Technology Assessment

Democracy's Crucible, the Future of Science and Technology, and Implications for Our Defense in the Twenty-first Century

Technology assessment (TA) has been known by different definitions down through the years, and it is possible that the failure to secure a uniform definition lies in the differences which social scientists, classical scientists, and the general public have about its core elements. Another key issue is that open and democratic societies seem to favor the practice of technology assessment despite variable ideas about what it means, while more restrictive societies with strict cultural and political sanctions on freedom of expression tend to oppose TA. For our purposes, we should try to outline a workable definition which is symptomatic of a highly innovative, technologically acquisitive, and scientifically robust society where political democracy and commercial entrepreneurship go hand in hand.

We should provide a definition that both reflects current reality and is expansive enough to encompass the next 25 years of political and technological development, swaying precariously between the extremes of reckless democratic expressionism and rampant materialistic nihilism. So what is technology assessment? *Technology assessment is the systematic evaluation of innovative, novel, and unique discoveries and developments in all fields of science and technology to examine both the immediate and long-term societal, political, and ethical impacts of new ideas and advancements to ascertain whether their net impact is either positive or negative. It also estimates any expected or unexpected outcomes which could result from, or be triggered by, these new ideas, advances, discoveries, and developments*.

Those vehemently concerned about TA, both historically and in contemporary times, may hold visions of modern-day Luddites, staunching every innovation or new scientific breakthrough because it contains an unknown level of risk to social stability. They point to Galileo and Copernicus, full of passion in defense of the pure pursuit of scientific knowledge, and quickly assert that all human progress is the direct result of scientific or technological innovation in one form or another. We can be proud of innovations in robotics, nanotechnology, genetic engineering, computer science, and other fields. However, the reciprocal caution we clearly understand with crude technical

insights is that new, history-making technologies bring unexpected costs as well as benefits. Democratic societies should exemplify and reflect the delicate balance between science's desires and society's needs—science wants free reign to create and explore, to open new frontiers, while society wants benefits and progress without adverse or inadvertent consequences.

It is especially important to assess the value of TA from a national security standpoint in terms of its potential to aid in threat analysis, to help thwart proliferation, and to awaken us to emerging weapons risks which are only decades away. While the partnership necessary to structure and sustain TA is a bit cumbersome and will likely be less than efficient in many respects, owing to its democratic and inclusive character, its overall aim is to partner the broadest array of citizens in an ongoing enterprise which tries to open a window on tomorrow. Military efforts to conduct TA will be ongoing and necessarily shielded from public view, but the explicit public TA process will shine illumination on all emerging and cutting-edge science, asking several fundamental questions:

- How will this discovery/technology affect society?
- How will the discovery/technology interact with existing technologies?
- What new risks attach to this new discovery/technology?
- Does the discovery/technology contain exploitable aspects for weapons?
- How will this discovery/technology alter our security?

In the spirit of TA's original purposes, we must consider its societal impact, negative political or economic consequences, the inadvertent triggering of new risks, or unforeseen secondary hazards, while systematically examining the overall benefits and disadvantages of any new technology on our community's security and safety. Open and democratic societies understand the crucial nature of this balancing act and will seek reasonable methods and mechanisms to undertake serious technological forecasting.

With the advent of carbon-based industrial processes, developments in atomic energy, and the creation of synthetic materials resistant to biodegradation, we were grimly brought face-to-face with profound new societal, political, ethical, and environmental challenges containing unknown or ambiguous downstream risks and consequences. We are still trying to tackle the unintended outcomes of these breakthrough technologies many years after they were unveiled. We are not arguing against technological progress or innovation and fearless exploration of the unknown.

Instead we argue that by displaying pragmatic caution, leaving room for reasonable doubt, and examining the downstream societal, cultural, and ethical consequences of new technologies, we avoid the Faustian bargain of endorsing something shiny and novel in exchange for absorbing its ambiguously malevolent properties. By weighing not only the benefits and advantages derived from new technologies but also grasping their less understood, sometimes latently harmful, and often subtly negative consequences, we have purchased a gift of enduring value. Using a strained allegory—it is not that progress cannot travel forward in time with society as co-passengers in a jetliner; instead, a security check is needed before we board the aircraft to ensure that all passengers on the flight into the future pose no risk or inadvertent threat to each other on the journey.

Before we find ourselves poised to blindly accept, hesitantly embrace, or vehemently oppose new discoveries in science and technology, we will need the benefit of facts and a willingness to provide a wide berth for critical analysis. Every advance in technology has admittedly breathtaking elements which hijack our imagination and pragmatic reserve long enough that our "gee whiz" rapture gradually overtakes any sentiment still lingering that the gizmo in our hands or the one driving our national aviation infrastructure is benign at worst. We are fascinated with new technologies, breakthroughs in biomedical sciences which save or prolong life, and handy "societal software" that makes overall life easier and less prone to drudgery. So we say, "Bring it on—let the consequences be damned." Or, we say "let's experiment with this long enough that we know with confidence it won't inadvertently harm or kill someone." For example, in accepting the blessings of nuclear power, we also tacitly accept in exchange the risks of a catastrophic radioactive emergency.

Examining the Risk Frontier

We face exciting and terribly beneficial discoveries in biotechnology, nanotechnology, plasma physics, materials science, space science, propulsion dynamics, artificial intelligence, cyber-engineering, and other fields, just to name a few. The tsunami-like wave of commercial endorsement for these discoveries and advancements is impossible to thwart even though many would argue that stifling obstacles in funding, restrictive boundaries on cutting-edge research domains, and enduring hurdles for new inventors threaten to keep us from leap-frogging to a much better life and economy. What is missing? It is the mechanism by which society, government, and

our major cultural institutions examine and experience newly emerging science and technology—*simply put, we have no mechanism sophisticated enough, clear enough, and sensible enough to permit the comprehensive and objective endorsement of future technologies*.

As a result, we find ourselves in an uncomfortable and untenable position. We are forced to trust scientists and our massive commercial-industrial infrastructure with the task of not only producing the great new breakthrough product, but also providing government and society with ironclad assurances that the immediate and long-term consequences for society, our political system, and our porous ethical standards will be benign at worst. While it may seem that what TA really seeks is greater regulation, stricter oversight of commercialization, tighter safety controls, and programs to safeguard society by sharply restricting the release of new technologies; that is not the goal. Nor is TA clinging to the notion of universal, industry-wide pledges of ethical conduct and personnel reliability programs to curtail unethical behavior among manufacturers or scientists. A serious discussion of safeguards and risk reduction is warranted.

The central problem is that no widely accepted, objective, reasonable, and enforceable system exists for TA—*simply put, we lack a reliable TA mechanism at the very time in our fragile social and political history when one is deeply needed*. This dilemma will hardly find adherents in most of the commercial world, because such efforts will be seen as imposing a net market disadvantage on American goods, technologies, and products in which other nations care not to engage. The United States must assess how and to what extent these TA issues will impinge on WTO agreements, world trade, market competitiveness, and salutary profit-taking, because the economic costs of investing in TA will be considerable. We cannot afford to forget how we accepted automobile seat belts, poultry inspectors, and financial disclosure statements as part of daily life and made them instrumental to reinforcing those aspects of an otherwise free democratic economy we cherish.

We must also be mindful of the national security implications of going down the TA road. The 2010 *Quadrennial Defense Review* (*QDR*) itemizes all the major initiatives and program areas of emphasis and DoD policy, including the continuity of terrorism, WMD proliferation, advancing our geopolitical interests, and promoting an international order cognizant of the rights and responsibilities of all nations. Seeking a fairly robust and transparent domestic TA mechanism poses the dilemma of protecting our

technologies, assessing over-the-horizon technology breakthroughs, and scanning the globe for emerging technologies that would impair or destabilize global security. This calls for a separate TA mechanism which, like its domestic counterpart, really does not exist right now, either within the intelligence community itself or among the blended interagency community of DoD, HHS, DHS, Energy, NASA, and other federal agencies purportedly seized with the advent of new technologies.

To assert the claim more bluntly, we have a risk frontier that is multidimensional. There is the *domestic component* focused on those technologies of commercial, medical, or national defense value. There is the *global component* which engages in a sophisticated analysis of existing and emerging technologies that would arguably have a benign influence on global security versus those technologies—dual use or otherwise—which would pose dramatic risks to alter, reshape, or destabilize the global security environment. Then there is yet a *third dimension* which eludes easy analysis. It entails space, cyber, nano, and micro technologies which operate unfettered in unrestricted domains of perpetual activity and research outside the boundaries of conventional trade or regulation. This will be called the *unbounded dimension* of technology assessment. It subscribes to no international legal or organizational rules and submits to no governing order. Instead, it arises in a diffuse free space of unarbitrated and undelineated dimensions like the traditional "Wild West," where the fastest gun tended to prevail and social stability was fleeting indeed. It largely answers to nobody and resists control.

For national security purposes, the chief concern is the apparent failure of strategic imagination and comprehensive threat analysis to adequately contemplate what the multidimensional scale, depth, and extent of the risk frontier actually is. Of course, the *QDR* states that we seek a military engaged globally with unmatched capabilities to perform a variety of missions. For our well- trained and equipped fighting forces, there can be no doubt we are second to none. If, however, as the *QDR* states, we must prevent and deter conflict—mindful of a wide range of contingencies to increase domain awareness, ramp up consequence management, increase the security capacity of partner states, and gradually nullify and reduce WMD threats—then how is this done in a strategic and systematic way? The answer is it cannot; we must jettison business as usual and strap on the synoptic analytical lens needed to genuinely assess the global risk frontier in the twenty-first century. This will be a massive and revolutionary long-

range undertaking that provides ample benefits in deterrence, force protection, and sustaining a strategic edge on all rivals, foes, and competitors. When we awaken in 2020, we must not be handicapped by the limited vision which guides us today. We must have a wider, more encyclopedic grasp of the global risk frontier; yet, we are a long distance from it.

Major Areas of Concern

The lack of a viable TA mechanism that earns the support of scientists, the public, and the media is especially troubling as we delve more deeply into the era of scientific experimentation and exploration in domains of high excitement and fascination—biotech, cybertech, nanotech, and hyperspace, for example. In each of these exciting domains, the green flag of welcome progress continues to fly proudly, yet there remains no system in place for analytically assessing whether we understand the downside risks and outcomes which may indirectly or inadvertently result. This dilemma exists for many advanced technologies to be sure, but there are a special few which come closer to covertly containing risks of unraveling our societal and political fabric than most others. A handful of revolutionary technologies in our midst deserve some closer scrutiny and consideration because they contain a high risk of dangerously adverse consequences.

Of course, these advanced technologies include fundamental risks such as (1) their inherently dual-use character, in that any one of them could potentially be exploited for weapons use or to inflict harm; (2) unforeseen risks that the technology will trigger cascading downstream effects inimical to society and culture; (3) unknown risks that arise when new technologies are blended with well-known technologies and the result is destructive or dangerous; and finally, (4) the new technology becomes a gateway to new societal risks only dimly understood, in the same manner that cybertech looks like the path to a more efficient world so long as the very real risks of cyber-terrorism are ignored.

This must be of special concern to everyday citizens and scientists alike, because new discoveries contain unknown risks that are often not systematically examined. We tend to tilt towards recognizing the benefits while ignoring the benign risks. For example, the search for an atomic weapon preceded the quest for nuclear power, while laser technology for medicine preceded development of airborne lasers for military use. We understand that possession of atomic weapons reflects the most potent strategic military leverage on Earth as of today, but we have no ironclad guarantees that

a new, more lethal technology cannot eventually be discovered, either as a rival offshoot or alternative mechanism of widespread destruction. It is possible to imagine a post-atomic weapon that equals, nullifies, or surpasses the atomic bomb and which grants devastating destructive power to its owner and alters the global security apparatus. Combining bionics, robotics, and new synthetic chemical properties could result in new "cyborg" outcomes or derivative weapons against which we would have no natural defenses.

We have procedures and some consensus on biosecurity safeguards and other related notions designed to protect society against untoward discoveries of new bioweapons or deadly pathogens. However, there is much work to be done, and the global pharmaceutical and biotech worlds routinely do not welcome intrusion or regulation, although they appear committed to trying the newer biosecurity and biosafety measures being proposed. We must also remember that a small, highly skilled cadre of bioweapons scientists could be covertly compelled by rogue regimes or terrorist groups to develop crude biological devices without regard to such safeguards, thereby raising the risks of deliberately inflicted pandemic for all nations.

Options for diverting legitimate advanced technology research into weaponization or misdirecting it for criminal purposes are dimly understood and easily dismissed as near science fiction; however, it is much less clear in the cybertech world, the nanotech frontier, and ongoing research into hyperspace possibilities. In each case, advances in technology always bring us to a crossroads of ethical ambiguity.

Genetic engineering, synthetic biology, and related biotech advances can allow scientists to manipulate the DNA, genomic structure, and related properties of certain diseases. Undesirable traits can be screened out, propensity for certain illnesses can be reduced, and healthier, smarter, or stronger people can be developed through cloning. Robotics, biomechanical hybrids, self-replicating nanobots, and emerging excursions into nano biotechnology make it even more difficult to sort out what new discoveries could produce. Harmless technologies benefitting society in ways never imagined is the hope—revealing new avenues to undermine and exploit humanity or society is the nightmare. Quite simply, we are victims of our own enchantment, because the desire to discover breakthroughs trumps any serious concerns about downside caution, let alone the trivialities of risk assessment.

In the national security arena, the areas of concern overlap all the subjects mentioned, with the additional caveat that possible weaponization of future technologies must be clearly understood and the options for preventing, curbing, or forestalling outcomes globally—which are inimical to our strategic interests—will be an overwhelming challenge. The very definition of a "weapon" could change in 20 years, as well as the prospect that the nature and variety of WMD could significantly increase. To think that incremental shifts in the strategic landscape are all we must worry about is to become foolish and unimaginative. Our focus must always be on significant technology leaps and quantum shifts in strategic capabilities which the United States and other nations may acquire and refine during the twenty-first century.

What is Needed?

It is not the issue of complexity which seems to steer us away from serious TA mechanisms. We have tried these imperfect systems before, laden with political and very unscientific hyperbola and fright mongering. Congress had its own Office of Technology Assessment (OTA) for over 20 years, ending in 1995, and efforts by the National Science Foundation, which predated the OTA, both reveal a process flawed by competing political, economic, and technical interests. What was missing was sustained political and scientific support for the notion of technology forecasting for its own sake.

What is needed is an explicit partnership between business, academia, and government where the views of ordinary citizens are also considered. Genetically modified foods worked their way into the American diet almost clandestinely and were gradually accepted; not so in Europe. Little serious thought these days is given to intensively examining genetically modified foods because they have been a part of our lives for more than 20 years. Downstream concerns about their generational effects, legacy impacts on public health, and their contributing role in cancer and other diseases must be discarded as hypothetical and irrational. We tend not to investigate that which we have socially accepted, even if engaging in long-term scientific analysis to assure our citizens might prove or disprove that belief.

Apart from the need to create an entirely new TA mechanism for the United States which exhaustively examines cutting-edge technologies to ascertain their positive and potentially negative aspects, there is a corre-

sponding need to engage inventors, venture capitalists, academicians, and other experts in the task of designing a viable TA system which can prove able to discharge its two most important functions—(1) to clarify, reveal, and advance promising technologies, tagging them for special endorsement and investment; and then, (2) to identify as much as possible the potentially negative and harmful effects of these technologies and how they may directly or inadvertently cause ill effects outside their intended areas of legitimate activity. We must show the way and demonstrate that such a process not only furthers science and technology but also safeguards democratic society. But this is not enough.

Promoting the effective use of a TA mechanism outside the United States also makes sense and would contribute to global stability and security if it is managed properly. Just as the G8 defines superpowers and the G-20 delineates prosperous economies, we should seriously consider creating a G-35 group of the states with the most robust science and technology infrastructure. This G-35 group would devote its energies toward the evaluation of emerging technology anywhere in the world, garner support for its nascent development, examine and foster the trajectory for its advancement, and safeguard it from nefarious manipulation into destructive outcomes or weaponization through a multilateral screening and evaluation mechanism.

Such a G-35 group will have to devote itself entirely to the global assessment of emerging technologies, taking account of those which are beneficial, harmful, or ambiguous in their overall societal, economic, and political effects. This will, of course, take many years and require the steady support and leadership energy of the G-20 membership, but it is neither impossible nor inadvisable. The emerging G-35 will become the world's next-best mechanism for technology forecasting and thereby contribute to the tasks of counterproliferation and development of new destructive weapons systems.

If we do nothing in either our domestic or international spheres, we risk finding ourselves awakening to a new era of destructive and devastating technologies which either came upon us by accident, by malevolent design, or by coercive manipulation of scientific energy. With a robust TA mechanism in place, we have erected a broader safeguard against future weapons more damaging than the atom bomb, the laser, or the hypersonic wave. We have purchased a measure of peace and bought precious time to allow existing and future democracies to flourish.

In many ways, the construction of a robust TA mechanism is democracy's crucible for filtering out destructive and inadvertently damaging technologies while ushering in an era of thoughtful, objective, and analytical assessment of emerging technologies in terms of their direct benefits to society. We can measure the harmful effects of existing technologies by looking at their impact on our environment, public health, national security, and overall livelihoods, but what about tomorrow's technologies? Will we have the tools and mechanisms for knowing as early as possible what the good and bad may be on the newest technologies, even as we embrace and support the ongoing appetite humanity so often displays for progress at any price?

The dilemma to be resolved is finding an appropriate balance between legitimate global TA mechanisms which hold the promise of balanced and controllable shifts in the global strategic landscape that are transparent and open to all, versus those which are legitimately the province of a sovereign state and enable that state to prepare and equip itself for exhibiting and retaining a strategic leadership posture in the community of global states. This offers yet another daunting challenge, because we remain vulnerable to strategic surprise, and our lack of a sophisticated, multidimensional threat analysis system which incorporates TA will be deterministic of our future as a sovereign state.

A future brimming with new technologies and discoveries is an exciting prospect to contemplate, but it will require adult supervision. Who can provide it in professional, accessible, and objective terms satisfactory to a skeptical and curious world? Without a mechanism to filter out and assess what the future contains that is rooted in our own ingenuity and fathomless tendency to create both good and evil, we face each new morning devoid of any protection against ourselves and where emerging technology takes us. Worse, without a strategy and structure for finding an equitable balance in domestic, global, and unbounded TA systems, we can expect that incrementalism itself will become the new mantra of strategic thought.

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