Nanotechnology’s Molecular Landscapes: Re-seeing the Trope of Invisible Worlds

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Today I’d like to look at some of the features of the images posted on the conference web page “molecular landscapes,” such as this one, entitled “A Copper Perspective” from the IBM-Almaden Visualization Lab web site. This image suggests a landscape, referring to perspective literally through its title and pictorially by the shadowing as well as the inclusion of a blue background and the coppers and browns of the foreground. All of these aspects have been added to highlight the differences between data points so that the overall effect resembles a canyon or mesa. In fact, when I showed this image to a colleague from the American West without telling him anything about it, he exclaimed, “Oh, where is that?”

Another image from the web site with which you are familiar, “Memorable Clues,” from the National Nanotechnology Initiative publication, “Nanotechnology: Shaping the World Atom by Atom,” also explicitly connects this image to a landscape, calling what seem like protrusions “mesas,” albeit unnaturally-occurring blue and green ones, that seem unearthly, like Heckl’s landscape also in the conference image collection. As we know, these images are not photographs or representations of objects, but are
expressions of data matrices, measurements of surface phenomena collected by the scanning tunneling microscope, for example, and image-processing software like Photoshop or MATLAB. Therefore, as we know from understanding the STM imaging processes, color, shadow, and other attributes that are suggestive of landscapes have been added by the researchers or image processors. Why make this explicit connection to landscapes? What work does it do? What do these evocations of new worlds or molecular landscapes contribute to audiences’ understanding and organization of nanoscale phenomena? How might this affect how we envision nanotechnology’s possibilities? These are a few questions I’ll take up in the next few minutes. I’m particularly interested in how these images work for viewers who may see them but not necessarily use the microscope.

This is important to pay attention to because, as I’ll argue, these images participate in a descriptive strategy employed by many nanotech images but also texts. Here’s one example, a comment Gerd Binnig makes in his and Heinrich Rohrer’s Nobel Prize acceptance speech, where Binnig describes his reaction to seeing their first imaged 7x7 Silicon images: “I could not stop looking at the images. It was like entering a new world. This appeared to me as the unsurpassable highlight of my scientific career” (399). I argue here that the link to landscapes, and so to invisible or newly visible worlds, should be viewed as a rhetorical strategy that performs powerful argumentative work. In the next few minutes, I aim to show how it does so in these nano images by comparing their use of landscapes and worlds to a trope common in more conventional microscopy. My comparison also shows an additional influence which I argue expands this trope in these nano images. I’ll conclude by very briefly considering what such an approach reveals about how these images make different arguments than conventional landscape microscope images, and also what these images argue about nanotechnology’s possibilities.
One way of reading this connection to landscapes or worlds is in terms of a common trope in microscopy since at least the 1665 publication of Robert Hooke’s *Micrographia*. I’m reaching back to Hooke because he too was depicting what had not really been seen before, as the microscope was still a new instrument. As Hooke explains in its Preface for example, “there is a new visible World discovered to the understanding....” Additionally, Hooke also uses pictorial landscape conventions to frame some of his drawings of microscopic observations, such as this image of blue mold (plate opposite page 125). This connection to a landscape or other world provides a conceptual frame for explaining two intertwined ideas: First, it allows microscope users to explain the less imaginable—the microscopic—in terms of the imaginable. This trope therefore helps render the “landscape” as a recognizable given, a backdrop against which objects may appear.

In Hooke’s case, this landscape or new worlds trope helps explain what microscope users should see, an important job considering that anyone who did use a microscope to see mold similar to this image of Hooke’s would discover a big difference between Hooke’s image and what they saw: early microscopes themselves frustrated any idea of transparent viewing, partly because of optical illusions and distortions that were an integral part of these instruments. Also, viewers can’t confirm with their eyes that what they see with a microscope really exists. This trope then allows microscope image viewers to imagine similarities between the world they know and what the microscope images describe, and so imagine themselves navigating such a space. The trope then helps the microscopists’ work gain credibility while also answering the questions of authenticity that have always accompanied descriptions of objects unverifiable by the unaided eye. Second, this connection helps communicate what has been learned about
phenomena as well as implying what is still left to explore, helping to evoke both wonder and excitement about what is already discovered as well as what is left to discover.

Reading STM images’ landscapes

So, can we read Binnig’s and other nanotechnologists’ uses of this “molecular landscapes” trope in this same vein? This conventional microscope trope seems to explain this occurrence in nanotechnology. For example, we can read Binnig’s statement that seeing the Silicon 7x7 images was like entering a new world in this way. In conjunction with the visual landscape connection, metaphors common in text explanations of microscope images, describing phenomena in terms of “hills,” “steps,” and “terraces,” also occur in descriptions of STM images in scientific journal articles [for example, see Stoll 68; Kushmerick et. al; Binnig and Rohrer “Scanning Tunneling Microscopy” 361; and Salling and Lagally 503, for example].

However, some other characteristics of these landscapes suggest that a different connection adds to the nano-molecular landscape trope, and argues for an additional vision of the nano-world. (Next I’ll explain this different connection before explaining this additional vision.) In the case of these “molecular landscapes,” the impulse to imagine oneself navigating such a world and interacting with what is found there intensifies because of how these images are produced by both the microscope and imaging programs like Photoshop.

One vivid example that at first seems to participate in the conventional “new visible world” trope, yet complicates it, is an image of what its creators call a “quantum corral,” also appearing on the IBM-Almaden Visualization Lab web site in the “Corral Reef” room which we have heard about today already. This image positions us viewers so that we peer between pointed atom peaks across the rippled floor towards a far row of atoms. This “corral” image resembles a
landscape image, yet the landscape view communicates more than the idea of a new world. The web site’s text accompanying this image points to this departure: “[t]he discovery of the STM’s ability to image variations in the density distribution of surface state electrons created in the artists a compulsion to have complete control of not only the atomic landscape, but the electronic landscape also.” Here the “artists” point out quite explicitly how they have not discovered this “landscape,” but instead have created it.

Therefore, while this image’s use of landscape does perhaps at first suggest a three-dimensional space similar to our everyday “macro” world, the image also adds another layer to this perception by emphasizing the user’s hand in creating this space. This is communicated in particular through the artists’ mention of “complete control” and in creating this space out of electronic features, not topographical ones. What becomes particularly slippery here if we only think of these images in terms of this older convention is that following the trope of “new visible worlds” similar to the macroscopic world suggests an analogous relation between these spaces. In fact, this simple analogy between two different scales through the spatial trope of worlds becomes problematic in the case of the nanoscale, because of atoms’ and molecules’ different behaviors at the nanoscale and the micro- and macro- scales. The analogy between nanoworld and macroworld obscures the changes that accompany shifts in scale, which, because of these different behaviors, are more difficult to bridge in reality than in image or language. Therefore, the analogy created by the microscope’s new worlds or landscapes trope obscures the nanoscale’s unique characteristics and also suggests an easy, yet less-than-accurate, comparison with the macroworld. This conventional microscope trope also hides humans’ participation and role in creating these images, and also in the case of the quantum corral, the landscape as well. Therefore, what we get from assuming that this trope is the same as that of the “new visible
world” of conventional microscopists is an established frame with which to understand these images. This may seem useful in communicating to non-scientists; however, this understanding obscures nanotechnology’s newness as well as our ability to participate in its—and these images’—creation.

**Nospace as Digital Space: Computer-generated spaces**

However, I suggest that there is another factor at work in these images’ (and nanotechnology’s) spatial tropes such as this one of landscapes or worlds, that does emphasize this manipulation while de-emphasizing the simple analogy to the “macro” world. Evelyn Fox Keller has argued that microscope users have always engaged in some manipulation as they prepare specimen samples for viewing: the STM apparatus and image production processes intensify this engagement between movement and manipulation so that what emerges is what we could call a co-created image, and a co-created nanoworld.

This idea of co-created world centers on the computer’s properties of allowing interaction with images as interfaces, [such as the ubiquitous desktop that has trained most of the Western world to interact with images as interfaces]. This interaction creates different effects on viewers and creators than simply viewing an image. One effect of the computer’s use for imaging (and the ability of computer users to alter images they create almost instantly) is that, as art historian James Elkins suggests, how we conceptualize space has changed. Writing about artists’ and illustrators’ tendency to create simpler, less complicated computer images, Elkins observes, “The lumpy, crowded spaces of Western painting have been replaced by the sheer, limitless spaces of contemporary graphics” (“Art History” 335). Here we can contrast the ordered planes of the STM images to the lumpiness of Hooke’s drawing, for example. Elkins
explains, “[c]ontemporary computer artists and scientists make a point of emphasizing the infinite, homogeneous and isotropic qualities of rational space” (340).

The newer, computer-generated characteristic of limitless space adds to and so changes the trope of the molecular landscapes and newly visible worlds. This aligns the nano-landscapes with other computer generated images like those produced by virtual reality programs where the user also moves across or over a data matrix, allowing the anticipation of an endless participation between pixels and person. The ability to adapt the image also allows image creators and viewers to develop practices of anticipating that the image may change in part due to their responses. This allows both creators and viewers to envision many possibilities for exploration, intensifying the viewer’s sense of immersion, of contact, with what the image shows.

However, association with computer-generated imaging raises questions for scientific images in that issues of authenticity and image credibility occur even more insistently than with traditional microscope images. While traditional microscopists have answered the charge of authenticity and credibility in part with the analogous relation of the “new visible world” to the macroscopic world, as I pointed out above, this strategy does not work as surely when images—and atoms—can be manipulated. Making these images overtly computer-generated, and so linking them to these limitless, digital spaces offers one possible solution to this authenticity question as well as to the problem of shifting scales through the articulation of what the computer does create as a world, as I’ll briefly explain next.

As anthropologist Stefan Helmreich has noted, from the 1970’s on, computer programmers also began to call simulations “microworlds,” perhaps, as one of Helmreich’s scientist informants suggested, influenced by physicists’ views of quantum mechanics (75-6). These simulations, considered self-sufficient worlds within the machine, allow for consistent
events to happen within their worlds. As Helmreich observed among the artificial life researchers he studied, “This notion that computers can contain separate, closed worlds came up again and again, and was one of the rhetorical moves people used to grant simulations their own ontology” (78). This linking of worlds, Helmreich argues, has become stronger, as the notion ‘microworld’ has shifted to “artificial world” emphasizing the world’s self-contained independence (71).

The version of the computer-generated nanoworld takes into account the gulf between the nano and macro worlds by positing a separate world at the nanoscale. This world, like those of the conventional microscope trope, allows researchers to immerse themselves within it. However, it also allows them to explore at the same time as they might create structures in it. Therefore, if we see these images in terms of computer-generated worlds, they do not only document an area that has been explored: but they themselves form interfaces for this exploration for the viewer as well as the user. The combination of the STM’s imaging process and the images’ production process through graphics programs to highlight certain data emphasize just this exploration: images of the nano-world are not only artifacts like photographs snapped of a foreign land—they are explicitly tools with which experimenters and possibly viewers can build that land as they experiment. This emphasis on experiment, leaning on computer-generated images’ possibilities for interaction, change this trope from its focus on recognition—the new visible world that is similar to our world, as Hooke’s image portrays—to a world whose limitlessness and invitation to the process of imaging invites its viewers to explore. Here the nano-landscapes’ very artificiality—the different colors and unearthly structures, for example, as well as the image planes stretching into the distance, emphasize this difference.
Conclusion: what this tells us about nanotechnology

In conclusion, I suggest that the trope of molecular landscapes and new worlds used to articulate the nanoscale communicates more than the conventional microscopical “new visible worlds” frame with which to understand what is found there. Instead, they also communicate connections to computer-generated virtual worlds. The makers of these images include a fundamentally different aspect: following the idea of computer-generated worlds, they do not stop at showing such “new terrain” but also emphasize their manipulation through altering and creating structures like the “corral.” In this way, they create the nanoworld quite visibly. It is this action, this ability “to fabricate on the atomic scale”, that Don Eigler for example suggests generates excitement: he explains in an essay, it “can best be viewed as a tool which the scientist can use to explore intellectual terra incognita. It is the excitement that comes from this exploration that ultimately is the real driving force for building things with atoms today” (Eigler 427).

Like the “IBM” image, images of molecular landscapes like the “corral” image as well as to a lesser degree these on the conference web site reach viewers other than those reading scientific papers, and the landscapes and new worlds they evoke help create visions of what the nanoscale may look like, framing our relations to nanoscale phenomena and the discourses that run through it and around it. What becomes visible, given this additional layer of computer-generated virtual worlds added to the conventional trope of microscopic worlds, is that the “nanoworld” is a world that we co-create: we can touch and experiment with it, these images argue, but also, we learn to navigate it as we create it.
Works Cited

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