Welcome to the Center for PostNatural History:
Rich Pell in Conversation with Emily Kutil

MURALS MAKE BEAVERS FEEL AT HOME

Beavers in a den at the Belle Isle Zoo, in Detroit, Mich., now cavort amid scenes resembling their natural habitat. To minimize the artificial appearance of the surroundings, an artist reproduced a colorful forest panorama, complete with pine trees, scrub brush, streams, and lakes, upon the concrete walls of the open beaver pit. Visitors are attracted by the novelty of viewing the animals against a woodland background.

Description at the entrance:

Welcome to the *Center for PostNatural History*. More than 10,000 years ago, humankind first succeeded at raising wild plants and animals in captivity. By breeding plants and animals for traits that we desire, humans have also influenced their evolutionary path, altering the form and function of the living world in surprising ways. The word "postnatural" refers to the living things that have been intentionally altered by human beings, through domestication, selective breeding, induced mutation, and genetic engineering. These include familiar entities such as farm animals, pets, food crops, racehorses, decorative flowers, and laboratory organisms. Unlike the life forms on display in a natural history museum, postnatural organisms can also be viewed as instruments of culture. They are living embodiments of human desire, hunger, power, and fear. Please continue on the self-guided tour. Questions and suggestions may be addressed on the blue cards available near the exit.

Emily Kutil First, could you describe postnatural history? How does it differ from natural history?

Rich Pell The postnatural includes all the living things that were intentionally shaped by people in some heritable way. We have defined this idea not so much as a geological period, or anything that has a hard dividing line; the postnatural goes back all the way to the dawn of domestication and selective breeding, and continues through to contemporary genetic engineering and synthetic biology.

An organism crosses over from the natural to the postnatural at the moment it begins to share its habitat with us—when we move in together. When dogs stopped living out on the prairie and started living in town. The other, more extreme component of this transformation is when we take responsibility for the sex life of that organism. This is where selective breeding comes into play. When we begin to decide who gets paired off, who is included and who is not, these organisms begin to change dramatically. And those changes are quite often a reflection of human desires. They're cultural choices, based on aesthetics and taste, and even sport, entertainment or religion. This extends to industrialized animals. In the US, we breed our chickens for uniformity. We also breed them for fat content and things like that. But above all else, they have to be virtually identical so that they fit into the machines that we've built to process them.

We look at the postnatural world similarly to how one might look at the architecture of a civilization, and try to infer things about the values of that civilization. We're looking at how that civilization has shaped its world.

EK It's an investigative process, then, in a sense?

RP It is. We put things under the microscope; we research the context, the circumstances that created what we are seeing. We are always reverse-engineering the things we are looking at. We start off with something that seems incredibly boring on the surface, and it often leads to really extraordinary stories.

EK One of the most striking things that I saw in the museum was the collection of books of standards of different species. You talked a bit about industrialization, the desire to standardize things. But some of the books were for show animals. It seems that there is almost a desire to fix the animal in a certain moment of development.

RP Absolutely. This is a very Western way of looking at things, to create hard and sharp categories that separate, for example, five different kinds of "poodle." We codify exactly what the traits are that define each of those different kinds.

At one point we had an exhibit of publications such as *The American Standard of Perfection*, which the poultry industry has used for 100 years, and *Variations in Dog Breeds*, which the American Kennel Society put out in the 1960s. For almost every breed, there is some kind of publication that tries to be the standard-bearer of what is and is not good within that breed.

This crosses over into laboratory sciences as well. We have quite a lot of publications called the *Mouse News Letter*, which goes back to the 1950s. Mouse researchers all over the world used this to compare notes, describing the mice that they had in their collection, and the sorts of mutations that were arising. This is how standardized names started to appear for laboratory animals.

EK Is the postnatural being discussed in contemporary zoos and museums of natural history? How do organisms like this fit within the taxonomic systems used by these kinds of institutions?

RP A lot of people haven't noticed this absence, but natural history museums tend to avoid or downplay domesticated animals. If they are there at all, they are a kind of a footnote or sideshow. Museums almost entirely ignore twentieth-century laboratory organisms. There are a few reasons, I think, for this. One of them was exemplified by an exhibit over at the Carnegie Natural History Museum which described what an "artifact" is. They said that an artifact is a man-made object, and so they showed an iPod. "Is this an artifact? Yes." And next to it they showed a raccoon skull. "This is not an artifact." That's where we differ, and where we show up. I'm willing to go along with the raccoon skull, but I would put that alongside a Chihuahua skull. I would say, "This is an artifact." Prior to human intervention there was nothing in the wild that looked like a Chihuahua. A Chihuahua is a long way from a grey wolf. This layer of human intervention is what defines the postnatural for us.

There is also the issue that natural historians are asking a different set of questions. They want to know about ecology, evolutionary history, perhaps climate. Animals that were raised in captivity, from their perspective, are almost like *bad data*. Also, on an intuitive level, natural historians find animals raised in captivity to be incredibly boring. I found this attitude across the board, whether I was talking to reptile people, mammal people, bird people, or plant people. The kinds of organisms that I was researching were just beyond the pale. "How could you...why would you...?" If I asked people who have spent their whole lives studying squirrels about laboratory rats, they would just shake their head in disbelief.

You asked about taxonomy. The whole project of the Center for PostNatural History started from a taxonomic perspective. Initially, I was reading a lot of evolutionary history at the same time as I was reading about synthetic biology. I was reading about how we map out the evolutionary tree by looking at genes, and I was learning about how we take genes and add them to different species where they haven't originated. And I started to think, how does that affect the shape of the tree? Is there a way that we could map out these

changes? We're taking a leaf of the evolutionary tree over here and duct-taping it to a branch over there—what does that look like?

I found that there really isn't a vocabulary for doing that. Even among scientists themselves, each lab has a different system for describing organisms. There was no system that could put them onto a larger evolutionary tree. Our first project was to try to fill in that space.

It proved to be a much larger space than we expected. There are hundreds of thousands, if not millions, of new, genetically modified varieties all over the world, too many to track. I was intrigued by the near impossibility of creating such a system. Various proposals have been made along the way to try to classify these transgenic organisms as sub-species; people have developed acronyms, so you would have genus, species, and then a long hyphenated thing after that. But these names are cumbersome, and nobody really uses them.

There is also the issue of visuaizing this tree. What shapes does the tree take? Our logo is a binary tree (an evolutionary tree is almost always described as a "binary tree") with an arrow going from one branch to another, representing transgenic gene flow, and also sort of completing the tree.

CENTER FOR POSTNATURAL HISTORY

EK So is there a taxonomic ambition for this museum? And what would that taxonomy actually be?

RP We're open to a taxonomy emerging from the bottom up, from the collection. We're continually discovering the postnatural to be larger and more complicated than we had anticipated. If we came up with an overarching scheme of representation, it would constantly be broken. But we are also surprised by the common threads we find in the collection. One of the first things we did was build a database of genetically modified organisms, the genes that had been added to them, and where those genes came from. Just by entering maybe 50 organisms into the database, we realized that the genes were actually coming from a very small subset of organisms. They were coming from E. coli, the plant *arabidopsis thaliana*, on occasion from mice, from the C. elegans worm, from *drosophila* (fruit fly), from zebrafish. These are all considered model organisms. They're what we use in the lab, so they're the organisms that we know the most about. And as a result, they're the organisms that we take our genetic "parts" from. We found an unexpected taxonomic order already in place because of the relationships to these organisms that humans had already established over the last 50 years or so in the lab. And the reason we had each of these organisms in the lab in the first place was because of the relationship we had to them for maybe the previous 100 years. Hobbyist breeders were breeding lab mice and lab rats for different coat colours before anyone even understood how Mendelian genetics worked. The tobacco plant is also a standard model organism because humans have been breeding it for so long, and we've been breeding it for so long because we like tobacco.

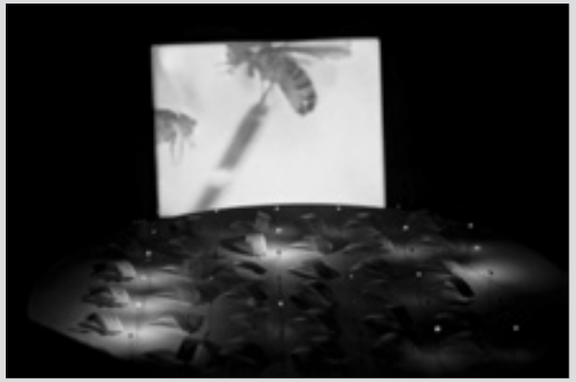
Every time we tried to map out an overall taxonomy, it started to look like culture more than it looked like the natural world. If we were to map out where these organisms live, they all, not surprisingly perhaps, would map out primarily to urban places, and also to ports. They map out to universities quite often. Almost any angle we take leads us to a cultural frame.

Our taxonomy is still in process, and probably always will be. We're using a system now where we just give objects numbers based on the day they've been added to the collection. We'll probably revisit that at some point when we have a large enough collection to come up with a more general picture.

EK Could you give an example of how the process of genetic research works?

RP We have an exhibit of fruit flies that were engineered in a lab in upstate New York. Fruit flies are important for genetic research because they have a short lifespan. Scientists can tweak a gene and fairly quickly have a full-grown adult animal that will express that gene. These fruit flies were all bred just to figure out what a single gene does. The scientists micro-injected a bunch of fruit fly embryos with a certain muscle gene, raised them to adults, and then dissected them for that muscle gene. It's sort of a mechanical, reductive approach to looking at genetics. Those tiny flies are dissected under the microscope just to get one muscle fibre out. As a result of this experiment, we discovered that the muscle gene

controls their wing muscles and makes them really weak. They never develop into the adult stage, so their wings fall off.



EK

What is the motivation behind discovering what this one muscle gene does?

RP

It's really just about understanding gene function, understanding how this one part works. It's impossible to study that one part by itself—it's like trying to study what a car part does without knowing anything about the rest of the car. So maybe we'd make a car that doesn't have that part, and then maybe we'd make a car that has too many of that part, and then we would use the results to infer what the part might be doing. This is how a lot of genetics works. It's reductive. We make a million of something in order to guess.

It's a very noisy, random process. With bacteria, it's very easy to use something like electroporation to try to get a gene into a million cells at once. We know that one of them will work, even if we're only interested in that one. But with something like a goat or a sheep the process is long and expensive, and it makes a lot of damaged goat embryos before it makes one that works. We're adding a part, but we don't have a lot of control as to where it goes in the machine. We're adding a carburetor, and most of the time it ends up on the backseat. Sometimes it's hooked up to the horn, and sometimes it's in backwards...

EK

We're trying to work on it like it's a machine, but it's not actually a machine.

RP

The whole idea behind synthetic biology is that we look

at living things through the eyes of an engineer. Synthetic biology uses all kinds of machine metaphors—for example, the host organism will often be referred to as a chassis. But things don't always work in the ways we expect them to.

EK

So we have to work at massive scales in order to get the results that we're looking for.

RP

More and more now, we're able to do these things with some care. We're not just adding one gene; we're adding a kind of constellation, a program of genes that turn each other on and off. These genes are substantially different from how they exist in nature. They're created by a DNA printer, a big machine that has four jars, literally labeled A, G, T, and C. The machine just squirts out different gene sequences.

EK

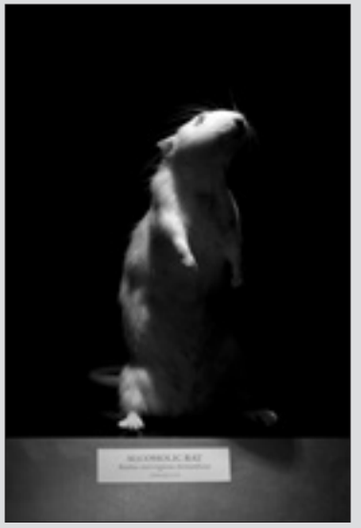
So in order to make a GloFish® we wouldn't have to borrow a gene from coral; we could make our own glowing gene?

RP

Exactly. Then we might make different versions of that gene to see which ones are the brightest. Then we might add them to bacteria, and then we might expose the bacteria to radiation to create mutations in the gene, such that every now and then the colour changes a little bit. Eventually what was green is now blue.

EK

Your exhibit about lab rats is really amazing, and I was wondering if you could talk a little bit about the ways that lab rats and mice are used to stand in for humans, both genetically and behaviourally.



RP

Lab rats have a really interesting history. As I mentioned, they were raised for fancy coat colours in the nineteenth century. Prior to that, they were raised as a part of a blood sport called rat-baiting, where you'd have 100 rats against one dog,

and people would bet on how long it would take the dog to kill all the rats. But when we use them in the lab, we're basically using them as miniature people, as stand-ins for us. In terms of behaviour studies, we put them in situations where they're either being denied food or something else that they want and we study how they respond to it. We change their genetics to map human genetic conditions so that they develop human diseases: cancers, obesity, etc. Researchers use those animals as the model stand-ins for people to develop treatments that are subsequently used on humans. We also engineer lab rats and mice to develop human conditions like baldness, things that aren't necessarily a health problem but that are considered a cultural problem for some people.

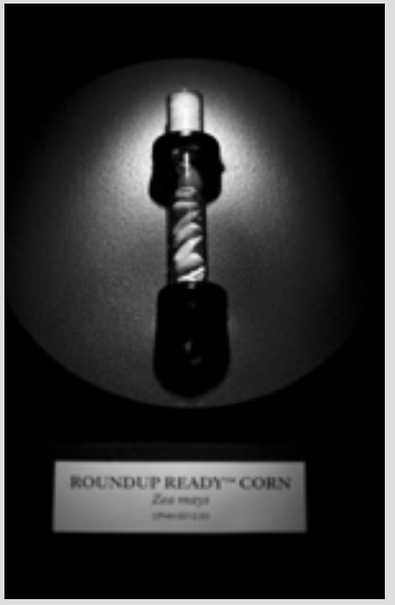
EK Did the use of rodents emerge because there was simultaneously a need to avoid using human subjects, and a need to study a lot more.

RP Yes, using human subjects gradually became unacceptable, and for related reasons, after dropping the atomic bomb in the Second World War, we needed to know how dangerous radiation was, and what it was good for.

EK Locality is a recurring theme in the museum. Many of the exhibits tell you how far away the organism is from Pittsburgh, and you have also done some locally focused exhibits. There was one about New York State, and one about Southern California. I'm interested in the interplay between this idea of locality and the massive scales of production of some the corporations that develop genetically modified organisms. What role does locality play in the postnatural?

RP Particularly when we're talking about genetically engineered organisms, habitat is defined in a really interesting way. It has nothing to do with ecology, or with any of the ways that one would typically define a habitat for an organism. It's defined by policy. It's defined by where the organism is legally allowed to live. This differs from country to country, and even from state to state—in the US, you have to get permits if you're going to move an organism that's genetically engineered across a state line. So when we do an exhibit like "Genetically Modified Organisms of New York State," that state border isn't just an arbitrary designation of place, it's a specific definition of habitat. These are the things that are allowed to be here and perhaps not allowed to be in Pennsylvania. Similarly, the European Union has its own mechanisms of control. There are organisms there that don't exist here; there are organisms here that can't be taken there in their living form.

As a function of our collection, for the most part we deal in dead organisms, because they're not controlled in the same way. Once it's dead, it's not able to reproduce—that's the main concern.



You asked about the interplay between large corporations and place. When corporations like Monsanto or DuPont come up with a new variety of genetically modified corn, they apply for a federal permit, which is issued on a state-by-state basis. Initially they'll file for a permit only in Iowa and possibly Hawaii, where they've got their two experimental stations. Maybe a few years later, if this particular variety is successful, they'll apply for a general release permit so that they can take the corn to market in whichever state they want.

This phenomenon becomes for us a kind of vista, a way of looking at the world of genetically modified organisms that are otherwise fairly indistinguishable. They often look exactly like their un-engineered counterparts, which is why genetic engineering remains largely invisible. Looking through the federal permit data-

bases, we start to see unexpected places appear. For example, Hawaii and Puerto Rico are really important sites for corn and soy beans. Hawaii is not normally considered part of the Corn Belt, but it absolutely is if you look at it over the course of the last 10 years. It plays a role in containing the upstream experimental parent seed of genetically modified corn. Both containment in a biological sense, where a small patch of corn is surrounded by almost a kilometre of dirt so that it can't cross-breed with any other plants, but also containment in a cultural sense, in terms of keeping out people that might want to sabotage those fields for political, economic, or ecological reasons. Again, cultural factors define postnatural places. In this sense, islands serve as a bunker of protection for industrial crops.

Farmers sign license agreements, like the Monsanto Technology Stewardship Agreement in our exhibit. In that case, the technology is the seed and the farmers are stewards, meaning they don't own it. They're just taking care of it for Monsanto. Monsanto owns the technology, but the farmers assume all the responsibilities. It's kind of like a software license agreement. You agree to those terms by opening the bag of seed.

One of our exhibits is a little plot of Monsanto corn that we managed to acquire without opening the bag of seed. We wanted to have specimens of the corn for our collection, but how would we get them without violating these terms and inviting their attorneys' wrath? We went to the pet store, bought pet food that had corn in it, like bird seed and squirrel food, and sprouted the corn seed in the front window for a couple of months. Then we sprayed it with Round-Up. About a third of the plants died immediately, and the rest of the plants were fine. Those were obviously owned by Monsanto.

EK Monsanto is the only company that has plants that are...

RP "Round-Up Ready," yes. In these federal permit databases, there's often a designation for species and for genes that says C.B.I., which stands for "confidential business information." This is a way that a company can protect its confidential information. It's the black marker that crosses out the name that people are not supposed to know about. Presumably the federal government knows about it, but that information is redacted for the public. The government allows for a certain amount of anonymizing the nature of

the organisms that are being engineered in order to protect the intellectual property of the companies.

In the database, C.B.I. shows up as a species in the list of all the different varieties: corn, potatoes, C.B.I.... It's also a gene. It starts to take on the quality of a character, the unknown organism. That's why we gave C.B.I. its own exhibit here at the museum. Its specimen is a little sign that says "specimen not available." It's a species of conjecture.

EK In that vein, you must have some interesting stories about obtaining specimens for the museum. What are some of the complications of collecting postnatural objects?

RP There are a number of complications. Genetically engineered organisms are not allowed to leave the lab alive. There are a lot of containment policies in place to prevent that from happening. As a function of collecting, these organisms have to be killed before they leave the lab. That job sometimes falls to me. I'm not an expert in killing; actually, I'm not an expert in virtually any aspect of this—it's all on-the-job training. I collected mosquitoes from a lab at UC Irvine that was trying to genetically engineer them so they couldn't carry malaria or dengue fever, with the hopes that the natural world could be repopulated with these mosquitoes. In that case I was left with a collection of living mosquitoes in ice cream containers, and some weird tools like a bucket of ice and a tank of carbon dioxide. I had no idea how all of these things worked together, so I ended up with dead mosquitoes and then pinned them to a block of Styrofoam. Later I learned that no entomologist would pin mosquitoes. They're far too tiny, and the pin is almost exactly the same size as they are, so it rips them apart. You're actually supposed to glue them to a tiny slip of paper and then pin the paper.

In maintaining the collection over time, the goal is to remove a living thing from the economy of food. Every living thing is also food for some other living thing. In a natural history museum they try to keep dead things dead forever, which ends up being a lot

harder than you might think. The Smithsonian has elaborately sealed rooms and white steel cabinets, so they can very quickly see if there's any kind of infestation going on. If an insect got in and ate some of their collection, that animal, that specimen, would be returned to the economy of food, which is also intimately connected to the economy of shit. You know you have an infestation when you see tiny piles of poop near your specimens.

I became aware of this when I left to work as a fellow at the Smithsonian for almost a year, and then came home and checked on my mosquito specimens. Half of the pins were bare. At the base of each pin were tiny specks, little poops. I eventually found the culprit: a little worm curled up in the corner of the lid. I put it under the microscope and found out that it was a dermestid beetle. The natural history museum keeps a living colony of these—they are used to clean the flesh off of bones for their collections. Natural history museums have a love-hate relationship with this particular bug, which otherwise is not from the region and might not even be able to live here if they hadn't brought it. My mosquitoes were eaten by a dermestid beetle, and it actually felt good in a way, like my collection was worth eating, just like the Smithsonian's! So it wasn't all a loss. We did keep that dermestid beetle as a mascot for a few months. I named him Ringo.

EK You explained how the territories of postnatural organisms are controlled with permits and licenses, and how the term "C.B.I." is used to protect intellectual property pertaining to genetically modified organisms. Are there any other ways that the postnatural world is regulated and controlled?

RP We haven't even talked about patents. Our first major publication, *U.S. Patents on Living Organisms, 1873–1981,* documents every patented living organism, from Louis Pasteur's beer yeast all the way through to General Electric's bacteria for breaking down oil.

EK This is every patent for every living organism?

RP We got the list from the G.E. archives. When they tried to patent a species of bacteria they had made that was supposed to break down oil, the patent office denied them on the grounds that you can't patent a living thing. G.E. took the case to the Supreme Court. There are two important things to point out here: one is that their bacteria didn't actually work. They were more interested in the exercise of expanding the idea of what commercial ownership could involve. In their argument to the Supreme Court, G.E. presented a list of patent numbers that they claimed were patents for living things, going all the way back to Pasteur. We took that list of patents, found all of the actual patent documents that go along with them, and put them in a book together. We refer to the book as Volume 1. Volume 2 would be the collection of patents that came after the Supreme Court decision [in favour of General Electric], which was really the moment the biotech industry was invented. Many companies were poised to profit from biology prior to 1980, but there was a fundamental problem of ownership. When your product makes copies of itself for free, how do you keep selling it? This Supreme Court decision was very significant. It ruled that companies could not only own an organism but could also own its entire offspring, its entire chunk of the evolutionary tree.

EK And that's when the experiments limiting reproduction in different ways come into play.

RP Exactly. This led to our second publication, something we call *Strategies in Genetic Copy Prevention*, which is a collection of different techniques, contemporary and historical, that people have developed to stop life from doing the thing that actually defines it: making copies of itself. The book includes spaying and neutering; castration of pets, farm animals, and people; cross-breeding; and hybridizing (like creating a mule that can't reproduce itself). Hybridizing produces seedless watermelons: crossing two species of watermelon such that the next generation doesn't produce seed. The book also includes the famous terminator gene

that companies like Monsanto use to keep their crops from producing a second generation. This gene is not actually on the market, because it has drawn a lot of resistance. It will probably be approved eventually, but it hasn't at this point.

EK The illustration for the terminator gene looks a lot like your logo.

RP One of the things that we're trying to show with the terminator gene is that it's not a single gene; it is more like a genetic machine. It's made of many different genes taken from many different parts of the evolutionary tree. So we depict them in that way. Some of the genes come from bacteria and viruses, some come from *Arabidopsis*, and they're all used to produce a feedback loop. This feedback loop essentially kills all reproductive abilities when the plant reaches puberty, unless it's bathed in an antibiotic called tetracycline. The tetracycline bath would allow Monsanto to keep propagating its seed internally. But like I said, this gene is not actually on the market yet. It's in the lab, but there has been too much resistance for its use to be approved.

EK Legal resistance?

RP Yes, largely from agricultural and ecological activists concerned that this would be a tool for very rapidly creating a monopoly. Imagine you're a developing nation. Your crops fail, or for whatever reason you need help, and the US gives you a bunch of seed. Imagine the US gives you Monsanto seed, and imagine those seeds have the terminator gene such that the next season, you won't be able to plant that crop again. You will now be dependent. There has been a lot of resistance for reasons such as this. But it's interesting to note that historically, environmental activists often lobbied for the development of the terminator gene, arguing that if we were going to be developing genetically modified organisms, there had to be a mechanism...

EK ...to stop it.

RP Yes. It's important to see the ways these technologies operate in relation to power. Technology doesn't have a built-in moral or

ethical "thumbs up" or "thumbs down." Its uses are very situational. And they're also very difficult to predict. What makes sense in one context might have wildly unpredictable consequences in a different one.

EK I have one more question about the design of the museum. It seems to take cues from early cabinets of curiosity; there's a sense of wonder and mystery about the place. How does that relate to the tone the museum is trying to create, and to the imagined audience of the museum? What are you trying to get at here?

RP We're trying to get at a lot of things, not any one thing—different things to different people. Aesthetically, we do reference the nineteenth-century cabinets of wonder and the traditional natural history museum, in part because it's a familiar way for people to look at dead animals. It's a familiar frame, and one in which people don't expect things to move very quickly. We want time to slow down here in the museum—not television speed, not internet speed—so that we can tell stories that sometimes take a while to unfold.

But we also take aesthetic cues from the biotech industry—from twentieth-century science, as opposed to nineteenth-century science. Another frame at work is that of the hobbyist. We often conduct our own experiments when we're trying to figure out how to preserve a certain kind of organism: how to preserve flowers, for example, such that we can keep their colour and their shape. But we keep those experiments where people can see them. We're very open about the fact that we're not experts, so we invite experts to come talk with us, work with us, and share their knowledge.

The other aspect of the cabinet of wonders idea is related to your previous question about taxonomy. Cabinets of curiosity in the

seventeenth and eighteenth centuries in particular, before Linnaeus created the biological taxonomy that we use today (genus, species, etc.), were organized by free association. Things were put together because they had the same colour, or the same shape, or were from the same place. Or maybe they were put next to each other because they were really different. It was wide open—a curator would visually craft a narrative by putting constellations of objects together. That idea is really important to us because we don't have a hard and fast taxonomy. We're not illustrating an evolution of complexity, or anything with an obvious beginning and end. We rely on each exhibit being different from the ones that are right next to it, so that the concept of what is postnatural is constantly being challenged and expanded. I think that's actually what wonder is: the feeling that the world is a little bit larger than it was just a moment ago. We're not trying to convince people of anything; we're just trying to open up the realm of possibility a little bit further.×

Bio

Emily Kutil is a recent graduate of the University of Michigan's Taubman College of Architecture and Urban Planning Master's program, where she studied architecture and museum studies. Emily's thesis explored architecture's relationship to the history and future of zoo design. She received a thesis award for her work. She recently co-edited and designed two publications: *Dimensions 25*, the student journal of architecture at the University of Michigan; and *StudioAfrica*, a book commemorating ten years of the University of Michigan's Ghana study abroad program. Emily is currently an intern at the Museum of Jurassic Technology in Los Angeles, California.

Richard Pell works at the intersections of science, engineering and culture. He is the founder of the Center for PostNatural History, an outreach organization dedicated to the collection and exposition of life-forms that have been intentionally altered through selective breeding or genetic engineering. The Center for PostNatural History operates a permanent exhibition facility in Pittsburgh, Pennsylvania, and produces traveling exhibitions for museums and galleries. Pell is also a founder of the internationally acclaimed collective, the Institute for Applied Autonomy, and is an associate professor of Electronic and Time-based Arts at Carnegie Mellon University.