MEERA LEE SETHI
ADAM BRIGGLE

Making Stories Visible

The Task for Bioethics Commissions

Because the foundation for future success is a well-educated workforce, the necessary first step in any competitiveness agenda is to improve science and mathematics education.

A little before lunchtime on December 6, 1957, when the United States made its first attempt to match the triumph of Russia's Sputnik 1 by launching its own Vanguard TV3 satellite into orbit around Earth, David Rejeski was one of millions of wide-eyed American grade-schoolers, raised on a steady diet of science fiction stories, whose day was being thrillingly interrupted by the future. Chins propped against crossed arms, ears held closely to an array of radio speakers perched atop desktops—*the glory of being allowed to bring their own radios to school, of all places, and actually take them out in the middle of class!*—David and his classmates listened breathlessly to the broadcast. The disembodied voice of the announcer from Cape Canaveral trembled through the static; the strange, stormy rumble that marked the sound of liftoff spread across the airwaves. Unhappily, the Vanguard was an ill-fated rocket that never made it into space; it lost thrust just two seconds after blasting into the air, sinking back onto the launch pad like a bad firecracker and disappearing into the flames that exploded from its still brimming fuel tanks. The new year would have to come and go before the Explorer 1 finally became the first successfully launched U.S. satellite and the nation's next dramatic move in the Cold War space race.

But for at least one little boy—already spending every spare moment building rockets and operating ham radios, already enshrined as the proud president of a basement chemistry club whose activities scared his mother half to death, already deep into a self-administered program of scientific study spanning the fields of aerodynamics, electronics, and physical matter—there could have been no greater rush than the one that came from huddling around the radio in school that day. It wasn't, you see, just the news he was listening to. Eavesdropping on the fate of that slim 72-foot rocket plucked David straight out of the four bland walls of his classroom and plunged him into a sensationally exciting issue of one of his beloved Captain Marvel comic

books. For when science was a tool caught between good and evil (as it seemed to be that morning, and as it seemed the day a few years later when David figured out how to put together a homemade Geiger counter so he'd know if it was safe to walk out of his house after the Bomb fell), the stories, books, and movies that filled the young boy's imagination became a powerful way to understand how science functioned in the real world.

More than five decades later, David Rejeski has grown basketball-player tall and cultivated a rumpled shock of salt-and-pepper hair that brushes over his ears; together with a matching mustache, it gives him a little of the look of a leggy Einstein. He has big, graceful hands that he still doesn't shy away from getting dirty. The first degree Rejeski earned was a B.F.A., and in one of his lives he dreams up and sculpts beautiful pieces of handcrafted furniture, like smooth hardwood tables whose tapering legs are inspired by the shape of chopsticks or whose surfaces bear the intricate texture of thousands of individually chiseled facets. In his work life, though, the one in which he finds himself wearing the uniform of suits and ties and uses those wood-calloused hands to gesture with broadly as he speaks before government officials, Rejeski grew up to be a scholar of science, policy, and technology. Among many other responsibilities, his current job as the director of the Woodrow Wilson Center's Program for Science and Technology Innovation involves assessing how the public understands both the promise and the peril of emerging scientific endeavors. He studies, in other words, fields such as nanotechnology and synthetic biology that mark today's bold new frontiers in science the way space travel did 50 years ago. And though it might seem surprising, he's still got Captain Marvel on the brain.

These days, though, when Rejeski encounters stories about science, he's a little less wide-eyed and much more savvy about where they come from and what they mean. He was paying close attention, for instance, on the bright May day this year when biologist J. Craig Venter announced his institute's historic accomplishment: creating the first viable bacterial cell whose genetic material had been written

Alexis Rockman

Alexis Rockman has been depicting the natural world with virtuosity and wit for more than two decades. He was one of the first contemporary artists to build his career around exploring environmental issues, from evolutionary biology and genetic engineering to deforestation and climate change. His work expresses deep concerns about the world's fragile ecosystems and the tension between nature and culture. These concerns are communicated through vivid, even apocalyptic, imagery. Rockman has garnered attention for embracing these issues, as well as for the epic quality of his projects, including several monumentally scaled paintings.

Rockman achieves his vision through a synthesis of fantasy and empirical fact, using sources as varied as natural history, botanical illustrations, museum dioramas, science fiction films, realist art traditions dating back to the Renaissance, and firsthand field study.

Alexis Rockman: A Fable for Tomorrow will be on view at the Smithsonian American Art Museum in Washington, DC, from November 19, 2010, through May 8, 2011. The exhibition is organized by Joanna Marsh, The James Dicke Curator of Contemporary Art, and is the first major survey of the artist's work, with 47 paintings and works on paper that trace his career from early works in the mid-1980s to the present. The exhibition will travel to the Wexner Center for the Arts in Columbus, Ohio in the fall of 2011.

Images courtesy of the Smithsonian American Art Museum.

ALEXIS ROCKMAN, *Biosphere: Hydrographer's Canyon*, oil on wood, 56 x 44 inches, 1994.

ALEXIS ROCKMAN, *Aviary*, oil on wood, 80 x 68 inches, 1992.

"Storytelling and narrative are absolutely critical to science. The public uses stories to understand science, and so do scientists, whether they're doing it on purpose or not."

in digital code and then synthesized in a lab. Venter was standing at a press conference podium wearing a sober blue jacket and shirt, not sitting cross-legged around a campfire with shadows at his back. His voice was nonchalant, even matter-of-fact, not theatrical. But Rejeski could see that Venter, who has a reputation for being a renegade researcher with little regard for the "rules" society attempts to place on science, was telling a powerful story designed to downplay the potential risks of synthetic biology. Previously, Venter had compared the process of working with genome base pairs to solving a jigsaw puzzle or connecting the spools and sticks of Tinker Toy pieces—the kind of analogy that has always irritated Rejeski mightily. "When you use those metaphors," he grumbles, "when you talk about building blocks and Legos, it infantilizes the science. It becomes something that children can play with, and therefore it can't be dangerous." At Venter's press conference, that storyline grew up a little; but it was still calculated to simplify what is an incredibly complex biological process.

"This is the first self-replicating species we've had on the planet whose parent is a computer," Venter said to a roomful of journalists. He spoke of long months spent "debugging" errors in the synthetic DNA and of "booting up" the cell into which it had been transplanted. Finally, he explained that the scientists who had created the cell, known as *Mycoplasma mycoides* JCVI-syn1.0, had "encoded" a series of messages into its genetic material, including the names of authors and key contributors, the URL of a Web site, and three literary quotations about the nature of discovery and creation.

By framing his work through the narrative of computer engineering, Venter was crafting a story about synthetic biology that presented it as a safe, repeatable, and controllable technology. *Life*, ran the story beneath his words, *is essentially information. Organisms are information-processing machines. Creating life is like making a machine; if its design contains errors, we will find and fix them. And like a machine, the nature of a synthetic organism is so malleable to engineering that its DNA can be stamped with its creators' intentions*. "What Venter's doing," says Rejeski, "is making use of an engineering narrative that sends a message to the policy people and the public that all this has a high degree of controllability. People tend to think, well, engineers do a fairly good job. Most of the time, bridges don't fall down. But a cell is essentially a stochastic system, and we don't have that kind of control over it. Venter's got enough of a microbiology background to know better. He's using a reassuring story that makes everything seem much simpler and less risky than it really is."

Science and storytelling appear antithetical. Science deals in a non-narrative form of rationality, offering facts where stories offer interpretations. But Rejeski pushes back on that easy dichotomy. "Storytelling and narrative are absolutely critical to science," he will tell you. "The public uses stories to understand science, and so do scientists, whether they're doing it on purpose or not." One place where the two realms intermingle is the space Rejeski happens to inhabit every day: evaluating the human significance of new scientific discoveries. *What is life? What would it mean to live in a world where humans synthesize life?*

Lacking a single "objective" answer to these questions, our responses to them depend on framing and perspective—aspects of storytelling. The philosopher Fern Wickson made this clear when she closely examined nine common cultural and scientific narratives about nanotechnology, each "a story that begins with particular presuppositions and ends in support for particular areas of nanotechnology development." In some, nanotechnology is shown as controlling nature; in others, transgressing its boundaries or treating its ills. Yet though these stories are clearly distinct, Wickson writes, each is presented "as a simple description of the way things are . . . this often masks the beliefs that underlie each of the different narratives and the research directions in which they tend to lead." In other words, many narratives about science are invisible. Not recognized as stories built on particular assumptions and expressing particular points of view, they can seem to be simple accounts of reality. This is particularly true of stories that accumulate around emerging disciplines such as nanotechnology and synthetic biology, whose applications,

implications, and limitations are not yet well understood by the public or scientists themselves.

Rejeski is among the few working in science who have made this issue his business, a fact that he laughingly admits can make him feel a little like Pandora: constantly opening the lid of a box most researchers and policymakers would rather keep shut tight. Yet with questions of law—Should we press on with this technology? With what limitations?—answers depend on the story one chooses. It is important to make those choices with our eyes open to the ways different stories, including those told by scientists and engineers, frame and interpret reality. This is the point Rejeski emphasized this past July during his invited testimony before the newly formed Presidential Commission for the Study of Bioethical Issues (PCSBI). Chaired by University of Pennsylvania president Amy Gutmann, the PCSBI is the government body that was charged by President Obama with assessing the risks and benefits of synthetic biology as soon as Venter's feat went public.

At about 9 a.m. on July 9, Rejeski, dignified in a dark gray suit that hung just a hair too large on his shoulders and a striped tie that he reached up to smooth several times as he began to speak, took the place assigned to him in the cool carpeted conference room of the Ritz-Carlton hotel in downtown Washington, DC, where the PCSBI had chosen to hold its first round of meetings. To his front and sides were the 13 members of the commission and two fellow panelists; together, these central attendees were seated at tables that formed a closed square. Behind them, and out of Rejeski's sight, about a half dozen rows of chairs were slowly filling up with members of the public. He didn't need a good view to know that these probably weren't teachers or electricians or firemen who just happened to have a personal fascination with genetics; instead, the audience was made up of a small and very specific set of people with a vested interest (money, mostly) in synthetic biology. Industry insiders. In fact, the meeting, which began with Gutmann introducing a designated federal officer to "make it legal," resembled nothing so much as the formal gathering of a board. Which is perhaps why it was so much fun for Rejeski to know that besides graphs and other data, in a few minutes he was about to show these people slides of comic books, movie posters, video games, and cartoons.

He was the first speaker of the day, and he began simply enough. "Let me start," he opened, "by saying that we have devoted about six years of our time . . . trying to bring the voice, or voices, of the public into the conversation about science policy on emerging technologies." If you weren't paying attention, you might have missed his next sentence, delivered almost as a throwaway as he searched on the table for the clicker he would need to control the rest of his presentation. It didn't draw a laugh from the crowd but was obviously charged with a deeply dry humor that emerged from Rejeski's sense of how little attention is paid to this kind of work. "In terms of how we do this?" he said, "It's pretty easy: We talk to them."

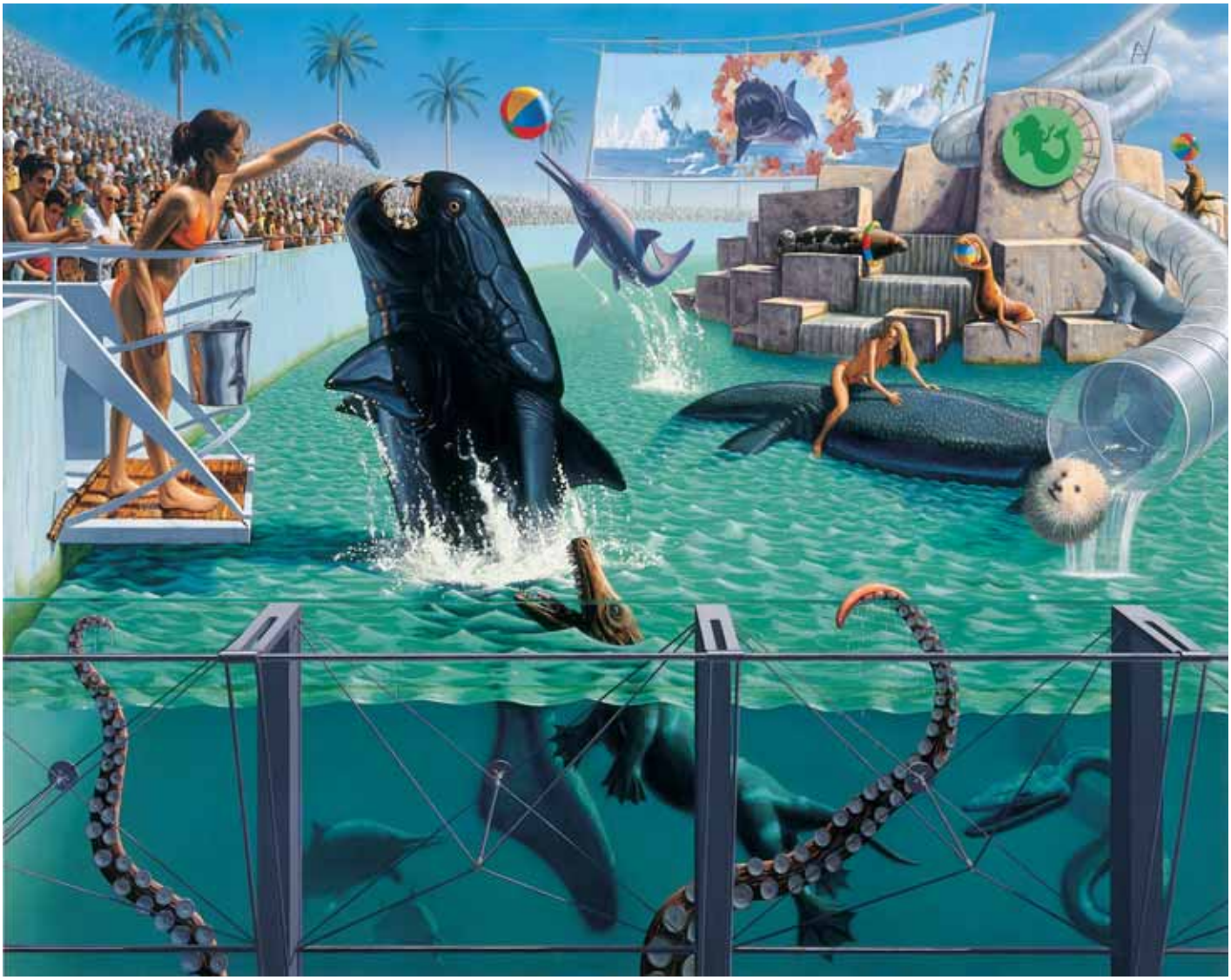
In the past few years, he'd traveled from Spokane to Dallas to Baltimore, Rejeski said, simply asking people what they knew and how they felt about synthetic biology. And what he'd found was that because most people don't understand the science behind it, the combination of these two words tends to set off a fast-moving train of loose associations in people's minds, fueled by half-remembered news stories. "The train," he explained, "goes something like this: Synthetic biology, is that like artificial life? Is that cloning?" Rejeski's pace, normally measured and thoughtful, became brisker as he counted out the links, which he said took most people about 15 seconds to get through. "Is that stem cells? Is that GMOs?" He stopped. Raised a pair of bushy eyebrows. When asked about the possibility of someone creating synthetic life, Rejeski explained, there was a clear trend among the people he met: "'I'm worried about this.' Over half. 'I'm excited about it.' Less than half." But if they didn't know much about this field of science, why exactly would public perception skew toward fear? Though most people in the room wouldn't realize it, Rejeski's answer would take him back to the little boy he'd once been.

For most of the past 10 minutes, the images appearing

ALEXIS ROCKMAN, *The Hammock*, oil on wood, 60 x 72 inches, 2000.

on Rejeski's slides had been perfectly conventional. True, a Gary Larson cartoon had sneaked in that gave him great pleasure to include. (In the first panel of the original, a man admonishes his dog to stay out of the garbage; in the second, a word-balloon shows the only thing getting through to the dog: its name. Rejeski had searched the Internet for hours to find the cartoon, one of his favorites, and carefully modified it to show how the public understands scientific communications about synthetic biology. In his version, the balloon in the top panel read "synthetic bacterial cell genome…artificial DNA base pairs…sustain life replicating;" the one on the bottom, "blah blah SYNTHETIC blah blah blah LIFE blah. When it went up, a smile came into view under the speaker's mustache that he couldn't quite hold back.) But otherwise, Rejeski's testimony had largely been illustrated with a series of neat color-coded bar graphs depicting the vast amounts of data he'd collected. He'd "stuck to the script," as he would later put it.

In the last minute of his testimony, though, his tone shifted. He returned, for just a moment, to the way in which he'd first begun to relate to science: through the lens of story. "Human beings," said Rejeski, quoting the late novelist David Foster Wallace, "are narrative animals. That is how we understand science." Even as he spoke, he clicked over to one of his last and most surprising slides—one that hadn't even made it into the first version of his testimony, but that in the end he couldn't resist using. It was full of stories. "This," Rejeski began cheerfully, pointing to a colorful vintage comic book cover complete with costumed superhero jetting across the sky, "is Captain Marvel and the Wonderful World of Mister Atom." He gestured to the right, where he'd placed images from *Spiderman 2*—the looming villain Doc Ock standing with his back to us, four long metallic tentacles twisting out of his back like snakes—and a frightening screenshot from an Xbox 360 game called *Bioshock*, set in a post-apocalyptic world populated by insanely violent, genetically mutated humans. Further down, if you'd been in the Ritz Carlton that day, you'd have seen the cover of Michael



ALEXIS ROCKMAN, *Sea World*, oil and acrylic on wood panel, 96 x 120 inches, 2001-2004.

"The thing that the scientists have to understand is that people will fall back on these narratives long before they will ever pick up a biology book. And they are incredibly pervasive, ubiquitous, and powerful."

Crichton's bestselling novel *Prey*: a black, buzzing cloud of tiny escaped nanobots darkening the sky like a Biblical plague; and an image from the new genetic engineering horror flick *Splice*: a bald, hoofed, three-fingered humanoid with huge blank eyes and a perky tail, crawling on top of a lab table.

"These are deep, deep narratives," Rejeski said. He described large circles in front of him with his hands as he talked, as if pushing the stories towards the commission members, willing them to understand their importance. Rejeski himself felt that importance keenly. These stories, he knew, were the primary source of the unease he'd sensed about synthetic biology from the people he'd talked to; these stories, functioning mostly on an unconscious level, were the fire fueling fears about escaped organisms, new terrorist threats, and the hubris of designing life. "The thing that the scientists have to understand," Rejeski concluded, in a voice that could not have been more urgent and sincere, is that "people will fall back on these narratives long before they will ever pick up a biology book. And they are incredibly pervasive, ubiquitous, and powerful."

When he thinks about it later, Rejeski still isn't sure how his testimony was received. He was warmly thanked by several commission members, he says, but can't tell whether those were simply formalities. Frankly, he says, he's just glad nobody attacked him in the corridor or called him crazy to spend so much time talking about comic books and movies. "I guess that means I'm still kind of tolerated," he chuckles. One thing Rejeski does admit is that the stories he chose to deconstruct in his talk aren't the only narratives about synthetic biology that have an impact on the discourse; not by any means. As his own frustration with Venter's conveniently adopted metaphors indicates, scientists themselves are not immune from the storytelling impulse. In fact, the day before Rejeski spoke, PCSBI heard from an array of scientists and engineers whose narratives, unlike those of Captain Marvel and Michael Crichton, remained largely unexamined—invisible to the substance of the debate.

One of these scientist-storytellers was Drew Endy, assistant professor of bioengineering at Stanford University and the director of BIOFAB, a facility that makes standardized DNA parts freely available to academic labs, biotechnology companies, and individual researchers. If Rejeski is approachable and avuncular, Endy, whom a recent *Stanford Magazine* profile called synthetic biology's "most fervent evangelist" and described as emitting "a sense of barely contained energy," has the charmingly intense air of a round-spectacled John Lennon after a recent haircut.

Endy, like Rejeski, is well aware of how much more powerful scientific narratives become when they are interwoven with popular culture. In 2005 *Nature* published a comic book written by Endy titled *Adventures in Synthetic Biology.* In its 12 brightly colored pages, Sally the Professor instructs "Dude," a plucky young science student, about the basics of synthetic biology. Dude's mastery of the subject comes from experimenting with a bacterium with the friendly name of "Buddy." Through his efforts, Dude learns that the genome is the "master program" and that organisms can be "reprogrammed" to perform unprecedented functions. The story is suffused with a sense of adventure and, yes, scientific playfulness. Life is portrayed not only as infinitely malleable, but also as essentially interchangeable with human artifacts. After all, life is the "stuff" Dude is "building," and he does so with inverter devices that incorporate bits of DNA. The story does contain one accident in which Buddy explodes, but this happens early on and Dude learns from his mistake. The wildly optimistic, even hubristic, message of the comic is that with sufficient knowledge humans can master life and reprogram it to suit their desires. Its last lines, which could have come straight out of a Dick and Jane picture book, read "Look at us! We're building stuff!"

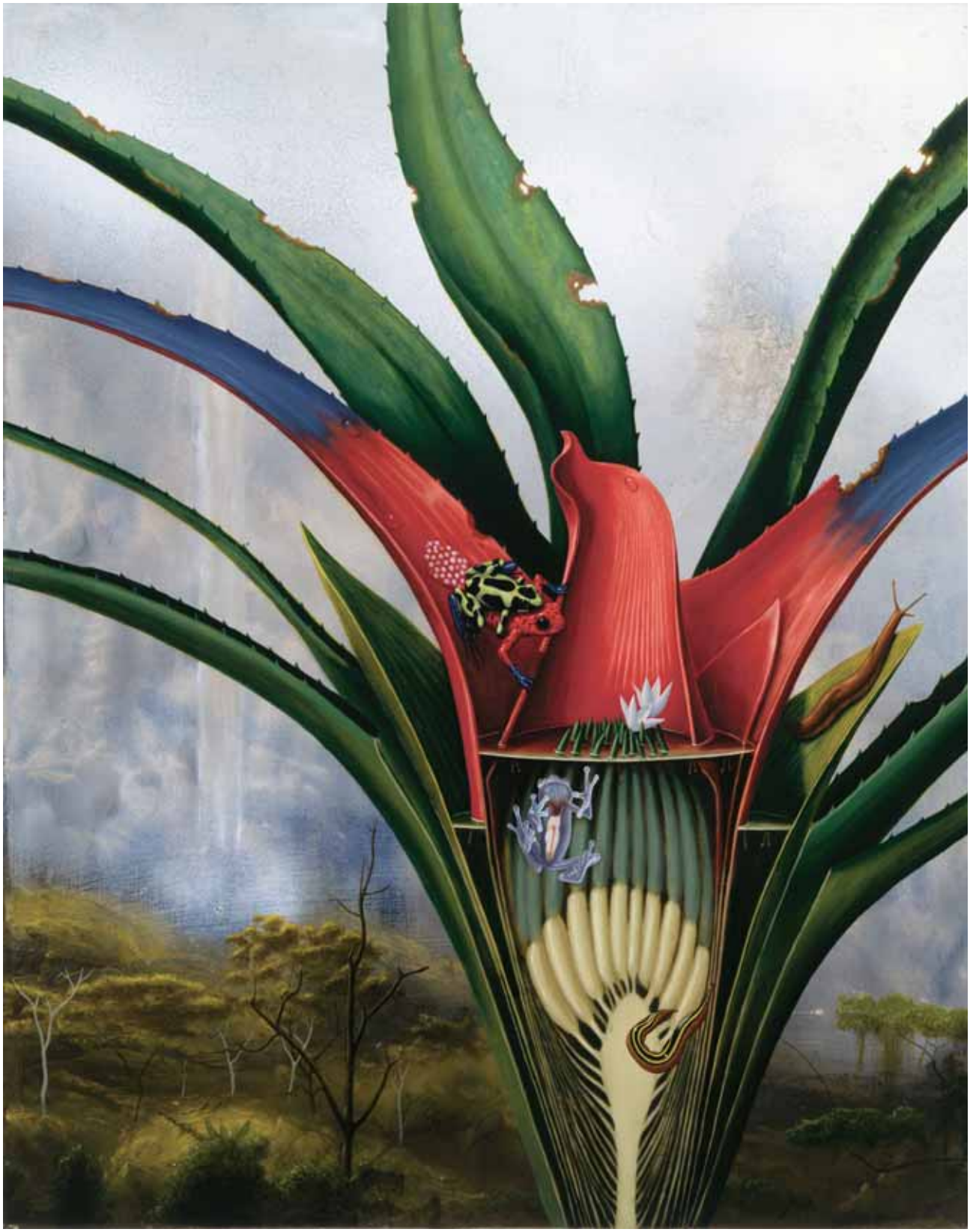
Not surprisingly, where Rejeski drew the commission's attention to the dystopian stories of pop culture, Endy focused on the utopian potentials of synthetic biology. He did so through a subtle storyline that drew on a well-established analogy between the genetic code and the structure of human language. And in so doing, Rejeski later reflected, he was making a "brilliant" narrative move that tied synthetic biol-

ALEXIS ROCKMAN, *Balance of Terror*, oil on canvas, 72 x 84 inches, 1988.

ogy to an old, unthreatening, and much-loved technology.

Dating back to James D. Watson and Francis Crick's own descriptions of the structure of DNA, the linguistic metaphor for understanding the genome refers to the chemical bases that make up each molecule of DNA as "letters." As such, each three-letter codon, or unit of genetic code, becomes a "word," and the genome itself is the ultimate publication: "the book of life." And if, as Endy suggested that day in his testimony, organisms are information that can be sequenced, stored in a database, and edited, then it's easy to see the tools of synthetic biology as tools for reading, writing, and publishing. To bring this story home, Endy made use of the narrative of literature and the printing press. Today's genetic engineering projects, he pointed out, are limited to using fewer than 20,000 base pairs of DNA. "20,000 characters," Endy mused. "That gets you things like the Gettysburg Address, which is around 1,500 characters. It gets you an editorial in the *New York Times*." He nodded as he spoke, as if cementing the comparison. But advancements in the tools belonging to the field of synthetic biology promised a future in which genetic engineering could involve a 400-fold increase in the number of characters (the number of DNA base pairs) that scientists could put together. "What," Endy asked carefully, in a rhetorical move worthy of Socrates, "would be the sort of stuff you could write with 8 million characters? You certainly get one-act plays, like *No Exit*. You get *The Color Purple*, which is not even a million characters. You even get *War and Peace*."

As with his comic book, Endy's testimony framed synthetic biology as a creative activity with limitless possibilities. But in order for such inspired human creativity to truly flourish, Endy emphasized that it was imperative for government policies to be instituted that would facilitate what he called "freedom of the DNA press." For instance, more public funds should be channeled into synthetic biology research, and individuals should be as free as possible to use this technology. "The ability to synthesize DNA in genomes is like a printing press," Endy explained, "but it's for the ma-



ALEXIS ROCKMAN, *Bromeliad: Kaieteur Falls*, oil and lacquer on wood, 40 x 32 inches, 1994.

ALEXIS ROCKMAN, *Biosphere: Orchids*, oil on wood, 18 x 24 inches, 1993.

terial that encodes much of life. If one publisher controlled all the presses, that would give a publisher tremendous leverage over what's said."

There could hardly be a more seductive narrative about synthetic biology. *Writing an organism's DNA*, ran Endy's hidden story, *is fundamentally a creative endeavor. It is a process by which we might reach the greatest heights of artistry and express the most profound truths, as long as our efforts are not stifled or censored. Like freedom of expression, the freedom to create new forms of life should be a fundamental right. Who knows where the next Shakespeare or Melville will come from? To restrict access to the tools of synthetic biology would be a form of censorship.*

Are these valid assumptions and an appropriate framing of synthetic biology? Perhaps. But perhaps not. Unlike human languages, for example, the "alphabet" of DNA does not lie inert on a printed page but takes physical form when the proteins it encodes are synthesized. And although it is easy to accept that the exercise of artistic creativity demands little or no government oversight, it is less clear that the same is true of all scientific explorations.

So why, despite its flaws, did Endy choose to frame his discussion of synthetic biology inside this particular narrative? Rejeski has an idea. What Endy was telling the commission, Rejeski points out, "is a story about scientific evolution, not revolution. It says that this is just an extension of existing science, and there's nothing disruptive or novel about it. Remember people doing work on recombinant DNA in the 1970s? They said the same thing. Oh, we're just doing what nature's been doing for a long while. It was a convenient story. And in that sense, Endy was brilliant to pull it back to the Gutenberg printing press. I mean, who's afraid of the printing press?"

Tellingly, however, whereas the cultural narratives raised by Rejeski the following day were immediately dismissed as overblown, no one in attendance on this occasion—not commission members, other speakers, or anyone in the audience—approached the narrative framework that lay beneath Endy's words with a critical eye. No one wondered whether this storyline might not be, in its own way, just as mythic as the Trojan horse or Pandora's box. Instead, the narrative remained implicit, and therefore unexamined. As if to prove the effectiveness of the scientist as storyteller, commission member Barbara F. Atkinson, currently the executive vice chancellor of the University of Kansas Medical Center, raised Endy's evocation of the freedom of the DNA press during the question session that followed his panel. She had been "caught by" this comparison, Atkinson said. Could the panel members recommend specific policy recommendations PCSBI might make to support the workings of the genetic free press?

The absence of criticism directed at Endy's narrative stems from the assumption that scientists and engineers are what biologist/philosopher Donna Haraway calls "modest witnesses." They are ventriloquists for the objective world, adding nothing of their own voices. Their "narratives have magical power, they lose all trace of their histories as stories . . . as contestable representations, or as constructed documents in their potent capacity to define the facts. The narratives become clear mirrors, fully magical mirrors, without once appealing to the transcendental or the magical."

In opening the commission's first meeting, Gutmann noted that "it is key for this commission to be an inclusive and deliberative body, encouraging the exchange of well-reasoned perspectives with the goal of making recommendations that will serve the public well and will serve the public good." In support of that mission, the commission would go on to hear hours of testimony from engineers, biologists, theologians, philosophers, social scientists, bioethicists, lawyers, and others. It would be told by some that Venter's work is nothing but an incremental step in a long history of genetic manipulation, and assured by others that the achievement represents a complete scientific game-changer. Commission members would be urged by some to advise a near-moratorium on synthetic biology in order to prevent an unjust bioeconomy, and encouraged by others to step hard on the accelerator to bring new products to market. To frame these diverse and often conflicting views, each speaker would bring a story or stories to the table.

Crucially, however, the testimony PCSBI has heard in the months since it was first formed has not treated all narratives with equal scrutiny. Thanks in part to Rejeski's efforts, the commission has made progress in rendering visible the most pervasive cultural narratives about artificial life, seeing these stories as imperfect and unscientific constructions by artists, the media, and other myth-makers. But those who have testified before the commission have been far less likely to turn a critical eye on scientific and engineering narratives, instead allowing these stories to remain implicit and therefore invisible. To produce a truly thoughtful and deliberative report on both the practical and ethical implications of synthetic biology, PCSBI must ensure that no story, no matter its provenance, goes unexamined. It must render each of the stories it is being told about this science more visible, exposing their interpretive frames and subjecting their assumptions to critical scrutiny. Because policymaking has to happen on the basis of one story or another, it is best to inform those decisions with an explicit account of the available

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options. Advisory bodies must not allow a single narrative to become the invisible lens through which the issue at hand is viewed. To do so constitutes a technocratic overreaching of expert advice, because it makes one story seem to be simply the facts. Policymaking would be constrained in advance to choices within a single narrative, and policy discourse would be limited to the terms and goals established by that story alone. Advisory bodies should clarify and expand, not limit, our choices.

One welcome critical treatment of narratives was at work in the testimony of Randy Rettberg, a principal research engineer in Biological Engineering and Computer Science and Artificial Intelligence at MIT and the director of MIT's Registry of Standard Biological Parts. Speaking at PCSBI's September 14 meeting, Rettberg told a story from his youth. "When I was a junior in high school," he began, "I decided that my father was an architect of buildings, and I wanted to be an architect of computers." At the beginning of his career, he went on, that seemed an impossible goal, but thanks to a development in the field that enabled processors to be built out of a set of tiny standardized parts known as transistor-transistor logic, the dream became achievable.

The testimony that followed was striking. Having told a story with obvious connections to synthetic biology, Rettberg immediately went on to clarify the underlying assumptions behind the narrative, pointing out which ones ought to be accepted and which discarded. What was accurate about his story, according to Rettberg, is the idea that making simple interchangeable parts freely available to a large population of researchers might revolutionize the genetic engineering industry in terms of what it is able to produce and who is able to produce it. Less accurate, but much more quickly grasped by listeners, is the idea that synthetic cells are actually like little computers, with each internal component operating in a fundamentally logical manner. This, cautioned Rettberg, was "not really right."

As Rettberg's testimony illustrates, stories about synthetic biology are often based on faulty comparisons. Yet it is clear from the meetings that PCSBI has held so far that they are also a ubiquitous part of the debate, because they serve as a way to make sense of complex and sometimes contradictory scientific information. The commission should acknowledge these multiple narratives, confront them with the careful attention Rettberg gave his own story, and explicitly probe them for valid and invalid assumptions. In its report, PCSBI should outline more than one set of policy options, bolstering each one with clear justifications for its premises and articulating, where appropriate, when a proposal stems from a particular narrative about this new technology. If, for instance, PCSBI were to adopt Endy's recommendation that a substantive public investment be made in the tools of synthetic biology, it should not do so without first thoroughly examining the suppositions behind the narrative of the "DNA free press." In so doing, it will multiply and clarify options for policymakers rather than handing them just another story with its black box of assumptions.

When Rejeski was invited to speak before the commission, he thought long and hard about what he would say. Was he really going to show up for its first meeting with slides of comic books, movie posters, video games, and cartoons under his arm? How exactly would his listeners respond? "I don't think 90% of people spend a lot of time," Rejeski muses, "asking whether the narratives people tell about science are valid, or just being used as a means of convenience. Do they hide issues we need to be thinking deeply about? Or do they unnecessarily exacerbate our fears? I mean, generally this stuff is all taking place subconsciously. There's no attempt to expose these stories. That would be like doing psychoanalysis on yourself, for God's sake!" Rejeski stops short, as if momentarily surprised by the sharpness of his own analogy. But then he chuckles. "And there's definitely no one else up there talking about comic books. I'm almost embarrassed sometimes to be bringing that stuff to the table. I always imagine that there are people who are saying 'Oh man, I'm not going there. That's off the wall.'"

In the end, though, Rejeski seems to enjoy the idea of antagonizing people, just a little bit. "I've reached the point in my life," he reflects, "where I'm not particularly concerned

ALEXIS ROCKMAN, *Reef*, oil, acrylic, and resin on wood, 64 x 36 inches, 2009.

whether I please the scientists or the policy folks. I think somebody's got to talk about this stuff, because it has huge implications that go right into the regulatory system." Think about that evolution, not revolution, storyline, he says earnestly. "That's one you really want to pull the veil back on. Scientists know that the wrong story will have direct links into regulation that they want to suppress. If synthetic biology is seen as truly novel, Rejeski points out—if the narrative we tell about it resembles a science fiction plot instead of harking back to an old technology—then it will trigger the Toxic Substances Control Act and various Food and Drug Administration regulations. "These aren't," he concludes, "just superficial stories. So if I were 30 years younger and my career was at stake, I might be more sensitive; but now? I have no problem pissing people off if I think there's something that has to be said." When he says this, it's easy to imagine Rejeski as a character in his own compelling story. Not Pandora; not really. More like an 11-year-old boy holding up a homemade Geiger counter, using his own good sense to make invisible forces visible.

Recommended reading

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Meera Lee Sethi (meeralee@gmail.com) is a Chicago-based writer who is particularly interested in the intersection between science and culture. Adam Briggle (adam.briggle @unt.edu), an assistant professor in the Department of Philosophy and Religion Studies at the University of North Texas, is the author of A Rich Bioethics: Public Policy, Biotechnology, and the Kass Council *(University of Notre Dame Press, 2010).*