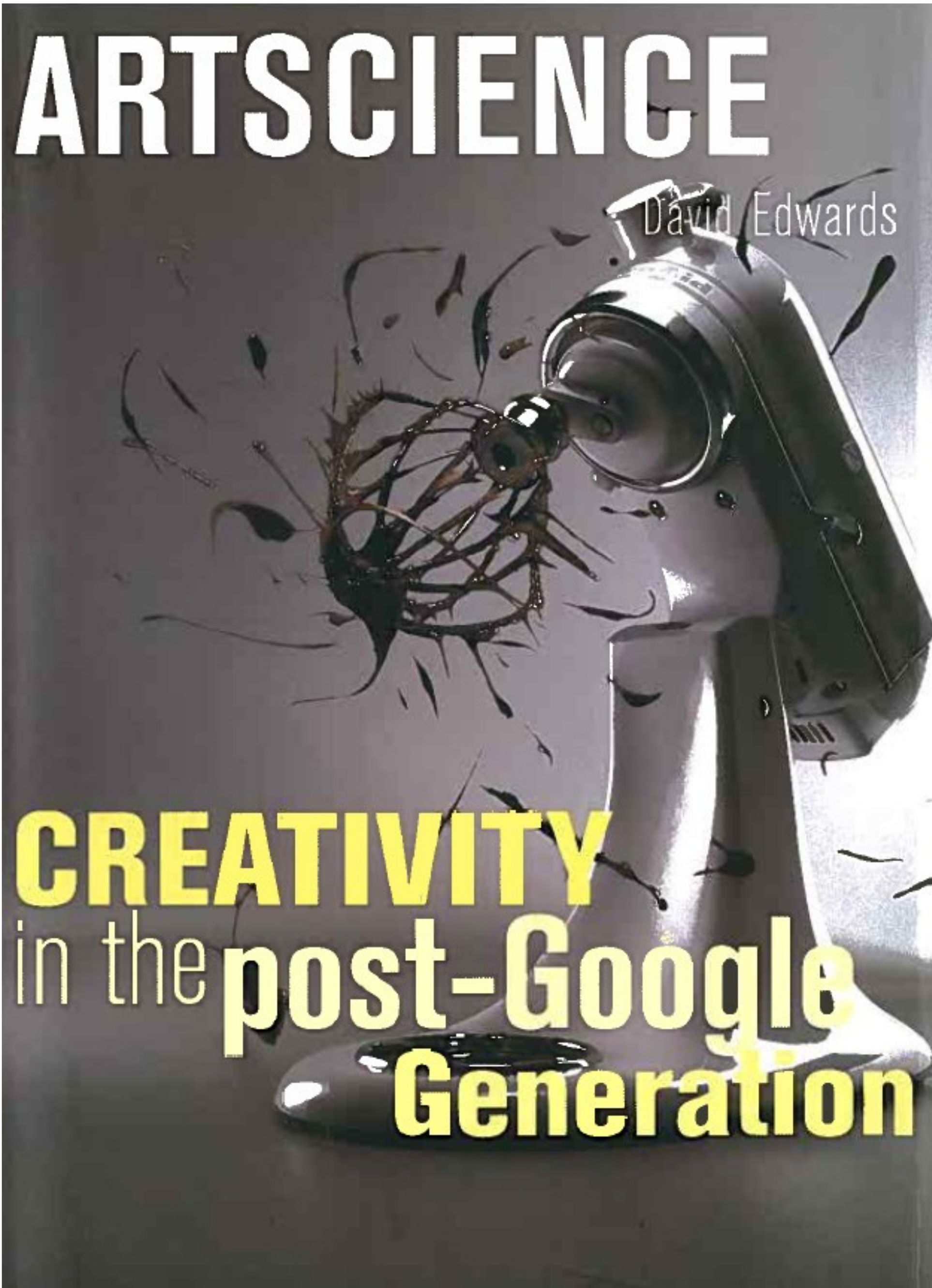
ARTSCIENCE
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CREATIVITY
in the post-Google
Generation

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## Creativity in the Post-Google Generation

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# Process

Today we encounter in theaters, museums, cinemas, opera houses, city streets, our own living rooms, and just about anywhere we can imagine, artists of dizzying varieties integrating into their work the science and technology that changes cultural expression as fast as it is changing our lives. Indeed, this integration into the arts of technology (computers, cameras, ever more novel light and sound resources) and science (genomics, cosmology, ecology) may be so pervasive that we do not question how it actually happens, or what it means when it does. We probably do not question how the cinematographer and the cosmologist, the musician and the computer scientist, or the visual artist and the biologist decide on a common language, what they learn as a consequence, or how their novel collaborations relax hidden assumptions that may limit their work.

This integration of art and science can even seem commonplace—and artists like Damien Hirst know to exploit the perception. Hirst is the British installation artist who first achieved celebrity in 1988 with his Freeze Exhibit, which he curated while a student at the University of London's Goldsmiths College. There may appear no great meeting of art and science when Hirst places a fourteen-foot shark corpse inside a formaldehyde tank. But that he does it, and that London's Saatchi Gallery asks us to consider his work as art, may challenge us to rethink the relationship between biological form and mortality. This is perhaps effective artscience, but Hirst did not need to study biology or think the way a biologist might about life and what it means to be alive in order to create his installation.

Hirst's creative process contrasts with that of Steven Kurtz. Kurtz is an artist and professor at SUNY at Buffalo who achieved celebrity (a few months after Hirst sold his embalmed shark) in a bizarre incident at his home in the spring of 2005. Having called the police to his house when his wife, Hope, suffered a fatal heart attack, Hirst himself soon became the victim of federal prosecutors who discovered that Hirst had created in his home a space that resembled a biological lab, in which he was growing mysterious bacteria, all part of the careful scientific research he was doing for his creative "bioart" work.

This distinction between an artscience work and the process leading to it is worth pursuing further. The playwright David Auburn won the 2001 Pulitzer Prize for his play *Proof*, which describes the experience of a young woman whose mathematician father dies after a long mental illness. Auburn did not study mathematics, did not live with mathematicians or experience the life of a mathematician, before he wrote *Proof*. He nevertheless created a terrific work of artscience. By contrast, Alan Lightman, who teaches creative writing at MIT, published his breakthrough novel *Einstein's Dreams* after obtaining a PhD in physics at Caltech.

Lightman's novel also became a play, although it did not win the attention that *Proof* did, or that Brecht's *Galileo Galilei* did, or that Michael Frayn's *Copenhagen* did. I remember speaking to Lightman not long after his novel earned acclaim for the poetic way it presented Einstein's famous but famously misunderstood concept of relativity and helped many readers understand it for the first time. I told him I loved his novel. He shrugged. He said I was wrong to call it a novel. It was something else—he was not sure what to call it.

Hirst, Kurtz, Auburn, and Lightman all produce works of artscience. But they do so in very different ways.

Scientist-artists like Kurtz and Lightman create art from their experience as scientists, not as artists who metaphorically peer at science as if from a window or borrow from science as your neighbor might borrow a tool. They create and sometimes learn with astonishing self-initiative as they do, some to produce cultural works of art, others to construct new scientific theories, others to create new designs for industry, and still others to engage society on issues of human rights.

Yet idea translation requires of artscientists some commonality of process. I summarize their artscience this way. Idea translators (1) passionately espouse some idea that they aim to realize in the arts or sciences; (2) study deeply and open themselves to invigorating new experience in science (if trained in the arts) or the arts (if trained in the sciences); (3) struggle against stiff resistance from colleagues and sometimes even their intended audience; (4) repeatedly test and frequently see their original idea evolve in unexpected ways in this new environment; and (5) throughout it all maintain a determination to arrive at an original artistic or scientific expression.

Of course, no creator actually follows this paradigm in translating an idea and achieving an outcome that has measurable impact. Just the opposite! As we shall see, a complex mix of passion, curiosity, and freedom propels creators along.

I first learned of Diana Dabby when a colleague stopped by my office one afternoon to invite me to our applied science seminar series. A pianist was about to give a performance. A pianist? Would anyone show up? I was intrigued and skeptical, though I had a class to teach and could not go. But my colleagues—mathematicians, physicists, engineers—did go, and, as I soon learned, they returned to their offices fascinated by what they had just experienced. Dabby had talked about chaos through musical variation, or musical variation through chaos—they were not entirely clear which.

Diana Dabby is an electrical engineering and music professor at Olin College, a new liberal arts and engineering college outside Boston. She is one of the founding faculty. But she is possibly unlike any academic you have ever met or heard of.

Dabby's experience provides an initial example of the processes of creativity and learning that lead to idea translation in artscience, the kinds of processes that an artscience lab might teach, or adopt as a model of best practices.

Diana's idea first surfaced when she was living in New York City and working as a concert pianist. It was the summer of 1982. Taking a rehearsal break, she wandered into the Lincoln Center Library. Curiosity led her to browse in a journal devoted to future trends in music. She noticed that the articles had not been written by musicians, or, if the authors were musicians, it was difficult to tell. The authors identified themselves as engineers and scientists, obviously interested in music, but not professionals. She had a music career—they had none. What could they teach her? Intrigued and inquisitive, she read the first article. In fact, she knew *nothing* about engineering and had practically no math training at all. The minutes passed by as she flipped through a few more articles, each filled with unfamiliar symbols. The minutes turned to hours. Finally she got up, returned the journals, and walked out of the library empty-handed.

Back in the humid New York air, Diana walked over to the apartment of a neighbor musician and relayed what she had just read. "What's an engineer?" she wondered, confiding the embarrassing question that had been nagging her all afternoon. Her friend, having just purchased a new *Encyclopedia Britannica,* immediately opened it up. The encyclopedia surely would address their obvious need for a clearer sense of what engineers actually did.

And that's about where the story might have ended—would have ended for most highly trained and successful professional musicians like Diana Dabby. But it was just then that Diana, looking over her friend's shoulder at the rambling *Britannica* definition ("one of the oldest professions in the world," "civil, mechanical, electrical and chemical," "application of scientific principles," the definition ran on . . .), had her idea.

If engineers and scientists could publish learned articles on the future of music, what would happen if a professional musician acquired the tools of an engineer—actually became an engineer? What kind of music would *that* produce?

The room, we can assume, grew silent. The two young women stared uncomfortably at each other over the beautiful *Britannica* volume, splayed open on the table. Diana's friend offered a different idea, a more reasonable one. Playing piano at a professional level was terrifically hard work. So few who played music would ever reach their level. They had worked crazy hours to keep it up—had worked this way most of their lives—and to think they might now spin around in another direction . . . Diana's idea was ludicrous. It really was.

Diana, however, held firm. Throwing herself at the future meant opening creative doors and just now she loved that idea. It did not go away with a night's sleep, not two nights' sleep, not a month's sleep. Before long Diana was looking into what it would take to enroll at New York's City College, what credits she could transfer from her liberal arts education.

To figure all this out she needed to choose a field of study, so, with nobody to dissuade her, she chose mechanical engineering, which, of course, had nothing at all to do with her aspirations. The *Britannica* definition had given her too many choices. Eventually she figured out that it was the "electrical" variety she had in mind.

The following September Diana Dabby was back in school, convinced that if a professional musician acquired the skills and language of the engineer, he or she could not help inventing and creating something new for music.

A young, talented, and ambitious musician, Diana obviously wanted to be part of whatever musical revolution might happen and she was not going to be deterred by a lack of useful knowledge of science and engineering. Her decision had no precedent she knew of, at first- or second-hand. She was about to invest years of study and discipline and even risk her own level of skill as a professional musician. Some friends and mentors, it turned out, were impressed, admiring her courage, while others were deeply dismayed, worried where exactly this would lead Diana Dabby in the end.

It is hard to explain why she plunged back into years of learning other than to say she was passionate about her idea (she loved music and was determined to participate in its future), curious (she knew so little about science), and free (she had no immediate family responsibilities or career preconceptions). Her creative idea, even more than the university she returned to, was her gateway to learning.

Translators of ideas like Diana Dabby succeed as they do, and have confidence they will succeed, because they love the adventure as much and frequently more than the treasure that their adventure is designed to bring them. It is not that the treasure means nothing to them. Just the opposite! In their minds and words the treasure is probably all there is. But it is the daily adventure of seeking out the treasure—making mistakes and correcting them, always making progress with the hope of more progress to come—it is this *process* that seduces them.

And it is the time before the process begins, when the path abandoned looms more real than the path to be charted, that proves hardest of all.

Indeed, it was a big stretch from the stacks of Lincoln Center Library to a first-semester calculus class. Diana taught herself algebra, waded through trigonometry—and fell in love with calculus. This saved her. Yet math did not come easily. She struggled over the idea of limits (who could admit to limits?), buckled down through roughly 150 exams. Meanwhile, there were pleasures. Without them the process—moving from the aesthetics to the science and trying to find the space in between—might have been unbearable. She loved the rich variety of languages she heard (sixty-six on campus, she read somewhere) and easily blended back into her professional musician's life, which also paid the bills.

Music was not just a way to make a living in these years; it gave her a fresh way of looking at science and made others look at her in an original way too.

Diana graduated in 1987 and went straight on to graduate school in electrical engineering and computer science at MIT.

Diana's original idea, the one that prompted her to return to school in 1983, was vague, the idea that, armed with science, she might pioneer music. But how? She had homed in on that question over the preceding years, moving from science to engineering, and then from mechanical to electrical, and from City College to MIT. Now she arrived at the idea of chaos. She came on it through an intermediary, an electrical engineering professor who introduced her to it.

"You're an artist," he said. "What would you do with chaos?"

The challenge had a magical effect on her. Mathematics, she knew, had been explored in music since Pythagoras and more recently by the composer Iannis Xenakis. But few had applied what science came to learn about chaos—at the origin of some of the most beautiful phenomena in nature, from forming clouds to breaking waves. What if she did?

Years had passed since her first idea in the Lincoln Center Library. Only now did she have a relatively clear sense of how she might pursue it to fulfill her original dream.

Of course, even here, the idea was still maddeningly vague. How could music come from chaos? It took her a few more years to figure that out.

Meanwhile Diana buckled down and again music served her, helping her navigate an oral qualifying exam, which she conjured up in her mind as a kind of Carnegie Hall performance, helping her tolerate the uncertainty and risk of thesis research over years of analytical effort, and, finally, helping her acquire the language and tools of the engineer.

Diana Dabby looked deeply into the equations that described chaos. In their infinite solutions, in the commonality of the orbits that these solutions (all different in a certain limited way) traced around their so very strange "strange attractor," she saw the idea of musical variation. When writing music as variation, the composer needs to maintain enough commonality so that a link still exists with the original source. But what, after all, did "enough commonality" mean, and, would any of her work with the equations suggest a novel way to view chaos, or, most important, a new technique for musical variation?

Diana's eureka moment occurred in the early 1990s, while she sat in a classroom with rain pounding the pavement outside the window. She was waiting for a student. With nothing to do—no books, no articles, nothing to read—she eventually wandered over to a wastebasket, found a scrap of paper, and carried it back to a desk and began to draw.

She sketched a strange attractor. Then she placed notes atop the trajectory and drew a new trajectory and projected notes onto this as a musical variation to the original piece. After six years of study, in five minutes Diana created a mathematical theory that could produce an unlimited number of musical variations from a single original source!

It took a decade for Diana's process of artscience (the aesthetic method of the music composer with the scientific method of the electrical engineer) to produce her "work" of artscience. Without intuition she would not have gone back to school, seized on the idea of chaos, spotted the link between musical variation and strange attractors; and without deduction she would not have made her way through engineering school or developed her theory of chaotic musical variation.

Diana certainly was not the first person to attempt an innovative exploration of the role of pioneering mathematics in contemporary Western music. But her use of chaos to generate musical variations had no precedent. It underpinned her thesis, "Musical Variations from a Chaotic Mapping," which she defended in 1995. It was Diana Dabby's artscience innovation.

Her work has since been featured on radio shows, in concert performances, and in countless seminars, such as the one I regrettably missed at Harvard University in December 2004.

As original as Damien Hirst's shark tank, Diana Dabby's musical variation technique stands apart as the creative product of deep crossover learning that required years of support from educational and cultural institutions. (The former educated her, the latter helped pay her way.) But this critical and accessible support was not easily obtained. Diana created her own path, motivated by her own idea, and used whatever cultural and educational resources she could find.

Having finished her doctoral degree, Diana faced a new obstacle. There was no place for her within traditional academic departments. They did not know what to do with her. University faculties may have admired her accomplishments, but they could not see a way to integrate her skills, place her in the tenure process, deploy her as a teacher. Cultural organizations had no place for her either.

Only after several years of searching did she find employment with Massachusetts's Olin College, an institution designed as an experiment with the aim of encouraging the exceptional educational and creative processes that today produce some of our most spectacular innovations.

What does Diana's story tell us about artscience?

Artscience was the mechanism of Diana's idea translation and it was also an innovation; it was process and product, and, again, process mattered more. It involved risks and rewards, some of which she anticipated better than others. Had she not found a way to balance these risks and rewards over years of translation she would not have produced anything. So while we will probably remember Diana's artscience as something she produced, she will likely remember it as the process of idea translation that got her there.

We might summarize her story of innovation as follows:

- *The idea:* With her training as a concert pianist, Diana was possessed with the idea that only through further training as an electrical engineer would she be able to explore frontiers of contemporary music.
- *The artscience process:* To translate her idea, Diana, the pianist, had to transform herself into an electrical engineer. But what seemed like an obstacle—having to return to school to learn a new discipline, having to acquire a first degree and then a second—in fact propelled her idea translation, or accelerated it. She studied science and engineering as deeply as she had studied music. And she remained a pianist, which paid her way through school. Alternating between "pianist" and "engineer" (the

pianist needed to become the engineer, the engineer the pianist) invigorated her.

- *The risks:* Enrolling in engineering school meant risking her continued development as a concert pianist. Alternating between "pianist" and "engineer" at times prevented the immersion in her music that she had previously experienced. She risked the confidence that she performed at the top of her art with the hope that she would assimilate new strange symbols, and survive the rigors of engineering school. She grew less familiar with old friends owing to geographical distance, even as she met new ones. Her direction probably seemed to her increasingly irreversible.

- *The rewards:* Diana was able to learn, and even to "perform," better as an engineer by drawing on her professional musical experiences. Her exposure to cutting-edge science and engineering fueled her imagination as a composer. She had the possibility of rising to an entirely new level as a composer and the freedom associated with seeing her path as her own.

- *Perception versus reality:* When Diana made her decision to become an engineer, she did not imagine the risks and rewards it implied. Mostly she did not even think about them. Her instinct guided her, an instinct to pursue with passion an idea of personal freedom and creativity. Obviously she focused on the benefits, like the benefit of returning to school to become an engineer (though not specifically to innovate in the way she eventually did), and the ability to continue her work as a pianist (which actually helped her to think more originally as an engineer).

- *The artscience work:* Diana achieved an innovation in music composition. She achieved it through science, but when you listened you heard art. Chaos theory had a scientific use; you solved problems with it. But Diana used it scientifically to solve an aesthetic problem. She transformed it into music.