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W. Patrick McCray. 2013. *The Visioneers: How a Group of Elite Scientists Pursued Space Colonies, Nanotechnologies, and a Limitless Future*. Princeton, NJ: Princeton University Press. 368 pages.

Erik Seedhouse. 2013. *SpaceX: Making Commercial Spaceflight a Reality.* New York: Springer-Praxis. 244 pages.

Over the past few decades, critical theorists have increasingly moved away from time as the privileged domain for explaining human experience and toward a geographical or spatial conceptualization of socio-political processes. For many critical theorists, history seems to have ended at some point between the conclusion of the 1960s and the beginning of the 1970s, for different if interrelated reasons. For Slavoj Žižek, it is 1968 and the capture and then betrayal of the hopes of that radical year by Western states' embrace of free-market ideologies now referred to as "neoliberalism." For Peter Sloterdijk, it is 1974 with Portugal's withdrawal from its overseas territories, bringing to an end 500 years of European colonialism. And for Bruno Latour, it is more generally in the early 1970s with the acknowledgment of the sustained ecological crisis resulting from the colonial-industrial age. The "end of history" thus marks the end of Western modernity's key narrative of progressive temporal stages—characterized by dates, events, charismatic individuals, growth, technological innovations and movements toward the future. For these scholars, the mode of social analysis is spatial rather than temporal, critiquing capitalism's rapaciousness and resulting social, political and economic inequalities by drawing attention to the simultaneity of global events and arrangements. And so the end of history is also the end of the future.

Yet the 1970s was also the period when "the future"—dystopian or utopian, fixed by forecasts but open to technological manipulation—seemed to most fully capture the imaginations of the lay public, politicians, policy makers and forecasters, including some anthropologists. The 1972 publication of the Club of Rome's *The Limits to Growth*—with its warnings of social collapse and the necessity of retrenching global socioeconomic structures in order for humans to live within their ecological means—catalyzed both dystopic visions of an imminently doomed world and counter-visions of a prosperous and ever-expanding human future. This latter future would arguably be secured by technology and resources at the very large and very small scales of matter. Patrick McCray's splendid *Visioneers* uses *Limits,* and the responses to it, as the fulcrum of his history of the individuals and techno-social movements that coalesced around plans for a future of space settlement at the large scale and nanotechnology at the small, just as the end of history had arrived.

McCray coins the term *visioneer* to describe a person who combines three factors: a vision of a positive and expansive human

future secured by technological developments; actual research and engineering which advances the vision; and the promotion of the vision to policy makers and the public through media and activist networks in the hope of advancing that future. The two men who are the visioneer-protagonists of this book—Gerard K. O'Neill, a Princeton physicist, and Eric Drexler, one of O'Neill's erstwhile students and an MIT graduate—imagined their futures at the two extremities of scale: O'Neill's plans for massive outer space settlements and Drexler's promotion of technological development at the nanoscale operate at spatial scales that challenged limits of possibility, investment and credibility. But they also operated at a temporal scale that required massively coordinated action in the present to secure the dynamic and expansive future they envisioned. In the end, as McCray shows, both spatial and temporal scales morphed their projects in very different ways—and the lesson might be indeed that history is over.

A respected and tenured professor at a leading research university, O'Neill is, as McCray points out, an unlikely figure to appear in the guise of a visioneer. Beginning with a physics seminar at Princeton organized around the possibilities of human space settlements in the fall of 1969—just after the first Apollo moon landing—O'Neill became increasingly convinced that space settlement was the answer to the conclusions of *Limits*. With the brief Apollo era concluded by 1972, both NASA and space proponents were turning their attention to the idea of space stations and establishing routine human presence in low Earth orbit (LEO), precursors (it was hoped by space proponents) to massive and sustainable human space settlement. The question for many, though, was why? After all, the United States had reached its Cold War goal of demonstrating technological (and thus ideological) superiority over the Soviet Union by sending humans to the moon. Why should it continue investing a large portion of its national budget in space? For O'Neill and proponents of space settlement, the initial answer was ideological: humans need a frontier, and space is human destiny. The practical answer, as McCray shows, came in the form of Peter Glaser's contemporaneous proposals for a space-based solar-power satellite system. Arising out of the same complex of space exploration and space technology, Glaser offered a response to the gloom of *Limits* by proposing a massive space infrastructure that would beam solar power from orbiting solar collectors, solving the looming energy crisis, reducing carbon-fuel pollution, and boosting the global economy by significantly reducing the costs of power. In space-based solar power, O'Neill and his supporters found the political-economic rationale for space settlement: residents of his space colonies would manufacture and manage solar power satellites from space resources. This would, in turn, resolve Earth's ecological crises, and the "virtuous cycle"

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of growth and expansion into the cosmos would be achieved naturally.

McCray insists that it was the actual work O'Neill and his collaborators did—designing, costing and even building early demonstration hardware—that in part makes him worthy of the title "visioneer." But O'Neill recognized that combating the inherent giggle factor of the space settlement movement was essential to advancing the movement's goals where it counted: in Congress and the White House. To this end, in 1974 O'Neill established the Space Studies Institute (SSI) in Princeton, an event featured in a front-page article in *The New York Times*, and he actively promoted his plans in the media and to policy makers. This public promotion is McCray's third criterion for qualifying as a visioneer. He devotes a fair amount of space to a discussion of the O'Neill-inspired L5 Society, a grassroots space-advocacy group—named for one of the points of gravitational stability between Earth and the moon—and to *Omni Magazine,* a key venue for the popularization of the space settlement movement in the 1970s and early 1980s. This tension between the seriousness of purpose (the tenured and respected physicist, the hardware, the solid numbers, the clear plans) and the kookiness of the whole thing (UFOlogy alongside space settlements in the pages of *Omni*, the outlandish enthusiasms of some amateur supporters) follows all modernist projects of radical futures. And as in so many of these, it doomed O'Neill's plans.

As McCray shows, the future imagined by O'Neill and his supporters slowly crumbled over the course of the 1970s. It wasn't just that O'Neill's proposals were enormously expensive; they required a leap of vision into the future that politicians and the public were increasingly unwilling to take. And the buy-in of politicians and policy makers was essential, for the idea of private enterprise taking on the risk and expense of developing space infrastructure was outlandish. For McCray, O'Neill's commitment to a state-led space colonization effort—tied to an understanding of the collective social good of space settlement—underpinned his politics.

This is one of the few false notes in McCray's otherwise insightful book. As he demonstrates in several places, "space" produces strange bedfellows. Space-settlement proponents and enthusiasts scatter across the conventional left/right arrangements of the politics that, in the early 1970s, were about to become even more polarized in US political life. McCray implies that from the 1970s to the 2010s, to which he jumps in his final chapter, the ideological underpinnings of the space-settlement movement shifted from a leftist commitment to a societal project of a new commons in space to a rightist and privatized individualistic mode. My own reading of O'Neill leads me, rather, to hold onto McCray's broader observation about the capacity of the promise of space to send terrestrial political alignments into disarray. It is not so much that O'Neill clung to a communalist view of the future. It was inconceivable in the 1970s that a private company would undertake such an effort, notwithstanding the science fiction of Robert Heinlein—another hero of the space-settlement movement—in stories such as *The Man Who Sold the Moon*. It is, rather, that space is the open signifier for American politics, enabling many kinds of imagined forms

of government and exchange to open up, a literal space for the unfolding of multiple possible future worlds.

By 1977, however, it was already clear that the investments required for space settlement and space-based solar-power satellites were not forthcoming. Despite the energy crisis, a space future of almost-free power and space colonies taking on industrial pollution and absorbing excess human populations was a few steps too far. It was on the cinema screen, not in actual hardware, that this future would unveil itself for late-20th century audiences.

But it was at this point too that a new kind of promising future and a new visioneer emerged. Eric Drexler, a research assistant to O'Neill in the early 1970s and the second protagonist of the book, was also deeply involved in the space settlement movement. For Drexler, the promise of a future in space would be guaranteed through what came to be called "nanotechnology." Drexler's path was different from O'Neill's—he worked through a self-established institute rather than a university, and his focus was on computer modeling bio-matter at the microscopic scale rather than costing and building actual hardware. However, Drexler's story feels much like O'Neill's, and McCray is clearly drawn by the similarities. Like O'Neill's work, Drexler's investigation into and popularization of the manipulation of matter—and in particular, biological matter—at the very small scale drew enormous popular and scientific attention, to the point where his name became synonymous with what eventually became known as nanotechnology. His vision of manipulating DNA to operate as miniature, self-replicating factories in the production of larger forms of matter was enormously compelling to audiences in the 1970s and 1980s. With articles about him in *Omni* and *Scientific American*, enthusiasm from many of the same advocates who supported O'Neill and support from the nascent field of cryonics, Drexler activated many imaginings about an expansive future. Drawing both on pervading analogies of biological functions to machines and on emerging technologies, such as the scanning tunneling microscope, Drexler viewed nanotechnology as a key solution not only to space settlement (his initial focus), but to social problems more generally. Like O'Neill's vision, Drexler's was not just technological but ultimately social.

Even without prior knowledge of Drexler or nanotechnology, readers of McCray's text can anticipate the impending failure of Drexler's visioneered vision. A range of factors worked against Drexler, not least the material difficulties of manipulating biological matter at the very small scale, a fact used against Drexler by another leading proponent of small-scale matter manipulation, Richard Smalley. Smalley's critique of Drexler was simple: Drexler's unproven proposals operated through computer modeling, not bench-laboratory science. The focus on biological matter was also seen as a step too far, ignoring how little scientists yet knew about DNA or genes. Although the criticisms stuck at the time, they clearly would not hold today given the integration of biology, genetics and computation. Drexler's plans (and reputation) were thus doomed by the same kind of temporal dissonance—being in the future before it was time—that plagued O'Neill. By the 1980s, the tone of media

coverage of Drexler's institute and his vision of prosperity-through-nanotechnology had shifted from breathless excitement to an arms-distant, ironic, even fearful stance. The "gray goo" Drexler proposed as the matrix of nanoscale productivity and the weirdness of cryonics allowed his unsubstantiated technology to be too easily associated with a dystopian future of nano-level matter gone wild and deadly, and to produce the same giggle factor with which O'Neill had contended. Smalley, by contrast, went on to establish a virtual academic empire of the very small scale, allowing the term "nanotechnology" to take something of a back seat and remain associated with Drexler; indeed, McCray documents how Drexler's very name became anathema to serious scientists working at the small scale, fearful of similar associations with a kookiness that might threaten their funding. And so once again, readers see the future coming back to upend itself. It is Smalley, not Drexler, who leads that future—a future now more modest, more respectable, more predictable.

* * *

The future seems to exist in two forms for the modern observer: growth or decline, progress or devolution, utopia or dystopia. This binarism collapses in the denouement, however; from the perspective of the present, the futures of historical actors already seem to be logical outcomes, whether as failures or successes. That is, the future seems to be known ahead of time, even if history has ended. Where McCray leaves off with the future in the past, Erik Seedhouse takes it up in the present, but in a different register. For

Where McCray leaves off with the future in the past, Erik Seedhouse takes it up in the present, but in a different register.

Seedhouse, as it was for O'Neill and Drexler, the future is very clear indeed. Ostensibly a book outlining the current successes of entrepreneur Elon Musk's Space Exploration Technologies (SpaceX), it is more instructively read as a future history—as though readers were back in 1974 again—outlining the inevitability of the commercialization of lower Earth orbit and the eventual future settlement of Mars, which is Musk's expressed goal for SpaceX. The story Seedhouse tells about the 2000s and early 2010s feels eerily familiar to someone who has just finished McCray's book. Grammatical tense becomes inadequate for thinking about revived futures that have already been relegated to the past. This doubling back between past and future is evident even in the collective term used by advocates to describe early 21st-century entrepreneurial space companies: Newspace.

Seedhouse's book is to some extent typical of a large range of offerings from presses such as Springer-Praxis, Apogee and Prometheus, books that revive the hopes of O'Neill and Drexler and give them new form in the context of neoliberal boosterism and a renewed commitment to the promises of technological salvation. If futurism had its heyday in the 1970s, the early decades of the 21st century have provided a range of new futurists, from Ray Kurzweil

to Nassim Taleb, and new proponents of a growth doctrine for outer space, including Peter Diamandis and Robert Zubrin, who continue to rail against the enduring influence of *Limits*. These new futurists see the disorientations and shocks of the modern world—and in particular, technological advances—as *resources* for the future, carrying the flames of free enterprise, open markets and exponential technological growth. This futurism rides alongside technology. Plans for space settlement and nanotechnology have never really gone away, but material developments in both fields have drawn media and public attention to them again, once more in the positive. McCray makes an excellent case for how Drexler's vision of nanoscale manipulation of matter has in part been achieved in the present day precisely because of his visioneering, but he focuses less on the achievements of contemporary commercial space enterprises bent towards eventual space settlement. However, those space settlement advocates are still around; indeed, as I have discovered in my own research on the space settlement movement, some of the same people from the O'Neill era remain hard at work on the goal.

Seedhouse's book feels like a lesson in modern time for the critical reader and represents Elon Musk as the kind of visioneer figure that McCray paints more cautiously and critically. Musk here is explicitly named as "the space industry's Tony Stark," a reference to the billionaire entrepreneur, inventor and Iron Man of Marvel Comics fame. With that kind of start, readers already know where they are going: Mars. Like a re-run of history, Seedhouse unveils the company's early failures, the unstoppable optimism, the media's first-skeptical, then-enthusiastic accounts of Musk and SpaceX, only this time via a private, commercial enterprise.

For a bit of a plot complication, Seedhouse introduces some of SpaceX's competitors, other providers with the goal of transporting cargo, and potentially astronauts, to the International Space Station (ISS). But there is never really a doubt about which company Seedhouse believes will make it. If McCray's book rounds history out by returning to an adult reality where the science fiction fantasies of O'Neill and Drexler are domesticated to a normalized modern time line, Seedhouse spins the plot anew into the future, his snappy prose moving readers inevitably toward the commercialization of LEO and the future settlement of Mars.

Published in 2013, this book comes well before the denouement to the plot that progressive history, science fiction, space advocates' decades-long imaginations of the future and SpaceX's own publicity machine have laid out: the crucial development of a fast, reliable, reusable rocket to take people to orbit, and then Mars, cheaply. What makes space travel, exploration and ultimately the idea of space settlement so expensive is the simple fact that it costs so much just to get to low Earth orbit. The high price is not necessarily due to the cost of fuel, but because all rockets are essentially expendable. In space advocates' oft-used analogy, it is like flying from Los Angeles to New York, scrapping the plane, and building a new one for the return flight. (It is worth noting that the Space Shuttle was reusable, but depended on massively expensive expendable external boosters that, among other factors, made each flight come in at around a whopping

$1 billion). Once travelers leave Earth's gravity well, the costs of moving around space are relatively low, especially if they can refine fuel from lunar or asteroidal water in its component elements of hydrogen and oxygen, as other entrepreneurial space companies such as Shackleton Enterprises and Deep Space Industries are planning. The development of a truly reusable and reliable space-transportation system would indeed be revolutionary, radically reducing the costs of going to low Earth orbit and opening space to a much broader array of people and activities. SpaceX has already had remarkable successes with its early ground tests of its reusable technology in McGregor, Texas, and has also done four controlled reentries of the first stage of its Falcon 9 rocket (the third coming very close to landing on an ocean-going barge, designed for that purpose), but they are still far from having proved the technology.

Sometimes the future arrives right on schedule.

Space settlement is not just about rockets and space stations, as O'Neill knew: life-support systems, hydroponics, radiation protection, adequate computer and communication technologies, lighter and more durable materials and much more are required for life beyond Earth. Though Seedhouse doesn't mention them, meeting these needs are a range of technological developments that seem to coalesce around both the big scale of space settlement and the small scale of nanotechnology, from research into synthetic biology to 3D printing. A start-up called Made in Space flew a 3D printer to the ISS in September 2014 to test its functioning in a microgravity environment. A range of other technological solutions are being promised today by the various fields that have followed in Smalley's nanotech footsteps, or even—as McCray notes— that are operating in ways Drexler dreamed of. But like SpaceX's reusable rocket, these are nascent and unproven technologies.

That doesn't matter to Seedhouse, nor to most space advocates. Bearing all the hallmarks of 1970s space advocacy, Seedhouse's book is aggressively optimistic, drawing on SpaceX's technological developments and Elon Musk's charismatic visioneering as inevitable engines toward the eventual humanization of outer space. Drawing here and there on the equally inevitable analogs to the American West or the barnstorming era, Seedhouse takes readers from SpaceX's failures in the early 2000s to the successful berthing of its Dragon capsule with the ISS on May 31, 2012, the first time a commercially produced spacecraft had ever achieved such a feat.

For space advocates, remembering where one was when the Dragon berthed with the ISS that day is almost like remembering one's location when Kennedy was assassinated. It's that big. Here is my story: I was at the International Space Development Conference in Washington, DC, where, in a serendipitous plot twist right out of a science fiction novel, I was listening with several hundred other people as Charles Bolden, NASA's administrator, gave the opening keynote. I had been in Florida earlier in the week, hoping to witness the launch of the Falcon 9 bear-

ing the Dragon on its way to the ISS, but the flight was scrubbed a half second before liftoff. Disappointed, I had flown to DC for the conference, a second launch being successful in the meantime. So the live feed from the space station on the screen behind Bolden was a wild coincidence, an accident of history. Bolden's announcement to a crowd of space enthusiasts that the Dragon had successfully berthed, the unbridled cheering from the audience, the confirmation that the commercial spaceflight era had begun, was not plotted as such, but in the way that things come together, it felt to me and to the ebullient crowd around me as though we were living the smooth story told by Seedhouse, as though someone had finally fixed the short-circuiting of time that emerges in McCray's book. Sometimes the future arrives right on schedule.

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In Mojave—90 minutes from Los Angeles over the mountains and into the desert—Newspace and the future seem to have coalesced. It was from here that Burt Rutan's SpaceShip1 won the Ansari X PRIZE in 2004 for being the first commercially built spacecraft to reach the edge of outer space. Here one finds the offices and manufacturing facilities of well-known companies including Virgin Galactic, XCOR, Masten Space Systems, Scaled Composites (builder of the Virgin Galactic craft), Stratolaunch and smaller companies whose names may not be on the lips of the public or skittish venture capitalists, but which are equally committed to O'Neill's morphed goals. Someone who gets the right calls might get up in the morning in time to watch one of several Newspace companies' rocket engine tests far out in the scrubby desert on the airport property, or a test flight of Virgin Galactic's SpaceShip2. Occasionally, those tests go terribly wrong, as they did on the morning of October 31, 2014, when Spaceship2 suffered a catastrophic failure just seconds after its engine was ignited, destroying the vehicle and killing one of its test pilots. Such failures almost inevitably reactivate questions about the future of commercial human spaceflight, about the possibility of humans in space at all, and Mojave has many reminders of such questions. For example, visitors can walk past the Roton, now a permanent exhibit near the main airport administration building, the prototype model of a single-stage-to-orbit spacecraft that flew a few test flights in the late 1990s. It failed—like so many commercial spaceflight ventures—not necessarily because of immature technology but because of a lack of money. The density of these things in the space of Mojave matters, as critical commentators would point out. To the people working there, Mojave matters for the future of outer space.

Nowadays the archive of the Space Studies Institute (SSI), the organization O'Neill founded in 1974 in Princeton, is based at the Mojave Air and Space Port in a squat, WWII-era building simply called Building 1. Its office doubles as its archive, a large collection of books, NASA contractor reports, journals, magazines, popular media clippings, space legislation, national space commission reports, comic books, art—pretty much anything that has to do with space and space settlement. Most of this material dates from O'Neill's days but has been augmented

by various donations and recent books on space settlement, asteroid mining, space-based solar power and so on. The dusty linoleum floor is littered with colored dots that have fallen from the spines of volumes, remnants of a former archival system that is now oblique to those (such as myself) who have sought to bring some order to the collection after its move. Working through this archive, one can read through early proposals for space-based solar power, asteroid mining, moon bases, Mars settlements. There is the Paine Report, product of the 1986 national commission on space under President Reagan which, like the Augustine Commission established more than 20 years later in 2009 by President Obama, sees sustained human presence in space—*settlement* and not simply its exploration—as a key goal. Despite the dust, the dried out glue and the cracking spines, block out the names and dates and this material can feel entirely contemporary, fresh and new, not just historical, archival or a fantasy of the past.

Time doubles back on itself in Mojave: clunky WW II–era architecture and super-high speed Internet, old fighter planes sitting quietly in a lot and the sleek, glossy lines of SpaceShip2 on the runway, the quiet, awesome Roton held down by cables against the roaring desert winds and the dusty volumes in the SSI office. And it is not just the past that comes up to meet the present. One evening, sitting in a shabby diner on the main strip of Mojave, waiting for an XCOR engineer to turn up for dinner, I saw a group of young, spandex-y people from Virgin Galactic being seated. These are the ones who fly in from the UK, not the ones who live here. For a moment, they looked to me as if they were wearing Star Fleet uniforms. My shock was not that I had gone so native as to believe that *Star Trek* and the future had met me on the strip in Mojave, but that it was so easy for time, narrative, history, fiction, space, to collapse in a moment. Like the dots on the floor, it is possible to feel unglued from time here.

So, reading McCray's cautionary book in Mojave is unsettling. Leaving the desert on Route 14 to go back to places where the experience of time feels as though it flows more properly, one might have a sense of already knowing the outcome of these Newspace ventures, a feeling for time's inevitable circling-round back to failure, revised goals, modest outcomes, formerly shiny system proposals now gathering dust on shelves and ultimately staying fixed on Earth's surface. Start reading Seedhouse's brightly optimistic view of the future opened up by Elon Musk and SpaceX while waiting for a plane at LAX—where iPads and Wifi and Google abound, technologies that came out of the fervor of the same California ideology that underpins the dreams of big space and tiny salvation machines—and one might feel a jarringly counter-sense of prescient optimism. Just a few miles away from LAX in Hawthorne, SpaceX is (will be? was?) gearing up to produce the world's first-ever fully reusable launch vehicle, a heavy lift rocket capable of taking people to Mars, and doubtless other innovations for which it has become justly famous.

As I finish this essay, news breaks that SpaceX has been awarded one of two contracts to transport astronauts to the Interna-

I would argue that the challenge ... is how to hold onto a sense of hope, of surprise, of openness about the future.

tional Space Station. History seems back on track. But Mojave's lesson—the lesson of O'Neill, Drexler, and all the other visioneers who pepper the American past, present and imagined future—seems to be that sooner, rather than later, people will be reading about SpaceX in a past tense at the SSI archive, with another red or blue dot lying in the desert dust on the floor.

But this is the challenge of the future at the end of history, equally for social theorists, historians, Newspace boosters and dogged space-settlement advocates. And it is a challenge to the distracted public watching these events unfold alongside other events that mark (will have marked?) the ends of history: violent conflicts, ethnic cleansing, increasing social and economic stratifications, natural and unnatural disasters, a changing climate, a precarious world. The spatial turn already seems to fold comfortably into the turn to outer space. It is satisfyingly easy to either imagine or to cut off the future by short-circuiting it back to the past, be it the settlement of the American West, the barnstorming era of the early 20th century or the Apollo era, analogs used by both Newspace proponents and their critics. For proponents, such analogs offer the promise of history repeating positively; for their critics, they spell the inevitable doom of space settlement endeavors, more dots on the floor. I would argue that the challenge, posed in a different context and in different ways by David Harvey and Sam Collins, is how to hold onto a sense of hope, of surprise, of openness about the future. The question is how to think about these histories (whose ends McCray neatly ties up and Seedhouse is so uncritically enthusiastic about) without recourse to an anterior-future-historical tense, time doubled back, already decided. Space—vast and nanoscale, terrestrial and psychic—needs its future back, a future that is neither simply progressive nor only regressive, a future that can be considered with more subtlety. Though he works in his final chapter to undermine this conclusion, McCray's book has the effect of drawing attention back to the primacy of the spatial, in its invocation of scale, and ties readers to the sense they would get at the Space Studies Institute archive: it's just the same future in updated clothing. Seedhouse writes as most Newspace boosters do: he sees the future as open, but open in a very specific way, i.e., for the inevitable unfolding of capitalist systems of value in the cosmos. But even if neither of these books takes a critical perspective on history and time, together they challenge readers to develop ways of thinking about the future that don't simply make it repeat itself, for the purposes of either a utopian or a dystopian punch line. Politically and theoretically, it is important to open up to the surprise that the future may bring and struggle over what it may become without a certainty of already knowing its outcome.

Suggestions for Further Reading

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David Valentine is associate professor of anthropology at the University of Minnesota. His first book, *Imagining Transgender: An Ethnography of a Category* (Duke University Press 2007), examines the politics of the emergence of "transgender" as a category of identity, analysis and political action. His current research is a five-year, longitudinal study of imaginings and narratives of the future among commercial outer-space entrepreneurs, funded by the National Science Foundation (BCS-1127070).