CORRESPONDENCE

China's Aims in Space

China is entering its space age, and some Americans, like Jeff Kueter, find this troubling ["China's Space Ambitions—And Ours," Spring 2007]. While their test of a destructive anti-satellite weapon (ASAT) is a cause for concern, both the United States and the Soviet Union experimented with comparable technologies earlier in their space programs. Both wisely decided to abandon them, and China may as well. Destructive ASATs don't actually provide any of the intended security benefits, while they do create debris that threatens the commercial, scientific, and military use of space.

Kueter believes that because China's leaders have the capability to destroy U.S. satellites, they intend to use it, much as American doomsayers in the 1960s believed that once Mao Zedong had nuclear weapons he would use them. Yet for more than forty years, China has kept its nuclear arsenal small, off alert, and ready to be used only after a first strike from another nuclear power. There is little reason to believe that China would be any less restrained in its use of military space technology.

Kueter points to PLA publications that contain proposals for space warfare. He fails to note that they were written by aging junior officers shunted off to PLA research institutes after being passed over for promotion to more responsible positions in the senior leadership. Chinese military professionals call them "garbage articles." Few in China take them seriously because most understand that real Chinese military strategists *don't publish*. These "garbage articles" on space warfare are often cribbed from American sources. Kueter and many of the American space hawks hyping the Chinese threat are scared of their own shadows, intimidated by Chinese echoes of their own words.

Now that China has the scientific, technical and industrial base to support a large aerospace industry, it should not be surprising or alarming to learn they are pursuing the same military and civilian space technologies valued by other spacefaring nations. Contrary to Kueter's claims, there is nothing unique or inherently aggressive about China's space programs. China's hesitant approach to early warning satellites is consistent with a restrained nuclear posture that does not require launch on warning. And Kueter is wrong about China's immediate priorities, which include reconnaissance satellites, along with an indigenous global positioning system, piloted spaceflight, and robotic exploration of the solar system. All four are clearly listed in the Chinese national planning documents Kueter should have read more carefully.

GREGORY KULACKI
Senior Analyst
Global Security Program
Union of Concerned Scientists
Cambridge, Mass.

Jeff Kueter's analysis of China's test of an ASAT is almost entirely correct. The test demonstrates that China understands defeating the United States in a future conflict would require the neutralization of American space assets. American military power and economic vitality are increasingly dependent on the unfettered use of space. The test also shows China's disregard for the dangers posed

by resulting space debris to satellites and other space facilities owned by other countries.

The purpose of China's space program, including nominally civilian efforts such as the Shenzhou space flights, is to enhance the military, economic, and political power of the Chinese state. Considering the aggressive nature of the Chinese regime, that power can only be improved at the expense of the United States.

Kueter is also correct on the appropriate response to the ASAT test. Purely diplomatic and political approaches will prove ineffective because China's quest for power means that it only understands the language of power. Measures to counter China's drive to increase its power in space must not be limited to defending and improving our own military space assets. Attention to America's economic and political interests in space is just as important. While there is a tendency to regard military, economic, and political power as separate, they are actually interrelated and mutually supportive.

Technology being developed by private space companies can have both civilian and military applications. For example, the same launch vehicles that can take tourists into space can also quickly deploy military assets, replacing those destroyed by a Chinese ASAT.

Conversely, as economic activity in space proliferates, from space tourism to perhaps someday mining the moon and Earth-approaching asteroids, facilities engaged in such operations will need defending. That implies developing the capability to sustain military assets in space on a more or less permanent basis.

Sea power made Great Britain the superpower of the eighteenth and nineteenth centuries. Air power made America the superpower of the twentieth century. Space power will determine which country will be the superpower of the twenty-first century and beyond. For the sake of the world, that superpower should be the United States, not China.

MARK R. WHITTINGTON
Houston, Texas

JEFF KUETER responds: Do I find China's entry into its space age troubling, as Gregory Kulacki suggests? No, I do not. What I find troubling is the apathy about and ignorance of the implications of its entry for the United States among policymakers and the American public. China may decide to abandon its ASAT capability, as Kulacki suggests; I hope it does. But why would it? And what are we prepared to do if it doesn't? These are questions I strove to address.

Kulacki believes I misinterpreted China's intentions and placed too much emphasis on the work of junior officers and their "garbage articles." There is no doubt that China has developed an ASAT capability, as we saw in January 2007. Why would it have developed the capability and then tested it in such a highly public fashion? Why does China believe it needs an ASAT capability? My explanation is that China sees the future of warfare as depending on the flow of information to and from space. China recognizes that the United States and others powers are highly dependent on such systems and that the ability to hold space assets at risk would provide it leverage vis-à-vis the United States. This explains why the Chinese government, not sidelined junior officers, developed the ASAT capability and why the government tested it so publicly, despite its rhetorical proclamations to the contrary. Judge Beijing on its actions.

Kulacki also asserts that I wrongly described China's immediate priorities. This is curious given that five paragraphs of the piece were devoted to summarizing the goals of China's space program with explicit reference to the government's white papers on space and the very items he mentions.

I commend Mark Whittington for looking beyond the immediate military questions to a future where there is more intensive commercial activity in space. When that day comes, it will bring with it an entirely new dimension to the security challenges faced in orbit. We are in the earliest stages of recognizing how space activities will transform our economic and national security outlook.

I do not see a China-U.S. conflict as inevitable. I do see in China a new and powerful competitor—and therefore expect the country to take steps to bolster its power. The emergence of China's ASAT capability is consistent with that view and adequately explained by no other.

Debating Nanoethics

As historians of nanotechnology, we read with great interest Adam Keiper's recent article "Nanoethics as a Discipline?" [Spring 2007]. Keiper's article suggests some excellent correctives to sloppy or hasty thinking that has characterized some work thus far on the social, cultural, economic, and ethical dimensions of nanotechnology. However, Keiper comes perilously close to throwing the baby out with the bathwater. We by no means speak for all people in this field, but we have been associated, for the past three-plus years, with organizations that have been heavily involved in bringing social science and humanities perspectives to the nanotech policy debate. Through our involvement in that debate, we have seen that there is both demand for and, increasingly, a supply of high-quality research on nanotechnology's complex relationship to our wider culture.

Let's start by asking what discipline is in question here. Keiper begins and ends his article by discussing "nanoethics," but the bulk of the piece is more concerned with an interdisciplinary farrago of sociologists, historians, anthropologists, political scientists, rhetoricians, philosophers, comp. lit. scholars, economists, management researchers, science and technology studies scholars, etc. This potpourri, as Keiper notes, goes by a number of different names, but we would call it "social studies of nanotechnology" or "nano studies"—that is, a field similar in make-up and intention to mature research areas like "Russian studies" or "American studies."

We definitely would not limit this field to questions of ethics, on the model (which Keiper upholds) of bioethics. This is not because, as Keiper suggests, practitioners of this field are uninterested in the "deeper questions" of "great social goods." Rather, we advocate this broad-based approach precisely to get at the deeper questions he refers to; the posing of more penetrating inquiries is impossible if it is uninformed by empirical data drawn from a broad array of disciplines.

Keiper lists four areas that concern nanoethicists: safety, social justice, dramatic social change, and transhumanism. We have no quibble with research in these four areas, and we wholeheartedly agree that such research needs to be more mindful of what mainstream scientists and engineers agree is technically achievable. However, we also believe there are several other necessary areas of scholarly inquiry that he neglects.

Consider this example: A great deal of the National Nanotechnology Initiative's

(NNI) efforts are currently directed at reshaping the American science education system from kindergarten to graduate school. One explicit goal of the NNI has been to establish institutions (such as university-based Nanoscale Science and Engineering Centers) that will undo the quilt of disciplines present in most American universities and replace it with an almost completely unified, interdisciplinary mass. This means not just breaking down the barriers holding apart physicists, chemists, electrical engineers, and biologists, but even integrating those fields as fully as possible with sociology, economics, legal studies, and more. At the same time, the NNI clearly aims to integrate universities in novel ways with more and more of the institutions of American society. These include business (through a plethora of Small Business Innovation Research grants and other incentives for professorial start-ups) and the K-12 education system (through public "Nano Days" for schoolchildren, through grade school classes taught by graduate students in various nano disciplines, and by encouraging high school science teachers to work in university nano labs over the summer).

Why should these activities concern nanoethicists? Many of the most rancorous, divisive questions in American life are concerned with the training of future generations. School boards and university administrators across the country must continually deal with ideological tugs-of-war over new movements in pedagogy: in language training (phonics, ebonics, and language-of-instruction issues for immigrants' children); in mathematics (student-centered learning); in history and social studies (how much revisionism is a good thing?); in literature; and in science (creationism and intelligent design).

Nanotechnology—whatever it turns out to be—will clearly both push and be dragged along with these national debates about pedagogy. There may be ethical questions at stake if future generations learn that there is no use to distinguishing chemistry from physics from mechanical engineering and that these all are just nanotechnology. There are even more urgent and important ethical matters at stake if today's students are trained to think of schools and universities as completely porous to industry or operating like any other for-profit business.

As individuals we may or may not agree with these changes. As historians, though, we strongly believe we and other nano studies practitioners can contribute empirical findings that should color ethical discussion of these shifts. Do enrollments in science courses go up as a result of nano-outreach? How does nanotechnology's influence on the academy affect retention of women and minorities in science and engineering? How do graduate students and postdocs participate in the value chain extending from their professors' labs to various companies? These are questions that need to be asked, and they are questions that historians, sociologists, economists, and other scholars can offer insights on.

Given, then, our commitment to a field of nano studies that *is* engaged with the "deeper questions," we take some exception to Keiper's characterizations of the field. First, we find very odd his dismissive comparison of nanoethics and bioethics. Bioethics, he claims, followed in the wake of biomedicine; nanoethics, prematurely, comes into being at the same time as nanotechnology. There are, we think, excellent reasons to be suspicions of comparisons between nano studies and bioethics, but this isn't one of them. The constituent

disciplines and industries of nanotechnology have been around for a very long time, as have many of the ethical issues today associated with nano.

Take, for instance, the microelectronics industry (one of our areas of research). The features of most commercial transistors are or very soon will be small enough that this entire industry will have to be categorized as part of nanotechnology. This is an industry that has been around for well over half a century, has spun off a very large proportion of the subfields and tools of academic nanotechnology, and contributes more than any other industry to U.S. gross domestic product. It's also an industry that pioneered outsourcing and offshoring, that was among the first to embrace the new business models of venture capital and the IPO, and is responsible for twenty-nine Superfund sites in Santa Clara county *alone*. Clearly, then, it is an industry where societal values and "deeper questions" point in lots of different directions, and where the ethical issues are particularly vexed. And yet, in those fifty years, no cohort of professional ethicists has stepped in to address and examine the material and cultural consequences, wonderful and not-so-great, of this giant industry. It is our urgent hope, then, that we can fold these broader existing issues into the purview of nano studies.

Keiper has a further litany of complaints about nano studies. It is, he says, the kind of field where every NGO and "liberal environmental group" has to pile in to have its say, whether they know anything or not. True, there are a lot of competing voices, some of them quite over-the-top—which can, we agree, be frustrating. On the other hand, we'd far rather see nano studies be the kind of field that keeps asking who the relevant constituencies are than wait

fifty years to discover that our analysis is meaningless because we forgot to include some crucial perspectives.

Similarly, he complains that there is an endless succession of conferences and journals on societal issues in nano. We agree; in fact, one of us (Mody) recently organized just such a conference at the Chemical Heritage Foundation (CHF). Here, several of the panelists expressed deep frustrations at the proliferation of such events. Yet we note that another panelist (Barbara Karn of the Environmental Protection Agency) then asked the audience how many of them had never been to such an event before and felt their questions about nano had yet to be addressed—close to two-thirds (about eighty people) raised their hands. Too many conferences may just be something everyone involved in nanotechnology will have to endure for a while.

Keiper also protests that social scientists involved in nano use too much jargon, that they will probably just use government funding to test their own theories, and that they only talk to each other. True, these are real dangers—*in any field*. We can't see any difference here between the natural sciences and the social sciences. The number of physicists and chemists using "nano" money just to test their own theories will always be orders of magnitude greater than the number of insular nano social scientists.

And, of course, every field uses jargon—though we are continually amazed by what, exactly, counts as jargon. At the same CHF conference, one prominent chemist, in the course of a somewhat technical (one might even say jargon-y) talk, stated that she enjoyed working with social scientists but that they use off-putting terms like "social justice." Social justice? We all use technical terms as shorthand. One challenge of nano-

technology will be to develop institutions that encourage us to point out each other's opaque terminology and keep us from simply retreating to test our pet theories.

Keiper quite rightly, however, notices the self-absorbed, navel-gazing quality of much of today's nano studies. Indeed. Our special pet peeve is the laboratory ethnography that essentially describes nothing more than the decision to allow the ethnographer to enter the laboratory. And yet, nano studies is trying to do something new and experimental. In any experiment, it pays to focus attention on the methods, to try and get the right process in place. Though Keiper upholds bioethics as a model for nano studies, we feel that bioethics probably could have used a great deal more methods-questioning early in its formation. As the call for papers of a 2005 conference on the "ethics of bioethics" puts it:

> Professional standards guide the conduct of all healthcare professions—except bioethics. All healthcare professions have standards for addressing real or potential conflicts of interest—except bioethics. Critics from within and without the field have recently challenged the ethics and integrity of bioethicists, charging that these self-appointed watchdogs are little more than self-serving lapdogs.

We hope that by thinking carefully about what nano studies is and how it should be done—and accepting that there are probably many different, useful answers to both questions—we can mitigate such characterizations of our field in the future.

CYRUS MODY
Assistant Professor
Department of History
Rice University
Houston, Texas

PATRICK MCCRAY
Professor
Department of History
University of California, Santa Barbara

JODY ROBERTS
Program Manager, Envir. History and Policy
Ctr. for Contemporary History and Policy
Chemical Heritage Foundation
Philadelphia, Penna.

As a "nanoethicist," I read with apprehension Adam Keiper's article "Nanoethics as a Discipline?" Perplexed over why such well-intended work was being assailed, I was taken aback by what appeared to be a rash devaluation of my academic cohorts and me. Keiper refers to the social scientists who are involved in nanoethics as self-important (sometimes verging on self-pitying) scholars convinced their work is vitally important. As for humanities scholars with an interest in nanotechnology, we have, in Keiper's words, a "rarified academic orientation" that coexists "only very uneasily with the 'real world.'" Fair enough; my aim, as both humanities scholar and citizen, is to contribute to the creation of another world, one where scientific research arises from humanitarian aims, especially when seeking to manipulate and control matter with precision at the atomic level. Such a "technological revolution" has the capacity to alter the fundamental constitution of human social, physical, cultural and spiritual life. What harm is done in pursuit of intelligent, self-reflective, critical thought about this newest of human technological enterprises?

As for the "prematurity" of the endeavor, well, so what if the pursuit of ethics means being careful and thoughtful about what is being done? At worst, "nanoethics" will

have little or no effect on the outcome of nanotechnology development; not on policy, funding allocations, public awareness or participation, or on how military empowerment, surveillance system development, or medical research through nanotechnology is pursued by our government-sponsored labs or those of corporations.

Keiper refers to the relative inability of scholars to seriously discuss questions of ethics. On that point I hedge, though I agree with him that the language of academics has become parched. This, in fact, is why I have chosen to use narrative as the basis of my own scholarship; in particular, informal discussions with scientists and engineers—and also science fiction. In talking with individual researchers who work at the nanoscale, I have observed an inspiring breadth of reflection over values and beliefs pertaining to the "nanotechnology revolution." Science fiction, as a pedagogical tool, has also helped me open the way for penetrating dialogue with researchers about what we might do and why, in nanoscale science and technology.

With or without the formation of a formal academic discipline of nanoethics, there is just and serious cause for perpension. The nanotechnology-based future is being created, not approached. If successful, the efforts of ethicists will contribute to its conscientious development.

ROSALYN W. BERNE
Associate Professor
University of Virginia
Charlottesville, Va.

As director of The Nanoethics Group—one of the organizations Adam Keiper mentioned in his article on nanoethics—I would like to respond to a few points he made. I agree with many of Keiper's observations. Yes, there are important meta-

issues in nanoethics which cast an uneasy shadow over the entire enterprise of nanoethics itself—how it is proceeding, how it should proceed, the motivation of the players, and more. Keiper's conclusion is apparently that nanoethics is not a coherent discipline and pursuing it is not in the public interest. The following is my brief attempt to address some of his criticisms.

First, Keiper compares bioethics to nanoethics. He is correct in identifying several major differences between the two; for instance, whereas bioethics deals with familiar problems in medicine and science, nanoethics is about a new, emerging area that is speculative and forward-looking. However, it is unclear that these and other differences reveal any failings in nanoethics. If they are as significant as they appear, these differences could suggest that the two are incommensurable. That is, the circumstances surrounding the two are dissimilar enough, as Keiper shows, that perhaps they cannot be usefully compared. Though the comparison between bioethics and nanoethics has been made elsewhere, I have yet to hear why it is a fair or appropriate one, other than that both bioethics and nanoethics ostensibly deal with science and ethics.

Second, Keiper points out that nanoethics is "plagued by a persistent confusion about what exactly nanotechnology is." This is a familiar charge. Others have used much the same criticism to argue that *nanotechnology itself* is not a discrete area of research in the first place. If that is the case, then there can be no ethics based upon it; for ethics to be coherent pursuit, its subject matter must first be coherent.

There is some truth to the claim that "nanotechnology" is really just a dressed-up amalgamation of old sciences like chemistry, biology, engineering, and so on. However, nanotechnology now has a life of

its own, even if it was artificially or politically created, and it should be treated as a distinct field of its own. Nanotechnology research is clearly making much progress and working its way from academic labs to the commercial marketplace. Despite academic debate about its ontological status, nanotechnology is costing money, making money, and enabling new products. It is not just a figment of our imaginations: there is something there to be studied.

Furthermore, as Keiper is able to delineate four broad categories of questions in nanoethics, any confusion or imprecision in nomenclature does not seem to hinder the progress of nanoethics as well; there are clear and specific questions to be addressed.

Third, related to the confusion over what nanotechnology is, Keiper points out that some scientists have radically different visions of nanotechnology and how it might unfold. As a result, "one of the difficulties facing aspiring 'nanoethicists' becomes clear right off the bat: our ability to anticipate the societal and ethical consequences of nanotechnology will plainly be conditioned on what actually turns out to be possible." And because what will be possible is hotly disputed, Keiper argues, nanoethics runs the risk of being grounded in false assumptions about the future.

This is true; we must take care that ethics is informed by real science, not just mere speculation or science fiction. And since anticipating the future usually means we really do not *know* what will happen in the future, studying the ethical and social impacts of *any* emerging technology will be risky business; some assumptions or predictions will be on the mark, others will be obviously wrong in hindsight.

But the solution should not be to forsake these forward-looking activities simply because we cannot perfectly foresee the future. Rather, we must think through many different contingencies or scenarios, striving to be over-prepared instead of under-prepared. Imagine if Keiper's criticism were made against national efforts to anticipate various terrorist scenarios: just because we do not know exactly how we will be attacked by terrorists should not lead us to conclude that there is no use in planning. If we wait until we know exactly how we will be attacked, it will be much too late.

Fourth, Keiper charges that much of nanoethics today is based on "the largely unexamined assumption that nanotechnology will transform the world and will have profound ethical and social consequences." In other words, nanoethics could be just fun-but-pointless musings or a purely academic exercise, if nanotechnology does not live up to its apparent promise to be so important that it might be disruptive to society and ethics.

Even if the fantastic, Drexlerian visions of nanotechnology are ultimately not realized, I would be hard-pressed to cite a credible, informed source who does not believe nanotechnology will transform the world in some way or another. Even the United States government—which typically underestimates technology rather than overestimates it—has called nanotechnology "The Next Industrial Revolution"; nations around the world have expressed similar sentiments and are pouring unprecedented amounts of funding into the area. Perhaps we have all been swept up by an irrational exuberance, but a more likely explanation is that there really is something to this nanotechnology business, as leading scientists and Nobel laureates believe.

If history is any guide, we can expect *any* significant new technology to have

some unintended but very real impacts on our world—creating new or enhanced ethical dilemmas. For instance, despite its great benefits, Gutenberg's printing press and our subsequent reliance on writing have caused human memories to suffer (as well as society's oral tradition of storytelling); automobiles have created pollution and facilitated urban sprawl; plastics have created an ecological crisis; the Internet is changing the way we think about and protect privacy and copyrights—among many other examples. These are impacts that would have been helpful to anticipate and address as much as possible in advance, so let us not lose that lesson with nanotechnology and other emerging areas of science.

Fifth, Keiper argues that nanoethics "bears all the signs of prematurity. Its time may come someday, but it is too soon to say just when and how." While this seems pragmatic and perhaps applicable to less consequential matters, being premature seems to be a much better alternative than being too late in nanoethics. And the odds of being "right on time" are virtually nil, given how long it takes to make any headway in ethics, especially compared to the speed at which technology is moving. Think of the other familiar examples of ethics arriving on the scene too late—for instance, the backlash against genetically-modified foods (particularly in Europe) that caught the biotech industry and most everyone else off-guard, or the cloning of Dolly the sheep a decade ago, where there was no or very little advance scientific warning and then knee-jerk "ethical" reactions around the world resulted in wholesale bans and moratoria on funding and research. Finally, Internet privacy and digital copyrights are being frantically debated now, years after the first

likely privacy and copyright violations had occurred.

At any rate, the disagreement over fundamental issues in nanotechnology and the fact that the future is unknowable both highlight the importance of exploring the many possible scenarios in nanoethics, to cover all our bases, while staying as scientifically grounded as possible. The worst approach would be to abandon nanoethics as the easy way out of difficult work.

Finally, Keiper correctly points out that (at least some) nanoethicists "seem uninterested, unwilling, or unable to engage… deeper questions" such as what great social goods we seek or should preserve or what high human goods we wish to defend. This is a problem with ethics in general, including bioethics. In fact, in bioethics, the reason we still have no consensus in the abortion debate, for instance, is the persistent disagreement over basic values or issues; so addressing these "deeper questions" does not resolve the debate but is exactly the core of it.

It seems to make more sense that *many* nanoethicists should work from the starting point of their own perspectives. It does not make practical sense to attempt to bridge the deep-seated ideological differences between opposing groups as a required prelude to a meaningful discussion in nanoethics (though admittedly that would be ideal, if it were possible).

In general, Keiper makes reasonable criticisms, but many of the more serious charges seem to stem from conventional approaches to ethics that may no longer apply to nanotechnology as an emerging, unconventional field. Traditionally, ethics is thought of as something that should be done either before or after some development; that is, the choice seems to be ethics-*first* or ethics-*last*. This is a false dichotomy.

With the advent of nanotechnology, it might be thought that we have an opportunity to do the ethics first. This is essentially the proposal offered by Bill Joy in his infamous 2000 *Wired* magazine article "Why the Future Doesn't Need Us," in which he suggests placing a moratorium on certain frontier science until we can understand its consequences. But the problem with the ethics-first model is that ethical assessment depends in large part on a factual determination of the harms and benefits of implementing the technology. But when one asks nanotechnologists what the future of nanotechnology will be in five years or ten years, let alone twenty-five or fifty years, reactions vary from blank stares to cautious speculations about some narrow aspect of the field.

But the ethics-*last* model does not work well either. Once an event or development has happened, much unnecessary harm may have already occurred. Technology sometimes gives rise to new or enhanced problems—problems that we should seek to anticipate and address.

Instead of taking an ethics-first or ethics-last approach, nanoethics needs be done *continually* as nanotechnology develops and as its potential consequences become better understood. Norbert Wiener hinted at this approach decades ago; in a 1960 *Science* magazine article talking about the rise of automation, he writes: "To be effective in warding off disastrous consequences, our understanding of our man-made machines should in general develop *pari passu* with the performance of the machine."

Further, ethics is dynamic in that the factual component on which it relies has to be continually updated; new technology often creates novel situations for which no ethics or agreed-upon policy approach exists or seems immediately obvious. In the face of policy vacuums, we need to consider how to formulate new and appropriate policies on ethical issues given the possible and probable facts.

Progress in ethical attitudes and policies can take much time, especially in a democracy. Meanwhile, science and technology appear to be accelerating to the point where we can hardly keep up with them (think of Moore's Law). If we believe that ethics has value, and if nanotechnology is real and advancing ahead (as it seems to be), then the time to study nanoethics is now—working through any growing pains as we come across them.

PATRICK LIN
Director, The Nanoethics Group
Visiting Assistant Professor
California Polytechnic State University
San Luis Obispo, Cal.

ADAM KEIPER responds: I am grateful to Messrs. Mody, McCray, and Roberts for their letter, and am happy to acknowledge the several points on which we agree. The interest of historians in the development of nanotechnology is welcome, especially if their work serves to clarify the multifarious meanings of the term "nanotechnology" and to remind us of the many ways in which science and technology can shape, and are shaped by, the contingencies and complexities of social and political affairs. Bring on the historians, I say.

Things become much trickier, though, when historians morph into "nano studies practitioners." Professor Mody and his colleagues suggest two areas in which such scholars can make useful contributions. The first relates to how nanotechnology is taught. The federal government's effort to reorient American science education toward nanotech is silly, trivial, and misguided; the NNI overestimates the value and underestimates the difficulty of the

task. Surely this project is not worth wringing our hands over. And scholars worried about shielding universities from the supposedly insidious encroachment of industry have plenty to fret about already in university computer science departments and biotech labs. It is hard to see how nanotechnology will make that problem much worse—if it is a problem at all.

But these are secondary questions of little interest outside the academy, as are the other education-related worries Professor Mody and his colleagues raise. Their economic and environmental concerns are of far broader importance, but the claim that offshoring, pollution, and other issues connected to the microelectronics industry have been ignored is incorrect; these have been major policy concerns for years, even without a "cohort of professional ethicists" studying them full-time.

Professor Berne hopes to help create "another world" where "scientific research arises from humanitarian aims." We already live in that world. The scientific enterprise aims "for the relief of man's estate"; its great goal is the improvement of human life, giving us more power, more control, more comfort, more choice, and better health. The ends of science are sometimes unwise—perhaps some parts of man's estate ought not be "relieved"—and its means are sometimes irresponsible, but it is tinged with nobility and streaked with humanitarian idealism.

Nanotechnology is one new and promising part of this enterprise. Does it merit the singular attention of social scholars and ethicists that it is now beginning to receive? Is nanoethics worth the time, energy, and resources (including taxpayer dollars) now being invested in it? Only if you accept, as Professor Berne does, that nanotechnology has the capacity to radically transform the world—"the fundamental constitution of human social, physical, cultural, and spiritual life." That's quite a grand claim, one that may someday prove true. For now, though, color me unconvinced.

In his letter, Patrick Lin makes a rather more modest claim: that nanotechnology "will transform the world in some way or another." Well, yes, to be sure. But do its potential transformative effects warrant the sustained attention of an entire academic discipline? Putting aside Professor Lin's bizarre and grossly simplistic remark about the printing press, would the world today be a better place if, as he hints, there had been university-housed *automobile ethicists* in the year 1900, perhaps with their own journal *CarEthics*? Or a professional body of *polymer ethicists* during the twentieth century watching over the rise of plastics?

The differences between bioethics and today's nascent nanoethics—differences that Professor Lin thinks make any comparison between the two irrelevant—are worth remembering precisely because some people now working in bioethics are beginning to take an interest in nanoethics. Even the President's Council on Bioethics is beginning to turn to the subject, devoting sessions to nanotechnology at recent meetings. Bioethicists intrigued by nanoethics would do well to heed what University of Texas professor Mauro Ferrari told the council in June 2007: "I don't think there is anything special about nanotechnology…from a bioethical perspective. Keeping in mind the limitations on the bioethical understanding, I don't see there is anything new." Beyond the health, safety, and environmental questions raised by nanotechnology, there is not yet anything near enough at hand to plausibly interest bioethicists. For the time

being, when it comes to nanoethics, there's no *there* there.

All three letters take issue with my claim that nanoethics is premature. Professor Mody and his colleagues argue that nano-ethics is actually long overdue, since nanotechnology comprises disciplines and industries that "have been around for a very long time." Naturally, if you define nanotechnology broadly enough, you can implicate all manner of disciplines and industries that have their own ethical baggage. Professor Berne argues that a premature nanoethics is no big deal since "at worst" it "will have little or no" real-world effect. I strongly disagree. A pre-mature nanoethics would, at worst, mean not merely fecklessness but recklessness: policies that unwisely encourage perni-cious or hamstring beneficial applications of nanotechnology. Professor Lin argues that it is better to be early with nanoethics than late—but then reverses his position and agrees with me that a sound "factual

determination of the harms and benefits of implementing" nanotechnology is still too far off.

Instead, Professor Lin suggests an approach in which nanoethics develops alongside nanotechnology. He laments how difficult it is to "make any headway in ethics," and how "progress in ethical atti-tudes" is slow while "science and technol-ogy appear to be accelerating to the point where we can hardly keep up with them." This notion quickens the pulse; one rather imagines a bustling locomotive chugging away while an exhausted man running along the tracks straggles behind. But eth-ics, properly understood, isn't about "keep-ing up." It is about applying longstanding principles and defending the most crucial human and social goods. Those principles must be applied to the reality of nanotech-nology as it develops, not to the shining dreams or shadowy nightmares so many nanoethicists now imagine.