might—as a character within the action itself—it might be able to *withdraw,* regaining the freedom to venture across this plane. The camera could then actually illuminate the illusion of two sides to the plane because a first-person look would constantly re-define the plane from the line of action in which it is immersed, looking out from within the scene rather than peering in.

In John Calhoun's 2005 interview for *American Cinematographer* with Salvatore Totino, cinematographer for director Ron Howard's boxing film *Cinderella Man*, Totino describes what this shift means for the camera precisely. Just as Howard Hughes did in *Hell's Angels*, Torino adapted his equipment to increase its ability to *withdraw* into the scene where its own ability to *look* and *feel* could be revealed in a boxing ring.[95]

> The blows being delivered therefore needed to have a feeling of weight behind them — to pack an extra punch. "I really wanted the viewer to feel as though he's in the ring," says Totino. "I kept wanting to get in there and box, and Ron wouldn't let me do it."…The cinematographer also worked with Clairmont Camera in Toronto, where the picture was shot, to develop a special punching-bag camera that was dubbed the "tire cam." He explains, "It was basically a big tire covered in foam with a mount on the inside for the camera, and with Plexiglas on the front to protect the lens. There are a few quick moments of the opponent getting hit, and Russell [Crowe] was actually hitting the camera. It was suspended off a bungee from the top and bottom with truss rings so it wouldn't sway around too

[95] *Cinderella Man.* Directed by Ron Howard. Produced by Imagine Entertainment. Universal Pictures, 2005.

> much. There was a little monitor in the back of it so that I could see, and I had a handle to hold the back of the tire and control what the punch felt like; it could be a big pan for a big punch, or, if I held it tight, it was like a combination of a left, a right, and a left hitting you in the face — it didn't spin your head around, it just sort of knocked you back a little."[96]

It is a stretch to call Totino's device *ready-to-hand*, since it was removed from his body and he was only able to see, with a monitor, what the camera was looking at in the ring. But certainly it reveals by its need that a conventional camera would be un-ready-to-hand when thrust into the action of such a scene. The spirit of Totino's invention reveals the *in-order-to* of the "tire cam" even though it may have lost the first-*person* POV that it is intending to embody (because it was held by a bungee rather than a human operator). It is odd to consider Totino's description of controlling, with a handle, "what the punch felt like." We can only imagine that Totino controlled the way of looking with the camera, tilting and angling it as though it was receiving a punch. And recounting that it "sort of knocked you back a little" seems related more to Totino's own physical impression of being punched, not what is seen (in the image). For the viewer the image on screen moves wildly, and indeed it provides a strong visual sense of what a woozy boxer might see during and between punches. But this is all that the viewer has to relate to the feeling of boxing, and without a human body to give and receive the jabs, it is more likely the viewer is relating to a punching bag. When we move into a

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[96] Calhoun, John. "Hard Knocks: Cinematographer Salvatore Totino Evokes the Depression Era for Cinderella Man, Which Tells the Inspirational Tale of Boxer James J. Braddock"." *American Cinematographer* 86, no. 6 (June 2005): 60-67, from page 60.

first-person POV, we are faced with the problem of losing whatever body has set the camera to look. The image cannot *feel* the punch for us, even if the camera can, just as the punching glove cannot reach through the image and strike us. We still need Totino to describe, as he has done here, the experience of being punched because the tire cam can only address the problem of the tactile gap for the operator, which is solved more simply by thrusting the camera into the action where it becomes a character. Altering the perspective to first person and attempting to mimic the bobbing of the head and blurring of the eyes can successfully introduce the camera to the action in a scene, but what is seen remains disembodied, and cannot contain the tactile experience associated with looking.

The physiology associated with looking

Studying the qualities of *disembodying* that persist in seeing can reveal precisely how the camera loses its body when it is thrust into the action in first-person POV. Gaspar Noé's 2009 film *Enter the Void* follows the stream of consciousness of a young drug dealer named Oscar who hallucinates and experiences his own death. The camera is situated at Oscar's eye-level, looking out, meant to embody his point-of-view. The camera lets us see Oscar as he sees himself, looking through his eyes out at the world. We experience the nuances of a floating pair of eyeballs in a head, to some degree—we blink, we look around, we nod, and sometimes we are given visual cues that fill for the absence of proprioception. Oscar checks his phone at his hip, or looks at his feet to let us know where and how we are in the world. Oscar goes to the sink and

splashes water on our face and when we glance up at the mirror, we see Oscar looking back at us.[97]

This first-hand experience continues throughout the film, but the first-person POV is short-lived. When Oscar experiences death he leaves his body (and we go with him). Oscar begins to float upward, out of his body and loses his physical connection to it, and likewise we lose his embodied perspective. We must imagine that the perspective change affects Oscar in a very real way within the story, but for us it merely gives us back our conventional third-person perspective. Granted, the experience of floating above and around the action is not as conventional as what we see in the blocking diagrams, where an over-the-shoulder view lets us peer into the action at a relatable, average human height and distance, but as a disembodied viewer Oscar has a relatively conventional perspective, existing outside of and invisible to the action. A *real* experience—the capturing of the stream of consciousness through another's eyes—is certainly the goal of the first-person POV in *Enter the Void,* but how might we extend our own mental impression to allow a *real* shared visual experience if we cannot *feel* the body with which we look? It is only through the mind's impression of the body, and through enhancements that might bridge the visual and tactile gap, that we might be able to consider the camera's first-person perspective as our own.

Neurophysiologist Miguel Nicolelis addresses what we see here as the problem of tactile disembodiment. Sequential shooting, first-person POV and Dasein mimesis (the spraying of water on the lens in the rain, the blinking of "eyes" effect, the nodding

[97] *Enter the Void.* Directed by Gaspar Noé. Produced by Fidélité Films. Wild Bunch Distribution, 2009.

and tilting of the gaze, etc.) allow the camera to look, as we might, upon the world. But to *feel* the world would require something else entirely. If the *body schema*—the mind's impression of the body—can perceive our physical body as equipment that is priori: the things most ready-to-hand; the things from which the notion of ready-to-hand is conceived, then perhaps a fluid body schema has the potential to extend its impression of equipment beyond its own body. This was the case for Ramachandran's patients Tom, Mirabelle and John described earlier, who *felt* their invisible appendages in a very real way. They each felt a specific appendage that was not part of their physical body, but knowing its position, size and capabilities without visual feedback. Their inability to use these phantom appendages made them un-ready-to-hand, even if this un-readiness is only observed visually rather than proprioceptively (a patient described that he was holding in his phantom hand a mug, for example, but could at the same time visually see that he was not). Apart from the visual feedback that clearly demonstrated a lack of an appendage, the patients were constantly reminded that their appendage, which might feel quite ready-to-hand, is not so.

Nicolelis cites a 1911 work by Henry Head and Gordon Holmes to illustrate that the body schema, with its fluidity, plays an intricate role in understanding precisely how equipment that is ready-to-hand might exist in the mind's body map. Head and Holmes explain the body Schema as follows

It is to the existence of these "schemata" that we owe the power of projecting our recognition of posture, movement and locality beyond the limits of our own bodies to the end of some instrument held in the hand. Without them we could not probe with a stick, nor use a spoon unless our eyes were fixed upon the plate. Anything which

participates in the conscious movement of our bodies is added to the [mind] model of ourselves and becomes part of these schemata: a woman's power of localization may extend to the feather in her hat.[98]

Nicolelis illustrates this further in Figure 3.7, which shows his theory of how Pelé, the world-renowned Brazilian footballer, had such great control of a soccer ball because of the seamless incorporation of the soccer ball in the body schema. Nicolelis explains

A similar process may explain why Pelé rarely looked directly at a moving soccer ball before initiating a dribble, pass, or commanding shot into the goal. The brain of the greatest of all soccer players had long assumed that the football was nothing but an extension of his moving feet.[99]

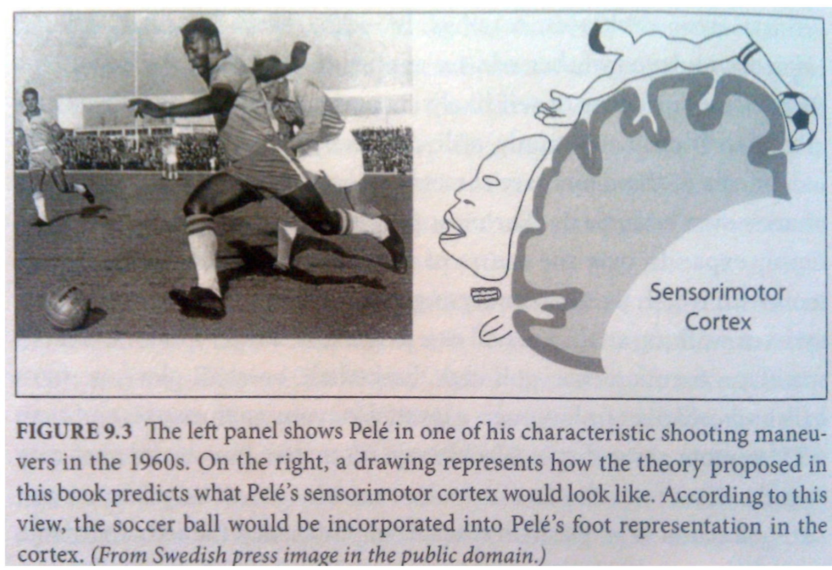

Figure 3.7: Miguel Nicolelis's Figure on Pelé and the body schema, *Beyond Boundaries*, page 218.

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[98] Head, Henry, and Gordon Holmes. "Sensory disturbances from cerebral lesion." *Brain,* 34 (1911), quoted in Nicolelis. *Beyond Boundaries*, page 207.

[27] Nicolelis, *Beyond Boundaries*, page 218.

As suggested already by Totino's "tire cam," the operator's body is in *touch* with the camera's perspective, looking *through* and *with* it in a joint experience of sight. But the operator's experience doesn't transfer to the viewer, who cannot feel the impact of the punches or feel the mat under his or her feet. *Enter the Void,* also lends to the operator Oscar's POV by doing much more than pointing a camera at the subjects and requesting that they look directly at the camera's lens. Even positioned behind the camera, peering *through* it with the eyepiece we can imagine the operator feels the subjects looking back at him or her in a direct way. But just peering *through* the camera as others peer back at it cannot convey Oscar's POV to a viewer. Much more must occur for the eye and the body to come together to fully *see* as Oscar does. Putting a camera up to the operator's eye-level and calling that "Oscar's POV" has to major limitations. First, the operator has access to a great deal of sensory data beyond what the camera can capture. Second, the camera is not itself designed for any particular POV. It alone is a motionless, disembodied perspective with very little influence over how its look might behave in a given situation. Just as Totino developed a camera *body* suitable for a boxing ring, so too must a *body* be developed for mobility. Consider once again Figure 3.1, where the looking is displaced to the camera on the shoulder, not fixed in the head. The basic physiology of how we look relies on not just eye movements, but head and body movements as well, with pivoting of the head via the neck, which also adapts to absorb the typical vibrations and shocks associated with our movements. Our heads are constantly tilting to the line of the horizon when we walk uphill, and our bodies hold them relatively stationary by our neck when we run, jump and do somersaults. Like the head atop the neck, the conventional camera has no

pivot points or stabilization itself. It relies on a station to mimic these movements, and they introduce their own qualities to the way the camera looks. The eye, rather than the head, is more accurately the point of view, but there are very few interfaces in mainstream filmmaking practice that implement eye tracking to give a more precise look in and around the details of a scene. This is surprising considering that medical surgeons in training have shown better performance by viewing their teachers' captured eye movements during surgery.[100] This lets the student see not just the general and full gaze of their teacher, but actually pinpoints the procedure of looking, like a visual step-by-step instruction process.

Short of eye-tracking, filmmakers have developed sophisticated techniques for mimicking the physiology of how we look. The Steadicam is perhaps the most popular of these in filmmaking environments where first-person or otherwise mobilized perspectives have created a need. This device is the best example of how filmmakers commonly mobilize large, cumbersome cameras in a way that allows movements we associate closely with how the head, neck and body navigate the world. The Steadicam is a counter-weight and spring system that puts the camera in front of the operator away from the human body. This allows free range of movement horizontally and vertically so that when the device can constantly adapt to the operator's movements while conveying a sense of looking from the head.

[100] According to Wilson, Mark R., Samuel J. Vine, Elizabeth Bright, Rich S. W. Masters, David Defriend, and John S. McGrath. "Gaze training enhances laparoscopic technical skill acquisition and multi-tasking performance: a randomized, controlled study." *Surgical Endoscopy* (Springer) 25 (2011): 3731-3739.

The Steadicam is a popular replacement for handheld and shoulder devices that place the full form and weight of the camera in the operator's hands, arm and shoulder. This forces a less human notion of looking because it forces the arms, which are displaced to the left and right of the head, to take on the role of the camera's body. Since the look is displaced, so are the operator's movements, causing more of a swinging body effect when the camera looks to the right or left. In the Steadicam configuration the operator walks freely with the Steadicam attached by a harness. The point-of-view can then be directly in front of the operator and at head-level. The harness serves to steady while the operator provides the mobility.

Figure 3.8: Operator John E. Fry with Master Steadicam, Taken November 5, 2011. From the public domain.

In Oscar's case in *Enter the Void*, this type of mobilizing system lets the operator look *through* the camera that adapts to their existing physiology, actually making it possible to see for Oscar. This is a truer sense of embodiment for the operator, and a decreased restriction between the operator's visual and tactile experience can convey a more human perspective to the viewer as well.

Chapter 4

"What I see is mine"[101]

Rendering images and having a world

The camera, in its varying forms, is responsible for our way of accessing the *seeable* with technology. It affords sight beyond our own means, making close those things that are too far, drawing with not enough or too much light, and peering out from places we cannot ourselves go. But this *looking* is only a part of technology's capacity for sight beyond our own because technology can also render for us, in vivid detail, an item coded specially to trigger our physiological system of imagination. Rendering an image, in a technical way for us to see, affords us the opportunity to merge what we take in with our existing canon of imagery. This chapter seeks to reveal the essence of this item that triggers sight and imagination—the image—in its varying states of readiness, on its way to its goal of being seen.

At its moment of capture the image has embodied the camera in some way by taking its look, but it also clings to its own traces of what Brentano called *intentionality*—the directedness of consciousness upon an object. *Intentionality* involves pairs of correlates and, even in some phenomenological study, the *intention* tends to be afforded to things that think, as an act upon the content of thought. That is

[101] Thoreau, Henry David. "Friday." In *A Week on the Concord and Merrimack Rivers*, by Henry David Thoreau, edited by Carl Hovde, William Howarth and Elizabeth Witherell, 272-319. Princeton: Princeton University Press, 2004, from page 285.

of course the rationalistic way of thinking about intention, but the image challenges this, as we will explore. Brentano explains

> A person who is being thought [ein gedachter Mensch) is as little something real as a person who has ceased to be [gewesener Mensch]. The person who is being thought hence has no proper cause and cannot properly have an effect. But when the act of consciousness (the thinking of the person) is effected, the person who is being thought (the non-real correlate of the person) coexists [ist mit da].[102]

Brentano later altered this doctrine toward the model of intentionality that we will maintain here, replacing the concept of something that is "being thought" with "there is a thinking thing." This suggests that everything is *ens reale* (having actual or potential existence beyond the mind), and we must consider that intentionality is defined within the correlation, not given to just one part. This is a major premise of the arguments in this chapter, which are based upon a general directedness toward a unified achievement of sight. This will become clear as we further explore the image in its varying states of readiness and within the correlates: the "seeing and what is seen."[103]

Certainly the everyday critical analysis of image composition is almost always pointed at an operator's intentionality, and this is rational because the camera seems to us inanimate and unintended on its own. It is for itself only ever *present-at*. Its *readiness-to* requires an intentioned *hand*. An image too requires this, but the

[102] Brentano. *Descriptive Psychology*, pages xix-xx and 179.

[103] Brentano. *Descriptive Psychology*, page xix.

processing of an image demands more than just a physical body from which to do the looking, but also a cognitive process to enable a spectrum of seeing. These states of readiness only make us more sure that these imaging devices do not have intention. But Chapter 3 has shown the correlation between the operator and the camera and exposed the look from where it has come. It is, at the point of looking, the camera's look just as in the capturing it becomes the image's, which it will afford to whomever attempts to see it. And not only will we share the intentionality in the correlate of seeing and what is seen, but the process itself requires a whole-bodied intentioning, and so a new understanding of *readiness*. An intentioning *hand* has been sufficient for wielding the equipment to this moment, for an operator can set a camera to looking without doing any of it him or herself. But when we *see* an image we grasp it with our eyes as well as our mind. Our intentioned body is not just one of pointing and shooting, but one of perceiving, through consideration and recall from our own point of view—the only one we shall ever know. With phenomenology still at the base, this chapter will examine *how* an image comes to be seen and what is revealed in the correlation when we have this experience. To enhance a phenomenological approach, several neuroscientific accounts of notions of blindness and vision will deepen our understanding of full-bodied sight and allow us to determine to a precise degree how an image makes itself known to both the mind and body.

Image and thought: states of readiness

An image is a technical record of a look, in varying forms to be discussed. But the term itself is elusive to say the least, and this is not the first attempt to clarify its definition. W. J. T. Mitchell points out the challenge in pinning down a working understanding of what the term means. He writes

> …the word *image* is notoriously ambiguous. It can denote both a physical object (a painting or sculpture) and a mental, imaginary entity, a psychological *imago*, the visual content of dreams, memories, and perception. It plays a role in both the visual and verbal arts, as the name of the represented content of a picture or its overall formal gestalt (what Adrian Stokes called the "image in form"); or it can designate a verbal motif, a named thing or quality, a metaphor or other "figure." Or even the formal totality of a text as a "verbal icon." It can even pass over the boundary between vision and hearing in the notion of an "acoustic image." And as a name for likeness, similitude, resemblance, and analogy it has a quasilogical status as one of the three great orders of sign formation, the "icon," which (along with C. S. Peirce's "symbol" and "index") constitutes the totality of semiotic relationships.[104]

[104] Mitchell, W. J. Thomas. *What Do Pictures Want?: the Lives and Loves of Images.* Chicago: University of Chicago, 2007, citing Hume's three laws of psychological association (resemblance, contiguity, and cause and effect) loosely correspond to Pierce's semiotic triad. See W. J. T. Mitchell, *Iconology: Image, Text, Ideology* (Chicago: University of Chicago Press, 1986), 58, quote from page *2.*

While *image* may have many meanings to us all, what this chapter seeks to do differently in pursuing the *essence* of an image is to strip away social, cultural and technical shields that cloak the intentionality of the image itself. Without these *applied* layers around an image, we might begin to know how it behaves in a fundamental, unwavering state of pursuit of its own goal, which is to be seen. We can fall easily down the path of defining *image* any time that we afford intentionality to the thinking thing alone. Likewise, by affording it to the image alone, we would consider the thing known once we realize that an image in a captured state reveals the camera's precise *look*, which is otherwise a fleeting moment. But an image is not something trapped in a camera nor is it something trapped in the mind. An image in this chapter is a *real* remnant of a camera's look. Requiring that the look originated in a camera, defined already in Chapter 3, means two things for us here: 1) the look happened in the lifeworld and was "captured," to the best of the camera's ability and 2) the camera had a physical presence, occupying a body from which to do the looking. Given this criterion we can cautiously use the term *real* to categorize these images among all others, but we should also use caution in suggesting a consistent form. In this chapter an image is not to be defined by one specific form, for it is the essence that we are after, and its essence is not restricted to how an image might be captured, displayed or otherwise given to our faculties for sight. An image carries in itself the blueprint for embodying part of a moment from the camera's perspective, but in itself it has no bodily perspective. When it is seen it asks that we embody it by adopting its point-of-view into our own. This single trait is what characterizes an image's part in intentionality—it affords its standpoint to the seer—a standpoint that cannot be

attributed to the camera or its operator because their embodiment of the look is permanently lost when it is we who, with the image, are the seeing thing.

But as we will discover, an image cannot always be seen. In finding its way to its state of correlation it will translate its content across several channels before it is fit for eyes. The act of readying an image will be discussed throughout the chapter as "rendering," and the rendering is understood as a process for making an image known, both technically and cognitively. Rendering is an act that must take place at every state wherein an image is translated toward its goal, which is to be seen. An image in its original state is that of capture. This state is a *noumonon*, which does not align with our notion of sight.[105] We are blind to this mode of the image because it is rendered in the form of technical data meant for mechanisms that do not adhere to our notion of sight. The properties of the captured state are known to the captured medium alone, just as the look itself was known only to the camera. The captured state is the first rendered image, containing all past, present and future renderings. The state that gives an image the form for sight can happen after the captured state because the image, like a strand of DNA, is encoded with all of the information needed to show itself. There is much more to be said about the captured state, but it would detract from our aim: we wish to reveal the essence of the image that is seen.

The image on display is the state that we are most familiar with, and it is the one we tend to consider as the defining state. This is natural since we see the world in images on display, through technical interfaces of our invention or through the window

[105] This term is used here in the Kantian opposition to *phenomenon*, which is an object of the senses. It is used here to suggest the unknowable (to the senses) qualities in the capture state of an image.

of our life—it is all seen from our body's point-of-view and through our cognitive process. Indeed, we see everything in the same manner, and though we have a memory lexicon and can perform invariance, reification, grouping and other gestaltisms, the physiological performance of sight is unwavering. An image on display is tailored to be seen, just as our own visual process has been tailored to see. An image in the state of display is the state that Dasein can know as *noema*.[106] Though it might seem counter-intuitive to associate the image on display—perhaps the most objectified version of the image—as the content of thought, it becomes so because it is in this state of readiness that it is seen. An image does not itself move from the captured state to the display state, and it is this state of readiness that is finds its place in the correlation of intentionality. An image on display is at the same time a physical object to be grasped and an object of consciousness. Damasio offers a neurophysiological description to help, defining generally the process of thought that renders images in the mind. He writes

> …the process whereby neural representations, which consist of biological modifications created by learning in a neuron circuit, become images in our minds; the process that allows for invisible microstructural changes in neuron circuits (in cell bodies, dendrites and axons, and synapses) to become a neural representation, which in turn becomes an image we each experience as belonging to us.[107]

[106] This term is defined more thoroughly in Chapters 1 and 2, referring to Husserl's technical term for the way of knowing things through thought—the objects of consciousness.

[107] Damasio. *Descartes' Error,* page 90.

The image on display is the source of the impression and the impression itself. This principle might cause pause if we do not consider images as intermedia between us and their content and context within the world. To *be* seen is indiscriminate, and does not specify *what* is seen. Our way of seeing is through spatial and representational vision, which depends on our ability to take in images as our bodies find them and set them against all other experiences we can imagine. An image is seen, without degrees, because it need only find itself within the mind to achieve its goal. The great challenge for the seeing thing in the correlation is the context in which an image is impressed and rendered as seen, and any number of other impressions and renderings will influence this along with the moment-to-moment environment that challenges our body and mind in its practices of looking and seeing.

***Seeing*: a cognitive process**

To really know how an image in the physical realm shares the same state as the image rendered in cognition, we need to understand some basic principles of our notion of sight. The reason we need to understand this is because the image on display is always seen, and that is its intermediary nature. Unlike a camera, which can look and capture without an operator, an image on display must be seen in order to exist. It must be given seeing eyes to lift it from its canvas or screen and be down/uploaded, decrypted and rendered in the language of our mind. Getting rid of the display medium is the first step to understanding how our notion of sight allows us to grapple with our world—how our imagination makes life out of images. The question, then, is what does an image become in the mind's eye? The solution of the display is

one of the outside world and not of the mind, because, as Ramachandran and Blakeslee note, if the image is put back together somewhere inside the brain and displayed, then you'd need another pair of eyes inside your brain to see it. Ramachandran and Blakeslee write

> So the first step in understading perception is to get rid of the idea of images in the brain and to begin thinking about symbolic descriptions of objects and events in the external world. A good example of a symbolic description is a written paragraph, like the ones on this page. If you had to convey to a friend in China what your apartment looks like, you wouldn't have to teletransport it to China. All you'd have to do would be to write a letter describing you apartment. Yet the actual squiggles of ink—the words and paragraphs in the letter—bear no physical resemblance to your bedroom. The letter is a symbolic description of your bedroom. At some point, the image must be broken down, just as it was put together. …What is meant by a symbolic description in the brain? Not squiggles of ink, of course, but the language of nerve impulses.[108]

[108] Ramachandran and Blakeslee. *Phantoms in the* Brain, page 66.

To go a bit further, the nerve impulses do not represent merely a direct translation of an image in the world, but rather they must decrypt and sort the image in order to channel its bits to different purposes of thought. In neurological terms this requires a dissection, or at least a dissemination of what is seen as it passes beyond the optic nerve toward where it terminates in both the parietal lobe and the temporal lobe (Figure 4.1).

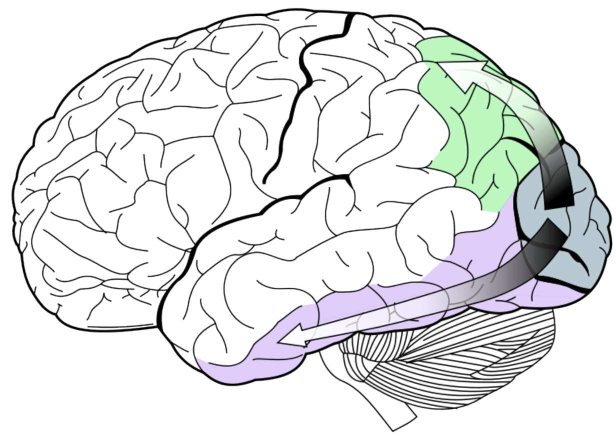

Figure 4.1: Image showing ventral stream (green/top arrow) and dorsal stream (purple/front arrow) in the human brain visual system, rendered digitally by Selket on December 15, 2007, used in accordance with the terms of the GNU Free Documentation License.

These locales are not the only two tasked with dealing with the bits of decrypted image, but they play a key role in determining for us, what is asked for and made up in the act of seeing. One of these pathways for visual information is known as the dorsal visual stream to the parietal lobe, or the "how" pathway, or the "vision for action" pathway. It is concerned with spatial vision—"the ability of organisms to walk around the world, negotiate uneven terrain and avoid bumping into objects or falling into black pits."[109] The process to the temporal lobe is called the ventral visual stream, or the "what" pathway, which gives us the neural catalog and representational intuition to identify objects categorically and uniquely (some of which are called "face cells" because they allow us to differentiate one person's face from another's). The ventral stream is sight as we know it most directly because it is processed in a way that is

[109] Ramachandran and Blakeslee. *Phantoms in the Brain*, page 77.

cohesive to the imagination and internal system of conscious reasoning and recall. The dorsal stream is not sight as we think of it, but the visual component in proprioception. Spatial vision seems to bypass the image-friendly cognitive process. In other words, we do not *imagine* that we see the world in this stream, but at every moment it demonstrates itself as sight by providing constant reference to the body and the physical world. This is the visual quality that lets us feel "caught up in the world" by situating our perspective in reference to our eyes and body.[110] Since it is separate from our ventral stream, where we can sequence and contextualize what we see, it is difficult to truly understand exactly how the dorsal stream *is* sight in the sense that we know it.

A case that might help to paint this picture comes from Oxford University and an operation by Dr. Larry Weiskrantz, who removed an abnormal clump of blood vessels in a patient's right primary visual cortex, causing the patient to be completely blind to the left half of the world (because the right side of the brain sees with the left sides of each eye and vice versa). During vision testing with Dr. Mike Sanders, the patient's ophthalmologist, the patient was asked to guess at the position of a stick (horizontal or vertical), placed in the patient's blind spot. Though the patient reported that he could not see the stick, he managed to guess correctly time and time again. "Can you say how you guessed—what it was that allowed you to say whether it was vertical or horizontal?" the doctor asked. The patient replied, "no I could not because I did not see

[110] Phrasing from Merleau-Ponty. *Phenomenology of Perception*, page 27.

anything; I just don't know." Weiskrantz coined the name of this condition, known as "blindsight."[111]

We might draw from this the opposite case, where the dorsal stream is impaired so that we would have full *sight* as we know it, but no visual understanding of our body in space. A patient with this type of impairment would have only foveal vision, and would not be able to discern the sizes and locations of objects around them. Indeed, such cases are well-documented, but we need only consider such a case in reference to the image—the thing that is seen. It is nearly impossible to imagine seeing without the dorsal stream of visual information (the "how" pathway) because we do not typically recognize it apart from its role within the whole scope of sight. Still, it is absent in any situation that allows us to see from a point of view that is not our own.

Figure 4.2: Image of The Temptations at the Royal Albert Hall, captured November 5, 2005. From the public domain.

If we look at Figure 4.2, we certainly recognize that the perspective that we're adapting is one that appears to look from an elevated distance, facing from house

[111] Ramachandran and Blakeslee. *Phantoms in the Brain*, page 75-76.

right-of-center. But since we are not spatially aware of the body from which we are looking, we would only guess, and with less accuracy than Drs. Weiskrantz's and Sanders' patient, exactly from *how* high above, *how* far away and *how* right-of-center we are perched. Having full capacity of the ventral stream does not enable us to *embody* the full image, though we attempt it every time we imagine what we did not physically experience. Return us to the real—the lifeworld where we have bodies that shape our perspective, and we quickly manage our images with full-bodied sight, building into our imagination the complete sensory experience of the moment, embedding all of the risks and rewards that only our bodies can afford.

Having an image: spatial vision and sensory immersion

Of course there is a great deal more to the neurological explanation for sight but what is most relevant to this chapter are the various processes that specifically allow an image to be rendered as seen. We know that the ventral stream is concerned primarily with building the content of our conscious, non-spatial imagination, and that the dorsal stream is concerned primarily with interpreting that content in relation to our physical world. These two streams in the visual process work together to imprint life and afford us the opportunity to have it for recall and application in future experience. Considering the practice of seeing images in such a way seems to give them a more permanent state of readiness than those things in the world with consistent physical properties. Zoltan Torey's book, *Out of Darkness* gives an autobiographical account of blindness, (as in the physiological condition of losing the sense of sight). Torey explains how over time he was able to build a visual world by studying it meticulously with his other senses and applying his imagination to *see* it. Torey did this with great

care and detail, allowing him to navigate with a visual map around his home, and even fix his roof in the middle of the night. For Torey, sight could be achieved without the ocular ability to distinguish light, and instead relied on rebuilding, from existing reference and ongoing physical, aural and other sensory experience, a visual world. "I learned…to hold the image in a tentative way, conferring credibility and status on it only when some information would tip the balance in its favor."[112]

Like Torey, John Hull also writes about an experience of blindness and he too argues that *seeing* is something that occurs in the mind, beyond the boundaries of the visual experience of light, suggesting that an image can be rendered through a variety of sensory inputs. Rather than having visual images originating from ocular information Hull experiences motor and aural images. After gradually losing his sight, Hull also eventually lost the conception of visual images within the imagination. Of course this included losing visual memories of faces and basic shapes, but it also meant a loss of an understanding of what *visual* sight actually is. The idea of *seeing* had no connection to the visual experience for Hull. To *see* the number "3" he would need to draw it in the air with his finger. Hull described himself as a "whole-body-seer" because sight did not depend on an ocular visual experience at all.[113]

Indeed, our ability to imagine in the form of neurological impulses is evidence that we need not have ocular vision to achieve sight. In dreaming we have no use for our eyes or body, though we might conjure enough neural image data to increase our

[112] Torey, Zoltan. *Out of Darkness,* New York: Picador, 2003 quoted in Sacks, Oliver. *The Mind's Eye.* New York: Vintage, 2011, pages 209-212.

[113] Hull, John. *Touching the Rock: An Experience of Blindness*, New York: Vintage books, 1992, quoted in Sacks, *The Mind's Eye,* pages 201-204.

heart and breathing rates and perhaps even startle ourselves to the point of waking. This complex, full-body experience is our notion of sight—a notion based on rendering neural data in a form we call imagination. So how do we grapple with a disembodied image, which we know contains limited blueprint data for a complete neural rendering?

We cannot deny an image its role as a correlate in intentionality because it has its own point-of-view, and we cannot afford this point-of-view to the operator or to the camera, for they are fleeting. As Merleau-Ponty puts it, "the body is our general means of having a world," and this has been something we could rely on in previous chapters.[114] The camera, even when stationed alone and apart from an operator has the physical bodily requirement from which to look. We, the seer, will adapt our point-of-view to the one that the image affords, but we would be wrong to say that it is our own because ours is beyond the image and from within our body. Ours is always a neural rendering constructed from the data in the image and set against the backdrop of our imagination. Chapter 3 focused heavily on the tactile challenges associated with looking through cameras, but is the nature of an image so ephemeral that it cannot become ready-*to-hand* in the way that a camera can? We might consider the objectness of the thing that is present-at-hand, which certainly an image can be when it is not able to be seen—perhaps in a photograph turned upside down on the desk, or in a file icon minimized in the corner of a computer screen. But just by facing it so that it can meet our gaze stretches the concept of readiness-to-hand, not only because images often reach our gaze without our willful intentioning (though never without our

[114] "Titres et travaux: Project d'enseignement," in *Parcours deux,* 1952-1961, ed. Lacques Prunair, 9-35, translated by Taylor Carman, quoted in Merleau-Ponty. *Phenomenology of Perception*, page xiii.

correlation as the seeing thing), but also because the in-order-to, in the case of images, is an action potential that is internalized, rather than externalized. The in-order-to, in the case of images, is *see,* and it invokes a degree of processing to achieve it. Spatial vision and light are what allow us to find the world, via our position in it, ready-to-see.

Ready-to-see: the range of technical rendering for display

It is clear that we render images for ourselves through a cognitive process. When we wish to give authorship to that cognitive process and render images for others—when we wish to share our adopted point-of-view—we must render images as on display once again. As we have discussed, having looked with a camera, which can identify light in a way that a human can, is not enough to create an image that can readily be seen because the data in capture remains in the domain of the technology. That data must find a process that can render it for display in accordance with our human notion of sight. The technical rendering, as we will refer to it, is that which occurs after the look at any point in which captured data is translated from its invisible state to one which can be seen. Technical rendering is everything that takes place after the look that results in an image on display—the scope of realizing what has been captured on our terms. We know from the previous chapter that a camera behaves in a way that depends on the measuring and processing of light, much like the human eye, but its configuration for capturing is similar to our way of imprinting in memory. It is a configuration that embeds data in its most fundamental form so that it can be arranged later into its defining form for sight. If the act of *looking*, for us, takes place in the eyes

and body, then *rendering*, for us, takes place through the cognitive process where an image is realized, stored in memory and ready for recall. Since this (cognitive) *rendering* is the state in which we take in and have the image ourselves, it is ultimately the state that lives in the mind. It is essential to consider images that are captured by an imaging device and displayed for us through technical notions of *seeing* (such as a photograph, in its varying forms), as *rendered* only in the strictest technical sense. Our own ability to render, through cognition, is always the way that an image must be seen, regardless of how it is rendered technically. The technical process begins in the camera when the bits, pixels, bytes or silver halide are called upon to arrange themselves in their medium, but the resulting imprinted look—arguably the only true form of an image—is not in a form that can be known by the human notion of sight. Thus, we have a need for technical rendering, where an image comes to be in line with our notion.

Developing film in a dark room can provide the most basic understanding of technical rendering because it is a process that maintains a dependence upon light rather than pixel data. This reduces the gap of sight between us and the mechanism, as both utilize the same notion of sight to imprint an image. In film developing an enlarger is used to re-capture the image by magnifying through a lens the negative under light. The projection of light hits a sheet of photographic paper, thus imprinting the image in the negative on the larger display. The paper is then immersed in a chemical that will make the latent image visible to us. The enlarger essentially behaves like a camera, looking at a negative under light and imprinting it in a larger medium so that when it does reveal itself through the chemical process it will be on a large display

where we can better see it. The chemical and enlargement processes of revealing the latent image serves as a basic model of range in technical rendering, allowing a malleable sub-state between its former (captured) state and its future (display) state.

Grasping with the eyes: lifeworld metaphors in digital rendering

Though the technical rendering state is *developing* in film, it takes on a different form in the digital realm, where captured data behave very differently different than they would as a light imprint in silver halide. We might say that the pixels that the digital camera captures are invisible to us, but not in the way that they are invisible in the film negative. The digital data requires a translator rather than a chemical catalyst. Unlike the crystals that awaken in the developing bath, the digital data is a double-digit mega-piece pixel puzzle that is put together upside down and backwards. If we were to "see" it in its data state we would "see" clusters of coded characters, and they would not present themselves to us in a colorful array of flowing digits, as seen in *The Matrix* (Figure 4.3).[115]

[115] *The Matrix.* Directed by Andy Wachowski and Lana Wachowski. Produced by Village Roadshow Pictures. Warner Bros. Pictures, 1999.

Figure 4.3: Still image from *The Matrix* (1999), Warner Bros. Pictures, rendered digitally for use by Adam Dean on September 5, 2012 in accordance with the Report of the Ad Hoc Committee of the Society For Cinema Studies, "Fair Usage Publication of Film Stills."

Just as a snapshot of neurological synapses *is* what *has been* seen, there is no display for the data state of what is *to be* seen. To raise the stakes a bit, technical rendering, unlike our imagination, does not do so well with recognition and representation. Thus if one of these coded pieces of data were to slip away, like a puzzle piece lost under the sofa cushion, we would have a distinct hole in the image on display. In our own cognitive process we are able to adapt and accommodate our memory when data pieces go missing. We do not see holes in our imagination, though there are distinct holes in the data (especially those caused by the blindspot at the base of our retina where the optic nerve connects).

Returning to the state of capture for a moment, we know that the lens system cannot assist us in seeing, since it can only present the camera's state of looking. It cannot render images through this system. It can only look upon the world. Though it has range between our notion of sight and the captured data state, technical rendering of an image for our way of seeing is precise and isolated, requiring a second system apart from the camera's way of looking.

In the need for a second system we are faced with a new problem: by giving technology such range, what is the new correlation in intentionality? The technology's

ability to translate image data from pixel puzzle to that which is seen suggests that we are no longer in the correlation as the seeing thing. But we do have intentionality as we well know, because we wield the technical rendering throughout. Editing, as an intentioning, is afforded to us by the range of technical rendering. Prior to this state the image was locked in its captured medium and we revealed our intention on the look itself. After this state we will have an image locked in a state of display, where we resume our intention as the seeing thing. It is malleable in the state of technical rendering.

We know that just as we *see* the content of our neurological data, the digital data is experienced by its medium alone, and so we need a new interface in which we can *see between* the captured data and display states. Not only do we need basic visual access to an apparent image to intention, but we also need to have a discernable arena to relate an image's behavior to our understanding of the world. The image interface comes to us in the form of the digital metaphor that makes use of our understanding of the social and tangible world around us. The metaphor grants access to the image by positioning itself between our notion of sight and the digital data so that we can maintain our trust in the general rules that we have come to know in the lifeworld, such as our concepts of time and space.

Paul Dourish refers to a well-known ethnographic study from Lancaster University in England on Air Traffic Control to explain how a user might call upon the social and tangible world for reference to what they are seeing on a screen.[116] To

[116] Dourish. *Where the Action Is,* pages 64-67.

summarize the relevant points, the controllers employ eight-inch by one-inch strips of card stock to represent the airplanes in their flight sector. The controllers hand-write information, such as call signals, heading, airspeed, etc., on these “flight strips” (Figure 4.4) and arrange them in racks that keep them in order (generally by altitude, with higher-flying planes on top).

These flight strips are still found in modern ATC environments because they provide a detailed record of notes that reveal process and instant reference in real-time for any controller that might glance at one. This system of rectangular paper strips gives the controllers a way of arranging airplanes representatively in a hierarchy of real-time and space.

Figure 4.4: Image of ATC flight strip bay near Soekarno-Hatta airport in Indonesia, captured January 23, 2004. From the public domain.

It is no coincidence that video editors utilize a similar structure to manage collections of digitally rendered images on a screen. Such a system of organization provides reference to our tangible and social understanding of how things can go “first” or “last” and “above” and “below.” Our path toward understanding the machine’s intricate way of technically rendering an image for sight is in the ethnomethodological

spirit as the Lancaster University study, but ours is not a strict dissection of the moment-to-moment, top-to-bottom execution of tasks. Certainly an analysis of a video editor's precise habits would serve to reveal how the digital metaphor behaves in the full design scope of the process/practice dichotomy, but for the purpose of this study we are specifically concerned with 1) the digital metaphor's understanding of an image and 2) how it seeks to translate that understanding into the entire domain in which we see. Standard video editing software will serve as the best example here because the majority has been configured to turn everything that the user imports into a representative image.[117]

[117] Some special additive effects, such as opacity, color correction and motion/positioning are depicted numerically, such as "100%" or "1920 x 1080," but in manipulating such effects the user typically has a channel mixer image—a metaphor of the up/down/left/right channel mixing control seen on sound or light boards. Such a metaphor associates a three-dimensional object on the screen, which the user can toggle.

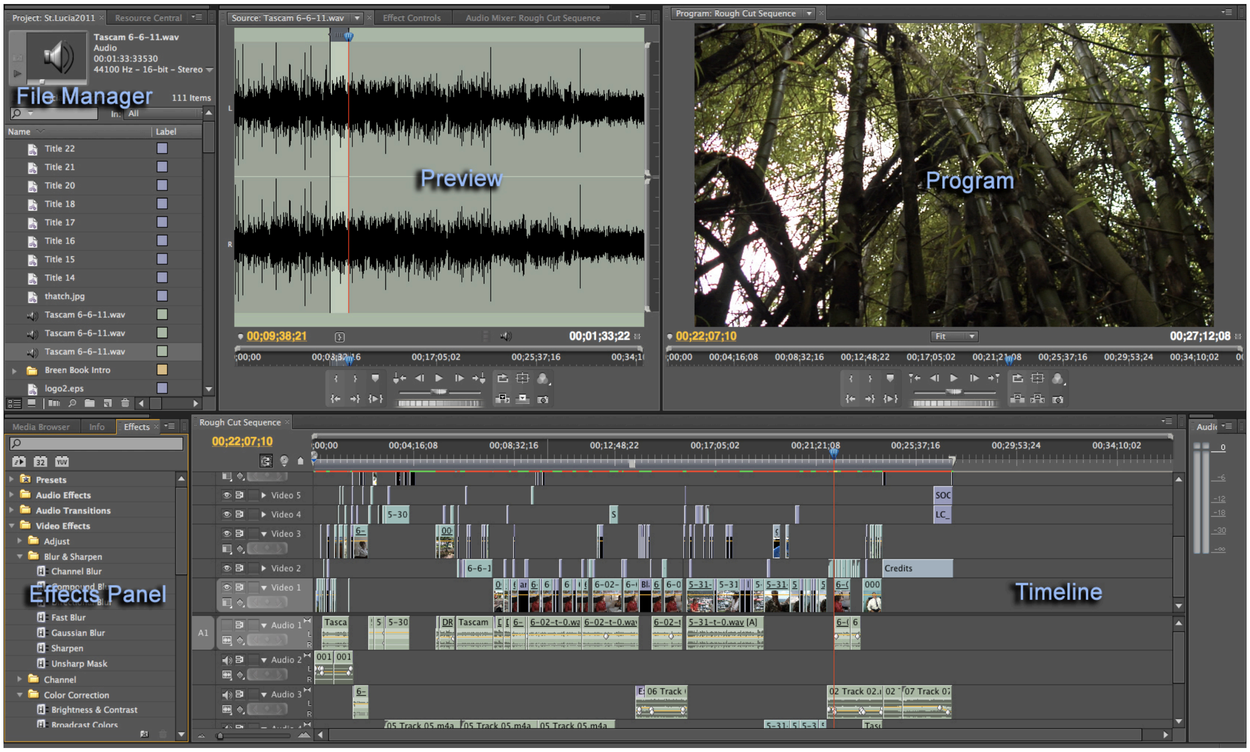

Figure 4.5: Image of video editing software model layout, digitally rendered on August 31, 2012 by Adam Dean.

Figure 4.5 shows an example of the basic layout modeled after a popular professional video editing suite. The labels indicate the various sections within the suite and each section, in its own way, is built upon a spatial and linear time metaphor that translates data into the domain of sight. The “File Manager” section turns all media that it collects into “assets,” which can be organized and stacked above, below or within folders. The “assets” can be almost any type of media, from document files to captured video, pictures, graphics or sound. The editor needs only to click and drag an asset to another section where it can be shaped and rendered for display. Dragging it to the “Preview” window makes it immediately seeable to the editor, even if it is sound shown in the form of waves, as we see in Figure 4.5. It is worth noting that when we trigger assets in the software, we render them for display within that boundary alone. *Seeing* sound in waves is a translation especially for the editor. We still know that the image,

when rendered on display, will not contain this depth of visual metaphor because it will be in a new state—one that does not offer the malleability within the range of technical rendering. In short, when an image is rendered for display it leaves this state of readiness in favor of its new, locked state.

Each representative image in the software is a piece of data that can be manipulated. Each asset, slider, toggle, switch and button corresponds to the technical data in the source, ready to impart within it the editor's role in the intentioning. When the user moves an asset to the timeline, which has an audio section and a video section, assets are translated from a collection of data bytes or pixels into image blocks on a timeline—an interface that we can manipulate in hours, minutes and seconds by moving it left and right.

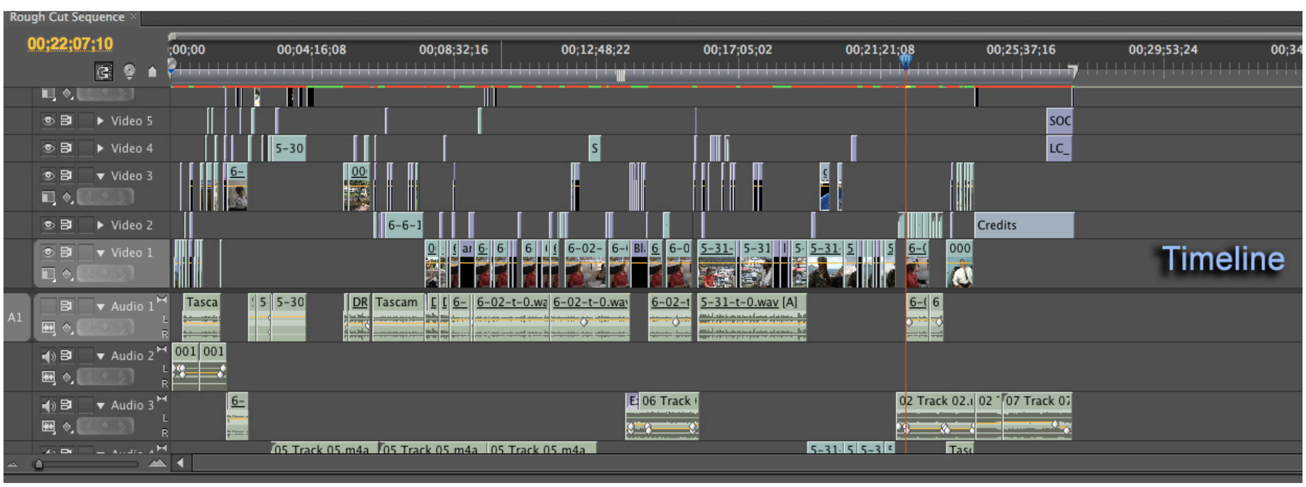

Figure 4.6: Image of video editing software model timeline layout, rendered digitally by Adam Dean on August 31, 2012.

Like the flight strips, the timeline also follows a spatial hierarchy. Images on top lines are understood as above those on lower lines. This means that an image on "Video 3" in Figure 4.6 would play over "Video 2" and "Video 1." If the image on "Video 3" is opaque and can cover the same set screen area as the images under it, it will

render them invisible when the video is finalized (though here in the project we can always see what is *under* the visible image). The translation is not just in the conversion of pixels to time-adjustable blocks, but also in the conversion of “higher” and “lower” to “front” and “back.” The 2-dimensional blocks are stackable, but on a flat screen within which they will later find a display, the images on “Video 2” and “Video 1” are actually behind (not simply lower in the hierarchy) than images on “Video 3.” With practice, this becomes a seamless translation for the filmmaker but it is difficult to grasp cognitively without seeing a displayed image as we have established it.

Unlike the eventual display screen for which these images are being prepared, when in blocks they find themselves trapped in a whirlpool of metaphors. Images in the software are blocks, which can be stacked. We cannot see the images in the timeline for their content, and when we click them we can experience sight in the “Preview” or “Program” windows only, because those are the sections of the suite tailored for our notion of seeing an image in its display state. What is more, our notion of past, present and future lack stability. The software has presented for us a timeline, but a single image has no time. We might stretch or trim its length on the timeline so that it will be on display for 5 or 10 seconds, for example. If we work instead with a moving sequence of recorded video, we might cut it apart and place the end of the sequence at the beginning of the timeline. While the timeline metaphor attempts to adhere to our “rules” of time and space, there are no such “rules” in the digital data itself. This might explain the commonplace manipulation of these “rules” for effect. Zettl explains how such manipulations can alter the image on display. He writes

> The time vectors in edited video are largely independent of the actual event. Through editing you can change the time order of past, present, and future at will and construct your own time arrow. For example, a flashforward will interrupt the normal cause/effect development of a story and provide viewers with a brief glimpse of a future event.[118]

The relative "rules" of the lifeworld are a driving force behind an editor's part in the intentioning. Technical rendering affords this, though the boundaries in the software are set by the seeing thing, reminding us that the image is always destined for its goal, which is to be seen. It is conditioned for display in a *real* place in *real* life.

Searching for embodiment: the stationary viewer

To this point we have sought to define an image through a study of its states: states *between* the camera and its capture device, *between* the captured data and the translating mechanism and *between* that mechanism and our internal cognitive process known as sight. Revealing these between states has led to the uncovering of what an image is in its essence. An image is a bridge. It is the object that allows a mechanism's notion of sight to meet our own, and it is an impression that allows our mind to render memory. Traveling from either side onto the bridge are data—the mechanism's in the form of silver halide or pixel data and ours in the form of synapses. We might take a few steps onto the bridge when video editing software renders for us a moving image

[118] Zettl, Herbert. "The Four-Dimensional Field: Time." In *Sight Sound Motion: Applied Media Aesthetics*, by Herbert Zettl, 228-250. Boston: Wadsworth, from page 248.

that we can manipulate through metaphors. We might venture onto the bridge again when we describe or draw on paper from that impression in our own rendering. At all points, the image connects modes of seeing, originating with a look, then encoding what is captured, then decoding for our notion of sight, and finally being seen in the imagination. Such different modes of *seeing* require the image interface and in this we find its essence.

We have explored these modes throughout, but there is still a great challenge left to the seer that must be addressed. As the image comes to our notion of sight, we take it in and embody it anew. We perceive it in our own way and, in part, adapt our point of view to align the captured experience with the rest of our memory. We *imagine* the experience and afford it the vitality of the lifeworld. We cannot help but do this, even if the image we have taken in does not readily fit what we know, because on this side of the bridge we have a body that fixes our gaze from which to view out. This is the basis for all that we can see. But having a body after having seen is either convenient or tragic, for the body is how we *feel*. Without our bodies we do not experience risk nor reward when we see because the consequences themselves are disembodied. Consider Figure 4.7 containing an image from the point of view of a soldier who is next to parachute from an aircraft. Having seen it, we have taken it in and engraved it in our memory. But we can only say that we have *seen* there, and not that we have *been* there.

That moment is not ours to embody, though we will attempt it anew each time we see it. This separation between our mind and body results in what Hubert Dreyfus might categorize as a "myth of meaning" because our access

Figure 4.7: Image of Senegal Army Soldiers static-line parachute jump from a U.S. Air Force MC-130 Talon over Dakar, Senegal, captured June 18, 2005. From the public domain.

to this point of view gives us a false understanding of the captured experience. A key piece of Dreyfus's argument is directed at digital identity and how we might tend toward nihilism and anonymity when we are given opportunity to find conditions in our commitments. Dreyfus suggests the noncommittal nature of the web results in a public arena for dialogue where the steaks are very low—which is something inherent in any interface that offers a disembodied experience. Having a body is a requirement for the experience of parachuting, and this is why we should (and typically do) reply with a disclaimer when prompted for a description. We might begin to answer with, *"I have not done it, but I have seen it done."*

The problem of physical disembodiment continues to elude the technical notion of sight, for there is currently no way for an imaging device to capture anything beyond

a series of glances, which are isolated from the sensory experience of being there. To perceive and make meaning of experience is to have *unconditional commitment*—a term Dreyfus borrows from Kierkegard to suggest that disembodied experience cannot have meaning comparable to embodied experience because it lacks the physical risks and rewards that one must invest in any given real-world event.[119] This is not only to say, as Merleau-Ponty and Heidegger argued, that being-in-the-world affords us our own point-of-view, but also that our point-of-view is physical and measurable. Our distance from things in the world will have quantifiable consequences for how we experience them. For instance, if we are hiking in the woods and we encounter a bear, it is chiefly our position that determines our experience. If the bear is 50 yards away, we might pause, but only for a moment while considering our exit point. But if the bear is 10 yards away, we should freeze and immediately consider our body's ability to find safety, as we are in imminent danger. This is not to say that we need only measure our position to determine our stake in the world, rather it means that our interactions with the world are also influenced by what we perceive as a measurable immersion. Damasio provides a foundation for precisely how we *feel*, or more simply, how our mind interprets the moment-to-moment risk/reward state of the body. Damasio writes

> The brain and the body are indissociably integrated by mutually targeted biochemical and neural circuits. There are two principal routes of interconnection. The route usually thought of first is made of sensory and motor peripheral nerves which carry signals from every part of the body to the brain, and from the brain to every part of the body. The other route,

[119] Dreyfus. *On the Internet*, pages 86-90.

> which comes less easily to mind although it is far older in evolution, is the bloodstream; it carries chemical signals such as hormones, neurotransmitters, and modulators.[120]

As we established in Chapter 3, when we look with the body, we maintain a physical relationship with our world. Damasio explains that this is not just synaptic but also chemical, thus it is an emotional investment that enhances the general stimuli to culminate our reasoning. We might have a body fully capable of looking, but when we set our gaze upon an environment beyond the body, we should not expect to achieve our full-bodied notion of sight. We have already established that when an image is seen, it has afforded us with its perspective, but not its body. We can only embody the remnants of the look that it is capable of holding, which does not include spatial vision nor sensory immersion in the captured life event. Damasio notes that an environment “makes its mark” on an organism by stimulating neural activity in the eyes, ears and “vestibule” (equilibrium) as well as the skin, taste buds, nasal mucosa and a myriad of other nerve terminals.[121] Such an immersion cannot be grasped in *seeing an image* but only in *seeing the world.* But images are rendered in the same cognitive way of the world, with spatial and sensory immersion afforded by the surroundings in the lifeworld so that we are able to get lost in an image merely by merging our immediate sensory experience with the detail within the image. This might be what Zoltan Torey does each time he encounters new faces and things that are not catalogued in his imagination. Perhaps this is what it is to *see* an image through its physical interface—on display in

[120] Damasio. *Descartes' Error*, page 87.

[121] Damasio. *Descartes’ Error*, pages 90-91.

the lifeworld, where its immediate situation lends its qualities to complete our notion of sight.

Indeed, this new notion of seeing fits the phenomonological model precisely, as we cannot ever see an image apart from its context in the lifeworld because it is processed in the same cognitive routine as our typical notion of sight. We cannot separate ourselves from the image just as we cannot separate ourselves from what we observe. We cannot switch off the dorsal stream and concentrate our attention only on the ventral stream, because if we could we would fill our imagination with flat, unmoving memories without context, and they would not be of much use in recall without these qualities. We are caught up in what we see, even if the level of affordance of spatial vision or sensory immersion cannot be generated from within the image itself. Humberto Maturana's work on how biological processes relate to cognition and language illustrates how a model for a "consensual domain" is a more probable understanding of our relation to our world than the traditional behaviorist's observations of an independent "organism" responding to stimuli in an independent "environment." Maturana introduces the term "coupling" to suggest a pattern or network of "mutually orienting behavior" that is arbitrary and contextual. They are called arbitrary because they can take any form and are not defined by their form (you cannot point to the behavior as a cause or effect itself) and they are contextual because the behavior can only be defined in its consensual domain (it has no place or definition beyond it).[122] Coupling is the thing that exists with the organism and environment at once.

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[122] Maturana. Biology of Language, cited in Winograd and Flores, *Understanding Computers and Cognition,* pages 48-4.

What should now be obvious is that on our side of the bridge the image has lost its tactile relationship with the look. The camera that was punched by the boxer in the ring in the film *Cinderella Man* is no longer with us and we are left with a memory that is rich with ventral stream data but lacks all dorsal stream data along with other variables for tactile (and other sensory) stimulus. We must imagine sensations that are not visually evident within the ventral stream, for neither the camera nor the image can capture and then render for us anything else. We must do this ourselves from the collective experiences that involved our body and its position in the world.

Visual effects: tools designed for embodiment in post-processing

Evey Hammond: “Does it have a happy ending?”

V: “As only celluloid can deliver.”[123]

The filmmaker understands the problem of tactile disembodiment better than most. It is a challenge that constantly undermines the ability to transform *real* human experience into one that is supremely visual and suited for a stationary viewer. The filmmaker must consider ways to bypass the body’s role in human experience by targeting its schema in the mind instead. *Jaws* cannot put us in imminent danger from a shark, but its precise goal is to make us feel *as if*. The film is about an imminent danger, and to capture that danger is to embody it in a physical way. The filmmaker is capable of altering physical perceptions through the ventral stream, and anyone that has jumped out of their seat slightly at the moment Jaws attacks can verify this simple

[123]From *V for Vendetta* (2005), Warner Bros. Pictures.

fact. Our bodies are in a state of physical experience, be it risk or reward, if our mind perceives it to be so. Consider the film *Strange Days*, which is based on this premise. The camera in *Strange Days* looks through a first-person point-of-view to depict a black-market simulation device within the story, called a SQUID (Superconducting QUantum Interference Device). The SQUID is similar in concept to a very real device invented by Miguel Nicolelis, discussed in Chapter 2. In summary, the SQUID allows the characters in *Strange Days* to view recorded experiences from the perspective of those that lived them. The SQUID is a non-invasive version of Nicolelis' Brain-Machine-Interface and Brain-Machine-Brain-Interface (BMI and BMBI) because it has the ability to record the visual (and other sensory) perceptions of the seer for playback into the brain of a later observer. SQUIDs are simple in appearance, with sensors attached to one another by flexible wiring, fitting easily on the head under hats and wigs. We know that BMIs and BMBIs are far more invasive. The proposed goal of the SQUID is to output the experience of the seer to a recording device, then distribute that experience to others, who can then wear a SQUID and experience the same senses as though it were first hand (full-bodied) sight.

Much like *Enter the Void*, which we explored in Chapter 3, *Strange Days* explores the camera's potential to look from within a body as a way of combatting the visual-tactile gap. What makes *Strange Days* particularly relevant here (and distinct from *Enter the Void*) is in the way that technical rendering through editing software exhibits its effects to embody. While *Enter the Void* made use of standard cuts to port Oscar from one experience to another, *Strange Days* shows a commitment to conveying *real* time within the SQUID recordings. For instance, in the opening scene in

the movie we share the perspective of the main character, Lenny Nero (played by Ralph Fiennes) as he experiences an armed robbery and subsequent escape attempt from a SQUID recording (which they call "playback"). With Lenny we follow the moment-to-moment decisions of the robber that made the recording, seeing what he sees and hearing what he hears. We come to understand that Lenny also *feels* what the robber feels (in sensory experience), though we cannot verify this ourselves. We follow the robber, hearing him shout, watching him wave his gun at others in front of us, moving his head and body frantically while escaping up the stairs and onto the roof, and finally jumping for a nearby rooftop and falling to his death, which ends in static on the screen. Lenny seems to *feel* this death more than we as viewers ever could, scolding his friend who gave him the playback, "you could've at least warned me! You know I hate the zap when they die…" Did Lenny *feel* an electrical synapse, which is the more primitive, fight/flight reactionary synapse that our neurons utilize to communicate quickly? We cannot know without sharing this experience as well, since for viewers this scene does not bridge the tactile gap. The effect that does enhance the *feeling of real* in this sequence is its fluidity. We experience this sequence without any cuts, and this allows us to have more time to get lost in the first-person point-of-view which we are meant to embody.

But even if the editor had been successful in capturing the bodily experience of the scene, it is not enough to intention the image in this way. In the case of *Strange Days*, the filmmaker also had to address the challenge of distinguishing the SQUID episodes from the reality of the movie. When characters put on the SQUID, we take on their perspective. We look in, rather than out at the world, where light seems more

diffused and colors less vivid. This intentioned separation between the SQUID world and the reality within the film reveals the problem of tactile disembodiment that seems so embedded in the image itself. We cannot even for a moment embody the perspective of the image—we cannot cross the bridge—and so we are trapped as stationary viewers, never to understand Oscar's or Lenny's experience beyond the visual. Juliette Lewis's character in the movie, Faith Justin, suggests this perceived inherency, saying to Lenny, "you know one of the ways that movies are still better than playback? Cuz the music comes up there's credits and you always know when it's over." Without separating elements, such as cuts and color correction, we might be able to *feel* the moment-to-moment experience that is often muted in the fine cut. In a typical feature-length film we might experience several days, months or years stacked on top of one-another in a two-hour block of real time. This means that we do not experience those mudane tasks with the characters we follow, though certainly they are to have experienced them—we jump-cut through brushing our teeth, tying our shoes, making and eating breakfast and driving to work. We might catch glimpses of remembrances, often under warm, glowing light or bleeding whites. We only experience the highlights of a reality that has been manufactured, even if the events were looked upon with authenticity.[124]

[124] *Strange Days.* Directed by Katheryn Bigelow. Produced by Lightstorm Entertainment. 20th Century Fox, 1995.

Intentioning and special effects: the desire to share full-bodied sight

In *Walden*, Thoreau asked, “could a greater miracle take place than for us to look through each other’s eyes for an instant?”[125] The desire to express one’s rendering to another is perhaps the most frequent call for use of the equipment in this discussion. We constantly make films, create art and build structures for this purpose, often attempting to convey some intricate *reality*, or, more often, embracing and sharing the abstraction of our sight. While Barthes (and many others) correctly held that a text could not convey the author’s context, we cannot deny the *real* that was looked upon from some *body’s* point-of-view, even if it is not possible to contain it in the capturing process. Indeed, the *author function*, as Foucault called it, stands as a marker that a point-of-view was had, and knowing this is itself an imprint in the image. This is the way that images can have intention themselves because it is we who adapt to the point-of-view afforded to us. When we take on the standpoint that the image gives us, we embody, thus relate ourselves to the content, and we can begin to exert control by intentioning it for ourselves. How, though, do we share our embodiment properties in an image that cannot capture our spatial vision or our sensory immersion? This is the “Special” in “Special Effects.” The filmmaker might digitally render a shot of a person experiencing a tragic loss, but upon review of the shot, the filmmaker might wonder, “what more can I do to make the audience *feel* the sorrow of this character’s loss?” We have already examined the ways that first person point-of-view and the mimesis of body movements can thrust us visually into the scene. Now we can

[125] Thoreau, Henry David. "Economy." In *Walden, or Life in the Woods*, by Henry David Thoreau, 5-63. Hazleton: The Penn State Electronics Classics Series, 2006, from page 11.

enhance such looking techniques with rendering effects that might signal other neurophysical processes of *feeling.* If the character is distraught in grief, we might impart chaos in the form of time and space manipulation, like cutting together a number of people talking at once, or increasing the speed of the action to 200% so that the increasing pace of action might trigger anxiousness for the viewer as well. If the character is straining to recall a distant memory, the filmmaker might affect the image with a grainy or blurry filter to convey to the viewer the same degraded perspective as the character experiences in the memory (Fig. 4.8a). If that memory is sad, we might add a cooling filter (Fig 4.8b) or if it is fond we might warm it up (Fig. 4.8c).

Figure 4.8a

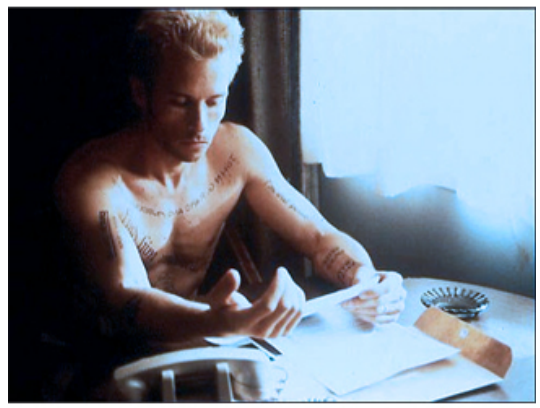

Figure 4.8b

Figure 4.8c

Figure 4.8: Still images from *Memento* (2000), Summit Entertainment, rendered digitally for use by Adam Dean on September 1, 2012 in accordance with the Report of the Ad Hoc Committee of the Society For Cinema Studies, "Fair Usage Publication of Film Stills."

Affecting an image with *feeling* is an editor's desire that we can witness every time we encounter one on display. It is not just the filmmaker that explores the limits of embodiment, finding visual

substitutes for spatial and other sensory reasoning. The popularity of simplified photo sharing software, such as Instagram, tells a story about a popular desire to affix the context of our body to an image on display for others. Instagram, a photo app readily available on photo-snapping smartphones, allows operators to post-process their images with a number of easy-to-use "filters." The digital filters are modeled after traditional lens filters that camera operators use to affect the look itself, prior to and during capture.

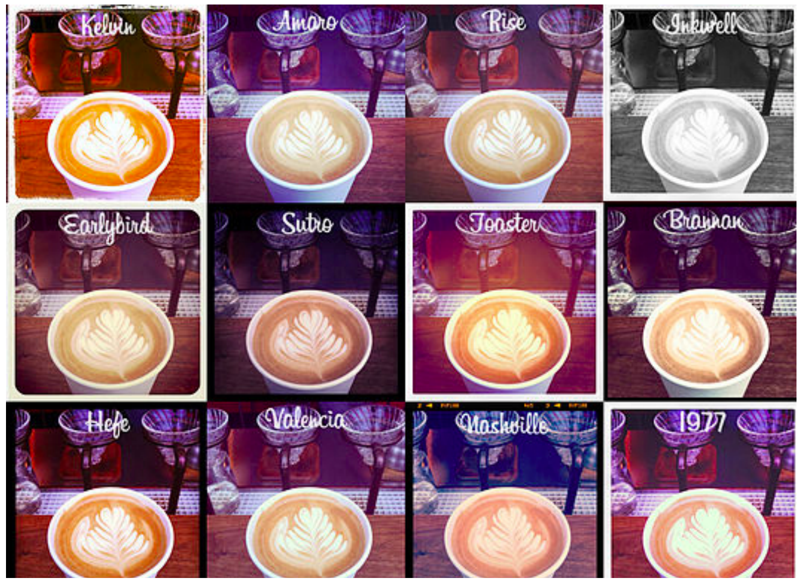

Figure 4.9: Image of Instagram filters used in digital rendering, captured by Jessica Zollman, October 4, 2011, used in accordance with Attribution-Share Alike 3.0 Unported.

Instagram's "filters" are applied in the rendering for display, so operators can easily apply dozens of different filters to effect the rendering. Figure 4.9 shows 12 of these filters in comparison. Each effect has some association with a mood or situation, like "Hefe," which imparts "fuzziness, with an emphasis on yellow and golden tones…*Use for*: Making last weekend's pool party look like it took place in Palm Springs, in 1960" or "X-Pro II," which has "warm, saturated tones with an emphasis on aquas and

greens."[126] Such effects might be used for any number of reasons, but embedded in their use is the intentioning of an image as our own.

It is not just that we are stationary and removed in our typical viewership role, but also that we possess a complex cognitive system for sight that depends on more than an ocular sensory experience. Even with improvements in 3D technologies in cameras and in displays, the viewer does not have access to the scene of sight itself. Providing depth of field on flat displays is certainly a step in the right direction toward resolving the absence of spatial data in capturing, technical rendering, and displaying, but it is a far cry from translating *seeing* to *doing*. We can only imagine the true scope of Lenny's sensory experience in *seeing* with the SQUID in *Strange Days*, but such an ideal for capturing sight is not unreasonable. We already intention images to do this, but they are unable to meet the expectation. Freeing the mind's eye from the restrictions of basic ocular sight is the key to embodying an image to render wholly for ourselves and for one another.

[126] Garber, Megan. *The Atlantic: A Guide to the Instagram Filters You'll Soon Be Seeing on Facebook.* April 10, 2012. http://www.theatlantic.com/technology/archive/2012/04/a-guide-to-the-instagram-filters-youll-soon-be-seeing-on-facebook/255650/ (accessed August 21, 2012).

Chapter 5: Plain Sight

The problem we seek to resolve with technology is the degree of separation caused by the division of the senses. Our eyes and way of visual processing work together to build our imagination where images can live and grow for our personal use. In this human way of rendering images we give ocular attention to specific things, and that attention defines the depth of our own impression. The more deeply we see, the more clearly we imagine. The experience of sight comes with an inherent choosing, and it is not so obvious to the looker what else there is to see. What is beyond our attention is elusive. This chapter covers experiments in technical looking and seeing that work to extend our human capability of sight in two specific ways. The first is by resolving the division of attention that is the primary source for blindness as we have studied it here. The second is by extending our understanding of *visibility* and *invisibility* as it pertains to the identification and measurement of reflected light. Just as Chapters 3 and 4 explored ways of looking and seeing, this chapter takes on the same approach. It examines technical developments that seek to alter or enhance our ways of looking and seeing with technology through changes in how cameras might be set to look, how they behave in looking, how they translate what they see into an image on display and how they might offer a range of sight independent of the reflection of light. In examining these technical developments, this chapter brings us closer to integrating technical and cognitive methods of discovering images so that future imaging devices can extend and redefine what we know as sight.

Two Worlds

Michael Chorost, the science-writing cyborg who gave a description of the cochlear implant cited in Chapter 1, also illustrates these two worlds as they compete in daily routine. Chorost describes an afternoon when his BlackBerry was out of order. He tells the story of walking through a market, paying attention to the "sights and smells of the world." He writes

> I walked about, nosed into stores, and ate lunch at my favorite taqueria. But it troubled me how separate the two worlds of my experience were. My BlackBerry offered me an infinite supply of information and messages. The material world offered me infinite sensation and variety, and the faces and voices of my friends. It seemed altogether wrong that each world could be experienced only by excluding the other.[127]

This is a typical summary of the problem we face with imaging technology—not just the polarization of the immediate world in favor of the one provided through a visual interface, but the cogito-sensory experience of blindness that occurs when our attention is directed toward an interface that renders for us an image-on-display*.* To have one's attention divided is a part of seeing as we know it, but perhaps it is emerging as a problem rather than a quality in our current visual tug-of-war with smartphones and the ubiquitous variety of billboards. Indeed, we are constantly scouring for visual choice and our attention is given to, or it lands on, that which

[127] Chorost, Michael. *World Wide Mind: The Coming Integration of Humanity, Machines, and the Internet.* New York: Free Press, 2011, page 3.

effectively captures it. Simply walking through an airport can reveal that images capture our eyes as much as it is the other way around. But there is always choosing, because regardless of what captures our gaze it is our mind that determines the degree of attention. Even if there are hundreds of blinking lights and flashing images in our immediate physical presence, we can choose to attend to other data streams available to us. All we have to do is set our eyes to look *upon* a book, a smartphone, a personal hobby or shut them entirely and set our mind to look with the imagination. There is a transcendental quality to this, where immediate object permanence is not taken for granted. While Dasein is fixed in the world, our ability to set our eyes to look (or not look) frees our mind from Dasein's consuming, and in other cases, unavoidable immediacy.

The ability to look or not to look is a quality of the eyes, as the mind cannot choose to see or not see. Even with eyes closed, awake or asleep, we imagine. What is in the imagination has a way of showing itself, unlike an image-on-display in the world. A billboard might catch us looking but it is the lasting imagination that determines what we see, and such an impression could emerge long after the billboard is out of sight. In that way the image-on-display is effective when it jumps off its canvas into the imagination. The bound box contains something that we must lay eyes upon even though the image seeks to live in the mind, the only place where it can be seen. It is not enough to say that the *real* image is trapped in its captured state, which by our means is completely inaccessible without a translation into the display state, but also that the screen has *prescribed* for us how we must use the image. We must set eyes upon it and suspend our world beyond it. We must seek to enter it as if it has no

boundaries. The horizontal and aerial perspectives convey depth, just as they would for our eyes if we were standing in the location of the camera, but there is no depth. We agree to look into an image without opportunity to press up against those items immediately in front of us. We can see the negative effects of the interface that divides these two worlds in any display environment. Consider Thad Starner's invention, the "wearable computer," which consists of a tiny 640x480 VGA display screen fixed to his left eyeglass lens and a "Twiddler" in his hand that allows him to type about 130 words per minute (Figure 5.1).

Figure 5.1: Image of Thad Starner's "wearable computer" from Starner's May 21, 2012 TEDxGeorgiaTech presentation.

Both of these human interfaces are connected to the computer itself, which Starner wears on a strap over his shoulder. Starner has been designing and wearing computers for about 20 years and uses his to search the internet and provide data for whatever his immediate needs might be, from looking at information about his current situation or checking his email.

Google also has a device in development with similarities to Starner's head-mounted display, though it differs slightly because it replaces the wearable computer on the lower body with a voice-image-movement-sensing input device. Google glasses have an advantage over Starner's computer because the company can give the user

direct access to Google's vast internet database, including maps, calendars, e-mail, and any other programs they can easily transfer to the head-mounted display screen via the internet and GPS. Still, the views from behind Starner's eyepiece and Google glasses (Figure 5.2) are perhaps the best example of how a clear division of visual

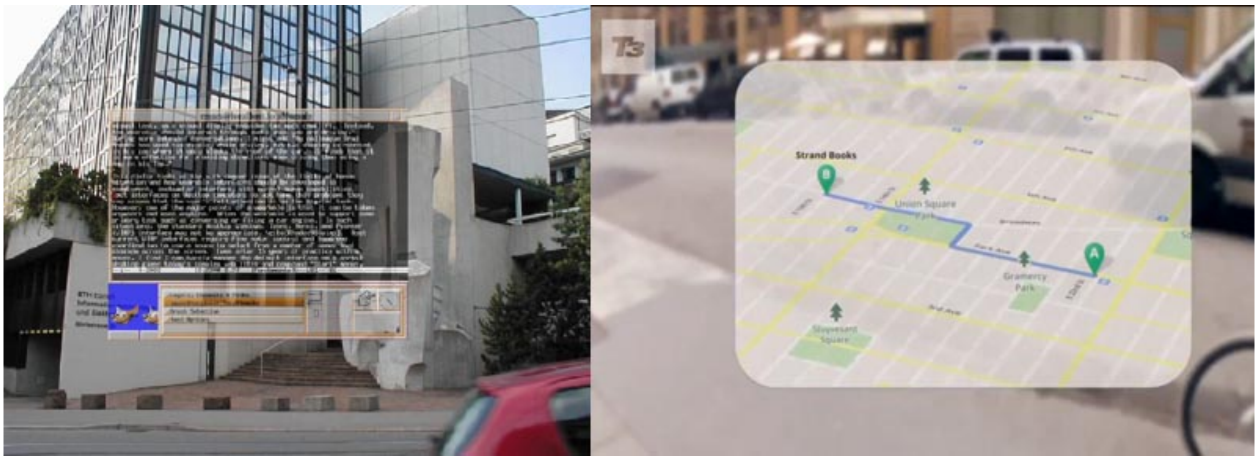

Figure 5.2: (Left) Image representation of Thad Starner's ocular perspective through the "wearable computer" from Starner's May 21, 2012 TEDxGeorgiaTech presentation. (Right) Image of Google glasses wearer's perspective from T3's June 28, 2012 video.

attention seems an inherent part of the human notion of sight.

These display devices are meant to augment the human notion of sight, but they more directly augment the degree of attention division. Even without the software's data screen in the center of the eye view we can identify some degree of attention draw for elements, according to graphic weight. Graphic weight is the degree of visual attention pull an element in an image has, based on its size, color, distance from the point-of-view, position and other qualities that have been shown to influence the viewer's

choosing to look.[128] The images in Figure 5.2, like all others captured by ocular vision, must be divided up by graphic weight. We must find some criteria to choose what we wish to visually attend, then plunge into those pieces and ignore what is beyond their boundaries. Given more time, we can choose other pieces in the image, which we base on the graphic weight hierarchy as well the needs of our imagination and its references, but our attention is always limited in this way. It is the same choice when we attend to viewing a flat display, then retreat back to the peripheral world, taking with us only our impressions of what we have studied with our eyes and mind.

Looking with the body

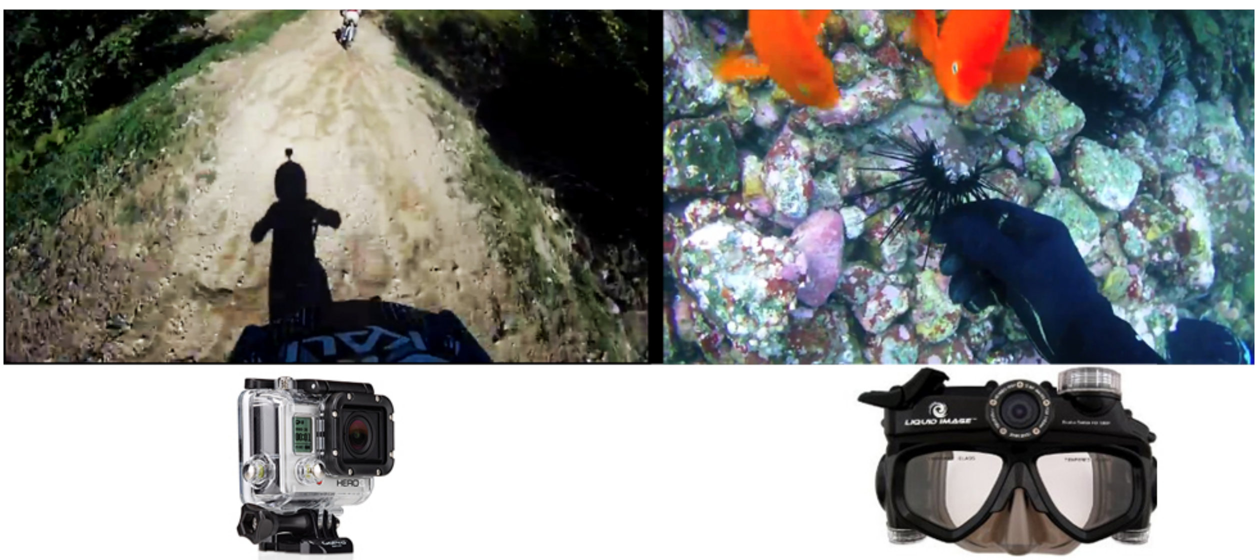

Figure 5.3: (Left top) Screenshot of GoPro POV from YouTube video "hellion first ramp," published by mainehaole on September 10, 2012. (Left bottom) GoPro Hero3 White Edition promotional image, from gopro.com on January 19, 2013. (Right top) Screenshot of Liquid Image POV from YouTube video "Liquid Image Wide Angle Cameras – DEMA show 2011," published by LiquidImageCo on October 29, 2011. (Right bottom) Liquid Image XSC 324 promotional image, from liquidimageco.com on January 19, 2013.

[128] Zettl. "Structuring the Two-dimensional Field: Interplay of Screen Forces," *Sight Sound Motion*, pages 129-153.

While the image capture device design principles established in Chapter 3 dominate the filmmaking and personal photography industries, there are a few cameras, in particular, that are emerging for the special types of human and extra-human mobility this study has been seeking. Two relatively straightforward mobile camera designers, GoPro and Liquid Image, offer cameras for environments that are quite suitable for adventurers, such as underwater or along bumpy terrain, where cameras discussed in Chapter 3 cannot go. GoPro and Liquid Image cameras make use of the human body as their mount and so they are designed to go wherever their user wishes to take them. By re-thinking the design to accommodate the human experience outside a studio and off a tripod, the GoPro and Liquid Image rely on the first-person perspective as their natural way of looking. They still require that a user set them to look but this is reduced to a single-shot setting, perhaps fixed to a helmet or, as in the case of the Liquid Image camera, locking its gaze to the windows of the goggles. Figure 5.3 illustrates the GoPro and Liquid Image cameras in action. The GoPro can be seen in the shadow it casts in front of the rider, revealing that its point-of-view is from atop the helmet. The Liquid Image camera is built directly into the goggles so that if goggles are in use, so too is the camera. The GoPro is fixed on the head, so we can see in the left image that a helmet separates us from the first-hand experience at eye-level. The Liquid Image resolves this with a cyclops-view, dead center between and slightly above the eyes. The placement of the camera determines for us the degree of *realness* in finding visual cues in place of the tactile cues that the user is experiencing. The hand in front of the “face” in the right image tells us who and how we are (a person looking slightly down, angling to the right). Since the camera’s

viewpoint is eye-level, we can assume from the Liquid Image view in 5.3 that we are seeing a digital version of what the wearer has seen. The users in both situations need just to turn on the cameras, and then setting them to look fades into the natural state of looking with the eyes. This alleviates some of the concerns related to spontaneity and first-person-point-of-view raised in Chapter 3.

In addition to developments in how cameras are set to look, there are also some noteworthy improvements in how they look, that is, how they detect and measure the reflection of light. While new camera developments continue to be based on this (the only) kind of ocular vision, the way of observing light through a lens has begun to exceed our own notion of seeing. The Lytro camera has a unique ability to capture image data not by bending light toward a point of convergence where it can be pieced together, but by attempting to remove impedance in the flow of light as it is directed toward the photosensor. This is unlike both the human eye and standard camera lens systems in the past.

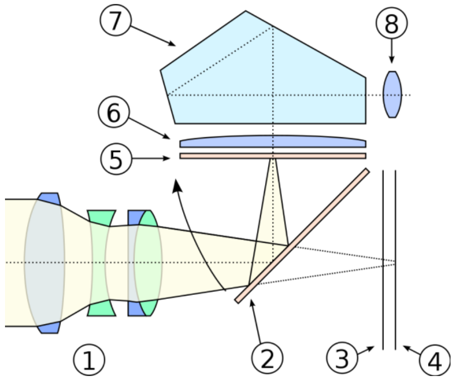

Figure 3.2: Cross-section of SLR, Image and key from Wikimedia Commons, licensed freely.

1. Lens assembly
2. Mirror in down position (image visible in viewfinder)
3. Focal-plane shutter
4. Sensor/Film
5. Focusing screen
6. Condensing lens
7. Pentaprism or Pentamirror
8. Eyepiece

Figure 3.2 illustrated for us the lens system of a standard camera. It shows the channeling of light toward a convergence point on the sensor. This channeling occurs through tiny bends as the light rays pass through each lens. Such a design is based on ocular vision, where light converges on the base of the retina after being bent at the lens. The system has two issues that pertain to attention and focus. The first is the way that light reaches the sensor or retina—through the lens system. While a number of factors in the eye can cause an object to be seen out of focus, there is a specific reason for an image to converge on the sensor or retina out of focus, unrelated to problems in the eye itself. If an object is in the foreground and the focuser (human or automatic) has chosen it as the subject of primary attention, it will come into focus at the cost of the background, which will be blurry. In the human eye the act of focusing is called accommodation, carried out by ciliary muscle contractions and relaxations that flex the lens, thus flattening it or curving it.[129] In a typical camera the lens itself is

[129] Hung, George K., Kenneth J. Ciuffreda, Madjid Khosroyani, and Bai-Chuan Jiang. "Models of Accomodation." In *Models of the Visual System*, by George K. Hung and Kenneth J. Ciuffreda, 287-340. New York: Kluwer Academic/Plenum, 2002, page 287.

inflexible but the mechanical apparatus itself can alter the focal length relative to the internal sensor and outer lens. Sometimes it takes a number of internal lenses and moving mechanisms in a camera to mimic what is a routine contraction or relaxation for the ciliary muscle. Figure 5.4 illustrates a camera's focusing mechanism design and the ciliary muscle in the human eye.

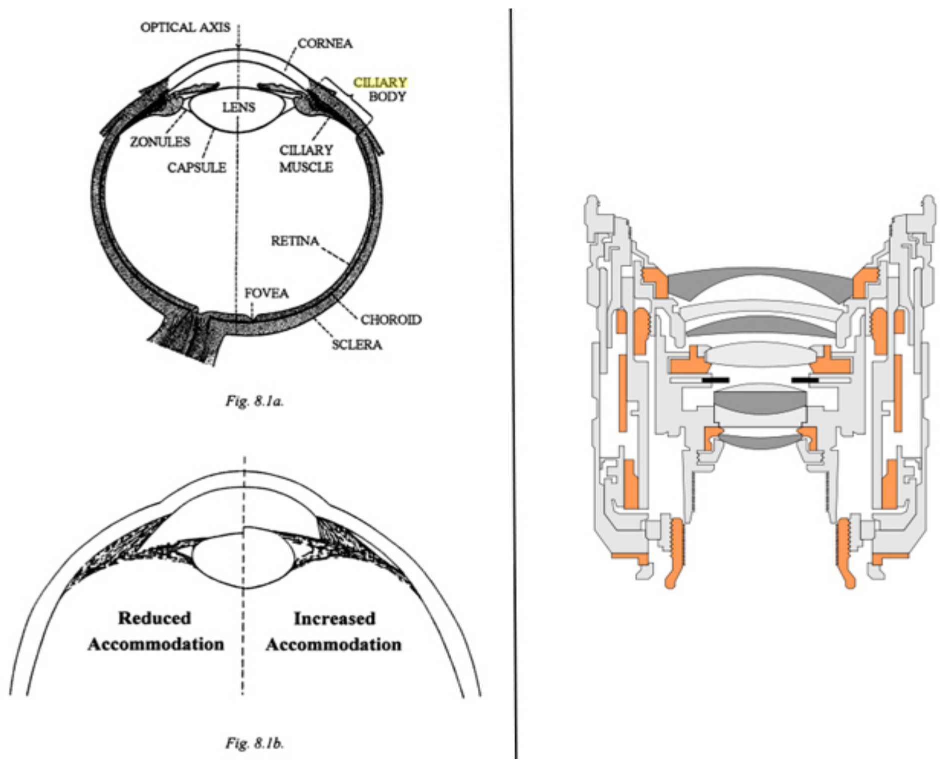

Figure 5.4: (Left) Illustration of how accommodation works in the human eye, from Hung, George K., Kenneth J. Ciuffreda, Madjid Khosroyani, and Bai-Chuan Jiang, page 289, rendered digitally by Adam Dean on December 30, 2012. (Right) Illustration of a (Leica) camera lens, rendered digitally by Evan Mason on June 22, 2012. Used in accordance with Creative Commons Attribution-Share Alike 3.0 Unported.

The standard camera lens design pictured here uses a number of moving mechanisms to push and pull individual lenses toward and away from that upon which it they are set to look. The user (or automatization feature) typically controls these individual lens movements with one type of movement: turning a focal ring on the outside of the lens. The inflexibility of the materials used in camera lenses is the primary cause for this

diversion from the ocular principle of bending and flattening the lens with the ciliary muscle. The ring is the primary cause for delay in the capture process.

The second issue that both optical and ocular lens systems have that pertain to attention and focus is the way the light is bent to a point of convergence at the base of the retina or sensor. Like standard camera lens systems the Lytro's are inflexible, but they are not designed to bend light toward a convergence point on the sensor, as is shown in the traditional lens system pictured in Figure 5.4. Instead, the Lytro uses microlenses to receive isolated light rays without bending them so that they reach the photosensor separately rather than at a point of convergence. The Lytro is a consumer-oriented "light-field" camera based on principles established in founder Ren Ng's dissertation, which does not seek to redesign the inflexible lens system, but rather to bypass it in favor of microlenses in a flat arrangement, each provisioned for a pixel's-worth in light data. Ng writes

> It turns out that conventional photographs tell us rather little about the light passing through the lens. In particular, they do not record the amount of light traveling along individual rays that contribute to the image. They tell us only the sum total of light rays striking each point in the image. To make an analogy with a music-recording studio, taking a conventional photograph is like recording all the musicians playing together, rather than recording each instrument on a separate audio track. In this dissertation, we will go after the missing information. With

micron-scale changes to its optics and sensor, we can enhance a conventional camera so that it measures the light along each individual ray flowing into the image sensor. In other words, the enhanced camera samples the total geometric distribution of light passing through the lens in a single exposure.[130]

Ng's research addresses light aberrations, which are the phenomenon of light rays' divergence from a single focal point even when they share a single point of origination. In other words, light aberrations are the phenomenon of light rays spreading into new paths when their original trajectory is diverted (by bending through lenses). The detection of movement blurs a still image, and this includes these small, subtle diversions in light, which occur at every passage through lenses that bend the light toward the converging point in the camera's image sensor. The solution that Ng proposes, and seems to fulfill in the design of the

Figure 5.5: Image of Lytro, made by Derrick Coetzee on February 23, 2012. From the public domain.

[130] Ng, Ren. *Digital Light Field Photography.* Ph.D. dissertation, Stanford University, 2006, from page 1.

Lytro, is to pass light through an array of microlenses stacked in front of the photosensor, thus minimizing the bends that cause aberrations and isolate the data of light rays themselves, not just the converged whole of the rays on the sensor.

The result of this type of camera design is an image (in state of capture) that contains a much larger amount of data than conventional cameras can capture. This is data that before was unknown to the sensor and thus invisible (because it did not exist) in the image on display. As this study has shown already in Chapter 4, the image data, as the camera knows it, is not the image data as the human eye and subsequently the human mind knows it. What the Lytro reveals further is that the image data, as the camera knows it, contains something more real because both the ocular and optical ways of looking are based on bending light into a point of convergence. The Lytro seeks to allow light to take a straighter path to the sensor, minimizing aberrations that cause image data to arrive out of focus.

The manipulation of light still dominates developments in technical sight. Sight, as we know it cognitively, is based on our ever-growing understanding of how things behave when they come in contact with light, so it is easy to understand why researchers continue to pursue ways of controlling light's behavior. But to understand how light, as we identify and measure it with ocular vision, is seen in the mind, we need to make an important distinction between *visible* and *invisible.* Image capture in the Lytro furthers our technical ability to identify, measure and capture light, but like its predecessors, it remains limited by its model—the human ability to detect and measure light. What is *visible to us* are, in the simplest terms, those things that reflect light. But

as much as 85% of the universe is made up of “dark matter,” which neither emits nor reflects light. It is the definition of *invisible to us.* Compared to those that track, measure and capture what is visible, there is only a small number of experiments concerned with tracking and understanding what is invisible. There are three pieces of technology that reveal different types of invisibility, though all three remain bound to a visible source (for verification of course). These “invisibility cloaks” have received a great deal of attention since Harry Potter planted the idea in the minds of the mass public, but in reality they do much more to reveal the reflection of light than conceal it.

The cloaking device that has received most of the research attention (because it makes *invisible to us* something that is otherwise *visible to us)* is one that can impede and redirect the path of visible light so that it can be bent around an object and effectively hide it from the human eye. Much in the way that the air directly above hot pavement impedes the normal flow of light and gives the appearance of rippling water, the invisibility cloak can displace the normal reflection of light by manipulating the temperature of carbon nanotubes with an electric current.

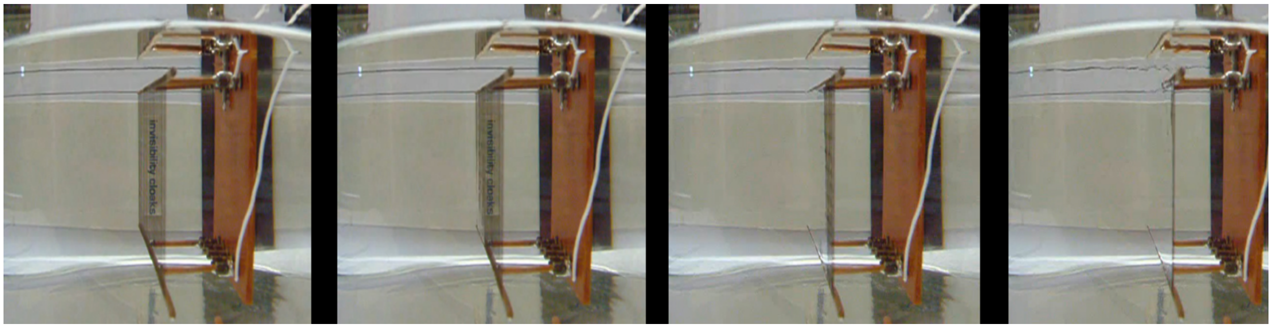

Figure 5.6: Four frames from *Institute of Physics* demonstration video, uploaded September 29, 2011, showing the carbon nanotubes at varying stages of visibility.

Figure 5.6 illustrates the nanotubes as their temperature is altered. The experiment is based on the well-known "mirage effect," and it is summarized in the Institute of Physics' article on this device. It reads

> Through electrical stimulation, the transparent sheet of highly aligned CNTs can be easily heated to high temperatures. They then have the ability to transfer that heat to its surrounding areas, causing a steep temperature gradient. Just like a mirage, this steep temperature gradient causes the light rays to bend away from the object concealed behind the device, making it appear invisible.[131]

The carbon nanotubes experiment specifically seeks to make light, as we understand it, invisible. In essence, the nanotube cloak demonstrates our otherwise inherent trust in the consistent reflection of light into our eyes. As it bounces off objects in daily life

[131] Institute of Physics. *"Mirage-effect" helps researchers hide objects.* Report on article by Ali E Aliev, Yuri N Gartstein and Ray H Baughman in Nanotechnology, Volume 22 Number 43, http://www.iop.org/news/11/oct/page_52313.html: Institute of Physics, 2011.

we can discern through what seems to us exact measurement. At each moment we decipher the sizes, shapes and distances of things around us to determine our situated perspective. This is the vision that orients us in our world, as we are relative to it, and the nanotube cloak reveals two key points for this study. First, the reflection of light is subject to forces that disrupt its consistency. This suggests that we are vulnerable to conditions that alter our lifelong reliance on the ocular translation of the lit world. Second, our perspective is relative to the behavior of light. Should light's behavior change even slightly, so too will our perspective.

The nanotube cloak is the most immediately relevant of the invisibility cloaks currently under development because of its manipulation of *visible* light, but there are other components of light that should not be ignored in any discussion of visibility and invisibility. Two other types of invisibility cloaks that are also based on displacing the path of the substance in light rays are the direct current cloaker and the microwave cloaker. We cannot see microwaves or direct current with our eyes already, though, so these experiments each concentrate on displacing a component of light for purposes beyond the human notion of sight. For instance, the study on DC cloaking predicts some future applications, including "electric impedance tomography, graphene, natural resource exploration, and military camouflage."[132] Cloaks like these, which are designed to elude electromagnetic detection, suggest a future that takes sight beyond the limit of the human eye. DC and microwave cloaks offer ways of interacting with electromagnetic fields with limited interference. These cloaks operate on the principle

[132] Fan Yang, Zhong Lei Mei, and Tian Yu Jin. "dc Electric Invisibility Cloak." *Physical Review Letters* 109, no. 5 (August 2012): 053902.

of “permittivity and magnetic permeability,” which means that they attempt to permit the formation of electrical fields while allowing magnetic fields to permeate.[133] This behavior is similar to the nanotube cloak, but tailored for light’s other components. Each cloak type is successful by facilitating safe passage of light’s components around and through an object, rather than impeding them and causing reflection. Such applications share an understanding of sight beyond ocular vision, even in environments without visible light. These models, where ocular invisibility does not serve as the limit for design, ask us to consider sight independent of any one kind of wave or current, but instead to consider sight as the ability to discern, through any available “bounce” or “reflection from” the universe.

Seeing with the mind

The technical notion of sight as we have explored it is based on the principles of human sight where the subtle changes in the reflection of light renders the world visible. However, as we have studied, this is something better classified as *ocular vision* rather than sight, which takes place through a cognitive process of identification and referencing, called imagining. The future for *seeing,* then, is one that must be based on the cognitive process more than the ocular one. Seeing technically need not emphasize the design of the physical apparatus—the camera—as discussed in Chapter 3, nor the physical body of the image, as discussed in Chapter 4. Instead, the

[133] Zyga, Lisa. "Nearly perfect, ultrathin invisibility cloak could have wide practical applications." *phys.org.* Omicron Technology Limited. January 17, 2013. http://phys.org/news/2013-01-ultrathin-invisibility-cloak-wide-applications.html (accessed January 22, 2013).

benefits of technical sight will be better realized when the seeing thing can take full advantage of the mechanism's ability to capture and retrieve image data neurologically. The camera and image-on-display serve as external substitutes for looking and seeing when an internal process already exists. It is the depth of our own attention, focus and imagination that we invite technology to expand. From Chapters 3 and 4 we can isolate at least 3 characteristics existing imaging devices have that humans do not. 1) Imaging devices can be developed to see at greater distance and in environments otherwise prohibitive to humans, such as underwater, deep into space, and at a sub-atomic level. 2) The capturing process renders precise and fixed details that, so far, are unrelated to the type of rendering of the imagination. In other words, images contain additional data beyond the scope of the human memory, and vice versa. 3) This image data at capture is fixed in a way that the viewing of the image-on-display is not, and this data is unknown to us because we process it indirectly—via an image-on-display rendered specifically for ocular vision. There is a satirical application of this third point developed by *The Onion*, called "The Dehumanizer" (Figure 5.7).

The Dehumanizer takes as input data any web link to an image and outputs the code that generates the display quality. The Dehumanizer, while in application is only facetious, identifies a real process of reverse translation—taking something that can be seen by the human eye and supposedly translating it back into pixel data for the machine. The result, of course, is an image not on display but in a state of being seen by the mechanism. It fails in the translation in the same way that *The Matrix* fails, by illustrating the code to be visually suitable for ocular vision so that the code that is embedded in the image data still has a displayed representation for our eyes. This is how we see everything, and it is understandable that any translation of an image will require an intermediary translator, such as colored fonts and characters lit up on a screen because, it seems, we cannot work with anything that we cannot see. It even seems to the programmer that the code and the image are one-in-the-same because the translation language is so familiar. Being able to read the code that generates the visible image is, to the human programmer, like seeing the image. This is merely

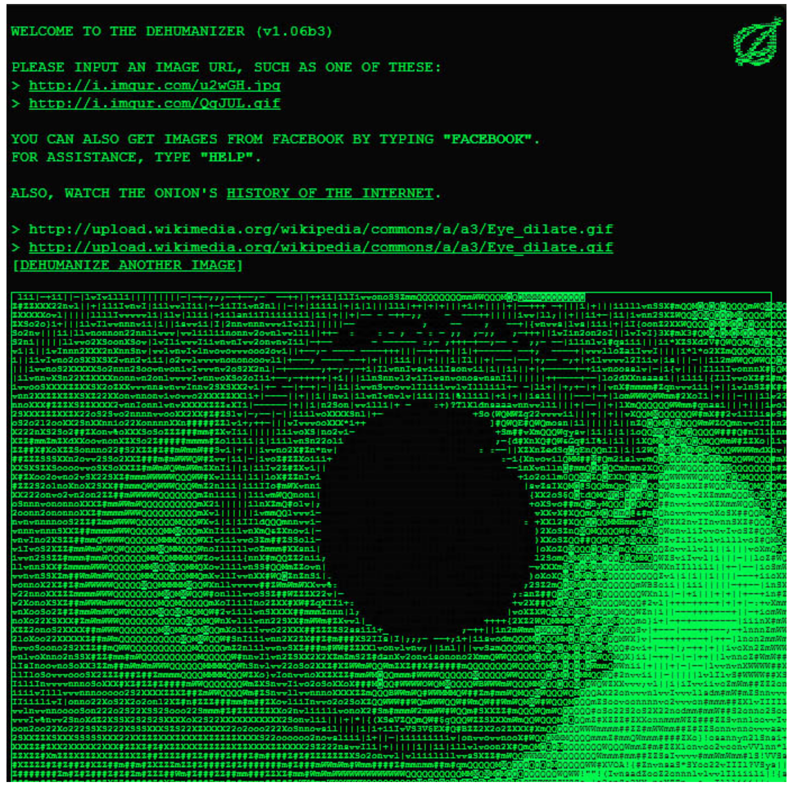

Figure 5.7: The Dehumanizer's rendering of a December 2006 image by Greyson Orlando of the human eye. From the public domain.

evidence that the image is still being depicted for ocular vision in some manner because image data must find its way to the cognitive process by way of ocular vision. Only when the data can be removed from a canvas or screen and exist in itself can we say that it is no longer bound to an ocular-based notion of sight.

One device that approaches this state of imaging is the thought-controlled headset, which does not render an image *for* cognition, but instead renders cognition *for* an image. Thought-controlled headsets provide an early example of how we might unlock and share imagination. Like many of the technical developments that this chapter examines, there are a number of variations of thought-controlled headsets that offer programs to "type" "draw" and "paint" to list just a few. The two are the Emotiv EEG and the g.tec intendiX. Like the comparison between mobile looking devices like the GoPro and the Liquid Image camera, these two devices are very similar in many ways, but their subtle differences can illustrate just how effectively they can work within and potentially exceed the boundaries of the human notion of sight.

Figure 5.8: (Left) Image of SQUID from *Strange Days,* (1995), Lightstorm Entertainment, rendered digitally for use by Adam Dean on January 12, 2013 in accordance with the *Report of the Ad Hoc Committee of the Society For Cinema Studies, "*Fair Usage Publication of Film Stills*."* (Right) Image of volunteer wearing Emotiv EEG, from Tan Le's July 2010 TEDGlobal presentation.

The Emotiv EEG is not too far from the SQUID imagined by the filmmakers behind *Strange Days* (Figure 5.8). It slips over the head without the

major impedance of conducting gels or caps, and of course it is not as invasive as Nicolelis' surgically connected BMI (brain-machine-interface) and BMBI (brain-machine-brain-interface) discussed in Chapter 2. The BMI and BMBI still serve as the basis for this kind of interface that intersects motor commands at the source: the brain. Nicolelis' experiments with Aurora, the rhesus monkey, involved a video game that Aurora controlled with a joystick and a separate mechanical arm that accessed, via software, Aurora's neurological motor commands associated with her hands on the joystick. Through training Aurora could control the game through the BMI, first by controlling a robotic arm by thinking in the same manner about the movements that she needed to implement in her own arm and hand with the joystick. The results showed that action potentials (the thinking in synaptic form) in the brain can indeed be liberated from the body and further, can be amplified and interpreted into robotic action.[134] The implications of this experiment put Nicolelis on a path toward universal displacement but the next step was clear: the link with the external motor function needs to be complete. Nicolelis wanted not only for the user to have the ability to command the action through cognition, but to *experience* the action. To have a sense of it would mean that the action should report back to the brain the outcome of the command. The need for *tactile feedback* gave way to the BMBI, which allows bidirectional communication between the brain and a virtual or otherwise foreign body. Through the BMBI Aurora no longer controlled a mysterious motorized arm in addition to her own, but instead could control the game directly. In the experiment Aurora "presses" buttons and receives tactile feedback that they've "been pressed," while sitting perfectly still.

[134] Nicolelis, *Beyond Boundaries*, "Freeing Aurora's Brain," pages 125-155.

The Emotiv EEG is based on the principle of the BMI and BMBI but it does not have the tactile feedback channel. Instead, it relies on visual or other sensory feedback to evaluate the degree of success of a cognitive command. In her 2010 presentation at the Oxford, England, TED conference, founder and CEO Tan Le starts by challenging the way that we give commands to machines. Tan says

> Up until now, our communication with machines has always been limited to conscious and direct forms. Whether it's something simple like turning on the lights with a switch or even as complex as programming robotics, we have always had to give a command to a machine or even a series of commands in order for it to do something for us.[135]

In the demonstration Tan brings to the stage a volunteer to execute a series of programming thought commands that will teach the Emotiv EEG how to read the volunteer's brainwaves and match them to specific tasks. The volunteer first imagines "pull" while looking at a floating box on the screen. The volunteer does this for a few seconds, then tests out the thought command again. The volunteer looks at the box and sure enough, it begins to come toward him as he is viewing it on the screen. Tan then asks the volunteer to imagine the box dissolving, and he does this for a few seconds so that the Emotiv EEG can read his brainwaves and associate their activity to that command. With a bit of practice over the next minute or so, we see the volunteer successfully link his imagination to the box—it disappears on the screen.

[135] Le, Tan. "A headest that reads your brainwaves." *TEDGlobal, Video Conference*. July 2010. http://www.ted.com/talks/tan_le_a_headset_that_reads_your_brainwaves.html (accessed December 17, 2012).

The Emotiv EEG is linked to three different programs so far, called Detection Suites. These detection suites are each designed to focus the EEG nodes on specific types of brain activity. The Expressiv Suite

> …uses the signals measured by the neuroheadset to interpret player facial expressions in real-time. When a user smiles, their avatar can mimic the expression even before they are aware of their own feelings. Artificial intelligence can now respond to users naturally, in ways only humans have been able to until now.

The Affectiv suite

> …monitors user emotional states in real-time. The Affectiv suite can be used to monitor user's state of mind. Gain true insight about how people respond and feel about material presented to them. Get real-time feedback on user enjoyment and engagement, or track fatigue and focus.

The Cognitiv suite

> …reads and interprets a user's conscious thoughts and intent. Users can manipulate virtual objects using only the power of their thought! For the first time, the fantasy of magic and supernatural power can be experienced.[136]

[136] Emotiv. *EEG Features.* Eveleigh, 2013.

The Detection Suites indicate that the Emotiv EEG software has a general understanding of brainwave behavior, allowing one suite to key in on brainwaves associated with motor commands while another keys in on those associated with different types of emotional reactions. While the descriptions of the Detection Suites might not make it clear, the Emotiv EEG really is not limited to these three directives. In itself it is a very powerful command module that can detect a wide range of commands given by the brain rather than by their motor output through the body. The software suites do not represent the limits of the headset, though the data streaming in from the headset is subject to the interpretation of the software. Tan shows a video of an EEG user who has programmed the headset to control, through facial expression, the movements of a motorized wheelchair. In the video example, the voiceover explains the commands as they are seen being educated. The user is told, and performs the following thought commands: "Now blink right to go right…now blink left to turn back left…now smile to go straight."[137] In Tan's demonstration video examples we do see users blinking and smiling, but if the thought-controlled headset works as it is theorized, the motor performance itself is not necessary. The Emotiv EEG is designed to read the command in the brain, not in the body, thus there are no nodes on the face to detect eye and mouth movement. Of course, it might not always be possible to think about blinking but resist the motor performance, as it is not merely "thinking about blinking," but the command "blink" to which the Emotiv EEG is designed to respond.

[137] Le, Tan. *A headest that reads your brainwaves.* July 2010.

The g.tec intendiX (figure 5.9) is not as consumer-oriented as the Emotiv EEG, costing quite a bit more and requiring a conductive gel and wired connections, but its primary role is as a more precise visual-response device.

The g.tec intendiX reads a specific type of electrical activity in the brain called the P300 event-related potential, which is a very distinct neural reflex associated with the visual cortex.

Figure 5.9: Image of the intendiX and accessories, from g.tec product catalog, accessed December 7, 2012.

Isolating the P300 event makes the intendiX a very effective thought-based word-processor. Chorost writes about his experience wearing an early version of the intendiX and being asked to “type” something on a screen at the 2008 Society for Neuroscience’s annual meeting. He writes

> …Okay: I would write my editor’s name...That meant I had to look at the A. It appeared to be flashing once or twice a second. Every time it lit up, I couldn’t help thinking, “A!” And since it lit up over and over again I found

> myself thinking, “A! A! A! A!” And then an *A* appeared on the output line.[138]

The g.tec intendiX probes for the P300 neural reflex and, by synchronizing that pulse with the blinking of a letter on the screen, can read the letter that the user is looking at and thinking about. If the user were to close their eyes, the synchronization would fail since the P300 pulse must refer to something that the intendiX’s EEG can read. The intendiX requires a digital correlation and the P300 pulse requires an ocular one. If, for instance, the user thinks about something abstract, or merely something not represented on screen, the intendiX can only refer to its pre-programmed lexica of flashing objects. The reference does not have to be a letter, but it does have to flash or in some way pulse in sync with the P300 neural reflex. If the user is thinking about zebras, perhaps the system could identify “Z,” but not the rich feelings and imagery contained in chemical and electrical neurotransmitters.

The g.tec and Emotiv headsets certainly advance the technology of Nicolelis’s BMI and make it accessible through non-invasive slip-on design and standard PC and Mac software for humans, and they also give hope to the notion of freeing the image from its display. If such EEG-based headsets can give a user the ability to export thought through an imaging program, then it is possible to unlock a vivid memory and re-create it on a display. With practice a quadriplegic could use it to paint, letting out what is captured in the mind’s eye. It remains to be seen if, then, that image could bypass the display and find an input channel so that the true vision could be shared

[138] Chorost, *World Wide Mind,* page 36.

without ever leaving cognition. The Emotiv and g.tec headsets require that the user make visual or other sensory contact with the results of the command to “see” the results, which leaves the Gulf of Evaluation the same as in any other case where we perform an activity directly (with our own body).[139] But Nicolelis’s BMBI integrates a second channel—the feedback loop—to send back to Aurora’s brain the results of her command. But a blind person could not use it to see, as this is the main thing the EEG asks of its user. As it stands the Emotiv and .gtec headsets are blind absolutely, requiring a human user to impart the visual feedback channel.

Beyond sight

The trust we have in visual feedback leads to advancements in ways of sharing imagination as it is output on a display. A number of display devices also seek to change the way we see things, rendering the image-on-display in three-dimensions with access to sharing features so that others can, in a way, see more of what a given moment held. MIT Media Lab’s Tangible Media Group came up with a device called *Second Surface,* which can augment the detail of a precise moment as it captured. *Second Surface* (Figure 5.10) is a camera-display hybrid, with one side capturing live view of the physical world and the other side rendering it on display digitally.

[139] Norman, The *Design of Everyday Things*, page 51.

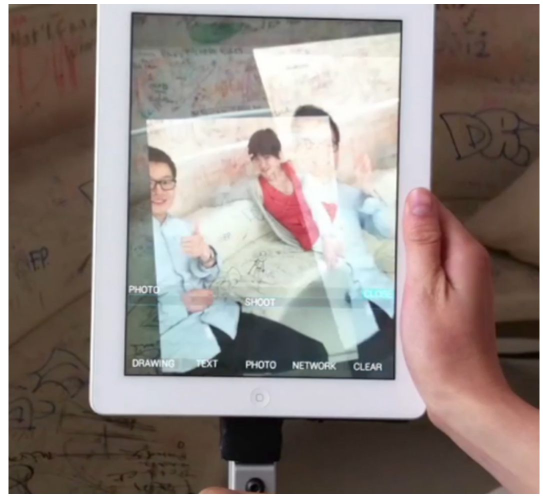

Figure 5.10: Image of *Second Surface*, video from Tangible Media Group, October 2012, used in accordance with Attribution-NonCommercial-NoDerivs 3.0 Unported.

Second Surface "allows users to place three dimensional drawings, texts, and photos relative to such objects and share this expression with any other person who uses the same software at the same spot."[140] *Second Surface* aims to capture visual experiences specific to environments, so as users approach the scene of another's image, they can interact, change and share these moments virtually without actually being in the same place at the same time. While this might not get closer to a goal of sharing and sharpening imagination without a display, its design group projects a dual visual reality that might look similar to Starner's digital-physical hybrid, but more integrated and based on a shared imagination imprinted digitally on the physical scene (Figure 5.11). To achieve it, the user would wear glasses that allow them to see the imprints from previous users that have visited the scene.

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[140] MIT Media Lab: Tangible Media Group. *Second Surface.* Valentin Heun, Austin S. Lee and Hiroshi Ishii Shunichi Kasahara. 2012. http://tangible.media.mit.edu/project/second-surface/ (accessed January 25, 2013).

We do not need imaging devices that can see like we do, but we do need them to see *more* than we do. This means not just improvements in the detection and measurement of light, but also in the pursuit of the invisible world. The invisible world is not only those things that are too small, too far away, or concealed from visible light, but also those things that are beyond our momentary attention. It is not enough to develop cameras that achieve a human notion of sight through their placement on mobile bodies or their ability to explore with us the far reaches of inhabitable terrain, just as it is not enough to view an image-on-display and equate it to a moment of whole-bodied experience. Such a false equation results in the fragmentation of the sensory experience through the interface. Consider again the two worlds that divide our attention and determine our immediate presence. Imaging devices that seek to alter our ability to see are designed as replacement, rather than augmentation. In using any camera to look, a user must sacrifice the nature of human sight entirely. The captured image is not indicative of the experience of seeing, and playing back the recording competes with that experience because it is an entirely separate perspective. The playing back of a moment as it is captured and on display is the pinnacle of the competing worlds. While the human user might have seen, heard,

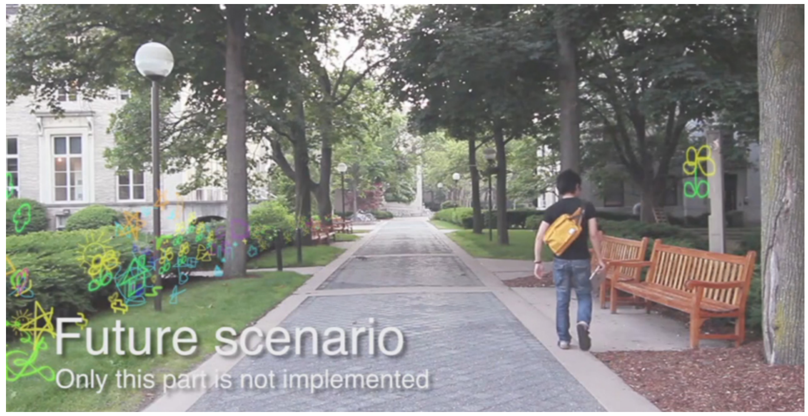

Figure 5.11: Image of *Second Surface*, video from Tangible Media Group, October 2012, used in accordance with Attribution-NonCommercial-NoDerivs 3.0 Unported.

felt and sensed wholly the moment captured by an imaging device, the playback of the moment captured by an imaging device can only blind the user to the whole-bodied experience that resides in the imagination. What is shared with others as the moment itself is that which is captured by the imaging device, not that which resides in the imagination.

Instead of sacrificing our human ability to experience the moment through our senses in favor of technically rendered images that serve as being there, future imaging device design must pursue a higher goal. A new kind of harmony is needed with the capturing mechanism rather than the image display. In re-aligning the human and technical notions of sight as complementary rather than competing, a more ambitious notion of sight and the eventual elimination of blindness can emerge. Our eyes provide for us a valuable connection to those things that reflect light, and Dasein embodies our imaginative process with an array of sensory data that eludes imaging devices entirely. By understanding that there is so much more that we should strive to see, we can develop models for imaging that enhance, rather than impede, our human notion of sight.

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