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Who knows? The universe as technospace

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ABSTRACT
This text looks at changing relationships between humans and technology in practices of producing and sharing knowledge about the universe, and does so from the perspective of contemporary media theory (Hansen, Ernst, Timeto, and others). The starting point is Eric Joris' artistic research that was part of the *Spectacular Astronomy* project and that works towards the development of a twenty-first century planetarium. Joris' planetarium stages encounters with the universe that draw attention to the entanglement of humans and technology in historical and contemporary practices of producing and sharing knowledge about the universe, and to parallels between the development of the interaction between scientists and their instruments in the history of astronomy and the interaction between humans and media technology. Technological developments put humans in situations in which they, and their modes of perceiving, are increasingly implicated in larger apparatuses that to a considerable extent operate outside their awareness and in ways to which they have no direct access. This engenders a shift in hierarchy between humans and technologies that starts already in the nineteenth century and in relation to analog technology, and is intensified with the rise of digital and networked technology. These developments foreground the similarities between the modes of operating of media technology and of scientific instruments of measurement and suggest an understanding of the universe as we know it as what Timeto (in *Diffractive Technospaces. A Feminist Approach tot he Mediations of Space and Representation. Surrey: Ashgate, 2016, p. 1*) proposes to term technospace: a dynamic and contingent formation whose emergence cannot be separated from the generativity of the mediations that traverse it.

KEYWORDS
Astronomy; technology; planetarium; media theory; technospace; scientific instruments

Planetariums and orreries are means to communicate knowledge about the solar system, the galaxy, the Milky Way, and other aspects of the universe. They demonstrate the relative positions of the planets and their orbits, and offer us glimpses into parts of the universe that escape human perception. Such demonstrations, Bal (1996) argues, are always also performative. They perform gestures of exposure that aim to show 'how it is'. Sometimes these gestures are quite explicit, for example, when a live performer or a recorded voice-over

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acts as a guide explaining what is shown. In other cases, gestures of exposure remain more implicit, like when projections on the inside of a dome-shaped planetarium offer views that suggest we are looking through the roof of the planetarium into space and peep right into its far away corners. The gesture of exposure thus performed is that of a transparent window that invites the audience to see for themselves how it is with the universe, which is a gesture that obscures precisely its own performativity. This performativity is not merely a matter of that which is seen being a projection instead of the real thing; rather, it describes how the viewer is implicated within the apparatus consisting of the totality of the setting, the projected images, and the narrative performed by them, as well as the broader context of discursive practices of which the planetarium and the viewer are part.

The apparatus that is the planetarium and how it performs gestures of exposure is the subject of Eric Joris' artistic research project that was part of *Spectacular Astronomy* and that works toward the development of a twenty-first century planetarium. His designs build on historical traditions of the orrery and the planetarium while also using advanced twenty-first century technologies to take these traditions in new directions. Joris' planetarium stages encounters with the universe that foreground what is performed in these encounters, both by humans and by technology. His design draws attention to the ways in which technology mediates in relating to that which lies beyond human perception and how this allows humans to develop an understanding of what it might be like 'out there'.

In the planetarium, technology mediates in sharing knowledge about the universe. However, the ways in which Joris' planetarium shows the entanglement of humans and technology also raises the question to what extent ways of knowing the universe themselves are entangled with, or in Federica Timeto's (2016, 1) words, 'traversed by' the technology that mediates what is out there. From Galileo's telescope to the Kepler Space Observatory, and beyond, technological developments have afforded new ways of probing the universe. One way of understanding the role of technology in such practices of knowledge production is analogous to that of a transparent instrument making available the universe as it is in itself to equally autonomous observers. Seen this way, it is the astronomer who does the discovering and the knowing from the position of an outside observer. Today's space explorations, however, involve sophisticated technologies that travel where no human can go, and probe the far corners of the universe with instruments that operate in ways quite different from human perception. Getting to know what it must be like 'out there' can no longer be understood as the result of the performance of autonomous individual scientists using instruments to extend human modes of perceiving and sense making but has become a matter of complex interactions between humans and large scale technology operating in ways that are largely inaccessible to human perception. This situation was nicely, albeit not necessarily intentionally, expressed in the headline of a Dutch newspaper De Volkskrant stating that 'Kepler discovers 11 billion years old planets' (Schilling 2015). The Kepler referred to is not the German astronomer Johannes Kepler (1571–1630) but the Kepler Space Observatory (launched in 2009). The headline identifies the Observatory as the agent of discovery, not the astronomers working with it, which is actually an accurate representation of the situation. For, although it was humans that built the Space Observatory, the discoveries made by it and how as a result the universe comes to be known, cannot be understood as something individual human beings did. Rather, the non-human modes of sensing, probing and processing of technologies of various kinds are what makes billion years old stars and other phenomena available to human knowers in the first place, and

how these stars become available and known is intimately intertwined with the technologies involved in reaching out to them.

The gestures of exposure performed by Joris' planetarium draw attention to this entanglement of humans and technology. A closer look from the perspective of contemporary media theory, in particular Hansen's (2015) account of what he proposes to term 'twenty-first century media', illuminates the specificities of the performance of technology in the planetarium, and how humans and human perception are implicated within larger technological apparatuses that to a large extent operate in ways that are inaccessible to them. With twenty-first century media, Hansen refers to the new forms of media prevalent in our world today, from social and mobile media, to data mining, to passive sensing and environmental microsensors, and more. Characteristic of these media is that their modes of operating can no longer be understood in terms of circulation of images and sounds that can be seen as records of human perception of a world (supposedly) existing independent of these records (the modes of operating of media like photography, film and sound recording). Instead, they directly impact how the world becomes perceptible. A closer look from the perspective of this tracing of the transformations brought about by twenty-first century media also reveals interesting parallels between the development of the interaction between humans and media technology and that of the interaction between scientists and their instruments in the history of astronomy, and how both mediate in the unfolding of what Timeto calls *technospaces*.

A twenty-first century planetarium

Eric Joris is a Flemish artist with a background in animation and drawing. For the past 15 years, he and his company CREW have attracted much attention with high-tech performances in which audience members are (partially) immersed in virtual worlds.[1] CREW is a multidisciplinary team of artists, researchers and technicians invested in exploring the esthetic possibilities and implications of innovative technologies. Characteristic of their ways of working is their use of various kinds of head-mounted displays that present users (or immersants, as CREW prefers to call them) with panoramic video images that respond to the user's viewing direction and movements (Figure 1). In CREW's planetarium, this technology is used to place immersants within a virtual solar system.

Unlike planetariums that present visions of the universe as if existing independent from viewers, in Joris' immersive planetarium the solar system unfolds from the encounter with immersants. This is not merely a matter of technology responding to the movements and direction of the eyes of a viewer in order to support an immersive illusion. Actually, Joris' creative strategies actively subvert any such suggestion of the transparency of technological mediation and direct attention to how the solar system emerges for a viewer as a result of how this viewer enacts the affordances of the technology. This starts already before the encounter with the virtual universe. The immersant-to-be first meets with a person who assists in putting on the head-mounted display and explains how to move around. After putting on the display, the immersant sees the image of an avatar speaking with the voice of that same person. This avatar introduces herself as a guide. The connection thus staged between the avatar encountered in the virtual universe and an actual person in the space within which the immersant finds herself, blurs the boundary between these two spaces and highlights how the virtual universe is generated in the here and now. The immersant finds

Figure 1. An immersant in the planetarium.
Notes: The image on the screen on his back presents an impression of the visualizations the immersant finds himself immersed in. Photo: CREW.

herself in what Hansen (2006), after Monica Fleischmann and Wolfgang Strauss, proposes to term 'mixed reality'. In mixed reality, the virtual is '[n]o longer a wholly distinct, if largely amorphous realm with rules all its own'. Instead, it denotes a 'space full of information' that can be 'activated, revealed, reorganized and recombined, added to and transformed as the user navigates … real space' (Hansen 2006, 2). The virtual here manifests itself in how technology opens new realms within reality, realms that

> can be accessed through embodied perception or enaction (Varela). In this way, emphasis falls less on the content of the virtual than on the means of access to it, less on what is perceived in the world than on how it comes to be perceived in the first place. (Hansen 2006, 5)

In Joris' planetarium, the virtual solar system is presented quite literally as a space full of information that is activated and transformed from within the space in which the immersant and the guide are materially present. At first, the virtual space is a rather empty space. Visualizations of partial views of the solar system are gradually built up, a process in which the guide plays an active role (Figure 2). The relationship between the virtual world and the space from where it is activated is made present time and again, for example, when the guide invites the immersant to touch a football on a string, the movements of which, tracked by motion capture, will be used to create an impression of the sun in orbit in the virtual space (Figure 3).

Far from immersing immersants in views of 'how it is' with the solar system, the planetarium presents itself as a tool for making sense of what lies beyond human perception, and exposes its own modes of operating. The planetarium not only invites users to step inside in the virtual solar system but also to look at how others are similarly moving around in

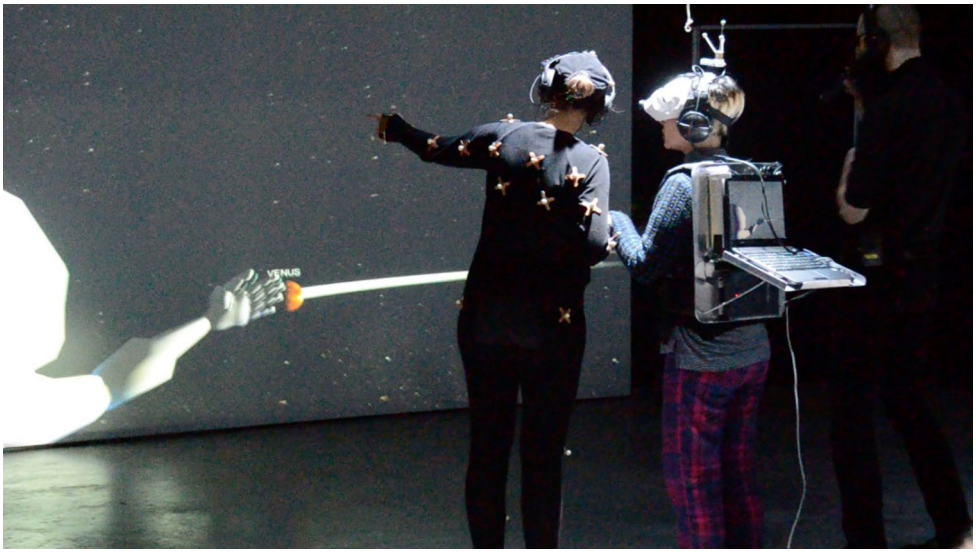

Figure 2. The actor performing the avatar together with an immersant. Although at first sight it may seem that both are looking at the visualization on the screen, this visualization is in fact only there for the avatar and the audience to get an impression of what the immersant is looking at within the virtual solar system. Photo: CREW.

Figure 3. Demonstration of the planetarium in Tourcoing, December 2015. Photo: CREW.

it. Immersants are invited to watch others before and after them going through the experience and are thus stimulated to develop an understanding of how the ways of imagining the universe they have encountered, or are about to encounter, are produced, and how it is

Figure 4. Compilation of images demonstrating various aspects of the planetarium-performance in Tourcoing, December 2015. Photos and compilation: CREW.

from their interaction with the technology that the virtual solar system emerges. Figure 4 shows an image of a presentation of the *Spectacular Astronomy* project (in the Imaginarium in Tourcoing, France, December 2015) in which the audience could attend short lectures about various aspects of astronomy and the project while simultaneously watching other people experiencing the planetarium.

Seen from the position of an outside observer, the planetarium presents a compelling image of humans feeling themselves around in technologically triggered imaginations of the solar system, and trying to make sense of the relative positions of the planets and the logic of their orbits by means of embodied enactment. Getting what is thus transmitted is not a matter of seeing the solar system as if with one's own eyes but of grasping an embodied sense of connections, relations, distances, and movements. The modes of operating of the planetarium bring to mind that of the orrery, transmitting knowledge about the universe by means of a mechanical model of the solar system that shows the relative positions and motions of the planets and moons. This permits the user to move around it and sometimes (in large scale orreries) through it, or (in the case of so-called living orreries) by collectively performing the movements of the planets in their respective orbits. Joris' planetarium also continues the practice of the historical orrery to upsize the planets relative to the distances between them. The distance between the planets that are part of our solar system is so big in comparison to the size of the planets that, if the model was made according to scale, the planets would be too small to be noticed by human perceivers. This concession to scale supports an understanding of knowledge transmission as being about grasping a logic of relationships and relative positions and movements rather than as a suggestion of providing access to the solar system as it is, as if perceived through a window opening up to space.

Technological expansions of the sensible

The modes of operation of Joris' planetarium are characteristic for what Hansen (2015) terms twenty-first century media. With twenty-first century media, he does not refer to a particular type of technology but to a particular tendency in how media operate. Micro-sensors, data processing, smart technologies, social media, search engines and other digital

and networked media perform operations to which humans have no direct access. They detect intensities, differences, fluctuations, and patterns. So doing, they 'open up an expanded domain of sensibility that can enhance human experience' (4). To access this domain of sensibility, 'humans must rely on technologies to perform operations to which they have absolutely no direct access whatsoever and that correlate to no already existent human faculty or capacity' (4–5). This does not mean that they dispense with human perception and experience. Rather 'the avenue of their impact on human experience and of their implication of humans within their operationality has shifted from a direct to an indirect modality' (6). Whereas there is a direct correlation between the modes of operating of nineteenth and twentieth century media like cinema, photography or sound recording, and human modes of sensory experience, the modes of operating of twenty-first century media are only indirectly correlated to human modes of experience and 'impact the general sensibility of the world prior to and as a condition for impacting human experience' (6). This difference is illustrated by, for example, the difference between a cinematic recording of a moving body and the same movement captured by motion capture. Motion capture does not capture and store something that can be perceived as the record of a human-like perception of a moving body but creates sets of data describing transformations of relations between dots in space. In order to be perceptible for humans, an additional layer of mediation is required. This can be, for example, a visualization of a moving body. This additional layer is not necessary for the technology to detect the movement and process the data but is required to make that which is captured available to human perception.

Joris' planetarium is an example of how twenty-first century media technology operates in ways that to a large extent have very little to do with human modes of perceiving. What users encounter is not records of human-like perceptions of the universe captured and brought to them by technology but a visualization produced for them on the basis of data and in response to their movements and actions. Space as it unfolds from the interaction between humans and technology does not pre-exist mediation. It is an example of what Timeto calls technospaces: 'dynamic and contingent formations whose emergence cannot be disjoined from the generativity of the mediations that traverse them' (Timeto 2016, 1). In Joris' planetarium, the solar system as technospace emerges from how immersants enact the affordances of the technology and in this way re-articulate the understanding of the solar system that the planetarium aims to transmit.

The data on which the visualizations of the solar system are based as well as the modes of processing them are inaccessible to human perception. What human users encounter is visualizations that correspond to their modes of perceiving and understanding and respond to their actions. The planetarium thus demonstrates Hansen's observation that with the rise of twenty-first century media, humans and human modes of perceiving are increasingly implicated within larger apparatuses that operate in ways that to a large extent remain outside their awareness. Characteristic of the functioning of twenty-first century media is that what humans encounter is in fact only the small part of the circulation going on within the technology that serves to communicate with humans. A lot more is happening outside human awareness and in ways quite different from how human perception and communication functions, but in which humans nevertheless find themselves implicated. Highlighting the construction of the experience and offering the users the double position of immersant and outside observer, the planetarium invites an exploration of and reflection on the implications of this condition.

The universe as technospace

The modes of operation of twenty-first century media foreground aspects of mediation that remain obscured in an understanding of media in terms of the circulation of records of perception. One of these aspects is the similarities between modes of operation of media technology and that of scientific instruments of measurement. Hansen is not the only one to make this observation. Wolfgang Ernst (2013) states that

> [m]edia are measuring devices, and as such they are scientific, analytical apparatuses. … The well-known television tube was developed out of a measuring device, Ferdinand Braun's electronic oscilloscope, just as the Edison phonograph was preceded by Léon Scott's Phoautograph, created to register the human voice for analytic purposes. Turning on an analog radio is experimenting with radio waves and their electromagnetic resonances. (184)

In his *A Geology of Media* (2015), Jussi Parikka observes that

> [o]ur relations with the earth are mediated through technologies and techniques of visualization, sonification, calculation, mapping, prediction, simulation, and so forth: it is through and in media that we grasp earth as object for cognitive, practical, and affective relations. Geological resources used to be mapped through surveys and field observation, now through advanced remote sensing technologies. (12)

Technological developments have created a shift in the ways in which the earth comes to be known from the mediation of human perception towards remote sensing technology. This shift is indicative for the transformations brought about by what Hansen describes as the rise of twenty-first century media and how these media effect a decentralizing of human perception in how the world comes to be known.

The characteristics of mediation brought to the fore by twenty-first century media, Hansen observes, are not unique to them, rather they are 'revealed to us *and* intensified by the computational technologies constituting twenty-first century media' (6, original italics), after having been obscured by an understanding of mediation as a matter of recording and expanding human perception or of making and circulating representations of a world similarly available to human perception. Hansen shows how anticipations of a such a non-prosthetic understanding of mediation can be found in, among others, Etienne-Jules Marey's chronophotographic practice, Herman Helmholtz's braintime experiments and the photographic apparatus as accounted for by Vilém Flusser (6). Their work draws attention to changes in human–machine relationships that started already in the nineteenth century and in relation to analog technologies, and that would be intensified and accelerated by digitization. These changing human–machine relationships, Hansen observes, require that humans develop increased awareness of being implicated in larger apparatuses that operate at least partly (and to an increasing extent) outside their scope of awareness.

A similar trend can be seen in the development of the modes of operating of measuring instruments in astronomy. Kepler's hand held telescopes directly correlate to human perception and operate directly on human sensory experience. They are technical means to extend human modes of perceiving. The operations of the Kepler Space Observatory, on the other hand, are largely inaccessible to human perception. Its photometer measures the brightness of stars and collects information in the form of digital data that are transmitted to earth to be analyzed by computer programs. Additional layers of mediation are required to presentify this expanded field of sensibility to human perceivers.

Technological developments like the Kepler Space Observatory put humans in situations in which they and their modes of perceiving are increasingly implicated in larger apparatuses that to a considerable extent operate outside their awareness and in ways to which they have no direct access. This engenders a shift in hierarchy between humans and technologies, from a situation in which technology like Kepler's telescope is subordinate to Kepler the astronomer, toward a situation in which humans operate in complex feedback loops with technology. Hansen refers to the work of the Czech media historian Vilém Flusser and his understanding of the ways in which technological developments engender a reversal of the relationship between human and machine:

> Certainly for the time being most apparatuses are not so completely automatic that they can go along without human intervention. They need functionaries. In this way, the original terms *human* and *apparatus* are reversed, and human beings operate as function of the apparatus. A man gives an apparatus instructions that the apparatus has instructed him to give. In this way a powerful flood of programs is unleashed, a flood of software with which people no longer pursue any particular intention but rather use to issue instructions as a function of an earlier program. As the programs become more and more complex and clever, they demand faster, smaller and cheaper apparatuses, more congenial hardware. And so one generation of apparatuses after another appears. With each new generation, human intention recedes further into the background – the intention, that is, that produced the first generation of apparatuses. (Flusser 2011, 74, quoted in Hansen 2015, 75)

Flusser describes how ongoing technological developments result in black boxing of the operations of technology analogous to the way in which technological developments improving the capacity of photography to produce life-like images contributed to the illusion of direct mechanical inscription and obscures the difference between the internal operations of the medium and the images produced for a human viewer. Such black boxing, Flusser observes, obscures how the ways in which humans can interact with complex technology and how they can make the technology do things, depends on how the technology affords humans the ability to interact with it and how, in this sense, what humans can do with technology is increasingly a matter of what the technology allows them to do. The Kepler Space Observatory, for example, is constructed to be used by humans to explore the universe. One might wonder, however, if actually the ways in which humans can use and instruct the apparatus are so much implicated in the construction of the apparatus that one might say it is the apparatus that requires humans to perform its operations.

This reversal in the relationship between humans and machines begins already in the nineteenth century and in relation to analog technologies. Flusser's example shows how the photographic apparatus integrates its user into its technicity. An example from the history of astronomy could be found in the differences between Kepler's hand held telescopes and telescopes on a tripod – allowing the astronomer to move about and move the instrument – and the nineteenth century observatory in which humans are literally implicated in large scale technology that fixates them in place and directs their modes of perceiving. In the observatory, humans have to align their modes of perceiving to the apparatus. The technological expansion of perception requires humans to become subservient to the apparatus. The apparatus controls and to a certain extent even dictates the behavior of the astronomer and it is through this handing over that the technology affords the astronomer the ability to measure the skies.

Hansen's tracings of the analog prehistory of the transformations brought about by twenty-first century technology are useful for how they draw attention to transformation in

human–technology relationships and how these affect how the world, and the universe, can come to be known. Joris' planetarium allows users to explore these relationships by providing access to visualizations of the solar system according to different explanations of how to imagine the relationships between the earth, the sun, and the planets by Ptolemy (c. AD 100 – c. 170), Copernicus (1473–1543) and Tycho Brahe (1546–1601). These historical articulations of the solar system are presented next to visualizations according to today's generally accepted understanding of 'how it is' with the solar system. The planetarium thus further foregrounds that what users encounter is not a transparent window opening up to outer space but technologically produced ways of imagining what the solar system must be like, and shows how each of the historical understandings mediate modes of understanding that are based on what is available to human perception in combination with what various tools and technologies have helped to discover. That is, they show the universe itself as a phenomenon that cannot be disjoined from the generativity of the human–technology configurations in which the world and the universe get articulated in an ongoing, open-ended process.

Note

1. http://www.crewonline.org/.

Disclosure statement

No potential conflict of interest was reported by the author.

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