BROAD INSTITUTE

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SPOTLIGHT: GENOMICS THROUGH THE EYES OF AN ARTIST

By Daniel Kohn, Artist-in-residence

"Towards Brooklyn 3," by Daniel Kohn, installed at Grand Central Station

My partnership with the Broad did not begin with any literal connection between my own art and scientific imagery. While some artists today incorporate science by depicting cells, petri dishes, or biological processes, I have always been more interested in places, both the outward appearance of a space and the intangible qualities that are invisible yet somehow perceptible. In the past, I had painted locations like my family's old farmhouse in France and views from the World Trade Center (http://www.kohnworkshop.com/gallery.php?gallery=72157603736438677), displayed at New York's Grand Central Station in 2002. One could say that both of these series are structured around our physical and emotional relation to "place." The place of science, though, had never been a subject of my work.

"After Dinner in 1997," by Daniel Kohn

It was through one of these site-specific projects, a series of paintings (http://www.kohnworkshop.com

/gallery.php?gallery=72157603743025251) commissioned by the Wheatleigh Hotel in Lenox, Massachusetts between 1997 and 2001 that my partnership with scientists began. In 2003, Broad Cancer Program director Todd Golub emailed me to say that he'd seen my work at the hotel. He speculated about the connections between Art and Science, which are usually seen as distinct, even opposite pursuits. In those early email exchanges, we found that we shared a common perspective: both fields can be fundamental in nature, each seeking to create a vision of the world within a historical tradition, using the tools of that tradition, and to communicate that vision to others. Todd expressed the need to both explore dimensionality and communicate a world-view to others, and I realized that this description of science echoed my own concerns as an artist.

Our conversations on the two cultures led to an invitation for me to visit Todd and his fellow researchers. I was becoming aware of the increasing role of genomics in our everyday lives but had little idea what kind of work Todd and his team were actually doing. I accepted his invitation and soon started visiting his lab on a regular basis. After a year or so of short, informal visits, it seemed that a more sustained residency at the Broad would be the best way to plumb some of my questions. In particular, a residency would give me extended time to meet scientists and a location to work in. The recurrence and regularity of these visits also would allow Broad members to have an extended dialogue with me, rather than a one-time encounter.

Artist among scientists: a chance encounter spurs an unusual collaboration

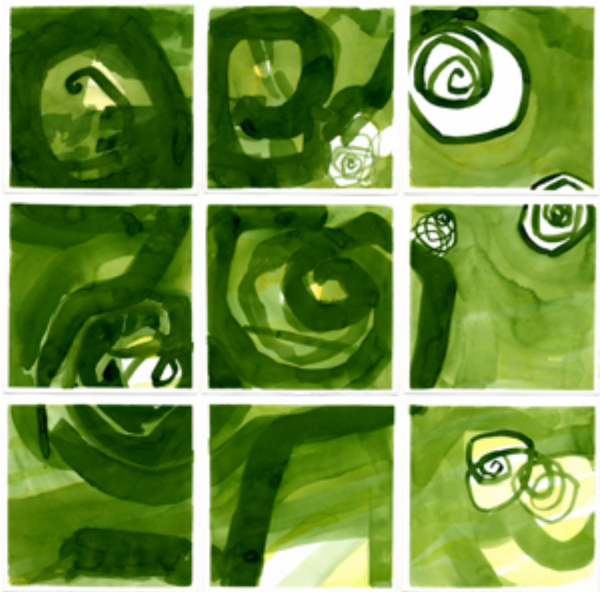
In December 2006, a yet-to-be-occupied half of a research lab was converted into my art studio. There I spent one week each month creating my own work, with scientists just across the laboratory performing experiments. As an artist among scientists, I was able to collect ideas and collaborate with members of the Broad community. I was especially curious about how scientists depict their work visually. Scientific images are interpretations of a reality which takes different forms for different observers from different perspectives. During a meeting with Stuart Schreiber, director of the Broad's Chemical Biology Program, I saw this first-hand. Stuart pointed to a model of a molecule and said, "I know that this is not real, but a figment of my imagination." In my opinion, scientists like Stuart are successful, in part, due to their ability to accept this dual nature of scientific reality: invented, yet real and useful.

Art studio in laboratory
Photo by Daniel Kohn

As someone who has devoted his career to exploring visual issues, I wanted to experiment artistically with the thought processes of genomic research, digesting ideas by trying things out visually. To do this, I engage in active discussions and debates with researchers, while allowing the science to wash over me. Making watercolors from the accumulated information allows me to discover what shapes the science might take in the space of my own work. Watercolor

"Watercolor sketch, 10-8-07#19-27," by Daniel Kohn

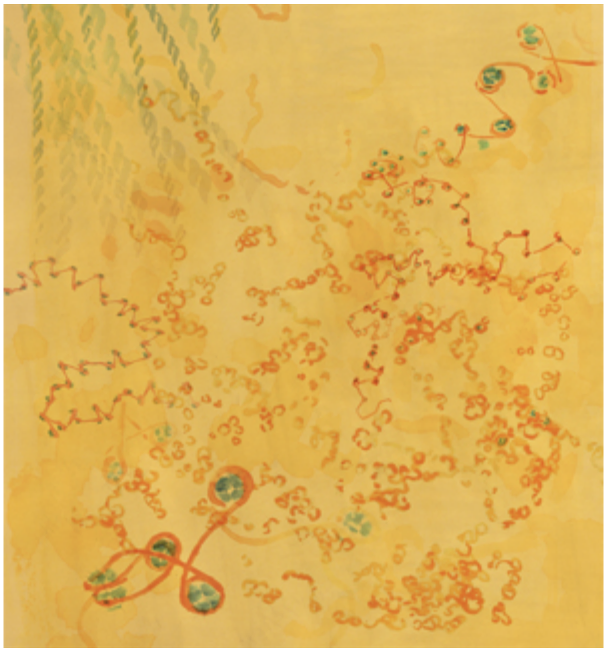
As an artist, you're allowed to let your mind and body run, even if you don't necessarily know where it's going. So, I throw ideas in the pool of thought, and from the ripples they form, hope to approach a new understanding. Talking with Damian Young, an organic chemist, led me to make networks of interconnected lines evocative of a chemistry



modeling kit, which helped me to better understand the relationship between atoms, covalent bonds, and atomic orbitals. After listening to computational biologists talk about the genome as a linear sequence of A's, T's, G's, and C's and struggling with the idea of a genome reduced to a string of letters, I made some watercolors based on parallel lines. A series of discussions on epigenetics — the study of heritable factors like chromatin or DNA modifications that do not involve the actual DNA sequence — led me to explore spirals and shapes based on chromatin structure. In this way, I play with ideas until they click, visually integrating complex information and generating my own insights in the process. The practice of making images is a slow and meandering one. I actually spent about two years meeting with scientists before I felt ready to start experimenting visually with the ideas. Today I'm still listening and experimenting, and working towards a deeper understanding of genomic concepts.

During my time at the Broad, I also hoped to help the researchers invent new ways of representing science. In one of my first such collaborations, I joined Bang Wong of the Communications Group to work with Brad Bernstein to develop graphics on the topic of epigenetics. I was excited about this project because it was my first time hearing about the metastructure of the genome, a twisted shape more complex than the double helix now so familiar. It was also a first foray for me into thinking visually in this new space, as well as a good place to collaborate with Bang, a visual thinker who is much more versed in biology than I am.

Western science, by nature, tends to isolate the system it is studying from its environment. Until now this has been one of its strengths. Scientists can talk about the "organs" of a cell without mentioning the cell itself, and in the realm of genetics, DNA is almost always isolated from the genome's epigenetic features. The context is assumed. We often see the genome as a one-dimensional string of A's, T's, G's, and C's, when in "reality" it is a three-dimensional chemical structure with shape and action and a place in the cell. To work around this we played with different ways of contextualizing this process, finally settling on the idea of sizing the elements — DNA, histone proteins, cells — so that each element is mapped within the next. The resulting image illustrates epigenetics in a new, contextual way.



Epigenetic watercolor by Daniel Kohn and Bang Wong

This experience underscored the rising importance of dimensionality to contemporary science. This is a dual problem, involving both understanding and communication. How do you conceptualize and manipulate a space in many dimensions? How do you collapse that space into the two or three dimensions that we have evolved to navigate intuitively? And how do you represent it in such a way that it is understandable to others?

This line of questioning was put to use during a collaboration with Ben Ebert and Aravind Subramanian on their project to develop a new kind of map that details how common stem cells differentiate into a variety of specialized cells. The researchers were attempting to superimpose a very large amount of molecular information onto the traditional map, which is a branching tree of cell types connected by lines. I had two initial responses to this challenge: shift the scale and make it dynamic. To overcome the limits of a traditional 8½-by-11-inch sheet of paper, I wondered what would happen if they expanded their map onto the 15-foot wall next to their office, or if they might consider a dynamic, computer-based, interactive map, which would unfold in response to the viewer's inquiries.

In my search for relevant tools, I found a computer data visualization program, which used multiple windows to view connected data. In this interface, the user can make a selection in any window and see it reflected in the other views. By adding multiple layers of linked information, the graphics can reflect data from multiple viewpoints, allowing researchers to make connections that weren't apparent in the single, static two-dimensional view.

Exploring this dynamic view brought me to wonder about time-based networks. A typical view of networked elements, such as genes, will show all measured relationships between the elements. In a complex process, such as stem cell differentiation, this leads to what is expressively called a "hairball," where there are so many connections that the parts are no longer visible. By giving time properties to the edges in such a network, one could begin to see operative connections for a given time point or cell state. These actual links may be more informative in this context than the full set of all possible connections (in this case, less is more). We later discovered that computational biologist Aviv Regev, one of the Broad Institute's core faculty members, was working on precisely this problem, and the researchers are now collaborating on this "cell differentiation map" project. The map is still being developed, but it was extraordinary for me, as a non-biologist and visual thinker, to interact and participate in the brainstorming that may lead to something truly innovative.

An artist explores the genome

During the residency, I eventually began painting on 3-by-3 grids of 8-inch square sheets of paper, which I then scanned into my computer. Not only did the work allow me to explore what I was learning about science, but also I had unwittingly developed a "high-throughput" drawing process, which seemed to produce a form of experimental data. The process yielded a database of serial images that could be shifted, sorted, analyzed, and reworked in a variety of ways. When reorganized, my images produced patterns and shapes that were surprising and sometimes more enlightening than the original.

From the data, I can discern patterns, and from patterns, we can extract new meaning. In the same way that experimental results can raise more questions than they answer and lead to new hypotheses to be tested, an image in my database could be removed from its original series and serve as the seed for a new grid. Within the digital environment, I can even remove a mark from a painting and begin a new one around that single element. The database has thus become a way for me to use image-making to process the science that I've learned and a unique, multi-dimensional tool in the creation of images. Daniel Kohn

Daniel Kohn
Photo by Maria Nemchuk

Through my own experiences moving around the globe and adopting new cultures, I know how long it takes to learn the shape of a new space and transform it into something significant. Clearly this is only the first stage of my investigation; I call it my *défrichage* — the French word for the clearing that happens before wild, forested land can be planted. I know that the images I have created so far are only superficially connected to the science being done here, but they are also a necessary point of departure. My ultimate interest is in finding visual analogs for complex ideas in the genomic sciences, and through them to discover emergent features of a larger world-view in today's culture. Just as my time as an artist-in-residence at the World Trade Center had lasting effects on my process of making art, I know my experiences at the Broad will shape my work for years to come. If I am successful, I, too, may leave a mark on the institute by giving members of the Broad community a better view of the "space" of genomics.

Too often, science and art are spoken through their antagonisms — science deals with truth, whereas artists deal with ego and expression. But for myself and many other artists, our pursuit is not one of personal expression, but of interrogation. As my time at the Broad progresses, I see with increasing clarity the confirmation of the initial intuition that Todd and I shared: that science and art are about knowledge, and that collaborations such as this one can deepen our understanding of this beautiful and complex world.