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AN IRRESISTIBLE FORCE MEETS A MOVEABLE OBJECT: THE TECHNOLOGY TSUNAMI AND THE LIBERAL WORLD ORDER

*Richard Danzig **

In response to a request to reflect on the impact of technology on “the liberal world order,” this essay, written for the Aspen Strategy Group, presents a dark view of what may come. I have elsewhere discouraged any pretension that we should rely on a particular prediction when we consider complex, long-run situations.¹ Consistent with that view, I urge readers to read this not as a confident assertion about the future, but rather as a description of one among many possible futures.

This analysis may turn out to be incorrect in significant respects—maybe even all respects. Technology is just one factor in our future and will interact with, be affected by, and itself affect, other factors, producing a resultant that is unpredictable. However, I believe that on balance, even amidst many counter-currents, present technologies push in certain directions, that these directions can be described, and that an analysis that describes these can illuminate our choices and our possible futures.

* Richard Danzig is a Senior Advisor to the Johns Hopkins Applied Physics Laboratory, a consultant to the Intelligence Advanced Research Projects Activity (IARPA), Chair of the Advisory Panel for Idaho National Laboratories’ Innovation Center, and a member of the Toyota Research Institute Advisory Board. Dr. Danzig served as the 71st Secretary of the Navy from November 1998 to January 2001. The author is grateful for comments from members of the group and also from Greg Allen, John Bialfe, Andrew Bochman, Steven Burton, Jack Goldsmith, Michael Hopmeier, Bryan Lee, Peter Levin, Tim Maurer, Will O’Neill, Jonathan Reiber and Anthony Vinci. This article is adapted from a paper for a forthcoming series on Modernizing the Global Order from the [Aspen Strategy Group](#) to be published this fall. The Aspen Strategy Group retains the copyright to this essay.

¹ Richard Danzig, “Driving in the Dark: Ten Propositions About Prediction” (Center for a New American Security, 2011) at <https://www.cnas.org/publications/reports/driving-in-the-dark-ten-propositions-about-prediction-and-national-security>.

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The invention and proliferation of the printing press and Galileo's use of the telescope undermined the Church. The industrial revolution gave birth to the modern state as well as capitalist and Marxist economies. In our own lifetimes, birth control technologies combined with other forces to encourage a fundamental rethinking of women's roles in society, overturning views and practices maintained for millennia. To this observer the soundest expectation is that the present technology tsunami will have similar transformative impacts on the theory and practice of American liberal democracy and on the trajectory it has followed since the Second World War seeking to achieve a liberal world order.

That there is a technology tsunami can hardly be doubted. Digital, silicon based information technologies dominate present discussions, but other technologies are developing as rapidly and have analogous transformative capabilities. No one can accurately predict the causes, character and scope of the resulting revolutions, but promising and already robust technologies that may have great impact include: additive manufacturing, artificial intelligence, big data analytics, biology, nano-technology and new materials, robotics and unmanned systems, quantum computing, operations in space and systems for creating virtual realities.² The rate of invention, adaptation and dissemination in all these technologies has risen, is rising and can be expected to continue to rise.³ This is because information and communication technology breakthroughs empower other technologies. Powerful, relatively easy to use, devices and

² Those interested in a current layman's overview of technologies of interest and their societal implications might consult "OECD Science, Technology and Innovation Outlook 2016" at

<http://www.oecd.org/sti/oecd-science-technology-and-innovation-outlook-25186167.htm> .

This extensive report drew its observations from six "foresight exercises" that identified "well over a hundred" technologies expected to be of significance over the next 10-20 years. The discussion at pp. 77ff focuses on ten technologies judged to be most important.

³ When the National Science Foundation funded an assessment of the rate of improvement across sixty-two technologies, the authors found that "[t]he historical data shows a strong tendency, across different types of technologies, toward constant exponential growth rates..." B'ela Nagy *et.al.*, "Statistical Basis for Predicting Technological Progress," Santa Fe Institute (July, 2012) at

<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0052669> .

For example, the cost of sequencing an entire human genome fell at the rate of Moore's law from 2001 to 2008. It declined much more rapidly in the years after that. The cost in January of 2011 was \$46,774; in October of that year it was \$29,092. By January of 2015 the cost was \$3,970. Nine months later it was \$1,245. See spread sheet data and graphs from Kris Wetterstrand, "DNA Sequencing Costs: Data from the NHGRI Genome Sequencing Program (GSP)" at www.genome.gov/sequencingcostsdata

instruments are simplifying invention, communication, collaboration and proliferation of ideas, tools and products. These trends are amplified by increases in world population, the spread of technological literacy, and the expansion of capital markets.⁴

Technology often functions as an intensifier. When, for example, it makes communication and calculation faster, it serves as a means for all ends—good, ill, important, or trivial.⁵ However, as the historical examples cited at the outset suggest, it also has broad effects that taken as a totality challenge the status quo in political and social institutions. These pages sketch four ways in which I think the contemporary technological tsunami is likely fundamentally to challenge the liberal order.⁶ I start at the level of the individual, move to terrorist groups and

⁴ As three particular markers of these general observations consider: There are more than one million scientific papers published globally each year. Since World War II, the number of science papers published each year has doubled every 9.7 years. In 1989 no nation had as many as a thousand published papers with collaborators from other nations. By 2011, “every country in Europe collaborates with every other country in the region...” For example, the United Kingdom and Germany had around 10,000 co-authored publications. By 2011, “the United States ... collaborate[d] on 3–4% of its papers with each of China (now its most frequent partner, with 19,141 papers in 2011), the United Kingdom (19,090) and Germany (16,753). These totals have all roughly doubled in the past decade.” References for these points are, respectively: Lindsay McKenzie, “Want to analyze millions of scientific papers all at once? Here’s the best way to do it,” *Science* (July 21, 2017) at <http://www.sciencemag.org/news/2017/07/want-analyze-millions-scientific-papers-all-once-here-s-best-way-do-it>; David Westergaard, “Text mining of 15 million full-text scientific articles, (2017, prepublication review version) at <http://www.biorxiv.org/content/biorxiv/early/2017/07/11/162099.full.pdf>; Jonathan Adams, “The Rise of Research Networks” *Nature* p (2012) p. 335 at <https://www.nature.com/nature/journal/v490/n7420/pdf/490335a.pdf>.

⁵ As an historian observed about a critical technology that began to proliferate more than 500 years ago: “Printing presses and books from the fifteenth to the eighteenth century were shared equally between vice and virtue, the retrograde and the progressive thought of Europe.... We cannot say whom the printing press served. It enlarged and invigorated everything.” Fernand Braudel, *Capitalism and Material Life 1400-1800* pp. 298-9 (1967). Recall also, Marshall McLuhan, *Understanding Media: The Extensions of Man* (1994), p. 8: “Whether [electric] light is being used for brain surgery or night baseball is a matter of indifference.”

⁶ This is not to suggest that all technological change subverts the liberal world order. Global trade, for example, expands and sustains that order even as it stresses it.

We need to be careful about sorting out multiple technology effects and cautious about presuming that unfamiliar change is necessarily incompatible with our basic values. For example, it is now widely bemoaned that technology is facilitating both narrowly targeted and broadly based blogs, podcasts, tweets, websites, etc. that flood the market-place of ideas often with false or distracting news. Technology is indubitably providing tools that are being used to circumvent previously stabilizing oligarchies amongst providers of news.

However, this picture is too simplistic. Twitter’s importance may be “more as a feeding ground for other [more traditional] media In this sense, Twitter is not that different from issuing a press release.” Brian Feldman, “Donald Trump Needs the Media, Just Not the Media You Think” (*New York Magazine*, November 23, 2016) at <http://nymag.com/selectall/2016/11/donald-trump-needs-the-media-just-not-the-media-you-think.html>.

private corporations, then to nation-states and conclude by highlighting rising risks of accidents and unintended emergent effects.⁷

I. CHANGING CONCEPTIONS OF THE INDIVIDUAL

Readers may object that changes in our concepts of the power and prerogatives of individuals, however important and interesting, should not be a priority for discussion by a strategy group concerned with international affairs. If you feel this way, I would urge you to reflect on the historical examples. For a liberal system of thought, concepts of individuality are foundational. Stresses and changes in American society arising from reworking these principles will reshape America's values, power, and priorities in the international order. Moreover, if—as is most likely—other countries respond to the same technology opportunities and challenges with less deference to individual rights, the resulting differences may intensify international tensions and force new security and societal decisions upon us. This section sketches some fundamental changes that I think are likely to have these effects.

A core concept of Western individualism is that each individual is the best judge of his or her own interests. We aim to reign over ourselves—to be our own sovereigns. America instantiates this liberal ideal and it is at the core of the example we offer to the world.

But machines can record, analyze and accordingly anticipate our preferences, evaluate our opportunities, perform our work, etc. better than we do. With ten Facebook “likes” as inputs, an algorithm predicts a subject's other preferences better than the average work colleague, with 70 likes better than a friend, with a 150 likes better than a family member and with 300 likes better

More fundamentally, it is not clear that the proliferation of news sources and voices is inimical to liberal democracy. Enshrining stable, powerful gate-keepers may be most congenial to an authoritarian state. Nostalgia may also obscure the turbulence that existed in past fights over McCathyism, the Vietnam War, abortion and civil rights. Furthermore, we may be reverting to a norm familiar to America's founders whose revolutionary pamphlets, geographic and other interest groups, competed in a noisy environment. That norm continued for nearly two centuries. It may be the late twentieth century when technology created a temporary oligarchy of television networks and radio stations that was aberrational.

That said, the new technologies also have other attributes, including their facilitation of self-segregation, anonymity, manipulation from abroad, and flooding communications channels through automation (botnets, etc.) For a reflective assessment see Nathaniel Persily, “Can Democracy Survive the Internet?”

(*Journal of Democracy*, April 2017) pp 63ff at http://www.journalofdemocracy.org/sites/default/files/07_28.2_Persily%20%28web%29.pdf, citing among other things the New York Magazine piece quoted earlier in this footnote.

Cass Sunstein, *#Republic* (2017) thoughtfully explores the consequences of self-segregation.

⁷ Technology is also a cause and a potential mitigator of climate change, but this critical issue is left for other papers.

than a spouse.⁸ The more efficacious machines are in assessing inputs and predicting desires, the more we delegate to them.⁹

Moreover, as unsupervised machine learning grows more prevalent, machine decision-making moves beyond our comprehension. In this situation, if we are to benefit from the machine's work, it is not only its development but also its output that becomes unsupervised. For example, when a NY hospital fed clinical data to a central computing system, administrators were surprised to find that the system provided sounder than human predictions of schizophrenia in patients. Hospital administrators cannot determine the computer's basis for these judgments.¹⁰

Noting Facebook's predictive power and our expanded use of biometric devices to assess, report on and control individual health, Yuval Noah Harari concludes:

Liberalism sanctifies the narrating self, and allows it to vote in the polling stations, in the supermarket and in the marriage market. For centuries this made good sense

⁸ Wu Youyou, *et.al.*, "Computer-based personality judgments are more accurate than those made by humans," <http://www.pnas.org/content/112/4/1036.full> Automated prediction of our preferences is at the core of Google's business model, drawing from the data base of our searches. Other large companies use shopping patterns. Charles Duhigg, "How Companies Learn Your Secrets," provided an early account, noting one company's ability to discern the likelihood that a woman was pregnant from the lotions that she purchased. (*New York Times Magazine*, February 16, 2012) at <http://www.nytimes.com/2012/02/19/magazine/shopping-habits.html>

⁹ Cathy O'Neil, *Weapons of Math Destruction* (2016) powerfully chronicles numerous instances of excessive deference to algorithms. Paul Robinette, *et.al.*, show in a limited experiment how subjects fleeing a fire follow a robot even in the face of vivid evidence of better routes. "Overtrust of Robots in Emergency Evacuation Scenarios," at <https://www.cc.gatech.edu/~alanwags/pubs/Robinette-HRI-2016.pdf>. Yuval Noah Harari observes: "Once... algorithms become all-knowing oracles, they may well evolve into agents and finally into sovereigns.... Once [Microsoft's AI assistants under development] evolve from oracles to agents, they might start speaking directly with one another, on their masters behalf." Yuval Noah Harari, *Homo Deus: A Brief History of Tomorrow*, pp 341-2. (2015).

¹⁰ "[W]hat's puzzling is that it can also predict whether a person is prone to schizophrenia or other psychiatric disorders in the future. Joel Dudley... who leads the team, admitted that they can build such advanced AI models but they have no idea how they work. The most powerful AI machines no longer depend on commands provided by humans. Instead, they create their own algorithm based on the data and desired output given to them. In short, machines program themselves." Mount Hospital, *University Herald* - Chris Brandt, "Deep Learning: The Most Advanced Artificial Intelligence" (June 2017) at <http://www.mountsinai.org/about-us/newsroom/in-the-news/university-herald-deep-learning-the-most-advanced-artificial-intelligence-chris-brandt>. See also, Will Knight, "The Dark Secret at the Heart of AI: No one really knows how the most advanced algorithms do what they do. That could be a problem." *MIT Technology Review* (April, 2017) and Mark Wilson, *AI Is Inventing Languages Humans Can't Understand. Should We Stop It?* (July 2017) at <https://www.fastcodesign.com/90132632/ai-is-inventing-its-own-perfect-languages-should-we-let-it>.

*because though the narrating self believed in all kinds of fictions and fantasies, no alternative knew me better. Yet once we have a system that really does know me better, it would be foolhardy to leave authority in the hands of the narrating self.*¹¹

Of course, it may be objected that we retain the freedom to reject the machine's outcome. But we are commonly seduced into rarely exercising that power and even when we might want to intervene, imperatives for speed and accuracy may cause us to forgo human decision as too slow, too ill-informed, and too prone to error. If another society delegates strategic or tactical war-making capabilities to artificial intelligence agents, will our values inhibit our capabilities by our insistence on a slow and error prone human in the loop?¹²

Beyond issues of war, I believe that the challenge to the liberal democratic model is the technocratic state. It is too sanguine and blinkered to repeat the cliché that China offers no ideology to compete with ours.¹³ The PRC is groping towards an authoritarian technocratic state dedicated to serving and controlling its population by utilizing modern technologies.¹⁴ It is not clear whether that

¹¹ Yuval Noah Harari, *Homo Deus: A Brief History of Tomorrow*, p 338. (2015)

¹² "Teaming military forces with autonomous systems will fundamentally alter how peace is kept and wars fought, and because potential adversaries are already heavily investing in their use, it is imperative that the United States keep pace. Military superpowers in the next century will have superior autonomous capabilities, or they will not be superpowers." [Cara LaPointe](#) and [Peter L. Levin](#), "Automated War: How to Think About Intelligent Autonomous Systems in the Military," *Foreign Affairs* (September 2016) at <https://www.foreignaffairs.com/articles/2016-09-05/automated-war>

¹³ Daniel A. Bell, *The China Model: Political Meritocracy and the Limits of Democracy* (2015) argues that China offers an exportable model of meritocratic national leadership that permits experimentation at intermediate levels and democracy at lower levels. In this respect, his perspective overlaps mine. I note that he acknowledges, but does not emphasize, authoritarian aspects of the Chinese system (e.g. at pp. 179 and 197).

¹⁴ China's evolving efforts at establishing a "social credit system" are suggestive of this approach. Wikipedia (https://en.wikipedia.org/wiki/Social_Credit_System) provides a reasonable summary:

The Social Credit System is a proposed Chinese government initiative for developing a national reputation system. It has been reported to be intended to assign a "social credit" rating to every citizen based on government data regarding their economic and social status. In addition, it is also meant to rate businesses operating on the Chinese market.

The Social Credit System is an example of China's "top-level design" approach. It is coordinated by the Central Leading Small Group for Comprehensively Deepening Reforms. According to the overall "Planning Outline for the Construction of a Social Credit System (2014-2020)" issued by the State Council, the Social Credit System will focus on four areas: "sincerity in government affairs" (政务诚信), "commercial sincerity" (商务诚信), "societal sincerity" (社会诚信), and "judicial credibility" (司法公信).^[9]

The Chinese government wants the basic structures of the Social Credit System to be in place by 2020. It is unclear whether the system will work as envisioned by then, but the Chinese government has fast-tracked the implementation of the Social Credit System, resulting in the publication of numerous policy documents and plans since the main plan

model or the historic American model will most broadly take hold in Asia, other continents or for that matter in the United States.

We can also see the turbulent effects of technology from another perspective. The liberal order is based on a consensus that individuals are free to develop and apply their minds as they judge appropriate. Our first amendment guarantee of free speech reflects this consensus, with occasional battles at the margin, for example over hate speech. But we are just beginning to come to grips with an issue as fundamental but much more divisive than free speech: to what extent do individuals have a right to control their own bodies? Some issues about “free bodies” are already indicative of the intensity of American conflicts in this domain: abortion, euthanasia, birth control, legalization of recreational hallucinogenic drugs. Others have been introduced in contexts that maximize consensus: medical implants and procedures to compensate for heart conditions, fertility treatments for the infertile,¹⁵ computer-assisted prosthetic limb and artificial voices, cochlear implants for those born with diminished hearing.

But the line between correction and improvement is difficult to discern—plastic surgery for the war wounded became cosmetic surgery for the affluent. How does liberal democracy deal with a desire to correct a fetus’s genetic predisposition to incipient diabetes?¹⁶ To autism? To improving my offspring?

was issued in 2014. If the Social Credit System is implemented as envisioned, it will constitute a new way of controlling both the behavior of individuals and of businesses. As of July 2017, no comprehensive, nation-wide social credit system exists, and very little firm information is available about how this system might work in practice. There are, however, multiple pilots testing the system on a local level as well as in specific sectors of industry.

See also Simon Denyer, “China’s plan to organize its society relies on ‘big data’ to rate everyone,” *Washington Post* (October 22, 2016) at https://www.washingtonpost.com/world/asia_pacific/chinas-plan-to-organize-its-whole-society-around-big-data-a-rating-for-everyone/2016/10/20/1cd0dd9c-9516-11e6-ae9d-0030ac1899cd_story.html?utm_term=.a33ad3db0959 and Shazeda Ahmed, “CASHLESS SOCIETY, CACHED DATA: Security Considerations for a Chinese Social Credit System,” (Citizen Lab, January 24, 2017) at <https://citizenlab.ca/2017/01/cashless-society-cached-data-security-considerations-chinese-social-credit-system/>.

It is worth noting how aspects of the American system, including credit scores for the general population and security evaluations for those engaged by national defense and intelligence agencies, reflect analogous efforts also empowered by new tools for data mining.

¹⁵ With remarkably little public comment, every day some 200 American babies are born after having been conceived in test tubes. (This is amongst a total of about 11,000 babies born in America each day). I infer this estimate (probably a modest under-estimate) from a numerator of *in vitro* births (70,354) in 2014 as reported by the CDC at https://nccd.cdc.gov/drh_art/rdPage.aspx?rdReport=DRH_ART.ClinicInfo&ClinicId=9999&ShowNational=1 (note that multiple births from *in vitro* fertilization are counted as a single birth in this data) and a denominator of some 3.99 million total births in that year. National Vital Statistics Reports, “Births: Final Data for 2014” (CDC, 2015) at https://www.cdc.gov/nchs/data/nvsr/nvsr64/nvsr64_12.pdf, with slight upward adjustments to account for likely changes from that date to the present.

¹⁶ Steve Connor, “First Human Embryos Edited in U.S.: Researchers have demonstrated they can efficiently improve the DNA of human embryos.” (*MIT Technology Review*, July 26,

To select among fetuses based on their likely intelligence? To improve my intelligence as an adult?¹⁷ On these issues there will be no ready consensus and our struggles to resolve them, like our struggles over slavery, will determine whether we are torn apart and—if we remain united—what we mean by a democracy built upon a foundation of individual freedom.

Whatever our 19th century difficulties in addressing slavery as an American issue, in a 21st century global environment (an environment itself created by technology) we must recognize that other societies and cultures will confront these same issues and at least in some cases very probably make other decisions. How would a liberal world order address the freedom of Chinese parents and the Chinese state to select for intelligence?¹⁸ How would the Chinese choice affect our choice? If another state enhances its soldiers' capabilities through drugs (or, as noted above, achieves greater speed or accuracy from allocating major war decisions to machines) can we ignore or reject that?¹⁹ Can we match these changes without undermining our concepts of a liberal world order?

2017) at https://www.technologyreview.com/s/608350/first-human-embryos-edited-in-us/?set=608352&utm_source=MIT+Technology+Review&utm_campaign=0b6e65d565-The_Download&utm_medium=email&utm_term=0_997ed6f472-0b6e65d565-155949869.

¹⁷ If in addition to participating in Aspen Strategy Group meetings, members attended the 47th Behavior Genetics Annual Meeting last month, they would have gotten a glimpse of rapidly emerging “new themes that shed light on the biological underpinnings of cognitive performance.” Suzanne Sniekers, et.al. “Genome-wide association meta-analysis of 78,308 individuals identifies new loci and genes influencing human intelligence” at <http://programme.exordo.com/bga17/delegates/presentation/214/>. The field is well summarized by Stephanie Pappas in “The Plot Thickens in the Gnarly Story of IQ and Genetics,” (Neo.Life, July 20, 2017) at <https://medium.com/neodotlife/intelligence-genes-eb18c5ef759c>.

¹⁸ David Cyranoski, “China’s embrace of embryo selection raises thorny questions,” (*Nature*, August 16, 2017) at <http://www.nature.com/news/china-s-embrace-of-embryo-selection-raises-thorny-questions-1.22468>, describes cultural differences between the US and China: In the West, PGD [pre-implantation genetic diagnosis for in vitro fertilized eggs] still raises fears about the creation of an elite genetic class, and critics talk of a slippery slope towards eugenics... In China, however, PGD lacks such baggage. The Chinese word for eugenics, *yousheng*, is used explicitly as a positive in almost all conversations about PGD. *Yousheng* is about giving birth to children of better quality. Not smoking during pregnancy is also part of *yousheng*.

The article also goes on to note, however, that

This is not to say that the Chinese haven’t thought about abuses of the technology. The Chinese government was worried, as were many Western governments, that PGD would be used to select physical characteristics, such as height or intelligence. The clinics licensed to do PGD can use it only to avoid serious disease or assist infertility treatments. And sex selection through PGD is off the table.

¹⁹ The Director of National Intelligence “2016 Worldwide Threat Assessment of the US Intelligence Community,” forthrightly stated: “Research in genome editing conducted by countries with different regulatory or ethical standards than those of Western countries probably increases the risk of the creation of potentially harmful biological agents or products. Given the broad distribution, low cost, and accelerated pace of development of this dual-use technology, its deliberate or unintentional misuse might lead to far-reaching economic and national security implications.”

It is widely recognized that privacy, a core value of the Western liberal order, is eroded by a regime of information sharing, multiple observation capabilities (cameras, geospatial identification of movement of cell phones and connected cars, credit card transactions, etc.), biometric analysis through collection of DNA and facial, iris or heartbeat identification,²⁰ and data analytics. Privacy is not simply a value unto itself—it is a prerequisite of freedom in the face of a totalitarian state or controlling private entity.²¹ Its erosion undermines the liberal order. And yet, as is widely recognized, technological change empowers and security challenges motivate the constriction, even essentially the elimination, of privacy.²²

Along with security, the credibility of all modern states is determined by their ability to deliver economic growth, personal opportunity and jobs. Depression challenged democracy and spawned fascism in the decade after 1929. Conversely, from World War II to the present, the relative success of capitalism powerfully enhanced the appeal of the American system. It remains to be seen how much the future resembles the past as authoritarian states aim to win this competition. What is clear is that the ability to develop and absorb technology will be critical in any such competition.

At the same time, technology is diluting the links between growth, opportunity and employment. Some current political debates reflect this, but the longer-term challenges are more fundamental. Economists have begun to ask whether the future of human employment is itself questionable. That circumstance seems far off, but the consensus expectation among the cognoscenti is that it will occur within the lifetimes of younger readers of this paper.²³ Even now movement in that direction is generating great tensions, within the United States and internationally, as nations compete to provide

Senate Armed Services Committee, Statement of James R. Clapper, Director of National Intelligence (February 9, 2016) at p9.

²⁰ “Present day: facial recognition reaches 500 metres; iris recognition, 50 metres; and, heartbeat recognition, 5 metres.” Canadian Security Intelligence Service, “2018 Security Outlook: Potential Risks and Threats,” (2016) p.76.

²¹ Timothy Snyder, *On Tyranny* (2017) articulates this point admirably. For those who seek a more visceral sense of the point, volume one of Vassily Aksyonov’s novel, *Generations of Winter* (1994), vividly depicts the corrosive effects of omnipresent informants in Russia’s Stalinist state.

²² As with all trends described here, there are counter-currents. Some technologies—for example encryption—can make privacy more robust.

²³ A recent survey elicited responses from 352 published experts on machine learning in response to questions about “when unaided machines [would be predicted to be able to] accomplish every task better and more cheaply than human workers.” In response, “the aggregate forecast gave a 50% chance of [this] occurring within 45 years and a 10% chance of it occurring within 9 years.” (Interestingly, “Asian respondents expect [this] in 30 years, whereas North Americans expect it in 74 years.”) Even if that could be achieved, respondents anticipated a long further delay before “machines could be built to carry out [all tasks] better and more cheaply than human workers.” Responses reflected only a 10% probability of achieving that in 20 years and a 50% probability that point would only be reached in 122 years. Katja Grace *et.al.*, “When Will AI Exceed Human Performance? Evidence from AI Experts,” ArXiv (May, 2017).

employment opportunities. If as seems plausible (even probable) increased productivity permits increases in standards of living and support of aging populations even as employment declines, systems providing a state assured income will expand. Domestically, this will, even more than now, have intensely debated effects that may distract us or cause us to change our conceptions of the relationship between an individual and government.

Further, what is not yet well recognized is the close tie between work and identity. Merely compensating for lost income will not satisfy this need and efforts to satisfy it (for example through systems of national service) or failures to address it may transform American democracy as well as everyday American life. Internationally, a large source of tension is likely to be the ability of more developed countries to demand royalties from the machine systems and other technologies they develop.²⁴ Great income inequality between citizens of different countries—an unusual situation that developed over the last two centuries along with disparate industrialization and technology absorption²⁵—may yet more intensely challenge the liberal world order.²⁶

II. GROWTH OF NON-STATE POWER

It is well understood that technology has amplified the individual's and small group's power to kill.²⁷ This is the most dramatic manifestation of a more general phenomenon: political groups, private corporations, criminal organizations and even individuals can now wield powers previously primarily reserved to nation states. For example, capabilities once exclusively marshaled by an elite intelligence agency are now broadly accessible because commercial tools empower surveillance (even from space using commercial satellite data), analysis (employing tools to interrogate “big data,” reaping the bounty of information from social media, and by crowd sourcing),²⁸ and espionage (for example, using cyber malware). Platforms for mass communication are available for attracting military recruits and civilian supporters. Commercial encryption permits protected messaging. Unmanned vehicles empower aerial and terrestrial attack and driverless cars may well soon deliver car bombs. Digital technologies

²⁴ We see harbingers of this in the debate about pharmaceutical prices in less developed countries.

²⁵ “[B]efore the late 1800s, there was relatively little income disparity across countries,” Keith Sill, “The Evolution of World Income,” *Business Review* (Q2 2008) 23 at www.philadelphiafed.org

²⁶ On the other hand, increases in income and the size of the middle class in developing countries may ameliorate international tensions.

²⁷ Martin Shubik, “Terrorism, Technology and the Socioeconomics of Death,” *Comparative Strategy* (October- December 1997) provided a first documentation.

²⁸ Thus, for example, Seth M. Goldstein et al, “Assessing the Accuracy of Geopolitical Forecasts from the US Intelligence Community’s Prediction Market” PNAS 2017 preprint: “... On unclassified questions, [crowd wisdom] platforms populated by laypeople from the general public performed as well or better than a state-of-the-art [crowd wisdom] method populated by real IC analysts. Moreover, we found no evidence that ... forecasters’ access to classified information conferred any advantage.”

permit long-distance, mass scale attacks.²⁹ The dark web facilitates transactions outside national legal systems, enforced by systems of private reputational ranking.³⁰ Assisting these developments, private currencies (Bitcoins, Ethereum and scores of others) are coming into use.³¹

These changes bring private power closer to the levels of public power. Two resulting challenges are now much discussed: terrorist threats that metastasize into small groups;³² and individuals and global corporations that enjoy private power beyond government control. What is not commonly observed is that these disparate centers of private power are enabled by the same underlying force: 21st century technology. The modern liberal state has much more sway over private corporations than it does over terrorists, but it does not yet know how to force shared approaches to security challenges (for example, iPhone encryptions; shared user data; information on cyber attacks) and there is no American consensus about the American responsibilities of American corporations. (When I asked him about this, a senior figure in a top 30 American corporation told me “Our goal is to be like Switzerland: neutral and engaged with all.”)³³

The liberal state is now greatly stressed by its need to control and compete with these centers of private power. An insightful account of this situation observes:

²⁹ “Never before could a dozen people in their pajamas meaningfully annul the monopoly on the use of force.” Canadian Security Intelligence Service, “2018 Security Outlook: Potential Risks and Threats,” (2016) p. 80.

³⁰ Dark web transactions are particularly resistant to government control. It should be noted though that they are small compared to off-line markets for drugs and guns and that governments have not been very successful in policing those either. For good assessments see Kristy Kruihof, *et.al.*, “The Role of the ‘Dark Web’ in the Trade of Illicit Drugs,” (RAND, 2016) at https://www.rand.org/pubs/research_briefs/RB9925.html and Giacomo Persi Paoli, *et.al.*, “Behind the curtain: The Illicit Trade of Firearms, Explosives and Ammunition on the Dark Web” (RAND, 2017) at https://www.rand.org/pubs/research_reports/RR2091.html.

³¹ <https://coinmarketcap.com/> lists the top one hundred crypto-currencies by market capitalization. Bitcoin’s capitalization is calculated at over \$45 billion and Ethereum’s at \$21 billion. The next seven have capitalizations from \$7 billion down to \$651,000. A recent academic study calculates that “between 5.8 million and 11.5 million [crypto-currency] wallets are estimated to be currently ‘active’.” Garrick Heilman and Michael Rauchs, “Global Cryptocurrency Benchmarking Study,” (The Cambridge Centre for Alternative Finance, Cambridge University, Judge Business School) p.10 (2017).

³² Global criminal groups create analogous problems. OECD, “Reviews of Risk Management: Illicit Trade: Converging Criminal Networks,” (2016) summarizes the nature and extent of these activities, pp. 22ff. Following the lead of a UN study, it estimates the size of this activity at approximately 1.5% of global GDP, particularly from drugs, counterfeiting and “forced labor from private enterprise.”

³³ Elite employees of global companies may share outlooks with one another more than with compatriots in their home countries, just as inhabitants of mountains, seacoasts and islands around the Mediterranean in the late 1500s had more in common with others similarly situated than with their more proximate neighbors. Fernand Braudel observed the earlier situation in *The Mediterranean and the Mediterranean World in the Age of Philipp II* (1949; English Second Edition, 1966).

While it is not yet literally the case, every individual, every group, every company, and every state will soon have the potential to threaten the security of—and have his, her, or its security threatened by—every individual, group, company and state.... [T]he relative power of the state to that of the citizenry is reduced ... we are unleashing ... enormous creative potential ... It threatens, however, to be Hobbesian as well—an environment of unaccountable freedom to do great harm.³⁴

Authoritarian states are challenged by this situation, but much less so because they are not inhibited by deference to individual liberties and they commonly view corporate actors as agents of the state acting in another form. The survival of the liberal order will significantly depend not only on its ability to cope with these Hobbesian challenges, but also on whether liberal states are judged inferior to authoritarian states in this respect.

III. GROWTH OF FOREIGN POWER

At the end of World War II, America was in a singular position. With Europe and much of Asia in ruins, our infrastructure was intact and our producers and consumers accounted for more than half of the world's GDP. In the ensuing seven decades the world has moved towards a more normal position, with America still economically privileged (we generate one-quarter of the world's GDP) but much less dominant. This reversion towards the norm has significant implications for America's global power, quite apart from the distribution of technological capabilities.

Of course, economic power is strongly correlated with technological capabilities. But insofar as we can assess technological capabilities as a separate variable, it seems evident that they intensified American post-War dominance.

³⁴ Benjamin Wittes and Gabriella Blum, *The Future of Violence* (2015) p.9. The authors also observe that:

A necessary corollary of the distribution of the capacity for attack and the distribution of vulnerability ... is a parallel distribution of the ability to defend.... [D]efense from harm becomes less a primary governmental function and more a collective responsibility that harnesses the private sector.

Ibid., pp. 69 and 72. See also pp. 95ff. It might be added that not only is the "relative power of the state to that of the citizenry" reduced, but also there are changes to the relative power of private citizens and groups. This can have adverse effects for the liberal democratic order. For example, "[i]n the digital realm, [civil society organizations] face the same threats as the private sector and government, while equipped with far fewer resources to secure themselves." Citizen Lab, "Communities @ Risk: Targeted Digital Threats Against Civil Society," (University of Toronto, 2014) at <https://targetedthreats.net/>. "[C]ivil society is largely on its own as it goes about its work to advance human rights and other public policy goals while struggling to stay ahead of debilitating cyber threats." Ron Deibert, "Civil Society Hung Out to Dry in Global Cyber Espionage," (Circle ID, March 4, 2013) at http://www.circleid.com/posts/20130304_civil_society_hung_out_to_dry_in_global_cyber_espionage/.

After World War II we were in a position of immense technological advantage from our wartime invention and production. Many of the world's scientists had taken refuge (and more were taking refuge) here. The US government was in the forefront of developing and more or less effectively controlling key technologies like nuclear weapons and nuclear power, missiles, computing, cryptology, digital storage, telecommunications, radar, aviation and submarine capabilities.

The 21st century world is more evenly distributed.³⁵ In part this is because, while some technologies remain exclusively military, many critical technologies are commercial. In the decades after WWII it was the US government that drove research and development and dominated the market for advanced technologies. Related civilian technologies were spin-offs from military technologies.³⁶ When Ash Carter wrote about government and civilian R&D in 1980, his and his co-authors' principal concern was whether government R&D would crowd out civilian developments. Now American civilian R&D is two and a half times government R&D and the American government is a small participant in many markets. As a striking example, the semiconductor industry association calculates that the US government comprised 90% of the global semiconductor market in the early 1980s. It is now .5% of that market.³⁷

The global distribution of commerce, wealth and invention levels the playing field. The resulting national security challenge is typically put as one of superiority: as China is projected to advance to equality with our GDP a decade from now and, more notably still, to a GDP that is 50% larger than ours around 2050, can we maintain technological superiority? But though this is one relevant measure, it is as significant that even if we remain superior, fast followers will be much closer to us, inventing, adapting and disseminating at a speed that shortens the first mover's advantage. Technological power, which after World War II sharply diverged, is now largely converging; hard-earned technological advantages tend only to be transitory; advantages in technology development can be negated (or amplified) by speed of dissemination and skill in adaptation. As a result, today's technologies, though often pursued under the banner of superiority, tend to be equalizers.

IV. RISK OF UNINTENDED CONSEQUENCES

Ever since we harnessed the awesome technology of the atomic bomb and nuclear reactors, we have been supremely aware of the risks of accidents. But even extraordinary American efforts have not avoided harrowing nuclear incidents, some of them causing numerous casualties and requiring substantial

³⁵ Chris Kirchoff's paper for these sessions ("A Flatter World Technology and the World Order") discusses the points in this and the next paragraph with broader scope and in richer detail.

³⁶ The internet and GPS are two striking examples.

³⁷ The data is reported in Section 809 Panel_Interim-Report_May2017_NOTES Advisory Panel on Streamlining and Codifying Acquisition Regulations Section 809 Panel Interim Report May 2017 https://section809panel.org/wp-content/uploads/2017/05/Sec809Panel_Interim-Report_May2017_FINAL-for-web.pdf.

relocations of affected populations.³⁸ These risks expanded as nuclear weapons were acquired by eight other nations,³⁹ many of which may not equal our inclination and ability to invest in mechanisms of control and mitigation. Moreover, these risks multiply as other technologies (particularly bio-engineering, cyber attack capabilities and artificial intelligence) proliferate to other nations. The risks of catastrophic accident cannot confidently be calculated,⁴⁰ but it can confidently be said that they are rapidly rising. It seems more probable than not, for example, that the 1977-78 global epidemic of H1N1 arose from human, not natural, activities.⁴¹

The proliferation of dangerous technologies in the hands of numerous states, groups and even individuals, also raises the likelihood of emergent effects—unpredictable consequences from the unexpected interactions of systems whose safety and other constraints are commonly conceived to operate separately. We do not know, for example, how machine decision-making systems from one country may interact with those of another, causing (as in the World War I mobilization systems) consequences that no nation would have chosen. We do not know how cyber or biological viruses created for one purpose may affect other systems if they are released or escape into the wild.

These and many analogous possibilities warrant concern because they may be catastrophic for our lives or our environment. They are noted here, though, because of a collateral consequence: if the liberal state cannot control destructive

³⁸ For example, the explosive force of a thermonuclear device tested in 1954 was three times what was predicted, with consequent exposure of 15 inhabited Pacific islands. Thomas Kunkle and Byron Ristvet, “CASTLE BRAVO: Fifty Years of Legend and Lore” Defense Threat Reduction Agency (D-TRAC SR-12-001, January 2013) at <https://web.archive.org/web/20140310004623/http://blog.nuclearsecrecy.com/wp-content/uploads/2013/06/SR-12-001-CASTLE-BRAVO.pdf>

³⁹ Atomic Archive.com briefly chronicles thirty-two accidents involving nuclear weapons and reactors throughout the world since 1950. “Broken Arrows: Nuclear Weapons Accidents” at http://www.atomicarchive.com/Almanac/Brokenarrows_static.shtml.

⁴⁰ In an ambitious effort to quantify one risk, Marc Lipsitch and Alison P. Galvani calculate that “a moderate research program of ten laboratories at US BSL3 standards for a decade would run a nearly 20% risk of resulting in at least one laboratory-acquired infection, which, in turn, may initiate a chain of transmission. The probability that a laboratory-acquired influenza infection would lead to extensive spread has been estimated to be at least 10%. Simple branching process models suggest a probability of an outbreak arising from an accidental influenza infection in the range of 5% to 60%.” “Ethical Alternatives to Experiments with Novel Potential Pandemic Pathogens,” *PLOS Medicine* (May 2014) at <http://journals.plos.org/plosmedicine/article/asset?id=10.1371/journal.pmed.1001646.PDF/> (footnotes omitted). The variation in these calculations underscores the limits of our understanding.

⁴¹ Michelle Rozo and Gigi Kwik Gronvall, credibly conclude that this epidemic was “probably not a natural event, as the genetic sequence of the virus was nearly identical to the sequences of decades-old strains.” They suggest that the most plausible explanation was a live-vaccine trial escape, the next most likely was a laboratory accident and the least likely was a deliberate release of a biological weapon. “The Reemergent 1977 H1N1 Strain and the Gain-of-Function Debate,” (2015) at <http://mbio.asm.org/content/6/4/e01013-15.full>

technologies (our own and others), that failure will fuel intense demands for a more secure, and I fear authoritarian, form of governance.

V. CONCLUSION

The tectonic plates of modern technology are shifting with results that already stress the foundations of the liberal order. Four main fault lines are evident, centering on the role of individuals, small groups and corporations, multi-state competitions and the risks of accidents and disastrous emergent effects.

All trends produce counter-trends. Technology can be sustaining as well as subverting. The liberal order has encountered and robustly emerged from other stresses. It may survive this century's technology tsunami. That outcome, though, is far from assured.