

A Screen Paradox

Tracing Digital Materialism As Conditioned by
the Screen

Bob Balm

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Author: Bob Balm

Student ID: 3218546

Teacher: Imar de Vries

Second Reader: Ann-Sophie Lehmann

Institution: Utrecht University

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Voor Opa, moge je rust vinden

Abstract

Situating itself as a critical amendment to an emerging viewpoint in media studies, that of digital materialism, this thesis seeks to address a lack of attention to the important role the screen as a display device plays in the material manifestation of digital phenomena. This role is postulated as a paradox, where on the one side the screen facilitates digital materialism, and limits that same digital materialism on the other. Each of this paradox' legs are then examined in separate chapters, to gain a better understanding of the screen's location in a modern mediascape. This understanding is necessary as the screen is the predominant medium for the digital to gain materiality. In order to further develop digital materialism as a theoretical viewpoint, then, the part the screen plays must be understood.

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Introduction

Screens are becoming more ubiquitous in our daily lives. We encounter screens, both static and mobile, in a large amount of spaces during our daily practices. When we wake up we may catch the news on television or computer; driving our car we follow our navigation systems to work; those who opt for public transport are confronted with digital timetables and information signs; at our office we browse through our digital agenda's and process our daily chores through computer screens; and all throughout the day we have our mobile smartphones to access personal information and browse the internet anywhere, at any time. This tendency towards an increase of screens present in our surroundings is not really something recent, nor is it theoretically unexplored terrain. What is striking, though, is the ongoing dominance of the screen in the development of new technologies. Despite technological fantasies and the mystification of the possibilities of the digital, the rectangular flat surface of the screen has been the prevalent, if indeed not the only mainstream method of displaying digital information since the dawn of the computer. Even before the digital age, the screens of television and classical cinema carried its shape, and we might even include traditional paintings and frescos in the list of cultural phenomena dominated by the characteristics of the screen. This fixation with the properties of the screen is not limited to

the realm of technological development, but extends into the fields of new media studies as well, up until today.

Some attempts have been made at breaching this dependence on the screen. One often cited work in screen discourse is that of Lev Manovich. In an essay originally written in the middle of the nineties, included in his work *The Language of New Media* (2001), Manovich offers a genealogy of the screen. From the classical screen, which in its simplest form is a “flat rectangular surface [...] intended for frontal viewing,” (p. 95) he traces screen development through dynamic screens, which include moving images, as in cinema; real-time screens, with content that refers to events occurring simultaneously in the physical world, such as military radar; and interactive screens, the ones we find on computers and which allow the user to interact with the computer’s hardware and memory. Manovich ends this genealogy with a look at the next step, which according to him is the arrival of Virtual Reality (VR). At the time of writing, VR was a prototypical technology at best, realized through cumbersome head mounted displays. He believed this technology would do away with the idea of a screen, ending the chapter with the almost ominous sounding line: “The screen had disappeared. It had completely taken over the visual field.” (p. 103) Yet here we are, almost two decades after Manovich’s original work was written, and the screen is still the most dominant display technology, with little evidence that this will change in the near future. Even Augmented Reality (AR), which can be considered a stepping stone towards VR, depends wholly on the use of a screen in order to be displayed. The flat rectangular surface is not that easy to circumvent, it seems.

This fascination with the screen stands in somewhat of a contrast with another vein of media studies. Traditionally, and especially in popular culture, the realm of the digital, the virtual, cyberspace, has been considered as separate from the real, the offline, the material – there are ample terms and juxtapositions. Popular culture is filled with references to this cyberspace, through movies like *Tron* or *The Matrix*, where the ‘real world’ has a digital counterpart made up of lines of code, bright neon colors, and is inhabited by digital entities like viruses and programs. New media studies, however, have come to consider the term virtual to be something more than just that world beyond our computer screens where zeroes and ones shape the landscape. Similarly, the relation between the digital and the non-digital has been

explored vigorously to the point where it is safe to state that there is more at play than a simple dichotomy of two worlds. Indeed, the view that one cannot simply separate the world into online and offline, digital and non-digital, virtual and real, is commonly accepted within this field of study, leading to the idea that digital phenomena are part of a single world that is predominantly material. We could call this view *digital materialism*.

When we take this view of inseparability as a given, we arrive upon the problem I want to study in this thesis. This problem appears when we consider the role the screen plays within the idea of digital materialism. From Renaissance painting via cinema to computer monitors, the screen has been described with metaphors such as ‘window to another world’, strengthening the belief that there are two different realms to speak of, with the screen as a membrane in between. Indeed, the use of the word screen in other contexts often implies a separation of two spaces, as in a windscreen that separates the interior of the car from the exterior, or a privacy screen in a dressing room. When we consider the screen’s physical properties and its functioning, we are faced with a plethora of features that strengthen the idea of the screen as a barrier or fence with two sides to it, as we shall see later on in this thesis.

It is accepted, then, that we cannot simply speak of a separate digital and non-digital world, but at the same time – and in the same broader field of study no less – this separation is held intact by the discourse surrounding the concept of screen. When we look at some of the often cited works in the field of new media with regards to screens, the window metaphor is still held in high regard. Anne Friedberg’s *The Virtual Window: From Alberti to Microsoft* (2006) for example, is an extensive work on the role of screens in the 20th century, as well as a look at the origins of the window metaphor in perspectival painting. Describing actual windows and their physical properties as a boundary between inside and outside, as well as the screen’s illusionary properties in early cinema, Friedberg seems intent on keeping the window metaphor, and its implied separation of two realms, intact. At the same time, works like *Digital Material: Tracing New Media in Everyday Life and Technology*, edited by Van den Boomen et al. (2010), attempt to breach this line of thought, focusing instead on the material anchoring of digital phenomena in a singular world. It is this discrepancy, namely the coexistence of two opposing theoretical standpoints in one broader theoretical view, which

lies at the basis of this research: In a discourse of digital materialism, the goal is to promote a singular world in which both digital and material phenomena take place, but that discourse is in part reliant upon screen theory, which in turn implies a separation of the two into separate realms.

Originally, in an attempt to resolve the issue, my intent with this essay was to find a different term; a new way of defining or understanding the concept of screen, which would take into account the theoretical standpoint that digital phenomena are as much part of a singular realm as non-digital, physical objects, and which would contain the properties needed to comply with this theoretical standpoint. After a thorough literary study however, I arrived upon the conclusion that finding such a solution borders on the impossible. The reason for this can be found in the fact that access to the digital – which according to our earlier postulation is in a way physically grounded, that is, not separated from a physical realm – takes place almost exclusively via screens, which in turn, as I said before, imply a separation. There is always something *behind* or *beyond* the screen. The screen forms a barrier, both as a theoretical concept and in the physical properties of the device, between the digital and the non-digital. We thus arrive at what seems to be a paradox.

This is of course not to imply that we should simply throw overboard the idea of a singular world in which the material and the digital cannot be divided. It does however necessitate a critical examination of the role screens play in this whole-yet-divided world, especially considering the ongoing ubiquity of screens in contemporary day-to-day life. So, rather than trying to offer a solution for the apparent incompatibility of screen discourse with the idea of digital materialism, I will study this incompatibility in itself in order to bring about a better understanding of it.

To do so, I have divided this essay into two chapters, each devoted to one part of the paradox. The first chapter deals with screens and the way they *afford* the digital to take up materiality. I will start with a brief examination of the idea of digital materialism. This viewpoint is explained in the introduction to the book mentioned before, *Digital Material: Tracing New Media in Everyday Life and Technology*, by Van den Boomen et al. Simply put, digital materialism is the idea that digital artifacts, events, phenomena and so on, have a material grounding. This does not necessarily imply that digital objects are physical or

tangible, but rather that they are incorporated in the physical world in several ways, such as being tied to a physical device – like music files on an mp3-player – or having an indexical relation to a physical environment – such as the digital maps and representations in a car’s navigation system. I will then examine how screens play their part in the materialization of digital phenomena. Such processes have been described in depth by Nanna Verhoeff in her work *Mobile Screens: The Visual Regime of Navigation*. Verhoeff examines, among other things, how navigation becomes part of constructing a reality through the use of screen devices such as smartphones, and how the presence of screens in urban environments affect the experience their inhabitants have.

The second chapter deals with how screens prevent the digital from taking up materiality. I will argue that this limitation occurs at three different levels: one between the screen and the digital data displayed on it, one between the screen and the body of the viewer, and one at the level of screen media history (and future), relating specifically to the dimensions and communicative conventions of displayed media. As part of this examination, I want to include an analysis of a previous work that I have done on High Dynamic Range (HDR) photography. This work shows the importance of the screen in the process of materially grounding digital artifacts, and at the same time demonstrates the problem with the necessary dependence on the screen’s physical properties. At the end of the second chapter, I will put the paradox into practical context with a look at what we can expect. As we will see, the screen’s physical limitations, as well as the standards it and its conceptual predecessors have set for the way in which media is generally consumed, play an important role in paving the way for future development in display technology. This look at the future will show that the regime of the screen does not seem to end for the time being.

Ultimately, my goal is to argue the need for a better understanding of the role the screen plays in the consumption of media and in critical thought about this consumption. This need flows forth from existing work on screens. These works are in my opinion either too limited to metaphorical descriptions of the screen, such as in Friedberg’s *The Virtual Window*, or lack concrete and detailed attention to the screen’s role in modern day manifestations of digital phenomena, such as Anna McCarthy’s research on screens in their specific physical environments, who, despite a similar plea and attempt to study the screen as a physical

device, still leaves certain physical aspects undescribed. This does not necessarily make these works badly written, but they do leave a gap to be filled. Friedberg sums it up nicely when she writes (in one of the few paragraphs which offer some attention to the role of the screen in a contemporary mediascape, as opposed to its history and its related metaphors):

“The changing technologies of ‘delivery’ alter the effects of moving images in ‘display.’ [...] Whatever form a [future screen] will take, we still need to ask questions about the altered and altering effects of screens that are mobile and fixed, that bring images and sounds in varied sizes and shapes, that permeate our spaces public and private, that sit on our desktops, in our living rooms, on our laps, or are hand-held, accompanying us on airplanes, in automobiles, to desert islands – with us here, there, everywhere.” (Friedberg 2006, p. 179-180)

It is the intent of this essay to do precisely that, question the “altered and altering effects” of the screen, departing from the juxtaposition of theories where the screen acts as a boundary on the one hand, and allows for merging on the other. The essay will not so much argue against digital materialism rather than provide a critical note to its basic ideas. I feel that digital materialism is indeed an inevitable theoretical direction, considering the mobile and connected world we live in, afforded by new media technologies of which the screen is one. But if we are to adopt a view of digital materialism, I feel it is necessary to take into account the – very important, I will argue – role of the screen in it. Its position on a scale of digital and material must be more clearly defined, in order to better understand the contemporary screen and our fascination with and dependence on it, as well as its part in a broader view of digital materialism.

Chapter 1: The Facilitating Screen

The purpose of this chapter is to gain a better understanding of digital materialism and its place within new media studies, and more specifically of the role of the screen within this somewhat recent vein of thought. Digital materialism is at the basis a viewpoint that goes against what Van den Boomen et al. call *digital mysticism* (Van den Boomen et al. 2010, p. 8). They explain this latter term as the ascription of almost magical powers to new media, a practice popular at the dawn of new media studies, when terms such as hyperlink and cyberspace were dominant in the discourse surrounding computers and the internet. It is still quite common in contemporary popular culture. We only have to recall the late *Apple* CEO Steve Jobs in his presentation of the original iPad – a device that is “incredible”, “amazing” and “terrific” despite introducing practically no substantial technological innovation – to see this mysticism at work today. As new media technologies became more commonly used, areas of new media studies began to shift their focus from this mysticism to the tracing of new media in everyday life. As Van den Boomen et al. write: “New media were no longer

considered as being ‘out there’ but rather as being ‘here and amongst us’” (p. 9). It is here that the materialism of the digital surfaces: it does not necessarily mean that digital phenomena gain materiality – that is, they are not directly tangible – but it implies a grounding of these phenomena in the realm of the material. Digital phenomena, over the years, have become more and more linked, so to say, with material objects and practices. Because of this, Van Den Boomen et al. argue, they can no longer be viewed as “floating as a metaphysical substance in virtual space” (ibid).

The commercial market today is filled with devices that provide this material grounding of digital objects: smartphones, mp3 players, digital cameras, and so on. These devices are collectively called *small tech* by Hawk et al. (2008). To characterize the digital materiality of these devices, Hawk et al. make use of the concept of *weightless economics*. This field in economic studies deals with the value of goods which are not physical, and thus carry no weight. Within it, a shift has taken place over the course of the twentieth century: while a nation’s economic value at the end of World War II was measured predominantly in material mass and property, the digital age introduced products and devices with a large economic value but whose material size is small. Hawk et al. bring up the example of the United States, whose economic value has tripled since World War II, but whose material weight remains the same. The value of these small tech devices, then, stems not from their physical mass, but from elsewhere, and that elsewhere lies in the digital realm. More specifically, this value is located in the force with which digital phenomena and practices affect material reality through these devices. This affection is a demonstration of what Van den Boomen et al. call the *in-materiality* of digital phenomena; their link to or placement inside material reality, without becoming physically tangible – not really material, but not immaterial either.

Parallel to digital phenomena gaining materiality is a movement in the opposite direction; the movement of existing media and their related practices towards the digital. This can be understood both very specifically and direct – as in paper books that are also available as e-books, or the transition from the traditional vinyl records to cd’s and later digital mp3 files – and on a larger more abstract scale, such as that of communication processes within organizations, or the process of navigation using digitally generated maps. These developments are part of a movement that has been called *virtualization* by Pierre Lévy. The

use of the word virtual here should not be mistaken for its common use to indicate a type of cyberspace, as in virtual reality. Rather, virtualization is a broader movement that takes place not just within the realm of new media (Lévy 1998, p. 15). To try and define the virtual in a few quick words is to do injustice to the depth and history of the term, but for the sake of brevity, a short definition by Lévy will have to suffice: “the virtual is [...] the knot of tendencies or forces that accompanies a situation, event, object, or entity” (p. 24). Lévy puts this into context using an example that is also relevant for the argument at hand; consider a contemporary company. Traditionally, companies were confined to a single office, with each employee having his own set place and time of work. This is the solution to the problematic of the work process. It puts into place several measures that allow the work to be carried out efficiently. The rise of telecommuting and working from home is an example of virtualization, as this “[transforms] the spatiotemporal coordinates of work into a continuously renewed problem rather than a stable solution.” (p. 26) The primary factors of such a work environment are now coordination, resource sharing and location planning, rather than the work being performed at a physical office. As Lévy says, “the virtual corporation can no longer be precisely located.” (p. 27) These are rules of a society moving towards a state of virtuality, afforded by the use of connected digital devices.

This process of virtualization constitutes *deterritorialization*. This too can be traced in very specific sites, such as hypertexts on webpages. When we ask the question where in space and time these texts are located, we have to consider factors such as the location of each individual webpage on servers, the path its readers decide to take via the various hyperlinks, the computers from which the webpages are accessed, and so on. And again, the same is true for larger scale phenomena, such as the example of the virtual company I just mentioned. With its employees spread across different spaces and working at various and inconsistent times, the entity of the company cannot be specifically located. However, despite “not being associated with any ‘there’,” (p. 28) as Lévy puts it, both the webpage and the virtual company exist – that is to say, they are very real entities that we can talk about and that exert their force on social reality. This exertion of force by digital phenomena is what lies at the basis of digital materialism, although Van den Boomen et al. warn against viewing the digital as “real and material in effect, not in fact” (Van den Boomen et al. 2010, p. 9), for this view still assumes an immaterial realm as separate from the material. The question is,

though, whether we can surpass this distinction. My answer to this question is not a definitive no, but rather that it is a very complex problem, a paradox even, with which we are faced. On the one hand, we must acknowledge, like Van den Boomen et al., that digital phenomena in contemporary society have a material grounding, as we shall see. But on the other hand, this acknowledgement is problematized when we consider the medium that constitutes this grounding.

For at the point where these two movements – the digital becoming material in one direction, and the virtualization of reality in the other – cross, we find the screen. Professed the ‘window to another world’ by so many of its researchers, theorists and admirers, it stands as the sole point of access to digital phenomena, at the same time a gate to pass through, and a gatekeeper, for its hardware is in part responsible for the manner and quality of display. The screen both frames and makes visible. Before allowing us to interact with digital data, it allows us to see it. This is an important realization, one that becomes apparent when we consider the small tech of Hawk et al. It is a challenge indeed to think of a device that carries *visible* digital information without a screen to make it so. Even data carriers, such as hard disks or USB drives, although they may not directly carry a display, are very dependent on the existence of the screen. What else could we call a hard drive but a *brick*, if we did not have the screen to view its data with? It can hardly be seen as a coincidence that this has become the term of choice for a piece of hardware whose software has become so corrupt or flawed that it can no longer be properly executed and thus displayed. The digital data stored within small tech devices need the screen to become visible. Arguably, they need the screen in order to exist at all. It is a matter of actualization, to speak with Lévy; digital data, through the screen, momentarily ‘take place’ in a particular solution of user, display device and purpose, before returning to their state of virtuality.

Screens thus play a paramount role in the materialization of the digital, one that we *must* consider if we are to accept a view of digital materialism. A screen grounds digital data in a material space, thereby also constructing that space. This necessitates a view of the screen as a physical object occupying a physical place in the material world. When considering this place in the material world, I want to propose three categories of screen, three different articulations of the device taking place in contemporary society. First, there is what I want to

call the home screen; screens in and around the house or office. These screens tend to be viewed by the same group of people in a more or less static environment, mostly with specific intent and for a predetermined amount of time. The second screen category is that of the urban screen; screens present in city landscapes, in transitory places of travel, like public transport hubs, malls and squares. These screens are present in, and at the same time generate, a constantly transforming environment, as I will argue. The final category is that of the mobile screen; personal devices that the majority of people within Western society carry with them wherever they go, in the form of mobile phones and tablet computers. These screens are portable and mobile, adding a third type of digital materialism.

The choice for these three specific categories is not motivated by a belief that screens are limited to only one of them at a time. Rather, I want to stress that modern day screens can display qualities of each of the categories, or indeed, that they are at times a culmination of some, or all three. Instead, the division between home, urban and mobile screen is based on the structure of the argument I want to make in this chapter. With each category, I discuss what I believe to be one of the core aspects of the screen in the modern mediascape. This tracing starts relatively simple and physically close to the device itself with the home screen, in one specific environment. It then expands outward when considering the urban screen, taking into account the complexity generated by the variety of environments and audiences in relation to which the screen can be positioned. Finally, it incorporates the mobility of the screen within and between such environments and audiences, the stage of the argument that is most complex because it takes into account itself and its two predecessors. The categorization then serves as an argumentative guideline. As a side note, the categories can also be viewed as somewhat historical, although they are not specifically chosen for this property: earlier manifestations of the screen, such as the cinema and television, are limited to the properties of the home screen; the urban screen becomes applicable as a category at the time when the screen started to appear into transitory public spaces; and most recently, with the arrival of mobile phones and other such portable devices, screens became mobile, justifying the final category. Thus the current screen can, and often will, be a culmination of the three categories, both as a physical device and with regards to its theoretical conceptualization.

The Home Screen

The prime example of the first category, the home screen, is the television. While the television's analogue signal has been replaced with a digital one only recently, it is still a screen, and one that demonstrates a series of very powerful aspects and practices when it comes to materialization. Traditionally, theories surrounding this medium have been discussing its almost magical powers of binding different spaces together, collapsing space and time onto themselves to bring the viewer images from across the world instantaneously into their living room. But these theories often forget to take into account the television set as a material object. As Anna McCarthy writes: "[Rather] than focusing solely on the immateriality of the television image, as terms like "placelessness" and "derealization" encourage, a television theory must also take into account the very material *thingness* of television technology (paradigmatically, the console itself.)" (McCarthy 2001, p. 96) She encourages researchers of the television to consider its banal physical aspects, such as the choice of its particular placement as a piece of furniture within the living room, or various decorations that people put on or around it. Such examinations of the television's position in the modern home have been conducted by Cecilia Tichi, who embeds the arrival of the television set at the homes of America in a tradition of family values and a sense of 'togetherness' around the hearth. She analyses advertisements for television sets from the fifties and sixties, which ascribe to the television the qualities of a fireplace, such as 'crackling' to describe its operating sound, and 'warm glow' as the image radiance. On the way the television set reconfigures the living room, she writes:

"Popular visual images of the early 1950s capture the nuclear family gathered to watch *Kukla, Fran and Ollie* in their living room, forming a semicircle of mom and dad, son and daughter, the boy "roughing it" on the rug, though the whole family is well groomed and respectable, and prosperous in middle-class terms. [...] Their profiles tell us of their attention and satisfaction, and in fact this TV hearth would lose its meaning were the family to be absent from the picture. The human figures say that the new cathode tube hearth brings the family together in a scene of harmony and affection." (Tichi 1991, p. 50)

The placement of the television set at the former locale of the hearth, not just as a meaning or concept, but also physically occupying the same place, shows the constructive effects of the

screen. It reconfigures the living room and the people in it around itself, constituting a material reality that is brought into existence by the contents of the screen. A similar tracing of the materiality of new media technologies is performed by Rick Dolphijn. He distinguishes three household revolutions that each increase the “organizational skills of media power in terms of its spatial consequences and in how the human being functions in it.” (Dolphijn 2007, p. 143) Like Tichi, Dolphijn starts with the television. It moved the center of the household from the kitchen table, where family members discussed among themselves, to the living room, where all bodies were positioned around, and faces were directed at, the screen of the television. This revolution is followed by that of the personal computer, whose screen addresses an individual, rather than all members of a household at once. The computer’s applications and related practices also dictate the device being placed remotely, separated from family life, in a study room or tucked away in a corner. Finally, the third revolution comes with mobile communication devices, whose reorganization of the material deserves more specific attention, which I will offer further on in this chapter.

To aid researchers like Tichi and Dolphijn in their examination of the television as physical object, McCarthy identifies three aspects of television’s materiality that lead to new ways of thinking about the idea of space, particularly the space affected by the television’s physical presence (McCarthy, p. 98). Each of these aspects can be applied to screens in general, depending on their displayed content. The first is television’s ability to tie two spaces together; that of the living room and of the studio, to name an example from television’s collection of program types. According to McCarthy, this takes place on two scales. First, there is the local variety where television’s viewers feel part of the same space as the content displayed on screen, through the direct address by for example a television show’s host. On a larger scale, this is the sense of national togetherness, for example when televisions around the nation tune in to an important match played by a national sports team. This space-binding, as McCarthy calls it, as a property of television as a concept (‘vision’ that is ‘tele’), is well documented – and quite lamented – by Paul Virilio. In his work *Lost Dimension* he writes:

“Thanks to satellites, the cathode-ray window brings to each viewer the light of another day and the presence of the antipodal place. If space is that which keeps

everything from occupying the same place, this abrupt confinement brings absolutely everything precisely to that “place,” that location that has no location. The exhaustion of physical, or natural, relief and of temporal distances telescopes all localization and all position. As with live televised events, the places become interchangeable at will.”(Virilio 1991, p. 17-8)

Virilio’s fascination with the space-time collapse of the televised image is echoed in another of McCarthy’s aspects of television’s material relation to space – that of its *dematerialization*, understood as a disengagement from physical reality. She argues that the television makes distance invisible, emphasizing that this is different from bridging it. The distance is still there, but it is unperceivable. It is enclosed within the (tele)visual image, implied by it. This begs the question of where the image is located, “here, there, or anywhere?” (McCarthy, p. 100) McCarthy concludes that television “becomes a thing that [...] takes place and not a thing that makes a place, or a thing that is made *by* a place.” (ibid, emphasis in original) This reminds us of the virtual momentarily becoming actual, and thus taking place, that we saw with Lévy. Here we also see the virtual knot of tendencies: the television as a physical device, the content that is displayed as an electronic (digital) signal, the locale of that which is depicted, the environment where the television is located, the spectator(s) and all their thoughts and feelings, et cetera. All these virtualities collide and collapse into a single actualization that constitutes the ‘taking place’ of which McCarthy speaks.

The Urban Screen

This single constituting actualization is also the bridge to the last of McCarthy’s aspects, namely the screen as a *site-specific* medium. With this aspect, we enter the second screen category, that of the urban screen. If we are to consider each specific screen as a different actualization of several virtuals, then we must also take into account that each of these screens is located in a different environment, and that environment will not always be limited to the familiar living room setup of the television set or the study of the computer. On the contrary, screens are rapidly taking over the places beyond the walls of our house, the cityscape; as McCarthy writes, they can be “giant video walls and video banks, flat screens that look like illuminated signs, small and large consoles, and all sorts of signal forms, from live transmissions to prerecorded program cycles, to simultaneous mixtures of both.” (p. 99) Indeed, the screen is a very malleable medium: it can retain its basic properties

and proportions, yet it can be located in a plethora of different spaces – McCarthy sketches a cab ride through Times Square, New York, which is filled with a great variety of screens all serving a different purpose – and each screen constructs and affects its respective space differently. Precisely because of this, McCarthy argues, it is important for theorists to go beyond an idealist notion of the television as a screen in the home:

“[A]lthough the home may be economically central to the broadcast television apparatus, this does not mean that critics should accept the pervasive ideological association of television with the domicile as an adequate representation of the actual geography of the medium. When we take the diverse proliferation of material forms and places of television into account, the medium starts to look very different. It becomes impossible to argue that the TV set always organizes relations between, say, public and private, subjects and collectivities, participation and isolation, in identical ways across locations.” (p. 99)

I want to take up this gauntlet and turn now to this different form of the screen, one that we may call the urban screen; screens present in public, often outdoor spaces that tend to be transitory in nature. These screens and the places they reside in have been studied extensively by Nanna Verhoeff in her book *Mobile Screens: The Visual Regime of Navigation* (2012). She uses a term conceptualized by Marc Augé to define these transitory spaces as *non-places*. Examples of such non-places are airports, railway stations, hotel lounges, malls, and so on. They are characterized by a lack of a clearly defined place that they occupy. Rather, they form the connection between other places, a sort of no man’s land that we have to travel through in order to reach another place. There is also a temporal aspect to them, in that they have no permanent residents. People only remain in them for a short while, thereby temporarily constituting the space before leaving it again. Verhoeff adds her own term to the definition of these places, to incorporate this temporal and temporary aspect: *non-times*. (Verhoeff 2012, p. 101) Resembling the actualization of the virtual discussed before, this temporary specificity is equally characterized by movement, of the space’s temporary inhabitants, and, through these inhabitants moving in and out of it, of the space itself. It is in this temporal/temporary configuration of environment, traveler and media that urban

screens have, as Verhoeff calls it, a *spacecificity*. Verhoeff takes Schiphol airport as an example of a non-place where screens exert their materiality:

“Passing the screens of customs and security, at every turn there is a screen telling which flight takes off from which gate, at what time one needs to report for boarding, while the time it takes to walk there is indicated on other screens. Taken together, all these elements cohere in the *visual regime of navigation* so typical for non-places of transit: while each element in a composite dispositif has its own function, they also work together.” (p. 105, emphasis mine)

Echoing the title of Verhoeff’s book, the term ‘visual regime of navigation’ demonstrates the power exerted by these screens; a sense of control over the travelers, herding them to their destinations which are prescribed by the airport logistic system. When viewed on its own, these screens are relatively simple; a display of information for the onlooker. But viewed as parts of a bigger whole these screens truly demonstrate the relation between the (digital) contents displayed on a screen, and the material world around the screen. Verhoeff defines this bigger whole as *screenspace*, and locates the specificity of the screen within it, comparing the screens to parts of a big machine working together to constitute the screenspace. Next to this influence exerted over the environment and travelers of the non-space by the digital, which is a movement from the digital to the material, the opposite is at work as well, like I discussed in the introduction to this chapter. An act of virtualization, which is a movement in the other direction – from the material to the digital – equally takes place. This is clearly demonstrated when we look at the example of Schiphol airport. The process of people finding their way around an airport has been virtualized, such that if we take the screen out of the equation that is the non-space of the airport, the process falls apart. As Verhoeff describes, without the information on the screens to control and inform the travelers, “the schedule collapses, air traffic is halted, and travelers are sleeping on their suitcases, utterly frustrated, and desperate to go home.” (p.106) What this example demonstrates is a sort of mutual reliance; the digital needs the material in order to give it meaning and relevance, and the material has come to rely on the digital to regulate such complex processes as an airport infrastructure. At the very least, it demonstrates the double movement I started this chapter with.

Much like with the screen in the living room, a dematerialization is at work in the domain of urban screens as well. This dematerialization is located in the transformation of formerly static architecture, such as building façades, into dynamic display surfaces that cause the spectator to forget he is looking *at* a screen. Rather, the spectator becomes preoccupied with the experience of its contents. These larger screens too, like the screens regulating Schiphol airport, operate together with the environment and spectators within it as a composite dispositif. We can measure the force with which these screens affect material reality by looking at their contents and uses. Verhoeff mentions the KPN communications tower in Rotterdam (p. 108-9). One prominently visible side of this skyscraper is decorated with a LED screen upon which pixels display various Space Invader-like animations. While this display is visible across a large part of the city and riverbank, the sense of dematerialization is relatively low. After all, once the initial spectacular experience wears off, the simplicity of the animations makes the realization that one is looking at a solid screen surface mounted on the side of a building come quickly. This becomes slightly different when we consider other examples. McCarthy names one, a video installation called *Rio Videowall*, located in an Atlanta shopping mall. In an attempt to demonstrate the “destruction of an ontological sense of place,” (McCarthy, p. 106) this installation featured twenty-five screens showing live footage from the local CNN channel, a display much like we know from rows of television sets in electronics stores. Every time a shopper passed in front of special video cameras scattered across the mall, their silhouette would appear overlaid on the CNN footage, acting as a cutout through which the site of the mall before it was built – grassland with trees – became visible. This installation shows more interaction between the digital and the material through the screen than the KPN communications tower. A more recent example that shows a very high degree of blending of the digital and the material, is that of another display in a shopping mall. In November of 2011, National Geographic and UPC started an augmented reality tour around shopping malls in Europe, involving a big screen placed at a central location in the mall that showed a camera feed of the area in front of it. On the floor was a pad that spectators could stand on, triggering various digital models of animals to walk into the digital representation of the area on the screen, and interact with the spectators. People could pet a cheetah or have a dolphin jump out of the ‘water’ towards their raised hand. The immediate constituting effect this on-screen display has on the physical environment

surrounding it becomes clear when we look at a video report of the event.¹ Not only are the screen's users performing all kinds of physical gestures to interact with the digital animals, but we see people in the immediate vicinity turn their heads in amazement, point at and talk about the screen with their fellow shoppers, and take out cameras to take pictures. Indeed, the transitory non-place of the mall temporarily transforms into a specific screenspace where the digital and material blend into each other, for as long as its occupants choose to interact with the screen.

The examples mentioned above all relate more or less to the contents of the screen; their materiality is largely a direct consequence of the screen's content and function within their specific environment. Such analysis answers to McCarthy's challenge of looking at the screens themselves as site-specific media. Zlatan Krajina (2009) acknowledges McCarthy's focus on screens in their specificity, but extends on this idea by expanding the field of study to some consequences which are not a direct result of a screen's function or content. To demonstrate this, Krajina looks at a LED display screen located on the side of a building on the Old Street roundabout in London. This screen displays news and weather reports alternated with advertisement stills. Its location was chosen strategically because of the big exposure, and its function is much like the other urban screens that I have described so far; it informs its spectators in one way or another. Additionally, however, there is a set of indirect consequences of the screen's position and physical properties. As Krajina describes:

"In the afternoon, the setting sun hits the surface directly, which makes it hard to read off the messages projected. [...] In the early morning, the rising sun shines from behind the screen so brightly that it causes passers-by to turn their heads away. The rain, on the other hand necessitates using umbrellas, which cover not only the atmospheric, but also luminous spillage from above the head. In the evening, the screen sheds light on the pavement so that it secures a well lit place which friends use to meet at nights out. [T]he site remains relatively open to the situational poetics of circumstance: looking at the screen to avoid eyesight of others, leaning on the fence while waiting on someone, etc." (Krajina 2009, p. 411)

¹See <<http://vimeo.com/31479392>> for a video of the National Geographic display in action.

As we can see, these consequences of the screen have practically nothing to do with what is displayed on the screen, and all the more with its physical aspects, such as the direction of the wall it is mounted on, the light emitted by it at nighttime, and the openness of the area around it. With this observation, Krajina pleads for the consideration of the “‘*environmental character*’ of urban screens” (p. 412). The combination of this viewpoint and earlier discussion about screens’ constitution of screenspace can be considered a prime example of Marshall McLuhan’s environmental thesis. The core of this thesis is that new media, through their presence in our lives, become imperceptible, and through this, part of our everyday environment. As McLuhan writes: “Environments are not passive wrappings, but are, rather, active processes which are invisible. The groundrules, pervasive structure, and over-all patterns of environments elude easy perception.” (McLuhan and Fiore 1967, p. 68) This is probably true for the screen on the Old Street roundabout; passers-by may consciously see the contents of the screen, but the presence of the device itself is not immediately noteworthy to them. As we have seen, this does not mean that the screen simply disappears, because its physical presence has a very constitutive effect on the immediate environment. Martin Lister et al. refer to this effect as “the elevation of the media above the message” (Lister et al. 2003, p. 89, cited in Krajina, p. 413); the urban screen’s effect exceeds beyond just the perception of contents displayed on it. Of course, if we are to consider the urban screen in this way, we have to take into account the possibly technological deterministic implication it carries. Krajina rightly warns against ascribing too much agency to the screen, as if the screen alone is responsible for the mentioned changes in its environment. Indeed, when we consider such displays as the National Geographic AR installation we discussed earlier, it is clear that there is an intricate relationship at work between user and screen (and environment). Nothing happens on the screen if the user doesn’t step on the platform or makes no gestures. The user is constituent of the screenspace as much as the screen is.

The Mobile Screen

After the home and urban screen, we now move to the third screen category, that of the mobile screen. This category, like the urban screen, expands upon its predecessor: the mobile screen partly constructs its surrounding physical reality, like the home screen; the manner of this construction is highly site specific, like the urban screen; and the portability and mobility of the screen add to the multiplicity of this screen’s uses. I want to stress the difference

between portability and mobility here. In my definition of the terms, portability means a screen can be transported to different locations. Mobility implies using the screen *while* it is being transported. For a screen to fall in this third category, it needs to be both portable and mobile. A laptop computer, for example, does not fall into this category. It is portable, in a sense of 'setting up shop'. We bring it to a specific place, so we can work there. But it is not mobile; we do not generally operate laptops while walking around, let alone use software on it that utilizes or even requires doing so. Truly mobile screens, then, are those found on the devices defined by Hawk et al. as *small tech*; mobile phones, digital cameras, navigation systems. Indeed, the most recent incarnations of these devices consist almost entirely of screen display surface, such as modern smartphones and tablet computers, utilizing touch screen technology for operation.

What makes mobile screens interesting and theoretically complex, is the large amount of uses for the devices they are attached to. Specifically smartphones and tablet computers often allow many different applications to run on them, each tailored to specific purposes, situations and environments. This variation of applications – both in the sense of software and uses – implies that the (site) specificity of these devices is highly dynamic and constantly transforming. Considering each of these screen uses as a singular site specific incarnation of a screen, as McCarthy pleaded, would be bordering on the impossible. To cope with this theoretical complexity, a framework that takes into account this plethora of applications is required. Verhoeff offers such a framework in her definition of these mobile screen devices as *theoretical consoles*. Recognizing the need to study such devices in their specificity, she acknowledges the shortcomings of a method that looks at each of its uses as a specific theoretical object. The dynamic of the mobile screen device is simply too complex for such an approach. Instead, Verhoeff defines devices such as smartphones and tablets, which she refers to as gadgets, as theoretical consoles: “objects that raise *theoretical and historical* questions, precisely, about their inherently temporary and hybrid status” (Verhoeff 2012, p. 73, emphasis mine). The theoretical questioning of the properties of these gadgets lies in the convergence of not just many different applications, but many different (screen) theories concerning these applications. Its historicity is found in the fact that many of these applications are not necessarily new individually; we have seen them individually before, but in their combination on a singular device do we find their newness. An example of this is

a typical smartphone's ability to play video files. We have seen this technology before on older screens, so in itself it is nothing new. But in its combination with mobile technology, networked communication such as the ability to share the video with friends, and so on, we find a new application of this older technology. This dual approach – theoretical and historical – is the merit of a theoretical console approach to studying a gadget – or, in our case, a mobile screen:

“The issue is not that different technologies join in one appliance [...] but that a singular constellation of technologies emerges in one console. This mixture offers a platform – console – for a whole array of possibilities for the gadget's applications. It is not a singular medium; it is, rather, a composite convergence of screen paradigms within a singular dispositive. Therefore, the features of the screen that both *converge* and *transform* in this apparatus bind synchrony to diachrony, and thus embody its status as theoretical console.”(p. 81-2)

With this method of studying mobile screens in mind, let us now turn to a specific example of a theoretical console, namely the Apple *iPhone*. Launched in June 2007, the iPhone was one of the first commercially successful smartphones. In its basic use, a smartphone is a phone with a connection to the internet, but the app-based structure of the iPhone's operating system has spawned a mass of other uses for the device. Simply put, any action taken on the iPhone is done through an app, represented by a small icon displayed on the device's main menu, the home screen. Users can download apps or create their own for a variety of uses, leading to apps used to tune guitars, store cookbook recipes, identifying plants in the garden using the camera feature, finding nearby restaurants, and much more. Clearly, then, by all accounts the iPhone can be described as a theoretical console, as principles – and thus relevant theories – of all kinds of technology, of the older kind re-appropriated in a mobile device, and newer ones afforded by the iPhone's hardware features such as the gyroscope², are found within one device. What is also interesting about the iPhone, is that its screen encompasses the majority of the device. There are only a few buttons, to change the volume

² The iPhone's gyroscope measures the device's orientation in physical space, and determines the representation of on-screen information relative to this orientation. For example, if the device is held horizontally and slightly angled, the gyroscope will tell the operating system to turn the screen into landscape mode (as opposed to portrait mode). The gyroscope's information is used by other apps as well, such as digital adaptations of the traditional game of rolling a small metal ball through a maze.

and to access the main menu, and they are hidden on the side or blended in with the front panel. The majority of the interaction with the device happens via the (touch)screen, to a point where holding the iPhone practically means holding a mobile screen, nothing else.

With the iPhone as our case study, let us look at a first theoretical implication of this mobile category of screen, that of its physical relationship with the user. This aspect has been studied thoroughly by Heidi Rae Cooley. In her 2004 essay *It's All About the Fit*, she examines the connection between users and their so-called *mobile screenic devices*, or MSD's. Through the operation of these devices, she argues, "vision is activated by the hand and its engagement with a MSD: seeing becomes tactile and, therefore, is no longer limited to the eyes." (Cooley 2004, p. 137) Cooley expresses this activation of vision by the hand as the *fit*, which is based on the design principles of MSD devices and how these govern, to some degree, the use of the device. In this fit, which she qualifies as an event that occurs when hand and device meet, rather than a quality of either, the hand and MSD become one. This becoming-one "produces a 'mystical feel' that arises out of a 'combination of a good mechanical marriage and something in the nervous system.'" (p. 139) In this description, we are reminded of McLuhan's extension thesis, where a medium, through its use, expands and alters the bodily function used to operate it (McLuhan 1964, p. 3-6). In this case, the MSD extends not just the use of the hand – as a tool to manipulate digital information displayed on the MSD – but also the eye, giving it 'tactile vision'. Cooley explains how this relation between hand and MSD extends beyond the screen, stating that the screen in this case is not a window that users look *through*, but indeed, a screen that users look *at*. From this follows that the user is not distanced from that which is seen, as would be the case with 'window-ed seeing', but is drawn toward the displayed imagery, putting the focus on experiencing that which is seen, something Cooley calls 'screenic seeing' (p. 143). Screenic seeing has consequences for that which is displayed as well. Cooley rightly argues that the objects on the screen do not exist separate from the screen. Rather, they converge with it. Here, she traces a material contingency of the screen's contents; because of the fit, the hand enters into interaction with the screen, and thus its displayed imagery, giving materiality to the displayed contents. This is indeed true if we look at the iPhone, whose touch screen allows for a very direct interaction with the displayed content. This screenic seeing is also marked by a 'liberation' of the eyes from the MSD's screen. The eyes can join in on the screenic

interaction, but are at the same time free to take in the environment. We see this principle at work in the use of the iPhone for such purposes as photography, navigation or the use of augmented reality applications; these applications require the user to constantly acquire information from either the environment or the phone, and to match that information with the other. A “material experience of vision” (p. 145) is created where the user, the screen, the hand and the environment cooperate in the establishment of a specific screenspace.

We come upon the truly mobile aspect of these screens when we consider the iPhone’s navigational tools. The iPhone’s app-based structure reconfigures the somewhat traditional division between author and consumer when it comes to imagery. As Verhoeff argues, with the phone’s camera, navigation system and network communication capabilities, the user becomes maker, transmitter and receiver of images all at once, turning the process of navigation using a device like the iPhone into a performative act. This act of navigation generates what Verhoeff calls a ‘navigational complex’ (Verhoeff, p. 138). This navigational complex is characterized first by a directional element: the user wants to move from point A to point B, utilizing the mobile screen to find the way. Secondly, there is a constructive aspect: through the user’s constant switching between what’s displayed on the iPhone’s screen and his surroundings, matching the state of the one with the other and vice versa, the user is not just traversing a space, but also constantly generating that (screen)space. As Verhoeff writes: “we see how we move, while how we move enables vision” (p. 153).

Verhoeff separates this ongoing process into three layers of interface. She starts with the level of the internal (digital) data; in case of the iPhone, this is the operating system and the software making use of navigational information. The next level is that of the navigation system. This includes the internal tools such as the accelerometer and gyroscope which tell the iPhone its speed and orientation, as well as a GPS system that uses global coordinates to ‘place’ the iPhone in the world. Lastly, the user interaction level allows the user to receive and act upon the information generated by combination of the first two levels (p. 150-2). These levels are not placed in hierarchy, but can be placed in a loop (see figure 1). The route from user via user interaction and software & operating system to the navigation system is two-way, one direction for input and the other for output. Meanwhile, the navigation system calculates the device’s, and hence the user’s position, which involves ‘taking’ data from the

user. The screenspace is generated by all these levels, but takes its perceivable form around the User Interaction and User levels.

At this point, this schematic is incomplete. It lacks a consideration of another important feature of the iPhone as a mobile screen: its operation as a networked communication device. The generation of screenspace is expanded upon when we consider the plethora of different navigational software, that is, various applications that interact with the physical

environment of the iPhone's user in all manner of ways. Next to traditional navigation tools intended to help someone find the way from one place to another, we find applications such as *Foursquare* or *Gowalla*, allowing the user to 'check in' to or locate public places of interest, or Augmented Reality applications like *Layar*, unlocking digital layers of the environment otherwise invisible by using the iPhone's camera lens. As users navigate these locations using these applications, they are fed data from other users, who in turn also feed off data generated by fellow users. In the use of these applications, we see how the interaction between the digital and material is constantly generating spaces in flux. Such spaces have been called *hybrid spaces* by Adriana de Souza e Silva. She describes these hybrid spaces as:

"[Mobile] spaces, created by the constant movement of users who carry portable devices continuously connected to the Internet *and to other users*. [...] The possibility of an "always-on" connection when one moves through a city transforms our

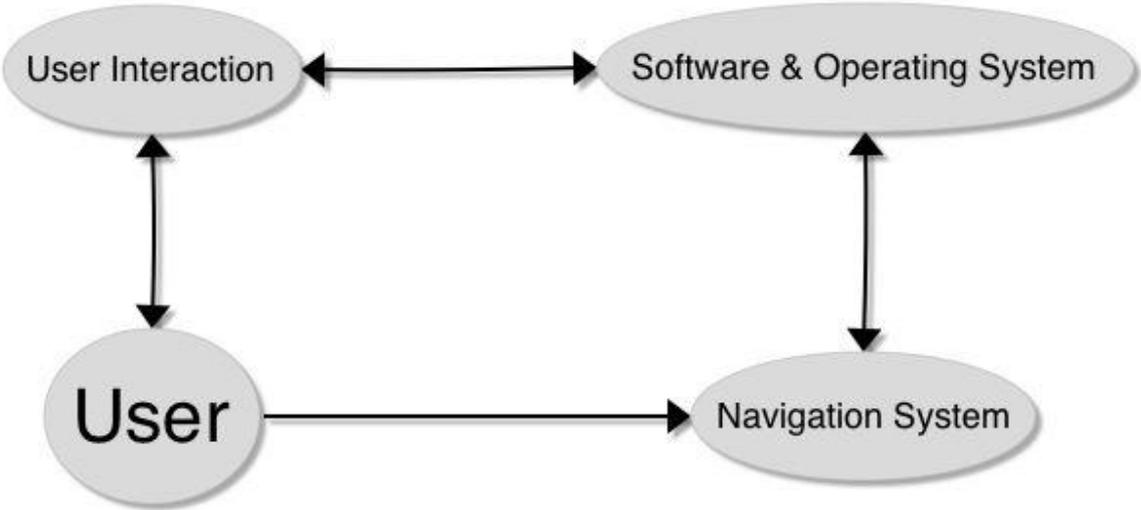


Figure 1: Verhoeff's layered interface of the iPhone displayed as a loop.

experience of space by enfolding remote contexts inside the present context. This connection is related both to social interactions and to connections to the information space, that is, the Internet.” (De Souza e Silva 2006, p. 262, emphasis mine)

De Souza e Silva argues that virtual communities (re)locate themselves within physical spaces through the use of mobile phones with internet connection capability. She describes the example of a Japanese location-based game called *Mogi*. The goal of the game is to collect virtual objects and creatures located in physical space. Players have to travel to the location of an object or creature. When they're close enough to the physical location, they can collect the digital item in question using their mobile phone. These objects or creatures can then be traded with other collectors, but only when both players are in close proximity to each other. A similar application called *Repudo* is available for the iPhone. It allows users to drop all kinds of media files, such as text, video or images, in physical locations, so that others may pick them up. This digital connection of users combined with the location-based element of navigation applications generates a *shared* screenspace. According to Verhoeff, this encompasses a “spatial continuity of the eyes, hand, screen and screened space” (Verhoeff, p. 90) of multiple users. In addition, “[space] itself is transported: the expansion of space through the media device [...] allows the player to do something else, somewhere else,” (ibid.) and we might add, *with* someone else. If we return to the schematic display of the constitution of mobile screenspace, we need to make an addition, then. Mobile screenspace, we can conclude, is constantly generated through the site specificity of the user, his environment the mobile screen, its back-end software and navigation system, with the addition of other users. These users in turn are also generating the same shared screenspace, using the same process. This expansion is schematized in figure 2. There are multiple ways within which users can interact through screenspace, so both the users and their devices are connected. Shared mobile screenspaces are then constantly generated by an endless amount of these loops, and perceived around each user and their respective User Interaction levels.

Viewing the mobile screen as a theoretical console has allowed us to examine three aspects of the mobile screen: first, its relation to the user through the concept of the fit and tactile vision; second, the addition of navigation to account for the mobility of the device and the

user; and finally, the addition of networked information and connections with other users to enrich the screenspace, making it shared.

Conclusion

In this chapter we have examined how various screen types play an important role in the materialization of the digital. Each of the screen types that we have looked at adds a new element. The home screen showed the constructing effects of the screen on its immediate environment. With the urban screen we have determined that screens need to be examined as site specific media, that is, their functioning and experience being determined by a range of factors related to their location within an environment and to different spectators, thus generating a specific screenspace. The mobile screen has added two elements. First, the element of navigation entails a construction of screenspace that is constantly at work. Second, screenspace can be shared with others, enriching its experience. What I want to stress with each of these screentypes, is first the importance of the screen in the materialization of the digital. The digital needs a screen in order to become visible and to be experienced. Flowing from this, and equally important, is the shaping power of the screen on this experience; the shape, location and movement of the screen all influence the consumption of and interaction with digital phenomena. Finally, we cannot deny the material aspect of these digital phenomena, as we have seen that these screens and their

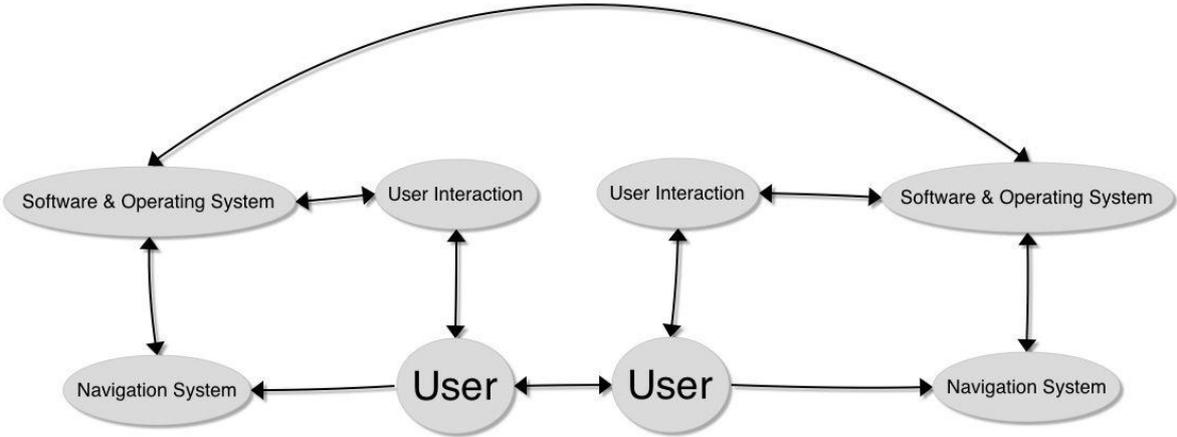


Figure 2: An expansion upon the layered interface loop.

contents affect the material reality around them in a profound way. The next chapter deals with a somewhat paradoxical statement, yet equally true; the boundary-shaping aspects of the screen, and how it imprisons the digital outside of the material, while at the same time grounding it within.

Chapter 2: The Limiting Screen

We arrive now upon the other side of the paradox I proposed at the start of this work. Whereas we spent the last pages tracing digital materialism occurring through the screen, in the next I will argue why the screen also – and this is the cause of the paradox – in a way prohibits that same digital materialism. In the last chapter, we saw that the screen makes visible the digital. Whether it be the images shown on television, the digital animals in the National Geographic display, or the various navigational maps shared with other users on mobile devices, each of these digital artifacts would not be perceivable, and thus materialized in their effect on or interaction with spectators and the environment, without the screen. But at the same time, due to its various very essential and material properties, such as the frame and the glass of which it is made, the screen prevents us from physically touching that which ‘lies beyond’ it. We need various digital representations of ourselves – ranging from the very basic mouse cursor as an extension of the hand, to very lifelike avatars in online gaming environments symbolizing our (alter)ego’s – in order to interact with and manipulate digital objects that we can see on the screen. While digital materialism of course does not necessarily advocate a direct physical relationship with digital phenomena, it does argue for an approach that goes beyond considering digital as “real and material in effect,

not in fact," as we recall from opening of the first chapter (Van den Boomen et al., p. 9). Whereas the aim of the previous chapter was to demonstrate that the in-materiality, as Van den Boomen et al. call it, of digital phenomena is governed in large part by the specificity of the screen in relation to its immediate environment, the central point of this chapter is the consideration that digital phenomena are barred from attaining any type of physicality by the physical properties of the screen. The screen, in a way, situates the digital in the material, while *at the same time* isolating the digital from the material, by upholding a strict distinction between the two.

Recent developments in touch screen technology make the idea of a screen as a barrier all the more real; despite the feeling of being able to manipulate digital content in a very direct manner, in the very use of touch screen we are constantly reminded of the separation of ourselves and the physical world around us, and that which is displayed on the screen, by the physical touch of the screen's glass, and thus its barrier. Other technologies include motion tracking, such as deployed in *Microsoft's Kinect*, a webcam-like peripheral sensor for the *Xbox 360* entertainment system, which allows players to interact with on-screen content by moving their hands and feet at the screen while facing the sensor. While removing the need for an input device – other than the sensor itself – the limiting and bounding act of the screen exists here in the demarcation of an area of play.

In this chapter, then, we will look at three ways in which the screen forcefully shapes, limits and imprisons the digital within itself. First, we will examine the way properties of the screen, such as its frame, limit what is visible on the screen, and how this also affects that which is at that time not visible on the screen. Simply put, this limitation deals with the screen and that which lies 'beyond' it. One example that I wish to utilize here is from an earlier work I did on the subject of High Dynamic Range (HDR) photography. This type of photography has a unique relationship with the properties of a screen which puts it at a position where it acts as a materialization of digital information, while at the same time being restricted by the screen in how it is displayed. The second type of limitation occurs between the screen and the user. Here, we are concerned with the manner of consumption of screen media, and how this affects our bodily position and physical relation with the screen. The example of the Xbox Kinect and touch screen technology will play a part in this

examination. Finally, we'll have a look at the screen's rectangular shape. This limitation does not specifically concern the relation to the digital content beyond it or the viewer before it, but rather involves questions about why many types of media content, despite the ongoing development of display technology, have always been displayed on a flat, rectangular shaped surface. To conclude the chapter, this last limitation will be put into the context of a look at the future. This will also situate the thesis as a whole within the future of digital materialism, arguing that we are not done with the screen, and it not with us, just yet, as Lev Manovich would have had us once believe.

The Framing Screen

Let us start with the first limitation, the screen's framing power over the digital content that it displays. For this examination, I want to briefly recall Heidi Rae Cooley's writing on the MSD and the fit, which we addressed in the previous chapter when looking at mobile screens. One passage in her article, which refers to the act of seeing with a mobile screen, goes as follows:

“[V]ision is not a practice of seeing through, i.e. a window, but looking at, i.e. the screen. And this shift from window-ed seeing to screenic seeing reconfigures one's relationship to that which is seen. Whereas a window distances viewers from what they are looking at, the screen draws them toward the images that are displayed on the screen (*not beyond it*). [...] Likewise, that which is being viewed (and perhaps recorded) no longer exists separate from that which is framing it. The object, formerly located on the other side of the frame, converges or fuses with the screen, its physicality becoming the physicality of the screen.” (Cooley 2004, p. 143, emphasis mine)

Cooley describes how images are displayed *on* the screen, as if somehow taped to the back of them. She uses terms such as 'fusing' and explicitly states that the images do not exist beyond the screen, but only on the screen itself. Viewed in this way, we could consider digital images like farm animals coming up to the fence in order to be fed or petted. Only these animals matter to the little children. Those in the meadow beyond might as well not exist. Indeed, when we take this existence literally, we are reminded of another metaphor; the proverbial tree in the woods. If it falls over with nobody around to hear it do so, will

anybody ever know, and as such, has it ever happened? The same question can be asked about digital images, or digital data in general. Do they exist when they are not directly visible within the frame of the screen? As I am writing this thesis I am using a word processing application which is currently visible on the screen. 'Behind' the application window is the computer's desktop, with shortcuts to other folders which contain thousands of digital files. But they are not visible at the moment. Do they exist?

The question appears somewhat moot when we put some effort of thought in it. The basic answer is of course yes; when we boot up our computers we see the operating system load, and when we access our hard drives through the explorer window, we see the files installed on it. And of course, added to this is the simple fact that we know there are files on the hard drive. Indeed, we put some of them on it ourselves. We have to consider though, that we only know these things to be so, because we have seen proof of it on the screen. Only through it can we see and manipulate digital data. It becomes slightly different when we consider the vast network of information that is the internet. Most of the data that exists on it can or will never be seen by an individual. To them, this data exists only as virtual data, in the Deleuzian sense of the term: the data always already exists, but only once it is experienced does the data gain actualization. This experience of data is framed by the screen – we should take care not to simply claim it is made possible by the screen, as that would imply a lack of agency on the user's behalf, which is not always the case – which at the same time makes invisible, and therefore keeps virtual, the data that is not within its frame. While I only spoke of a computer screen so far, this explanation holds true for any screen displaying digital information: the screen, as a frame, cuts off and separates. The often-used metaphor of 'a window to another world' when speaking of screens makes this explanation clear: if we look out a window, we see only a part of the world outside, namely that which is framed by the edges of the window. The rest of the world is implied, obviously, and in the case of an actual window we can usually go outside and experience that which is not visible through the window. This is not the case with the digital screen however; we cannot step 'outside' into the world 'beyond' the screen, therefore the screen severely limits our experience of the digital as a whole.

Of course, this is a rather strong statement, and one that immediately summons the question whether or not this is a problem. Do we want to step outside of or around the framed screen? Do we need alternatives to the screen in order to (better) experience the digital? Perhaps the desired step is not immediately one that goes beyond the screen's frame, but the history of digital imagery is certainly shaped by attempts at achieving an ever increasing similarity to physical reality. In other words, there is a quest for bringing the digital ever closer to the 'boundary' of the screen, in order to make it appear as ever more indistinguishable from physical reality. In *The Language of New Media*, Lev Manovich describes how top animation and computer companies and research groups, like Pixar and SIGGRAPH, are constantly developing new algorithms to render images of increasingly realistic quality, in order to stay competitive (Manovich, p. 188-198). Similarly, Henrik Wann Jensen and Tomas Akenine-Möller describe the race for photorealism in real-time environments such as computer games, which is driven by and at the same time dependent on the development of better software algorithms and faster hardware components (Wann Jensen and Akenine-Möller 2010). Such striving to bring an increasingly photorealistic image to the surface of the screen allows for a speculation of a future where a point is reached at which the only logical 'next step' is to take the digital from the screen into a more immersive environment. The desire, then, may definitely arrive at a point in the future. The argument I want to make here is that precisely because we cannot go beyond the borders of the frame – at least not for the time being – we are bound to and highly dependent on the screen's properties when it comes to visually experiencing digital content.

Let me delve deeper into this using an earlier work I wrote on High Dynamic Range photography. It addresses a problem with this technique that pertains to a limit of the screen's capabilities, rendering the resulting photograph more or less 'lost in digital space'. The problem to which HDR photography is a solution, is that a conventional photo camera is incapable of taking a picture with a luminosity range similar to that of the human eye. Simply put, it cannot create a high contrast picture where both the brightly lit and shadowy areas show a large amount of detail, something that comes naturally to the human eye (Balm 2010, p. 3). In order to solve this problem, generating a HDR image entails taking several different 'source' shots at various exposure lengths, that is, different levels of luminous detail; shots with less exposure time will have detailed bright areas and darker shadowed

areas, whereas the lighter areas in a longer exposed shot will be overly bright, and the dark areas will be rich with detail. These shots are then blended together to generate an image that incorporates the best of both worlds, so to speak: high detail no matter the luminosity of an area.³ The discrepancy lies in the fact that HDR photographs are generally generated from source shots in the RAW image format, because this is a format that includes all of the raw sensor data from the camera, without any digital compression, hence carrying all the required luminosity information. RAW images have a bit range upwards of 12 bits per color channel, resulting in an image of at least 36 bits overall. A loose explanation of this is that the pixels that make up a RAW image can each have 2^{12} different types of red, green and blue assigned to them, the additive result of which results in the pixel's final color. Conventional display devices however, all operate at 24 bits, 8 bits per color channel, and as a result cannot display true HDR photographs (p. 5-6). Those pixels in a HDR photograph with a value outside of the bit range of the display device will be clipped, creating a bland and pale image as a result. The solution to this problem is to compress the image using an algorithm called tone-mapping. This preserves the HDR effect somewhat by calculating a pixel's color value based on its surrounding pixels, rather than simply assigning the nearest possible value. This procedure creates a side effect, however, which is the typical surreal look we have come to associate with HDR photographs.⁴

What is compelling about this is that these surreal images that we have come to know as HDR are in fact precisely *not* HDR, because HDR in its essence is barred from being displayed by the limitations of the screen. In this, it embodies the paradox I am putting forward in this thesis. HDR, through being displayed on the screen in such a peculiar way, exerts a certain force on material reality: We speak of HDR, academic research has been conducted into the technique, communities create and share amateur HDR images, and so on (p. 9). At the same time however, HDR remains outside our grasp, locked in a sort of 'limbo' beyond the screen, until the time when screens are capable of properly displaying it. The problem becomes even bigger when we take into account that screens, limiting in their bit

³ See <<http://500px.com/photo/2998260>> for an example of a basic HDR shot: The image shows broad luminosity and details even in areas that are backlit by the sun and would normally be darkened because of this.

⁴ See <<http://500px.com/photo/2998269>> for an example of such a surreal HDR image as a result of the tone mapping algorithm.

rating as they are, are not manufactured according to a single standard either. Sean Cubitt (2011) describes how today's different monitor types – LED, LCD, CRT and so on – and different image gathering chip types – CMOS and CCD are two examples – result in images with different color gamuts (Cubitt 2011, p. 29-30). If we consider what this means for a networked society where transferring images between different users – and thus different display devices – is commonplace, we see even stronger the limiting factor of the screen. It becomes a critical consideration in for example medical environments, where images of a patient's body may be transferred from one doctor's computer to another, yielding different results depending on the machine used to view the images with.

I used the work of Pierre Lévy to describe this limbo state of HDR beyond the screen. On hypertext, another phenomenon which suffers from the same problem, Lévy writes:

“Does [hypertext] “virtually” occupy every point in the network connected to the digital memory in which it is encoded? Does it extend to each terminal from which it can be copied in a matter of seconds? [...] Deterritorialized, fully present in all its existing versions, copies and projections, deprived of inertia, ubiquitous inhabitant of cyberspace, hypertext helps produce events of textual actualization, navigation and reading. Only such events can be said to be truly situated. And although it requires a real physical substrate for its subsistence and actualization, the imponderable hypertext has no place.” (Lévy 1998, p. 28)

Lévy explains how the hypertext is never “situated” other than through its specific navigation by a user, who chooses a path along the many links possible, actualizing a specific version of the text. I would argue that this applies to any type of navigation through a digital environment, whether it be (hyper)text, digital imagery or something else, and I want to stress that this actualization takes place through the screen. With a screen as a sort of lens, a user selects the information he wants to see or interact with, brings it towards the screen in favor of other information. The screen then acts as a limiting filter, whether it be by choice of the user – when he selects some information over other – or not – for example when watching a movie, where the viewer is ‘subject’ to the choices of the director in terms of what is and is not displayed on the screen. Verhoeff describes the relation between what is displayed on the screen and what is not when considering the map application on the

iPhone, writing that “[the] frame is always a detail of a larger whole. The map is always larger than the part displayed on the screen” (Verhoeff 2012, p. 152). Using the iPhone’s touch controls we swipe the map around to find an area. The map feels as if it is right behind the screen, and the screen frames the part we see within it, while excluding the rest.

This first part of the chapter has considered how the screen limits the visibility of digital data ‘beyond’ the screen. In the next part, we examine the limitation exerted upon the screen’s viewer.

The Immobilizing Screen

The second type of limitation that is a result of the screen deals with its relationship to the body of the viewer. We have already come across a prime example of this limitation in the first chapter, although we discussed it in a different context: The television set at home creates a hearth-type atmosphere around it, where family members gather around it to watch the images displayed on it. In the first chapter, the example demonstrated the material effect of the digital imagery. Here, I want to employ it to argue how it *enforces* that same atmosphere. By design, a television set must be viewed from the front, because that is the side where the display is located. Corollary, if multiple people want to view the television set at once, it should be located somewhere central, with an open space in front of it. Its viewers tend to want to sit down while watching it, so couches and chairs are placed directly in front or in a semicircle around the device. These changes are enforced by the screen’s properties, and as such are a restricting act. Modern technology, although sometimes hailed as a spectacular and often liberating innovation, does not change this restriction much. Consider the Kinect device for Microsoft’s Xbox 360 entertainment system I mentioned in the introduction to this chapter. The product’s tagline is “With Kinect, there are no controllers. Or remotes. There’s just you.” The promise is one of full body freedom, but if we consider the Xbox system, all the restrictions that apply to the television set are still in play, and it brings about some new ones. You have to stand within 1.8 to 2.5 meters from the screen and cannot move too far left or right. The minimum distance also acts as a limit; if a player gets too close to the screen, an error message appears and you have to step away in order to see the content again. In this situation, the digital is quite literally tantalizingly close to becoming tangible. Lastly, in order to make anything happen on the screen, we *have* to use our bodies. Games designed specifically for the Kinect require us to use our hands to hover over action

buttons in order to navigate through menu structures. While marketed as a feature, this requirement can also act as a frustrating restriction when the sensor doesn't properly pick up the player's gestures.

The relationship between the body of the spectator and the screen, in the sense of restriction of movement on the part of the spectator, has been described by Anne Friedberg as a double paradox within the context of early twentieth century cinema (Friedberg, p. 150). The first is less relevant here, and has been implied already throughout this thesis: the materiality of the screen's direct environment versus the immateriality of the screen's displayed contents. The second is that of the mobility of the images on screen versus the immobility of the spectator. In the traditional cinema theaters, "the body of the spectator is seated, fixed, confined, facing a frame, a screen, a flat surface of projection" (p. 167). The images displayed on the screen are in contrast with the fixated body of the spectator, in that they move around; there is motion happening within the shot, and the images themselves move from shot to shot, demonstrating different camera angles or entirely different scenes. The paradox is in the fact that while the spectator remains immobile, the perceived images and their mobility imply the spectator's presence, and thus mobility, in the portrayed scene, where the camera acts as the spectator's eyes. If we look at the history of screen media, we see that this distinction has always been at work. Friedberg traces it in early twentieth century cinema, in such examples as the famous 1902 film *Panorama of Moving Boardwalk*, showing the 1900 Paris Universal Expedition as filmed from a stationary camera on a moving boardwalk. The situation where a body is fixed before a screen, even if the portrayed images are not mobile – although Friedberg argues that 'polyscenic paintings', Renaissance works where multiple scenes from a storyline are portrayed within a single frame, imply the same movement as cinematic images – can be traced back even further. In a discussion of Renaissance paintings, Friedberg cites art historian Dagobert Frey, who writes that the viewer of such paintings "must not stray from [the fixed position of the beholder] if the illusion of space is to remain convincing." (Frey 1929, cited in Friedberg, p. 36) We already see the restrictive force of the picture frame upon the viewer; both the perspective painting technique and the framed flat surface require the viewer to stand in front of the picture at the correct height in order to be able to view it correctly. A similar forcing act of the framed image is laid upon the

Renaissance painter, as he utilizes tools such as the *velo*-grid, a frame with netting stretched over it, forming a grid of squares that serves as a measurement tool.

What is relevant here is not so much the existence of the paradox in itself; a lot of research has already been done into the relationship of the immobile body with the mobile images on screen, and it has been well theorized. What *is* important to note here, is that this fixed position of the beholder is still at play in screen media of today, and indeed looks to be present in the future of it as well, as I will describe in the next part. Verhoeff briefly addresses this in her analysis of the Nintendo DS as theoretical console, stating that: “[t]he player is sitting or standing; the relationship between the screen and player is still, immobile, even if she is in a state of mobility, for example, taking a bus ride.” (Verhoeff, p. 91) While Verhoeff pays little attention to this fact in the larger scale of her discussion of the gadget as a mobile screen, I want to magnify it here, in order to drive home my point: even though the state of contemporary screen technology allows us to move around while utilizing screens, therefore freeing us from the fixed bodily locations required for viewing traditional screens and paintings, we cannot escape having to view the screen from a frontal position. The complex of screen and spectator as a whole may now be mobile, the body in relation to the screen is still an entity that is required to remain fixed. It is in this fixation that a tremendous governing and limiting force resides, one that we must understand and take into account in a larger context of digital materialism.

Another recent technology that falls into this category of limitation is that of touch screen. The touch screen is somewhat of a paradox. On the one hand, the novelty sensation of it stems from the experience of directly and physically manipulating digital data; on the other, this experience is a very physical reminder of the barrier that resides between us and the digital, namely the glass surface of the screen. A barrier, again, formed by a physical aspect of the screen. The touch aspect of this type of screen fits in with and expands on a longstanding tradition of visual media functionality, as Verhoeff argues, namely “the idea of moving *through*” (p. 82). In this way, touch screen technology provides a new understanding of what was already a theoretical implication of earlier screen media studies: it brings the wish for transportation ‘into’ the digital world a step closer to fulfillment. In her study of the Nintendo DS, Verhoeff characterizes the device’s touch screen as a dirty window, referring

to an ad promoting the device where a boy writes “Go” on a van’s dirty rear window, upon which it drives off. In this comparison, we see the screen as a material thing, at the same time being an opaque barrier and a tool with which to grant digital phenomena a materiality.

Verhoeff writes:

“When the screen functions as a transparent window, it is invisible as object. When it is opaque its materiality, its thing-ness, surfaces. This paradox of non-functionality that correlates visibility to thing-ness is particularly intriguing in the case of the screen. Unlike the window, the operation of this screen necessitates opaqueness for virtual transparency: it needs the surface to reflect the images *on* screen.” (p. 83)

Verhoeff puts the above in the context of an argument that demonstrates how touch screen technology makes seeing digital data a tactile act, executed through the finger – which is one side of the touch screen’s paradox, the idea of directly and physically manipulating digital data. Again though, I want to magnify the other side of it, which is left with less attention in Verhoeff’s argument: the touch screen’s physical surface, its physical manifestation as a barrier that separates us from the digital, the proof of which we are confronted with the moment we engage in operating it, is a requirement for the interaction itself. In other words, we take a conscious step on the spot in the physical confrontation with the touch screen, in order to experience what it would be like to move forwards, towards a direct physical manipulation of digital data. We may even consider it a step backwards, as expressions in popular culture such as the futuristic gesture screen in the movie *Minority Report* and technology stemming from this such as the Kinect gesture interface already more or less put us ‘through’ the physical barrier of a screen.

The Conventional Screen

From the screen’s limiting relationship with the user’s body, we now move towards the final limitation I want to discuss in this thesis: the shape of the screen and its media contents as a governing aspect of display technology. This limitation has less to do with the current properties of the screen, but is more aimed at considering the historically grounded aspects of screen media. As Lev Manovich already stated in his genealogy of the screen, screens have always been flat and rectangular surfaces (Manovich, p. 95). Historically seen, the screen as a container of moving images is in this sense a continuation of the photograph and the

painting before it. The contents of the 'screenic' surface are cut off from the environment, either by an actual physical frame or simply the edges of the displayed image. In most media expressions, this frame and its rectangular dimensions have two functions, as described by Claudio Pinhanez and Mark Podlaseck (2005). First, they orient the view of the spectator towards the depicted. This is especially true in perspective art, photography and later video or digital representations of environments. Secondly, the frame acts as a tool to indicate the separation of the depicted from the environment in which it is depicted, both in the sense of space and time (Pinhanez and Podlaseck 2005, p. 3). This second purpose is mostly true in the case of traditional paintings, as we have argued precisely the space- and time-binding properties of modern televisual screens in the first chapter. Still, the television frame too allows whichever is depicted to only manifest itself within the confines of the television's display surface. In their article, Pinhanez and Podlaseck examine the consequences of enabling frameless displays. While they come up with some examples of frameless displays – mostly in the form of projected imagery with some type of masking applied to make the black in the image appear transparent – they note that traditional media conventions make a transition into frameless displays difficult, and not always appropriate. From the perspective of media designers, this limitation is caused by lack of experience in working with frameless imagery, as professionals have been trained to work with framed media (p. 14). I would add to this a much larger obstacle on the side of the consumer. When we consider media in general, we can see how dominant the rectangular shape has been in media consumption: I've already mentioned the painting, photograph and video, but we may add text to this as well. While the 'page' is not necessarily a screen, the rectangular shape equally finds its way into books and other displays of text. So many communicative media expressions are based on and dependent on the rectangular shape of the framed 'screen'. Pinhanez and Podlaseck state about frameless displays that they "should be mostly used when [a] connection or contextualization [of digital phenomena into the environment] is needed and *avoided otherwise*" (p. 1, emphasis mine). I want to side with their statement, most certainly with regards to future development in the area of display devices. Some prototypical development has taken place in the area of holographic displays which allow for digital content to be displayed free of the constraints of a screen, essentially freely floating in

physical space, to be touched and manipulated like any other physical object.⁵ But we have to ask ourselves here, how does such a technology deal with standing media conventions which are based on the frame? Indeed, many of the demo products still require conformity to conventions such as a frontal viewing position, because the illusion is lost when the object is viewed from the side. Such conventions are important: Pinhanez and Podlaseck make reference to comic books, where the sequential placement of framed images indicates narrative progression, and to cinematic tools such as over-the-shoulder shots or close-ups which indicate the direction of conversations (p. 5 & 15). Both these examples are highly dependent on the framed image in their conveyance of meaning and narrative.

Rather, if we put aside the fantasies of holographic displays or VR installations, realized so far only in prototypes and gimmicky applications, and take a look at actual screen development, we can understand that the dominance of the framed rectangular display in screen development is rooted not just in the communicative standards they embody, but in existing technological standards as well. As Cubitt argues:

“The emerging new digital architectures, for example those of the LCD, LED (light-emitting diode), and DLP (digital light processing) screen technologies, are of necessity built on existing standards. They must, for example, be able to at least speak to component and composite video, recognize different color spaces like RGB and YPbPr, and connect to existing infrastructures such as the electricity grid, broadcast transmission wavebands, and the Internet. [...] Electronic screen design is formulated not only on the technological affordances of the day, but on the accumulated technical practices of the past, and the regulatory framework of the present, which itself is typically a historical aggregation.” (Cubitt, p. 25)

Cubitt concludes that screen development has shifted from finding innovative new technologies to finding ‘sustainable’ – not necessarily in the environmental sense alone, but also, and most importantly, as cheap, fast and mass producible – screen solutions. As he writes, “[in] our haste to populate our lives, intimate and public, with screens, we have opted for the good enough over the best possible, and in the process abandoned technical

⁵ See for some examples the following links:

Trade Show Hologram: <<http://www.youtube.com/watch?v=Ljva0SC-7HM>>

Airborne Ultrasound Tactile Display: <<http://www.physorg.com/news168797748.html>>

trajectories that might have suggested other social and political capacities and affordances” (p. 33). Cubitt’s argumentation, then, indicates that the screen and its material properties will remain the primary tool for displaying digital data for the time being. And this is not because we can’t think of other methods, but for reasons related to communicative conventions and material limitations.

Indeed, we can consider a very actual example of this principle. The company Corning, a manufacturer of glass and display surfaces, recently released a video demonstrating their vision of the future. At first glance the video, named *A Day Made Of Glass*, feels like a polished fantasy, as if taken straight from a sci-fi movie such as *Minority Report*. We see a young child picking which clothes to wear on her closet door which doubles as a display surface showing her a digital representation of her wardrobe. The fridge in the kitchen shows a scattered collage of photographs, a giant table at school acts as a multi-user touch screen upon which children learn all about colors, and the father, who is a doctor, has a video conference with a doctor elsewhere in the world using the entire wall as an interactive video display, showing the actual room and patient, overlaid with the patient’s data. The list goes on as screens in the form of display surfaces show up everywhere in the video. The same company released a companion video explaining how these technologies work, and which of them are already in the process of development. We have to realize what this means. Of course the video looks very smooth and slick, as they are surely intended for marketing purposes, and we should not adapt such views uncritically. But we have to take into account that this is a company that develops and manufactures these displays, and not a small one at that: Corning is allegedly responsible for the production of glass for around 50% of LCD displays manufactured worldwide, working together with manufacturers of screens such as Samsung.⁶ As such, they stand at the forefront of the development of screen technology. This consideration gives value to the claims made in the video with regards to the direction screen development will take in the coming years, suggesting that the screen and its technological and communicative standards, including the restrictive nature of these standards, which I have argued in this chapter, will remain the dominant device for expressing digital phenomena in foreseeable future.

⁶ Info obtained from <http://nl.wikipedia.org/wiki/Corning_Incorporated> (Dutch) at 25-02-2012.

Conclusion

In this chapter I have aimed to provide insight into my claim that screens are not only the devices which make digital materialism possible, but at the same time apply limitations to how this affordance occurs. These limitations take place on several different levels: we have discussed the framing act of the screen upon that which is visible, which at the same time limits and cuts off that which is not visible; the screen also forces the body in a certain relationship towards it – a viewer must be in front of the screen and cannot pass through the material pane of the device; and finally, the rectangular shape of the screen is a governing aspect of how media, both digital and analogue, have historically been displayed. This last given has also provided insight into how future display technology may articulate itself, suggesting that the screen will remain dominant for the time being.

Epilogue

As I go into the concluding words of this thesis, I want to reiterate that my original aim has not been to dismiss the core idea behind digital materialism, which has been the central theory in this essay. In my eyes, rather, its point of view provides an excellent theoretical solution and point of departure to analyze the consequences of a society that is increasingly moving towards virtualization, in other words shifting more and more of its daily routines towards digital platforms. Conceptualizing the digital as being part of the material world, in the process doing away with traditional boundaries between the digital and the material, is a good way to critically study contemporary and emerging applications and devices with a link to the digital, such as the networked smartphone and location based software apps. These media are all not just material themselves, but intrinsically linked to material sites, thereby grounding their digitality into the physical environment in which they are used.

At the same time, screen theory has come to acknowledge this materiality, whereby screens have been increasingly studied in their site specificity. These analyses, of which I have given examples in my writing, all serve to further the theoretical cause of digital materialism, as they clearly show how the experience of digital phenomena is linked to their take place in specific material environments. What these writings lack however, I have come to conclude,

is a specific attention to the power and essential role of the screen in these materializations. While authors like Verhoeff and McCarthy do argue for a closer analysis of the screen as site specific object in the process of digital materialization, I have argued that their conclusions lack attention to the fact that this process not only takes place through the screen, but *could not take place at all without it*. At the same time, this process is highly influenced and limited by the properties of that same screen. So we arrived at a paradoxical statement: The digital needs the screen in order to materialize, and the digital is limited by the screen in its materialization. I found it necessary to explore this paradox, as in my eyes, it stands at the theoretical basis of digital materialism: any act of digital phenomena being anchored in material reality takes place almost exclusively through a screen of one kind or another.

I have traced each side of this paradox in the separate chapters that make up this thesis. First, we explored the modern screen by dividing it up into three separate types of screens, each allowing the digital to take place in their physical environment. What this analysis has demonstrated is the constituting effect the screen as a physical object has on its immediate environment, through the contents displayed on the screen, and their application – as in appropriation – by the screen’s users or spectators. The multitude of ways in which this constituting effect occurs – in living rooms, urban environments, and in different ways for each user and each application on their mobile screens – is a testament to the importance of a consideration of the screen’s role in digital materialization. That role is highly dynamic and yet shapes the process of digital materialization very strongly. Truly, the screen allows the materialization of the digital to take place in all kinds of ways.

And at the same time, as I have described in the second chapter, the screen limits, indeed almost punishes the digital for choosing it as its medium of choice. The chapter focused on three types of limitations, the first of which pertains to the content displayed on the screen. I argued that the screen, as a sort of lens into the digital realm, filters those things out which are not displayed. This filtering can be a conscious choice of the user or not, but in either case, there is always something that is ‘not displayed’. I have described this using the example of HDR, where the screen’s technical shortcomings directly attack and alter the very reason for HDR to exist in the first place. As a direct consequence, the materialization of HDR takes on a different form than one would expect from its technical description. The

second limitation affects the relationship between screen and user. It argues that despite numerous developments in the technology of screens and the manner of their display, there is a historical constant in the conditions under which a screen must be watched: always from the front and with a certain distance to the screen. From Renaissance painting to Microsoft's Kinect system, the viewer has to look upon the screen from the front and at the right distance, or the experience is disrupted. Finally, the last limitation shows that future screen development is not simply governed by fantasies of what we want, like holographic displays or virtual reality systems, but is based on conventions in two fields: current technology and communicative standards. New technological developments in the area of display technology often requires adaptation to existing standards and submission to materials that are durable but also cheap and easy to produce on a large scale. These factors often weigh heavier than the importance of technological innovation. Likewise, new display technology has only so many directions it can develop in, as it has to take into account communicative conventions such as the rectangular shape that is common for screens. This shape allows for narrative continuity and demarcation, which is more difficult for a medium that would employ, for example, a frameless method of display.

To conclude, I want to plead that if new media studies accept digital materialism as a new theoretical point of departure for the analysis of media's place in society, it has to take into account the screen paradox that I have outlined in this thesis, as it governs the materialization of digital phenomena and forces it into a specific certain shape and direction. With the closer examination of the role of the screen within materialization of the digital, I hope to have offered a valuable amendment to both this emerging form of media studies and theorization of future digital display devices.

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