MICROSCOPIC TRANSFORMATIONS: SCIENTIFIC VISUALIZATION, BIOPOWER, AND THE ARTS

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This paper examines the practice of looking and the biopolitics manifested in microscopy and scientific visualization. By simultaneously appropriating and subverting conventional models and notions of seeing, artists and the industry dedicated to visualization often trigger molecular, yet gradual changes able to transform the way in which we see the object of visualization, the concepts and notions that frame it.

Of Microscopes and Wonder

During ISEA 2010, science and arts collective Hackteria offered a DIY microscopy workshop that showed how to turn a cheap webcam into a microscope by simply inverting its lens. To complete this rudimentary though functional microscope, those who attended were given directions on how to build a microscope stage that had to comply with rather simple optics rules but had otherwise no aesthetic or material restrictions. The process concerning the collection of specimens and the construction of the instrument was unanimously considered empowering, enabling individuals with little or no technical knowledge to put together a functioning instrument. However, it was the moment the reverse webcam/DIY microscope was turned on and the mysterious world of the microscopic was suddenly revealed to the onlooker that caused most excitement. The workshop itself almost came to a halt, with mesmerized participants obsessively staring at a myriad of tiny organisms, suddenly made visible, busily making their way across the area magnified by the microscope. In the following hours, the participants kept going back over and over again to check on their creatures or trying different specimens to explore more of that unknown world. Equipped with LED and other simple electronics, they successively lit, stimulated and embellished this newly found mysterious world, to observe and wonder at its reaction and to turn it into a personal staged scene, a theatrical performance where the observer played the god-like director.

Proposed as a DIY workshop where technological instruments and scientific processes are demystified and détourned by artists and makers, Hackteria did far more than disclose the scientific principles needed to construct a homemade microscope and to introduce the participants to the new and unusual applications that this instrument could offer. The simplicity of the technologies used and the minimal operations performed during the workshop moved the attention of the participants from the technological aspects of microscopy, to the way in which default notions of seeing affect not only our approach to the object observed, but also how we build the instruments made to observe such object.

This shift fostered reflections on the significance of unveiling the invisible, an operation practiced in microscopy and scientific visualization and obtained by means of technological instruments such as the microscope (light or EM, depending on the magnification needs and the size of the object studied), and a variety of software packages like Tecplot [1], Vmd [2] or Chimera [3] designed for a range of distinct scientists and offering features that can be chosen according to what needs to be accomplished. How do

cultural assumptions and conventional approaches to seeing affect our reactions to the unveiling of the invisible? How are they reflected in the way these invisible objects are reproduced and re-created by means of the above technologies and software packages? Can these assumptions be rearranged?

Rearranged Context

The participants in the Hackteria lab were not indifferent to these dynamics, as their attitudes towards those tiny organisms captured by the webcam/microscope replicated exactly those default approaches to the invisible that many mainstream activities would invoke; mainly, an inclination towards "disembodied witnessing"[4], encouraging to interpret the microscopic world as alien and abject, resulting in a certain entitlement to manipulation and subjugation of the object to fit goals to their own benefits (or aesthetic pleasure) [5]. Yet, the nature of the environment, the minimal distraction posed by the technologies employed and the format of the workshop, which leaned towards self-reflexivity, facilitated a discussion about, and challenged, many of the cultural, scientific and goal-driven assumptions that creep into this and other similar activities.

The case of Hackteria is not an exception. A growing number of artists and creative individuals actively participate in scientific practices involving microscopy and the visualization of the invisible. To different degrees, they all manage to foster moments of reflection like the one described above, to create short-circuits, in the endlessly repeated narratives promoted by conventional modes of representation and normative rules leading to the visualization of the microscopic. However, the way that these short-circuits happen is rarely by means of direct critique or confrontation. In fact, most of these artistic initiatives seem to simultaneously implement and defy these regimes of knowledge. Artists participate in, rather than completely reject, the conventional rules existing in the sciences and in the cultural rituals of looking; being well-aware of the seductive power of the tropes that dominate their objects of research, they appropriate and exploit them. At the same time, they break these very rules and rituals, by relocating them outside the lab, by engaging the audience in debates about specific issues raised by their research, or by introducing slight changes that shake and induce reflection on problematic elements perpetuated by the above cultural/scientific notions.

Drawing upon a comparative approach that takes into consideration both conventional scientific practice and artistic elaborations in microscopy and scientific visualization, the purpose of this paper is twofold: first, it seeks to show how the above dynamics, both manifestation and subversion of a biopolitical regime that promotes an implicit homogenization of the message communicated by given practices of seeing, are also exemplified in many mainstream scientific operations that examine and visualize the invisible. The aesthetics and variety of scientific visualization in popular science magazines and science journals often reveal the urge to constrain, regulate and control visual expressions to serve a number of agendas. Thus, these visual expressions support and tiredly repeat old ideas of the microscopic as spectacle, other and abject. This inclination, however, is constantly ousted by a drive towards new ways of seeing, and towards challenging these notions, through subtle introductions of innovative elements (technological and conceptual) into the image.

Second, the above considerations confirm that the representation of the microscopic, whether it is done by an artist or by another professional is heavily mediated through, and not severed from, our cultural assumptions and notion of seeing. Works proposed by the Hackteria collective and by other artists like

Suzanne Edwards (whose work focuses on general microscopy), Luke Jerram and Caitlin Berrigam (who focused on the visualization of, and our coexistence with, viruses) are not exempt from engaging in the biopolitical mechanisms that characterize the scientific practices in which they are engaged. However, their location at the crossroad between the sciences and the arts puts them in the position to reveal with greater clarity those problematic areas and those assumptions that characterize the study and representation of the invisible. As a result, their work might be able to create dedicated spaces of debate, promoting public awareness of the practice of seeing, facilitating shifts in the already transformative fields of microscopy and scientific visualization.

Biopolitics of the Invisible

Using visual language, microscopy and scientific visualization are fully embedded in a system that mixes and exploits, on the one hand, technical information and "entertainment", and on the other hand well-established visual tropes and innovation aspiring to move away from these tropes. These aspects seem in opposition with each other. Yet, they coexist any time the microscopic is reproduced.

Historically, Stafford reminds us, "the division between a sensuous, pleasurable, or merely curious *watching* and a rational, tasking, language-driven *observation* arose during the eighteenth century"[5]. The entertaining nature of a scientific image portraying a microscopic organism ("enjoyable watching" [6]) distracts the viewer from the specific information ("exacting observation") provided by the image. However, the entertaining component also draws attention to the image, following a historical practice of seeing the object as the "spectacle of nature"[7], and as the work of god. The approach of the scientist towards the object seen through the microscope appears to be more the one of a voyeur than a detached viewer. The practice of observing organisms through a lens was an experience that combined a sadistic attitude towards the dirty and base, yet marvelous and fantastic, organisms under scrutiny, as well as a composed observation of rigorous scientific material on the invisible unknown where "mysterious animalcules with unexpected powers could be not only watched under the enlarging lens, but controlled and directed, even as they rushed by"[8]. The invention of solar microscopes that would allow many to observe minuscule worlds on a slide "contributed to the growth of a new and visual form of education heralded by the publication of scientific 'amusements', physical 'recreations', and useful toys"[9].

Today "There are a variety of potential uses for visual representation as a learning tool [..]The scientist, the science communicator, and the public use visual images in many of these capacities, as news and information about science is made available"[10]. Despite the rise of a new "instrumentalized" looking where images are produced to achieve goals and to communicate specific information, entertainment and aesthetics were never expunged from the scientific observation and rendition of the microscopic. In fact, the contemporary goal-oriented practice of microscopy has maintained an implicit aggressive approach to the space of the microscopic as a territory that can be colonized and dissected, subjected and manipulated. The object of study is treated as if it could be indefinitely manipulated through processes like staining, coating and freezing. This treatment is reflected in science magazines and journals, where microscopic entities are depicted in isolation, are artificially tinted with fluorescent colors, their shape geometrically enhanced as if they emerged from an alien world. This assumed otherness uncannily brings up memories of the colonial and postcolonial approach to the racialized other, and the apprehension towards the mysterious and base world of the exotic unknown [11]. This entitles the scientist to

manipulate microscopic entities without much ethical regret and entices viewers to express a voyeuristic curiosity not unlike the one manifested by their Eighteenth century colleagues.

The entities we examine through the microscope are translated as images, which "reproduce something recognizable, with which we are able to interact and that we can seize in their characteristics"[12]. These images are pieced together through a pattern of associations extending along history and culture, helping us organize our memory and our thoughts, enabling us to retain what we see by enacting more associations with other familiar images. The observer classifies an object and associates it to a variety of other forms and objects. This mechanism of self-regulation turns images and gestures into a communicable form of knowledge. Tropes and cultural indicators drawn from popular imagination (the fear for viruses, or the assumed dirtiness of other microscopic organisms are all characteristics evoked by the colors and shapes used to reproduce them on journals and magazines) have sometimes the ability to distort messages disseminated by labs or by scientific committees, by creating false assumptions and alarmism, and triggering stereotypical ideas of the microscopic as dangerous, filthy, monstrous. Yet these tropes and cultural references are needed. Eliminating these elements would hinder the recognition of a microscopic entity such as a bacteria or a virus or would obstruct the communication between scientists working in different areas of science, or between technicians and graphic designers.

The practice of microscopy and visualization are located in a biopolitical system, where the homogenization promoted by the tropes utilized, the claims of scientific objectivity and exactitude, as well as the well-established conventions that bind the activity of scientists and other professionals are constantly trying to catch up with an increasing variety of techniques, aesthetic experimentations and unconventional perspectives. Assumptions about the behavior, or the disruptive characteristics of bacteria and viruses are passed on and recognized across different images through patterns, colors and shapes, they areadded as familiar elements to the scientific data retrieved, acting as invisible agreements that allow the recognition of a particular entity. While any innovation in the visualization industry needs to acknowledge these elements, it also constitutes a continuous challenge to them. In fact, any slight modification to or elimination of a trope to validate a new scientific finding might throw the whole system in disarray, as the patterns of recognition that had been put in place are disrupted.

In Foucault's account, biopower refers to the "conjunction of strategies adopted by the state and a diverse range of institutions and agencies to constitute and govern the population, made possible by forms of specialized knowledge and self-governing participants"[13]. Visualization and microscopy participate in this system by appealing to a series of implied rules that are not imposed, but are needed to keep the whole system in balance. The above-mentioned historical combination of information and aesthetics in early microscopy simultaneously modulates and challenge the practice of seeing. In a similar way, the default patterns and conventions used implicitly govern and limit microscopy and the resulting visualization. Yet, the never ending renewing and upgrading of visualization devices and imaging techniques, voice the drive of scientific visualization towards engaging with incessant innovation, as well as the inability to come out with a fixed set of regulations on how the microscopic must be represented. The dialectics between these contradictory tendencies does not paralyze, but fuels the continuous renewal of scientific visualization and fosters new ways to approach the study of the microscopic.

Microscopic Transformations

As mentioned above, a variety of artists have engaged with the practices of microscopy and visualization. The Hackteria collective, as well as other artists such as Luke Jerram, Suzanna Edwards and Caitlin Berrigan have followed the trends of the industry: they can't escape assumptions and tropes utilized by mainstream science and understood by the general audiences. In fact, this seems to be the only way that works engaging with these scientific subjects can communicate with a crowd accustomed to deciphering scientific messages by using common patterns and by assuming a quasi-colonial approach to the objects represented. The focus of these artists is on triggering small innovative changes that reflect on sometimes-unnoticed details in the production of microscopy and visualization. This proves effective in shaking assumptions that had never been questioned before. Thus, following this principle, in a series of glass sculptures reproducing the molecular structure of well-known viruses, from HIV to SARS, glass-blowing artist Luke Jerram eliminated coloring, and with it, a number of assumptions that are normally evoked when fluorescent colors are used to represent microscopic organisms. Indeed, Jerram's colorless sculptures trigger a series of reflections regarding the role of colors in the molecular visualization of viruses. First, this choice dissipates the wide-spread idea that the colors embellishing pictures of microscopic entities are natural and not artificially applied (for technical or ideological reasons). Second, if the choice of colors to portray a microscopic substance can influence the way in which we see and interpret the image, then, eliminating one of these elements has the potential to underline the extent to which such practice reflects and, in turn, "adversely distort the opinion of the viewer" [14].

Similarly, Caitlin Berrigam' molecular models of the Hepatitis C virus, faithfully reproduced "from a magnified 3D cryoelectron micrograph" found in the Protein Data Bank, were sculpted using chocolate, and offered to the gallery goers to test their "desire to eat the enticing chocolates mixed with a repulsion for the infectious virus"[15], and thus, to challenge popular assumptions of contagion and virus-human coexistence. While the accuracy of the appearances and the material used, chocolate, triggers anxiety regarding Hepatitis C and its means of transmission (apparently some spectators had to be reassured that the chocolate candies contained no virus), the edible form of this particular representation definitely exposes the uncanny familiarity and ubiquity of this virus, with which many people often silently and secretly, sometimes unknowingly, coexist. Berrigan's decision to use chocolate is, according to the artist, an **"**approachable way to ignite discussion and facilitate awareness in public environments" [16].

Like Jerram and Berrigam, Suzanna Edwards' series of micrographs focused on the rendition of the microscopic object and on the effect that processes, instruments and assumptions have on the way we represent and we see such objects. Using an old stash of Nineteenth century slides she had found in a charity shop, Edwards took digital photographs of selected specimens which she submitted to a number of different microscopes (from light microscopes from the Nineteenth century to modern electron microscopes) "documenting and utilizing each stage of microscopy development"[17], and illustrating how the image of the specimen reproduced by each microscope was transformed according to the instrument and magnification used. When we see an image reproduced through a microscope on a science magazine, seldom are we told what type of microscope has been used or what processes have been utilized to obtain such picture. We are never shown how other microscopes would portray the same object. While Edwards' archival work doesn't fit the immediate agendas of science, it carries both educational and historical significance and may benefit both scientific and popular audiences. In fact, by exhibiting a variety of micrographs that expose the processes that lead to the visual representation of the

scientific object, it manages to redress the assumption that these images reflect an immutable, standardized, and "verisimile" reality: it shows how the object, once portrayed by the microscope and passed through editing, technological manipulation and conventional analytical approaches to seeing cannot be understood as neutral.

Regardless of their diverse topics and goals, the above artworks have the ability to lay bare unquestioned issues in the practices of microscopy and visualization. This is achieved by displacing and appropriating these practices and by turning them into creative gestures and artistic experimentations. Science is relocated outside the lab and turned over to the collective reflection of individuals, who might or might not be aware of issues concerning microscopic organisms and the practices that lead to their visual display (in galleries, cultural gatherings or groups of discussions). These artworks may become effective in producing different levels of molecular transformations: they enable the artist to expose specific and novel aspects regarding a microscopic phenomenon and the way we observe it that conventional visualization could not be able to do; they indirectly affect the aesthetics concerning the practices of looking and the very scientific production of images in science.

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