ARTICLE

I Have Seen the Future! Ethics, Progress, and the *Grand Challenges for Engineering*

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This article is a critique of the U.S. National Academy of Engineering's report, *Grand Challenges for Engineering*, based upon the "technocratic view" of progress as defined by historian Leo Marx and as exemplified by the public works of Robert Moses, including the 1964 World's Fair, as well as technological determinist narratives on the digital age drawn from contemporary culture. While the so-called Grand Challenges purport to have social aims, a close reading of the document's overview essay suggests that the technocratic view of progress—which views technology primarily as an end in itself rather than as a means to social progress and fails to explicitly account for engineers' social and ethical responsibilities—still dominates the thinking of at least some leaders of the engineering profession. This technocratic thinking presents a critical barrier to achieving social justice both within engineering and in the larger world.

KEYWORDS: Grand Challenges, National Academy of Engineering, Robert Moses, progress myth, technocratic view of progress, technology as culture

INTRODUCTION

The future ain't what it used to be.

-Yogi Berra (Berra & Kaplan, 2002, p. 159)

John, you are a Timex watch in a digital age.

-Thomas Gabriel (played by Timothy Olyphant) in *Live Free or Die Hard* (Wiseman, 2007)

In the summer of 1964, while on vacation with his father, one of the authors (Herkert) attended the 1964 New York World's Fair, the creation of the city's master builder, Robert Moses.¹ The fair, whose various themes/mottos were "Peace Through Understanding," "Man's Achievements in an Expanding Universe," and "A Millennium of Progress," was a tribute to the world-changing potential of technology. Attending the fair was probably a significant factor in Herkert's decision to study engineering as an undergraduate. Moses's vision of a world made better through technological progress, though not an original idea, has nonetheless endured through more than four decades of domestic and global struggles for human rights and environmental protection. While Herkert was present at what many writers (Hall, 2002; Jackson, 1987) have called the genesis point of America's

¹ During the same trip Herkert also saw his boyhood heroes, The New York Yankees, play at Yankee Stadium under the leadership of their new manager and former star, Yogi Berra. Berra is well known for his tortured quotations; the one included at the beginning of this article is perhaps his most insightful.

car culture, the other author (Banks) grew up in its aftermath: A native of South Florida, Banks witnessed the frequent and violent car crashes, lack of public space, and never-ending suburban sprawl that automobile-dominated transportation has wrought on the American landscape. Despite a displacement of a few decades and a thousand miles, both authors have experienced Robert Moses's influence on the American built environment.

Moses is known for the ways in which he shaped New York City and its surrounding counties in the 20th century, with his accomplishments serving in turn as a model for engineering, architecture, and urban planning in the nation at large. The son of a successful merchant and real-estate developer, Moses attended Yale and Columbia, obtaining a PhD in political science and entering city politics in New York, where he gained the attention of an advisor to Al Smith, future governor of New York. When Smith rose to power, Moses was granted authority through political appointments for planning bridges, highways, the state parks system, and urban renewal projects (Goldberger, 1981). Marshall Berman described the system put in place as a "network of enormous, interlocking, 'public authorities,' capable of raising virtually unlimited sums of money to build with, and accountable to no executive, legislative or judicial power" (2003, p. 141).

Robert Moses was able to defend and justify his authoritarian actions by situating them within a particularly brutal rendition of the progress myth. Berman recalls an infamous Moses quote: "When you operate in an over built metropolis, you have to hack your way with a meat ax" (2003, p. 134). Moses was a product and symbol of his time. His unquestioned power had a cozy rhetorical home within the myth of technological progress. He was able to convince the public that his ax wielding, while seemingly uncaring, was necessary for New York's long-term survival in the modern era. To oppose Moses was to oppose "modernity itself" (Berman, 2003).

Moses was hacking up the Bronx just as the myth of technological progress was reaching an apex. Over the 1960s and '70s it would contract under the constant threat of nuclear war, followed by mounting evidence of irreparable environmental destruction. Today, the popular reasoning goes, we are more cynical and suspicious of experts and the technology they bring to bear on perceived problems (Beck, Bonss, & Lau, 2003; Beck, Giddens, & Lash, 1994; Beunen & Opdam, 2011; Bleich, Blendon, & Adams, 2012; Fischer, 2009). Most cultural critics would agree with Franco Berardi when he calls the 20th century "the [last] century that trusted the future" (Berardi, Genosko, & Thoburn, 2011, p. 17) and Kurt Anderson when he says, "the future has arrived and it's all about dreaming of the past" (2012, *Nostalgic Gaze*, para. 4). The public is suspicious of large bureaucracies and major technological interventions. The wunderkind expert has been replaced with an ephemeral, almost supernatural, being: the market. The market decides how to proceed—not individuals or organizations. The naturalization of market forces (Graeber, 2011; K. Marx & Engels, 2011) makes claims about the necessity and primacy of cost unassailable.

We see it otherwise. The appeal to abstract market forces and mythical job creators is the same old technological somnambulism in a new wrapper.² No longer embodied in the visage of one man (e.g., Moses) or even one organization (e.g., General Motors or NASA), the utopian visions of the New York World's Fair have returned with a vengeance. We contend that Leo Marx's titular question, "Does Improved Technology Mean Progress?" (2006, p. 3), is more pertinent (and important!) today

² Here we are borrowing the purposely overly-scientific phrasing of Langdon Winner (1986) who, lamenting the lack of critical philosophy of technology, characterizes most people as "sleep walkers"—unthinkingly reproducing domination and control over others through the implicit and explicit embrace of technology as the solution to perceived problems. Winner writes, ". . . the interesting puzzle in our times is that we so willingly sleepwalk through the process of reconstituting the conditions of human existence" (p. 10).

than ever. A prominent case in point is the *Grand Challenges for Engineering*³ report of the National Academy of Engineering (NAE, 2008), which demonstrates that technological determinism is still alive and well in western culture and that the collective faith in technology to solve society's problems has never been stronger. The report's authors' explicit reference to popular depictions of technology highlights not only the continued relevance of Leo Marx's critique of technocratic thinking, but also forces cultural commentators concerned with these aspects of society to broaden their scope when it comes to offering prescriptive conclusions on changing engineering practice. Moreover, we must recognize the importance of scaling aspirations and goals to the appropriate level (Allenby & Sarewitz, 2011). The concept of a "Grand Challenge" must be problematized or new socially conscious and ethical solutions of an equally large scale must be submitted for consideration.

TECHNOLOGICAL DETERMINISM AND A SEARCH FOR ETHICS

Today Moses' vision of technology-driven progress is manifest in many forms including the *Grand Challenges*. It depicts the world's problems as issues of logistics, physics, and economics. There is little room in this vision for the deep sociotechnical complexities that are often at the heart of "Grand Challenges." The future has proven to be more complex than even Moses could have imagined; it is disappointing to find leaders of the engineering profession still clinging to a vision of progress that does not account for this complexity and fails to make explicit the social and ethical responsibilities of engineers, precluding among other things a meaningful conversation about social justice. The document only briefly loses its "view from nowhere" (Haraway, 1997) in the introduction to the section titled "Secure cyberspace." This section begins with its one and only explicit reference to popular culture:

Electronic computing and communication pose some of the most complex challenges engineering has ever faced. They range from protecting the confidentiality and integrity of transmitted information and deterring identity theft to preventing the scenario recently dramatized in the Bruce Willis movie "Live Free or Die Hard," in which hackers take down the transportation system, then communications, and finally the power grid. (NAE, 2008, 40)

While being careful not to overstate our case, we will revisit the significance of this reference, at length, later in the article. For now, however, suffice it to say that the *Grand Challenges* report is thoroughly and completely a product of a western standpoint. This is not to say that the search for clean water or renewable energy only benefits rich countries, or that virtual reality and cyber security are goals unworthy of research. Rather, NAE's privileged standpoint is belied by the report's inclusion of "Reverse-engineering the brain," health informatics, and enhanced virtual reality alongside providing clean water and restoring infrastructure. These challenges are presented as self-evident: the obvious problems faced by people today. The authors qualify their choice of challenges by saying, "Foremost among the challenges are those that must be met to ensure the future itself. The Earth is a planet of finite resources, and its growing population currently consumes them at a rate that cannot be sustained" (NAE, 2008, p. 2). While we agree with this claim, it fails (along with the rest of *Grand Challenges*) to explicitly recognize a role for ethics in engineering decision making.

The overview essay for *Grand Challenges* does not mention ethics (and neither do all but one of the essays on the fourteen individual grand challenges). This in itself does not prove that the Grand

³ Editors' note: The capitalized, non-italicized forms of "Grand Challenges" and "Challenges" found throughout this paper refer to the broader body of work stemming from the original 2008 NAE Publication. Where the actual publication is inferred, the terms are presented in italics.

Challenges are bereft of ethical substance. After all, the authors' avoidance of language of "ethics" may have been deliberate; most teachers of engineering ethics have reflected at one time or another on the barriers that the use of the "E-word" poses for capturing the attention of engineering students and their academic advisers. We may even give the authors the benefit of the doubt and say that ethics runs implicitly throughout the document: What is more ethical than devoting your life to creating optimal levels of "sustainability, health, vulnerability, and joy of living?" The cracks in this reasoning come from a close reading of *Grand Challenges'* overview essay, "Introduction to the Grand Challenges for Engineering." Such a reading reveals an underlying philosophy that Leo Marx (2006) has referred to as the "technocratic" view of progress that either, at best, is indifferent to ethical considerations or, at worst, undermines engineering ethics.

In his well known essay, "Does Improved Technology Mean Progress?," Leo Marx contrasted the Enlightenment and technocratic concepts of progress. Whereas the Enlightenment concept saw improved technology as a means to achieving social progress, such as the realization of democratic values, the technocratic view sees improved technology as an end in itself: "Over time [the Enlightenment] conception was transformed, or partly supplanted, by the now familiar view that innovations in science-based technologies are in themselves a sufficient and reliable basis for progress" (2006, p. 11).

The technocratic view of progress is clearly on display in the work of Moses, who was responsible for much of New York City's public works and infrastructure (Obenhaus, 1988). Though a popular figure early in his career, as Moses's power grew, his projects displaced more and more people and seemed to take on a life of their own. To Moses, Enlightenment democratization was an impediment to technological progress. He often derided his critics as misinformed outsiders and frequently bulldozed structures before those in his path had a chance to seek legal recourse. His technological achievements—Jones Beach, the Triborough and Verrazano-Narrows bridges to name a few—are legion, but many of his projects had deeply problematic social outcomes. While tenements were cleared as part of Moses's plans to build modern high-rise buildings, viable, albeit poor, communities were destroyed in the process. And projects such as the Cross-Bronx Expressway destroyed vibrant, middle-class communities. The destruction of these communities and the authoritarian processes by which they were carried out represent grave injustices that result directly from the technocratic view.

It is important to acknowledge that even as Moses was in a privileged position to further technocracy, the technocratic view did not and does not exist exclusively among elites. It is reinforced in historical and current U.S. culture by people of all backgrounds and social positions who believe in technological progress as itself sufficient for social progress.

The *Grand Challenges* introductory essay also adopts a technocratic view, sometimes explicitly and at other times more subtly. Early in the introduction, for example, the document sings the praises of technology and strongly implies that social progress has followed suit:

In the modern era, the Industrial Revolution brought engineering's influence to every niche of life, as machines supplemented and replaced human labor for countless tasks, improved systems for sanitation enhanced health, and the steam engine facilitated mining, powered trains and ships, and provided energy for factories.

In the century just ended, engineering recorded its grandest accomplishments. The widespread development and distribution of electricity and clean water, automobiles and airplanes, radio and television, spacecraft and lasers, antibiotics and medical imaging, and computers and the Internet are just some of the highlights from a century in which

engineering revolutionized and improved virtually every aspect of human life. (NAE, 2008, pp. 1–2)

The claim that technological progress naturally leads to social progress is hammered home in the introduction's concluding sentence, which states:

Meeting all those challenges must make the world not only a more technologically advanced and connected place, but also a more sustainable, safe, healthy, and joyous—in other words, better—place. (NAE, 2008, p. 6)

To be sure, the *Grand Challenges* introduction does highlight social indicators engineers can address (i.e., sustainability, health, vulnerability, and joy of living), but true to the technocratic view these benefits are seen as derivative of improved technology rather than being the motivating goals of technological progress. Moreover, it is a rather limited range of indicators. What about justice? Peace? Education? Self-governance?

Curiously, *Grand Challenges* also discusses a limited range of attributes ascribed to engineers in meeting the Grand Challenges:

Applying the rules of reason, the findings of science, the aesthetics of art, and the spark of creative imagination, engineers will continue the tradition of forging a better future. (NAE, 2008, p. 2)

Here is where the absence of ethics is most obvious in *Grand Challenges*. There are arguably other missing attributes as well, such as humility, empathy, and interdisciplinary thinking. And note in this last quote a return to the theme of technological progress automatically leading to a “better future.”

Consistent with the technocratic view of progress, and with Moses's projects, the *Grand Challenges* introduction reminds us of the technocratic imperative that people must adapt to technological change (and not the other way around):

Public understanding of engineering and its underlying science will be important to support the calls for funding, as well as to enhance the prospect for successful adoption of new technologies. The ultimate users of engineering's products are people with individual and personal concerns, and in many cases, resistance to new ways of doing things will have to be overcome. Teachers must revamp their curricula and teaching styles to benefit from electronic methods of personalized learning. Doctors and hospital personnel will have to alter their methods to make use of health informatics systems and implement personalized medicine. New systems for drug regulation and approval will be needed when medicines are designed for small numbers of individuals rather than patient populations as a whole. (NAE, 2008, p. 5)

Not only must people adapt to technological imperatives, but the *Grand Challenges* introduction also suggests that, like the thousands evicted by Moses, people's goals and desires are obstacles and barriers to technological progress (see Nieusma and Tang, this issue):

Part of the engineering task will be discovering which approaches work best at ensuring user cooperation with new technologies.

In sum, governmental and institutional, political and economic, and personal and social barriers will repeatedly arise to impede the pursuit of solutions to problems. As they have

throughout history, engineers will have to integrate their methods and solutions with the goals and desires of all society's members. (NAE, 2008, pp. 5–6)

This fundamental lack of social and ethical concerns is especially troubling given that introductory texts on environmental sociology or science and technology studies contain theoretical and empirical examples of how addressing social concerns makes for *better engineering*. Social ecologists (e.g., Murray Bookchin) or treadmill of production theorists (e.g., Allan Schnaiberg, Kenneth A. Gould, or David Pellow) would remind us that resource sustainability is only possible through political, social, and economic justice (Gould & Lewis, 2009).

Note that advocating for ethics, or even a socially-conscious engineering pedagogy, does not necessitate an acceptance of a luddite epistemology (Winner, 1977) or an outright rejection of solving problems with technological inventions. In fact, such an outright rejection of technology would be no better than the determinism we are critiquing. Bookchin writes:

It is not surprising to find that the tension between promise and threat is increasingly being resolved in favor of threat by blanket rejection of technology. To an ever-growing extent, technology is viewed as a demon, imbued with a sinister life of its own, that is likely to mechanize man if it fails to exterminate him. The deep pessimism this produces is often as simplistic as the optimism that prevailed in earlier decades. (2004, p. 42)

To be clear, then, we are not saying that the NAE's Grand Challenges are unimportant, or that the application of engineering expertise is the wrong course of action for solving problems like access to clean water. We do contend, however, that ethics and the politics of technology should feature just as prominently and fundamentally in engineering challenges as, for example, economics. Consider the quote from the introductory essay of the report:

Most obviously, engineering solutions must always be designed with economic considerations in mind—for instance, despite environmental regulations, cheaper polluting technologies often remain preferred over more expensive, clean technologies. (NAE, 2008, p. 5)

Now, add “ethical” to “economic” and change the example accordingly:

Most obviously, engineering solutions must always be designed with both economic and ethical considerations in mind—for instance, despite environmental regulations, cheaper polluting technologies often remain preferred over more expensive, clean technologies.

Explicit recognition of social and environmental costs would help level the playing field among competing technologies, while simultaneously acknowledging engineers' ethical responsibilities to protect people and the environment. For example, a water filtration system that makes it easy to bottle water and sell it has different societal effects than a system that delivers potable water from a public spigot.

In this section we have outlined our objection to the *Grand Challenges* report: it reinforces the technocratic view of progress as described by Leo Marx (2006), and it fails to meaningfully consider social and ethical concerns. Not only does this lead the authors to equate the importance of such elite interests as “improving virtual reality” with the necessities of access to clean water, but it also makes for bad engineering, where technology's development trajectory is taken as given. Such *technological determinism*—the assumption that technology's development trajectory is inevitable and, hence, not subject to human intentions—strips engineers and others of their imagination for

shaping the future in alternative ways. The next section will consider the broader cultural milieu that informs and, in turn, is shaped by the *Grand Challenges* report. By elaborating this cultural perspective, we hope to demonstrate what is at stake when documents such as the *Grand Challenges* report ignore ethics, while also revealing that the report itself is a cultural artifact.

TECHNOLOGICAL DETERMINISM DIES HARD

To their credit the *Grand Challenges* authors acknowledge the existence of social/ethical issues in the application of engineering solutions when they note that “many of engineering’s gifts to civilization are distributed unevenly” (NAE, 2008, p. 6). But their characterizations of such issues are oversimplified, false dichotomies of social divides (e.g., “wealth and poverty, health and sickness, food and hunger”). Such complex conditions are not binary on-off states but rather a continuum that exists both within nations and across the globe. Who goes hungry, for example, is as much a function of politics, culture, economics, and ethics as it is of agricultural production (Bijker, 2009; Winner, 1986; Woolgar & Cooper, 1999). Though *Grand Challenges* suggests that “engineers must frame their work with the ultimate goal of universal accessibility in mind” (NAE, 2008, p. 6), no attention is given to how engineers might go about contributing to the solution of such complex problems, other than, à la Moses, pushing forward with technological innovation.

It is worth restating that the technocratic view not held exclusively by the technological elite; it is also reinforced and constantly reinvigorated by popular cultural artifacts and events. We have already briefly mentioned the 1964 World’s Fair, which we will dive a little bit deeper into its historical significance. Then, we will move on to the importance of more recent cultural touchstones in articulating Americans’ evolving relationship to technology.

By the 1920s, the automobile had already increased the average distance between home and work in the U.S. context (Hall, 2002). The monumental changes, however, came just as America was entering World War II. Large private companies had begun buying up local rail lines and letting them go derelict, just as affordable automobiles were coming on the market. For those who could not afford these cars, buses would have to suffice. New bus lines were marketed as modern, even the wave the future, but did not offer the same reliability as fixed rail trains (Hall, 2002; Jackson, 1987). The 1939 New York World’s Fair was a prerequisite for the third fair in 1964–1965. (The first New York World’s fair was held in 1853 in what is now Bryant Park.) It was at the 1939 World’s Fair that America got its first taste of General Motors’s vision for the future. Kenneth Jackson describes General Motors’ 1939 *Futurama* exhibit:

Miniature superhighways with 50,000 automated cars wove past model farms en route to model cities. Five million persons peered eventually at such novelties as elevated freeways, expressway traffic moving at 100 miles per hour, and “modern and efficient city planning—breath-taking architecture—each city block a complete unit in itself [with] broad, one-way thoroughfares—space, sunshine, light, and air.” (1987, p. 248)

The models were not fantastical imaginings of a possible future. They were meant to state, with authority, that the future *would* look like this, and General Motors (GM) was actively working to make it happen. Such spectacular plans could only be implemented by a consortium of some of the most powerful corporations in the world. Indeed, the American Road Builders Association (ARBA), with General Motors as its largest member, lobbied Congress with huge sums of money. ARBA, by the end of World War II, “had become one of the most broad-based of all pressure groups, consisting of the oil, rubber, asphalt, and construction industries; the car dealers and renters; the trucking and bus concerns; the banks and advertising agencies that depended upon the companies involved; and labor unions” (Jackson, 1987, p. 248).

The ARBA lobby held an essay contest in 1953 on the need for better roads. The winning essay was titled "How to Plan and Pay for Better Highways." Its author and the recipient of the \$25,000 prize was none other than Robert Moses (Caro, 1974; Jackson, 1987; Samuel, 2010). Moses, as we noted above, was able to amass immense influence over private and public funds. He used his power and wealth to radically alter the New York City landscape: tearing through viable Bronx neighborhoods (Berman, 2003) and bucolic Long Island estates (Hall, 2002) with impunity.

Moses had completely transformed New York City in the intervening years between the 1939 and the 1964 World's Fairs. He used the 1964 Fair itself as an excuse to build more highways and, as organizer of the Fair, gave preferential treatment to the car companies at the Fair by giving them seven times more space than any other vendor (Samuel, 2010). The updated 1964 *Futurama* exhibit was even more ornate and spectacular than the prior one. *Futurama* ranked as the most popular exhibit both in 1939 and in 1964, but in the latter version, the goals were bigger, further away technologically, and with larger time horizons. This future was occupied by underwater resorts, moon colonies, and deserts turned into automated farms watered by desalinated seawater. The promises of *Futurama* were only slightly more optimistic than those offered in the *Grand Challenges* report.

In an effort to keep up with GM, Ford hired Walt Disney as lead consultant for its pavilion. Disney's participation in the show made it "inevitable that corporate America would look to Walt Disney to embed promotion of their brands within an entertainment format, that is, to cloak consumer culture as popular culture as a persuasive selling technique" (Samuel, 2010, p. 109). The 1964 World's Fair was not the first and certainly not the last time Disney, or any other media empire, was hired to sell a product or enrich a brand. What was unique about the New York World's Fairs was the singularly grand vision for the future that cars demanded. *Futurama* was meant to sell cars, certainly; but in order to assure a century of ever-expanding business, the automobile companies had to be world creators, not merely makers of cars. They built, from whole cloth, a brand new world and presented its inevitability as both apparent and objective. So as to affirm this inevitability, each participant left *Futurama* with a pin that read, "I have seen the future!" GM and Ford had the financial and political resources to create the vision, but it would take widespread public acceptance of that future to make the vision a reality.

Significant parallels can be drawn from how cars were sold to Americans in the 1950s and how information technologies are being sold today. GM, Ford, and Chrysler have been replaced by Apple, Microsoft, and Google as the business behemoths of North America. These are the newest world builders, and their vision is just as grand and ambitious. World building need not be as deliberate, or as conspiratorial, as ARBA's decision to buy up streetcars and replace them with buses and cars while at the same time pressuring the federal government to spend unprecedented sums on roadway infrastructure improvements. In the case of information technologies, the technology-steeped future was illustrated by industry as well as members of the public sector. The work of making the Internet seem inevitable was just as much in the hands of *WIRED Magazine* gurus Kevin Kelly (2010) and Chris Anderson as it was in the hands of the U.S. National Science Foundation (NSF) and the Defense Advanced Research Projects Agency (DARPA). The institutional interweaving among industry, government, and academe has been widely covered (Collins & Evans, 2002; Etzkowitz & Leydesdorff, 2000; Kleinman & Vallas, 2001; Slaughter & Rhoades, 2009) and so we wish to take a different approach, elaborating the semiotics and cultural interchange among these broadly defined actors.

As mentioned earlier, the *Grand Challenges* report briefly diverges from its “objective” mode to cite the 2007 movie, *Live Free or Die Hard*, as a reasonable depiction of what could happen if cyber security is not taken up as one of engineering’s Grand Challenges. The Die Hard franchise is notable, among other reasons, for the variety of its source material. The first two movies were based on paperback action novels published in the mid to late 1980s (McTiernan, 1988; Harlin, 1990). The third installment, *Die Hard: With a Vengeance* (McTiernan, 1995), was adapted from an orphaned screenplay titled *Simon Says*. The fourth movie, *Live Free or Die Hard* (Wiseman, 2007), however, is a radical departure from the prior three (Banks, 2012). *Live Free* is based on a *WIRED Magazine* article, “A Farewell to Arms,” in which John Carlin describes the U.S. military’s preparations for “I-war” (Carlin, 1997). Carlin quotes the Chinese military newspaper, *Jiefangju Bao*, for a summary of I-war. It reads, in part:

After the Gulf War, when everyone was looking forward to eternal peace, a new military revolution emerged. This revolution is essentially a transformation from the mechanized warfare of the industrial age to the information warfare of the information age. Information warfare is a war of decisions and control, a war of knowledge, and a war of intellect. The aim of information warfare will be gradually changed from “preserving oneself and wiping out the enemy” to “preserving oneself and controlling the opponent.” (1997, For a Crisp, Succinct . . . section, para. 2)

Live Free is about control: the control of people, resources, institutions, and (most importantly) infrastructure. The plot revolves around a spurned government cyber-security official named Thomas Gabriel (quoted at the beginning of this article), who carries out the mythical “fire sale” cyber security breach. The “fire sale” is named as such because, just like the eponymous inventory clearance event, “everything must go.” Mass media, financial systems, and infrastructure are all compromised and brought under the control of Gabriel’s small army of hackers and mercenaries. They are only able to accomplish such a feat by anonymously soliciting outside hackers to write viruses under the auspices of a corporate computer security firm. Once the viruses have been written, Gabriel orders all of the hackers killed. John McClane (played by Bruce Willis) saves one of the hackers, Matthew Farrell (played by Justin Long), just as the assassin team arrives at his apartment. The rest of the movie follows Farrell and McClane as they attempt to thwart the massive attack on America’s computer-run infrastructure.

The casting of Justin Long as an emasculated, naïve-yet-cynical computer geek—the foil to Willis’s grizzled and raw masculinity—can be read as an extended allegory for the generational tension between the millennials and the baby boomers.⁴ The millennial is a technological determinist, but is much more nihilistic and dystopian about what may actually come to pass. He is shot through with the cyber-libertarian ethics of hacker groups such as Anonymous and Lulsec and the millionaire playboy pirates who run his favorite torrenting sites. Technology, as it appears to Farrell, improves individuals’ lives; society is an afterthought. McClane has come to recognize that there is no technological white knight that will end hunger or disease. His technological optimism-turned pragmatic idealism is representative of his fellow baby boomers who, just as they are reaching retirement, find the social safety net in tatters. Institutions are corrupt and inept, and technology is just as alienating as it is tragically flawed. This tension is perfectly demonstrated in two scenes.

In the first scene, McClane is escorting Farrell to a police precinct just as the “Fire Sale” begins. Gabriel calls McClane and offers him a tradeoff similar to the U.S. far right’s current economic plan: sacrifice Farrell (the millennial) and McClane’s debt will be eliminated and his children will be “set

⁴ Interestingly enough, these two generations are also represented by this article’s authors.

for life.” He makes this offer only after emptying McClane’s retirement fund as a demonstration of his power.⁵ McClane declines the offer and (by way of machine-gun-equipped black helicopter) is immediately denied by Gabriel the relative safety of his cop-filled SUV.

The second scene comes just as the full effects of the Fire Sale have become clear. Farrell, recognizing his own latent desire for wanton destruction of “the system,” prompts a frank discussion of what is at stake:

Farrell: This is virtual terrorism.

McClane: What?

Farrell: You know, first time I heard about the concept of a fire sale . . . I actually thought it would be cool if anyone ever did it. Just hit the reset button and melt the system just for fun.

McClane: Hey, it’s not a system; it’s a country. You’re talking about people, all right? A whole country full of people. Sitting at home alone scared to death in their houses, all right? So if you’re done with your little nostalgic moment and think a little bit and help me catch these guys, just help me. Just put yourself in their shoes.

This exchange between McClane and Farrell mirrors the Faustian bargain demanded by *Grand Challenges*: if you take any interest in these engineering “challenges” that does not conform to the grand narrative of progress (such as hitting the “reset button”), you are co-signing your fellow Americans to a short life of Hobbesian terror.⁶ The young radical and the skeptical citizen alike are posing a danger to everyone’s collective livelihood. Conversely, the established order should be ready to sacrifice itself for the wellbeing of the younger class of knowledge workers that (literally as well as figuratively) holds the passkeys to our digital infrastructure. The “old national faith in the advancement of technology as a basis for social progress” (L. Marx, 2006, p. 4) not only keeps McClane (and the sympathetic audience) loyal to this sociotechnical regime, but it translates a system of pipes and cables into a country.

The thread we have followed from non-fiction (*WIRED* article) to fiction (*Live Free or Die Hard*) and then back to non-fiction (the *Grand Challenges* report) does not represent a sort of grand collusion on the scale of ARBA automobile-centered world building, but it is just as effectual. Kelly, the creator and original editor of *WIRED Magazine*, has long been an evangelist for the digital future-apparent. His book, *What Technology Wants* (2010), is a remarkable blend of Eastern religions, technological determinism, utopian dreaming, reflection on the Unabomber’s manifestos, and honest debate with texts like Langdon Winner’s *Autonomous Technology* (1977). Kelly claims to have read “almost every book on the philosophy and theory of technology” (2010, p. 199) and yet his conclusions are morally ambivalent and rather uncritical of the effects of technology. He contends that the “technium”—the globally interconnected system of technology—acts as a counter to the natural entropy of the universe. While nature tends toward chaos and lessening diversity, the

⁵ This makes for an interesting comparison to *With a Vengeance*, wherein an equally decade-appropriate offer is made: a dump truck full of inflation-resistant gold bullion stolen from the Federal Reserve Bank of New York (McTiernan, 1995).

⁶ The Enlightenment thinker, Thomas Hobbes, is most popularly known for his description of life without societal comforts: “In such condition, there is no place for Industry; because the fruit thereof is uncertain; and consequently no Culture of the Earth; no Navigation, nor use of the commodities that may be imported by Sea; no commodious Building; no Instruments of moving, and removing such things as require much force; no Knowledge of the face of the Earth; no account of Time; no Arts; no Letters; no Society; and which is worst of all, continuall feare, and danger of violent death; And the life of man, solitary, poore, nasty, brutish, and short” (1651).

technium builds complexity and order (2010). The job of humans, according to Kelly, is to nurture this superhuman force and push it toward the service of all mankind. We are in agreement with Kelly that taking an explicit and active role in shaping the path of technology is necessary, but we cannot abide the naturalistic metaphor and the sense of ever-increasing technological complexity and the control that it demands.⁷

Kelly can frequently be found on the lecture circuit, giving talks with titles like, “Quantifying Ourselves through Technology: How What Technology Wants Can Inform What the Healthcare Consumer Wants,” to a room full of medical-device manufactures at the “ePharma Summit” (“ePharma Summit Agenda,” 2012). This constantly revolving door of futurist authors, business leaders, tastemakers, and engineers reflect and comprise the self-reinforcing logic of technological determinism. Indeed, some of the coauthors of the *Grand Challenges* report work in, and have helped to create, Kelly’s world.

Kelly’s book title, *What Technology Wants*, is a fascinating reversal of Leo Marx’s concluding questions:

Does improved technology mean progress? Yes, it certainly could mean just that. But only if we are willing and able to answer the next question: progress toward what? What is it that we want our new technologies to accomplish? (2006, p. 12)

Kelly, epitomizing the technocratic view, flips this logic on its head, and instead says that improved technology produces progress by its very nature:

[W]e will generate more options, more opportunities, more connections, more diversity, more unity, more thought, more beauty, and more problems. Those add up to good, an infinite game worth playing.

That’s what Technology wants. (2010, p. 359)

Returning to the *Grand Challenges* report’s silence on social and ethical concerns, we see that such considerations are a *non sequitur* to today’s technological determinist. We do not want to ascribe too much influence to Kelly, and we do not think we have. He is merely an easy connection to *Grand Challenges*—by way of *WIRED* and *Die Hard*—which is why we focused on his particular contributions to technological determinist thought. But Kelly is not alone. He is one of many technocratic boosters of the information society and all it entails (and disregards). Still, Kelly’s role is formative and hence central to the continued success of the information economy, just as the car companies were formative and central to the future of automobile culture as represented at the World’s Fairs. It is through their cheery TED Talks (Jurgenson, 2012), international consortia (Burrell, 2012), and everyday influence on individuals’ relationship to computers (Eubanks, 2011) that Kelly and his apostles frame the debate around what constitutes progress.

CONCLUSION

Here we have offered a few broad remarks on how the *Grand Challenges in Engineering* report contributes to and is a product of the larger cultural milieu dominated by technological determinist thinking. The report gives us a mixed bag of challenges, with economical solar energy and access to clean water side by side with such large-scale technological fixes as nuclear fusion and carbon

⁷ For a full review of Kelly’s book and its dangerous political and ethical implications, we direct the reader to Evgeny Morozov’s (2011) review of *What Technology Wants*.

sequestration. Again, we can learn something from the book of Moses wherein large-scale technological fixes have produced social injustice and technological quagmires. The high-rise projects constructed by Moses, though intended as technological fixes for poverty, lacked the community values of the neighborhoods they replaced. As a result, drug-abuse and crime plagued many of them. And today the Cross Bronx Expressway, Moses' technological fix for streets jammed with traffic, is itself the most congested roadway bottleneck in the nation (Dolnick, 2010). Indeed, it becomes apparent, as Langdon Winner observed, that a technocratic view can mask racist and classist political commitments and impacts (Winner, 1986).

The *Grand Challenges* similarly does not make its political commitments and impacts transparent, and so begs us to ask what political commitments and impacts are masked by today's technocratic vocabulary. By explicitly referencing blockbuster movies like *Die Hard*, *Grand Challenges'* authors are not-so-subtly demonstrating their symbiotic relationship with a culture industry that encourages technological determinism. Kelly and others ask that we seek out and embrace technocrats like Robert Moses (or Justin Long) rather than asking more fundamental questions about how we go about solving problems with technology. In the end, *Grand Challenges*, *Die Hard*, and Kelly's philosophy all say the same thing: The risks associated with complex technological systems are best mitigated by adding more technology and trusting experts implicitly.

As noted above, the *Grand Challenges* introduction points to the importance of "public understanding of engineering." Most efforts to increase public understanding, like the technocratic view, get it backwards. Rather than starting with the achievements of engineering—past, present, and future, marvelous though they may be—it would better serve both engineering and the public to clearly specify what the social and ethical commitments of engineering are and ought to be. From this vantage point, the challenges of engineering would be no less difficult to achieve than those put forward in *Grand Challenges*, but they would be far more likely to result in genuine social progress.

Regardless of the particular content or subject of future reports, we must also remain sensitive to the scale of perceived problems and their attendant solutions. As Allenby and Sarewitz have suggested, we should:

Lower the amplitude and increase the frequency of decision making. Many small decisions allow much more attention to be paid to complex systems as they evolve, so that policies can track the system more easily and more consistently and so that gaps between policy and reality don't grow dangerously large. (2011, p. 164)

Lower amplitude and increased frequency means less-grand challenges and more human problems. It means fewer grand, sweeping narratives and more contingency and reflection on the immediate past. Working and thinking at a more human scale means considering what is possible in each contingent scenario and reacting to the needs of individuals as well as real, not imagined, communities. This is a good step towards a more ethical engineering practice with a more explicit focus on social justice. It is essential, however, that such a scaling down of work is explicitly stated. Otherwise, such small endeavors look somehow less meaningful or powerful than the large, sweeping generalizations that are so maladroitly put forward in *Grand Challenges for Engineering*.

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