Technological Progress and its Motivators: Should Regulation even Be Attempted?

Álvaro Marín Melero, Class of 2014
Weiss College House
March 30, 2014

Álvaro Marín Melero hails from Madrid, Spain. He majored in Business, Organizations, & Society at F&M while also pursuing Architecture at both F&M and Columbia University. Álvaro seeks to combine entrepreneurship, innovation and technology in his future exploits.
The opportunities that new, transformative technologies generate bring with them ethical dilemmas, challenging the basic assumptions that we hold about the man-machine interface, adoption of new technologies and, more fundamentally, the direction of human development itself (Lee and Jose, 2002, p.113). Indeed, we seem to be unknowingly strapped onto an ever-accelerating rollercoaster of technological development with no ability to predict what may lie before us. Tensions exist between the self-interest of corporations to gain a competitive advantage in the market on one side, and self-restraint in exercising ethical choices to ensure responsible development of technology on the other. Current regulatory approaches to minimize the potential dangers of transformative technologies are inadequate, as they take time to develop, are often only applicable in very specific cases, and fail to promote the greatest governance mechanism of all: self regulation.

Today, I wish to begin a discussion about the shortcomings of current regulatory efforts in overseeing the rapid acceleration of technological development. First, I will go through the four motivators that push scientists and entrepreneurs to develop and implement new technologies. Second, I will use current attempts to regulate nanotechnology to illustrate the failures in the systems of governance established to avoid a major technological catastrophe. Finally, I will end by beginning to explore possible avenues for reform that may help ensure a robust and responsible pace and implementation of technological innovation.

I. MOTIVATORS of TECHNOLOGICAL DEVELOPMENT

Four motivators push technological development on. Needs for food, shelter, health and security stand behind some of history’s major technological evolutions. Curiosity has also played, and will continue to play, an important role in advancing humankind’s progress. More recently, two other motivators, the pursuit of competitive advantages and the pursuit of personal gain, have pushed technologies even further. They have always been present, but their role has exploded in the last centuries. These four motivators will continue to push the limits of technology at an ever-faster rate, for an unforeseeably long time and will perhaps, only perhaps, be redefined should we enter a new technological age.

The first motivator for technology development is addressing a direct need for a new technique or tool that helps overcome an insufficiency living conditions (food, shelter, health or security). The development of systematic crop rotation is one example of such a need. Although the Romans had begun using crop rotation in the B.C. era, its first carefully thought-out implementation, systematic crop rotation, took place many centuries later (Parker, 1920, p.30). Systematic crop rotation, the common practice of “alternation of the grain, grass and cultivated crops on a certain area of land,” was first introduced in England during the 17th and 18th centuries (Parker, 1920, p.30). This technology avoids a decrease in soil fertility while also preventing the decrease in productivity that results from fallowing (leaving a field to rest). Crops that leach the soil of one kind of nutrient are followed during the next growing season by a dissimilar crop that either returns that nutrient to the soil or draws a different ratio of nutrients (e.g., rice followed by cotton). In the long run, farmers can enjoy an increase in both productivity and the quality of their harvests. Although this technology at first glance appears to be motivated by the pursuit personal gain or the pursuit of a competitive advantage, it belongs here due a soaring increase in the population of the United Kingdom that took place during these years. This increase forced crop rotation to be adopted by all farms in order to support the growing number of mouths to
feed. This technique didn’t allow for “luxury” foods but rather basic, life-supporting foods to be produced more efficiently. Very basic to advanced technological developments belong in this category. The creation and manipulation of fire (provides security and helps making food edible) and earthquake resistant structures (provide health and security) are other such examples. The first major advances in human history were motivated by need, as humans sought to limit threats to their well-being.

The second motivator for technological advancement is a common human trait: curiosity. Curiosity has led to many a significant discovery and is, in this author’s eyes, a fundamental characteristic of all innovators. Curiosity, not the pursuit of money or power, fueled Antonie van Leeuwenhoe’s pioneering work in the late 17th century. The Dutchman’s inquisitiveness led to the perfecting of an optical tool vital to many future advances in technology, modern biology being only one of many fields to have sprung therefrom. Galileo Galilei provides another example of curiosity as a motivator. His interest in the fields of physics, mathematics, and astronomy led him to create practical innovations such as important improvements in the microscope and the telescope (Hason, 1960, and Westfall, 1985). More recently, with the advent of research oriented universities and other research institutions, and given the complexity of today’s technology, many technological advances result from team efforts and are at times restricted by such factors as inadequate funding and political agendas. Notwithstanding, I have yet to meet a scientist who is not in great part motivated by the thrill of potentially discovering something new. Furthermore, curiosity often plays a salient role in setting off chains of discovery and innovation, which are then fueled further by any other of the four motivators. Case in point is the lust for knowledge of the atomic realm that made the atomic bomb imaginable first and possible second. Curiosity is perhaps the most virtuous of the four motivators, and in one way or another is ever-present in any form of progress.

Third, the pursuit of competitive advantages, be it militarily, economically, or even socially, has always pushed humans to develop new technologies. This motivator encompasses any desire to outperform a competitor. Militarily, nations constantly try to outperform each other. Many technologies have been developed for military uses, and then regularly end up trickling down to the broader population. Radar, for instance, was perfected in World War II. The goal behind this technology was to detect the position and velocity of enemy ships (Watson, 2009). The military competition within and between European nations and the U.S.A. led to continuous and significant improvements of radar devices throughout the war. Today, radar is used for a number of functions including aircraft positioning, weather forecasting, and even as collision-avoidance systems in high-end automobiles. Other examples of such technologies include the creation of the atomic bomb and its supporting technologies, which now find civilian uses in energy production (Genth, 1988, p.281).

World War II marks a key shift to technological reliance in warfare, with tremendous quantities of money being poured into the development of new technologies (Archer, 2002). The U.S. Department of Defense budget for RDT&E (Research Development Test and Evaluation) for the year 2011 alone surpasses $80 billion dollars. And this extraordinary amount represents the spending of just one nation. Technologies widely in use today, created by the military, include global navigation systems and even the World Wide Web. Seeking military supremacy has become a huge motivator for technological advancement in the 20th and 21st centuries, almost deserving a category of its own if it weren’t for the similitudes it shares with other forms

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of competition. Businesses worldwide, particularly large manufacturing and technology firms, must develop and adopt new technologies in order to remain competitive in their industries, be it by offering a technologically advanced product, or by benefiting from new technologies internally (i.e., for production, administration, design, etc.). Gaining a competitive advantage has become increasingly central in pushing the boundaries of science and technologies in a world where a small technological edge, be it military or commercial, can make all the difference.

Finally, technological development is encouraged by the prospect of personal gain. While the third motivator, gaining a competitive advantage, illustrates the competitive dynamic between two or more actors, the prospect of personal gain focuses on the “selfish” forces at play, if you will. We can observe this motivator at play in the market. Consumers continuously wish to have more and better products and services. Companies are more than willing to satisfy consumer demands for the financial benefit they stand to gain. Both consumers and companies therefore create a cycle of innovation that benefits each of their “selfish” wants. This dynamic contrasts starkly with the winner-loser nature of competition as a motivator, yet, in practice, the two are often intertwined. This motivator is not limited to companies and their customers, but may be extended to individuals and societal groups as well. Many “things” stand to be gained, be they a product, service, money, or simply fame.

Note that these four motivators are not mutually exclusive. On the contrary, they often play in unison. Harrison’s marine chronometer finally solved the problem of establishing the longitude of a ship at sea, that is, its East-West position; this had been a great intellectual challenge which many had attempted to solve to no avail. We can speculate that the self-educated carpenter and clockmaker John Harrison developed his clocks motivated by curiosity—the very fact that he was self-educated seems to indicate so—yet we can also assume that the £20,000 Longitude Prize, which amounts to $4.25 million in today’s currency, may have also played at least a small role. Different factors act together to motivate all technological advances. The importance of each motivator varies from case to case.

II. ISSUES REGARDING the REGULATION OF NEW TECHNOLOGIES

We will next see how these motivators render regulation of new technologies exceedingly difficult, using the example of nanotechnologies. The development of nanotechnologies is particularly well suited to discuss the topic of technological regulation. It has been described as one of the most powerful and transformative technologies in human history with the capacity to deliver revolutions in a wide range of industrial sectors (Lee & Jose, 2008, p.113). As a nascent technology, many of its safety and practical implications are unknown. According to Lee and Jose (2008), there are alternating visions of almost magical products and services, and dismal images of technological and biological catastrophes (p.114). Simultaneously, huge amounts of money are being spent on research and development owing to the financial benefits that stand to be gained. It is acknowledged that there are often long time lags between the development and diffusion of disruptive and novel innovations, understanding of their wider impacts and associated risks (on health, environment, and society), and subsequent regulation (Owen & Goldberg, 2010, p.1699).

So why precisely has regulation of nanotechnologies failed? A dominant problem in regulating nanotechnology is related to uncertainty about the behavior of nanoscale materials
compared to their more conventional equivalents (Lee & Jose, 2008, p.115). Risk assessment is difficult to conduct, as many potential hazards are currently unknown. Yet, regulation leans heavily upon risk assessment. This observation has two consequences for the governance of new technologies. First, it makes the governance of the initial stages of new technologies extremely difficult. This can lead to overly restrictive policies that hamper innovation or to completely misplaced ones that fail to accomplish their goals. If researchers themselves are not fully aware of all implications of their research, how can government agencies, with a level of expertise on the researched subjects far inferior to that of the researchers, possibly create an adaptive regulatory framework? Indeed, Fink, Harm and Hatak (2012) find that while legal regulation can play a role in shaping the behavior or nanotechnology researchers, their impact is highly contingent on the context of the researcher (p.578). They find that whilst basic research is driven by the curiosity of the researchers and is thus a creative process which is contingent in its own development and open in its results, applied research takes previous findings from basic research as a defined starting point and aims at developing marketable applications. Basic researchers’ behavior, motivated by curiosity, cannot be effectively restricted by legal regulation, but only by self-commitment to informal codes of conduct (Fink, Harm & Hatak, 2012, p.579). Applied researchers can, in theory, be restricted to the extent that regulation can control the revenue stream to be gained from the resulting products.

The second consequence of the difficulty in assessing risk is that regulators often leave it to market forces to determine what constitutes safety, both to humans and the environment. Lee and Jose argue that “where we are content that products present no hazards other than those that are apparent in the nature of that product, regulatory measures may be ignored in favor of market choice, allowing consumers to choose safety features alongside other criteria of product quality” (Lee & Jose, 2008, p.115). Regulators then, facing limited knowledge of the potential hazards of products, leave it up to market actors who also lack significant knowledge of the products they are using to determine what constitutes safety for themselves and the environment. The system, then, relies on the ability of consumers to see beyond the immediate upsides of these products and to consider wide ranging, complex, multidisciplinary safety and ethical considerations.

Given that these actors are primarily motivated by the personal utility they will achieve from using the product in the short-term, along with their likely lack of technical expertise to undertake the necessary health and ethical considerations, one cannot expect market forces to successfully self-regulate either nanotechnologies or high-tech products in general.

A further reason for failure in the regulation of nanotechnologies is the contest between the self-interest of corporations and the public good. Corporations stand to gain a competitive advantage in the market and reap the potentially massive financial rewards of successful applications of new technologies, which can put a damper on their self-restraint in exercising ethical considerations to ensure responsible development of technology (Lee & Jose, 2008, p.115). In contrast to basic research, the well-defined starting point and clear aims of applied research could make an understanding of potential benefits and dangers easier than during basic research (Fink, Harm & Hatak, 2012, p.579). However, applied researchers are overwhelmingly motivated by competition, and, to a lesser extent, personal gain. The intense competition has the negative effect of greatly diminishing a researcher’s self-commitment to informal codes of conduct. Without effective regulation, and with diminished motivation to adhere to informal codes of conduct, the opportunity for dangerous mistakes grows.

The failures in formal regulation and self-governance illustrated above are shared by all new transformative technologies. These failures are intrinsic to the development of new
technologies on the one hand, but are also exacerbated by the system in which they are developed on the other hand. Little can be done to fully correct for the failures above through tighter regulation. Formal regulation will be ineffective because of the time taken both to learn of the social consequences of the technology and to adapt regulatory structures as instruments of control. Informal regulation, through codes of conduct, is partially effective, particularly when the researchers and developers are motivated primarily by curiosity. Meanwhile, the public is relatively uninformed of the development of these technologies, limiting the effect of responsible behavior via corporate regard for stakeholder interests. As such, fundamental changes to the currently decentralized network of government, private corporations, and researchers and universities remain one of the only avenues to enforce some level of governance, mostly through self-regulation. Formal regulation, self-governance, and greater public awareness of the dangers of new technology must act in unison.

III. AMERICAN INDUSTRIAL POLICY

Here, I advocate for the need to reform and evolve the current state of America’s Developmental Network State (DNS), the starting line of technological innovation in the United States, as penned by Block (2008), to increase transparency and accountability. Given that effective regulation of high-tech is unlikely because of its very nature, a revamp of the environment in which these technologies are developed is the remaining option. Despite the government’s reluctance to officially admit to enacting industrial policies, a great level of such policy is currently in place throughout high-tech industries (Block, 2008, p.30). These industrial policies are responsible for the funding, largely by the government, of major technological advances across the country. The DNS involves public sector officials working closely with firms to identify and financially support the most promising avenues for innovation. Most innovation occurs among networks of collaborators across the public-private divide (Block, 2008). However, the DNS is highly decentralized and lacks transparency. As such, it is an unfit climate for technologies that can’t be formally regulated in a top down fashion. A whole dimension of accountability, to the general public and other stakeholders, is lost. Thus, there is a need for reform to better respond to the challenges presented by transformative technologies. An evolved DNS system of strategic collaboration and coordination between the private and public sector must promote both formal and informal self-restraint through greater transparency and accountability, as well as better coordination of information.

How can we achieve such a transition? There is no magical solution. Here are two proposals to push the DNS towards the goals of greater democratic legitimization/transparency and coordination/centralization of information. First, I recommend the creation of self-organizing industry investment and information boards, an expanded version of the boards proposed by Dani Rodrick (2009, p.12). These industry-specific investment boards will go beyond providing specific public input to the industry. They would be built as system of discovery with greater transparency and coordination and include representatives from firms, universities and investors. Additionally, a government liaison with the mission of facilitating the coordination of the different players involved would be present. The liaison serves the functions of (a) centralizing information on government investments by different agencies in one place to increase efficiency and promote inter-agency coordination, (b) directly representing the government to the different
technology industries, thus promoting public-private coordination, and (c) representing the government’s industry promotion efforts to the public, thereby increasing accountability through greater transparency. Government involvement in the boards themselves would be limited to an observer and liaison role that provides adequate information to all members of the system to uncover significant bottlenecks, learn from mistakes, and spread knowledge. This knowledge would consist of information that is already available publicly and to the government. It is by compiling this information and making it readily available that it becomes truly powerful.

Second, I recommend a revamping of the public-private partnership model to require financial reciprocity between technology manufacturers, researchers, and public investors. Specifically, I recommend a partnership model in which government support and subsidies must be paid back following the successful commercialization of technologies. This requirement of repayment of capital will promote smarter use and distribution of cash and will foster strong, long-term ties between the parties involved. The challenge, of course, given the decentralized nature of the system and the trickle-down effects of technological advances, is identifying who should repay these government investments. Nonetheless, even a small return on easy to identify recipients would enforce the notion that corporations are in a reciprocal relationship with the government, and, by extension, taxpayers.

Are these two proposals flawed? Surely. Getting all relevant actors to collaborate will be a challenge. Transforming insights gained into practical solutions will be a challenge. And all these efforts may only avoid potential technological catastrophes if all nations and multi-national entities play ball together, a greater challenge still. Nonetheless, they serve to highlight qualities needed in the next DNS. They seek to foster a reciprocal relationship between public and private actors that promotes ongoing dialogue with policymakers and stakeholders, thereby increasing accountability, promoting self-regulation, and making formal regulation more agile, appropriate, and effective. They help to keep everyone on the same page, making it more feasible to monitor early warning signals in technology development and to forecast trends to proactively identify and prepare for potential dangers.

In conclusion, the regulation of transformative technologies presents many difficulties. Given the motivators of need, curiosity, competitive advantages, and personal gain, it is unlikely that human kind will ever cease pushing technology forward. The uncertainty surrounding the implications of new technologies, as illustrated by nanotechnologies, adds on to the tensions created by the different interests of researchers, marketers, and the public, making formal regulation mostly ineffective and self-regulation unreliable. Efforts must therefore be made to revamp the Developmental Network State to promote accountability, transparency, and self-regulation. And, above all else, the public at large must take a greater interest in the forces that will shape, for better or for worse, the world we will live in tomorrow.


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