

Appendix N: Drivers and Evolving Threats

Certain threats and hazards frequently appeared in documents across governmental, intergovernmental, non-profit, and academic sources as growing issues for the United States as a whole and the world in the near-term and long-term. The list of evolving threats included in the SNRA emerged from a variety of sources. We examined data sets used to prepare the National Preparedness Report over the past three years. The majority of the sources included in the NPR data sets stretched from 2011 to 2014. Another group of sources used for the SNRA evolving threats list were government documents. Reports from the Department of Homeland Security, the White House, the Department of Health and Human Services, the Congressional Research Service, the Government Accountability Office, testimonies from House and Senate committees, the Department of Agriculture, the National Intelligence Council, and the U.S. Census Bureau provided additional insight beyond the information included in the NPR data sets. In addition to government reports, the list of evolving threats grew from information in peer reviewed academic journals and books as well as reports from non-profits and intergovernmental organizations such as the United Nations.

Critical Infrastructure

The country's critical infrastructure provides essential services that underpin American society in sectors such as transportation, communication, energy, and health care.¹ Over the next 15–20 years, aging transportation, communication, energy, and health care infrastructure poses significant risk due to potential cascading impacts of failures and harm to the Nation's long term economic competitiveness.² The scale of the Nation's critical infrastructure makes it vulnerable to a diversity of risks. Severe weather events; terrorists and other actors seeking to cause harm and disrupt essential services through physical and cyber -attacks; pandemic influenza or other health crises; and potential accidents and failures from infrastructure operating beyond its lifespan are threats to the Nation's critical infrastructure systems.³

Aging Infrastructure

Age is one of the most pressing issues facing America's critical infrastructure, but it is not the only factor that determines the health and safety of critical infrastructure. Age -related failure mechanisms include material fatigue, corrosion, and erosion that occur over time making infrastructure susceptible to failure without proper maintenance.⁴ One in nine of the Nation's bridges are structurally deficient, while the average age of the country's 607,380 bridges is 42.⁵ Additionally, out of 4 million miles of road, 65 percent of America's major roads are rated in less than good condition.⁶ The poor condition of America's roads cost \$67 billion a year for U.S. motorists.⁷

¹ Department of Homeland Security, *Aging Infrastructure: Issues, Research, and Technology*, December 2010, p. 1–2; *Homeland Security Presidential Directive 7*, 2003, <http://www.dhs.gov/homeland-security-presidential-directive-7>.

² Federal Emergency Management Agency, *Strategic Foresight Initiative*, January 2012, p. 9.

³ Department of Homeland Security, *National Infrastructure Protection Plan: Partnering for Critical Infrastructure, Security, and Resilience*, 2013, p. 8.

⁴ Department of Homeland Security, *National Risk Estimate: Aging and Failing Critical Infrastructure Systems*, December 2014, p. 12.

⁵ American Society of Civil Engineers, 2013 Report Card for America's Critical Infrastructure, p. 6.

⁶ The White House, *An Economic Analysis of Transportation Infrastructure Investment*, July 2014, p. 2.

⁷ American Society of Civil Engineers, 2013 Report Card for America's Critical Infrastructure, p. 48.

America's aging infrastructure extends beyond roads and bridges to also include water. Water infrastructure systems in the U.S., including dams, drinking water systems, levees, and wastewater, are overextended and outdated.⁸ The growth of the U.S. population over the decades has strained critical water systems.⁹ The average age of the 84,000 dams in the country is 52, while the number of high-hazard dams is on the rise.¹⁰ Many of the Nation's estimated 100,000 miles of levees were originally used to protect farmland, but are now increasingly protecting developed communities.¹¹ Moreover, the country's drinking water infrastructure is nearing the end of its life. There are approximately 240,000 water main breaks in the U.S. every year as repairs take place every day to sustain critical infrastructure.¹² The cost to replace the drinking water aging infrastructure over the next couple of decades could reach nearly \$1 trillion.¹³

Banking and Finance/Economic Security

Homeland Security Presidential Directive-7 included the banking and finance sector as an important component of the Nation's critical infrastructure. The Nation's banking and finance sector accounts for more than 8 percent of the U.S. annual gross domestic product and is the backbone for the world economy.¹⁴ America's economic strength is key to the Nation's natural security.¹⁵ The sector is composed of federally insured depository institutions; providers of various investment products; providers of risk transfer products (insurers); and other credit and finance organizations.¹⁶ They are all tied together through a network of electronic systems with innumerable entry points. The sector is threatened by terrorist attacks, large scale power outages, and natural disasters.¹⁷

The impacts of market crashes, cyber -attacks, and natural disasters on the banking and finance sector have ramifications beyond the sector. The current economic crisis has impacted local, state, and Federal budget forecasts. In the decade ahead, the United States and the world face challenges in ensuring continued economic growth and the strength of government finances.¹⁸ The current and near-term budget forecasts for local, state, and Federal budgets are grim and may lead to critical shortfalls in funding to address aging infrastructure and build resilience to and recover from manmade and natural disasters.¹⁹

Energy Sector

The U.S. energy infrastructure is vital to the U.S. economy. America's energy infrastructure is divided into three interrelated segments: electricity, petroleum, and natural gas.²⁰ Currently, the U.S. is the world's largest natural gas and oil producer, reducing the country's dependence on

⁸ American Society of Civil Engineers, 2013 Report Card for America's Critical Infrastructure, p. 4-5.

⁹ American Water Works Association, *Buried No Longer: Confronting America's Water Infrastructure Challenge*, 2011, p. 3.

¹⁰ American Society of Civil Engineers, "Executive Summary," 2013 Report Card for America's Critical Infrastructure, <http://www.infrastructurereportcard.org/a/#p/overview/executive-summary>

¹¹ Ibid.

¹² Ibid.

¹³ American Water Works Association, *Buried No Longer: Confronting America's Water Infrastructure Challenge*, 2011, p. 3.

¹⁴ Department of Homeland Security and Department of the Treasury, *Banking and Finance: Critical Infrastructure and Key Resources Sector-Specific Plan as Input to the National Infrastructure Protection Plan*, May 2007, p. 1.

¹⁵ The White House, *National Security Strategy*, February 2015, p. i.

¹⁶ Department of Homeland Security and the Department of the Treasury, *Banking and Finance: Critical Infrastructure and Key Resources Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan*, 2010, p. 1.

¹⁷ Ibid.

¹⁸ Government Accountability Office, *Strategic Plan 2014-2019*, p. 9.

¹⁹ Federal Emergency Management Agency, *Strategic Foresight Initiative; White Paper: Climate Change*, January 2012, p. 4, <http://www.fema.gov/media-library/assets/documents/103600>.

²⁰ Department of Homeland Security, *National Infrastructure Protection Plan: Energy Sector*, 2011, p. 1.

foreign oil to a 20 -year low.²¹ The U.S. energy infrastructure is vulnerable to terrorist and cyber-attacks, natural disasters, and aging equipment.²² Power outages have increased from 76 in 2007 to 307 in 2011 as a result of aging equipment.²³

Since 2008, numerous oil and pipeline failures have occurred.²⁴ Pipeline failures can potentially impact surrounding populations, property, and the environment.²⁵ With population growth projected to increase, the U.S. energy infrastructure will encounter problems meeting demand after 2020.²⁶

Cyber Security

The range of cyber threat actors, methods of attack, targeted systems, and victims are expanding and growing.²⁷ While computerized and networked systems provide significant benefits, cyber threats against the country and private institutions can have a serious impact on national security, the economy, and public health and safety.²⁸ The Nation's economy, safety, and health are linked through a networked infrastructure that is targeted by malicious government, criminal, and individual actors.²⁹

The number of reported cyber -attacks has continued to grow, resulting in economic loss, privacy breaches, data theft, the compromise of proprietary information or intellectual property, and harm to national security.³⁰ Cyber threats can be both intentional and unintentional. Types of intentional cyber threats include computer network and disruption activities such as denial of service attacks and destructive attacks that delete information or render systems inoperable. Unintentional cyber threats can result from software upgrades or defective equipment that inadvertently disrupt systems.³¹

Demographic Shifts in the U.S. and Potential Future Challenges

Over the next four decades, the U.S. population will undergo significant demographic changes. By 2025, nearly one in five Americans will be over the age of 65 as that population will jump from 43.1 million in 2012 to 83.7 million in 2050.³² The growth of the 65 and older population will have significant ramifications for the country economically, socially, politically, and for the emergency management community. The Nation's expenditures on health care will rise considerably. Older Americans are more likely to suffer from chronic diseases as two out of

²¹ The White House, *National Security Strategy*, February 2015, p. 5.

²² American Society of Civil Engineers, 2013 Report Card for America's Critical Infrastructure, p. 60-61; Department of Homeland Security, Energy Sector-Specific Plan: An Annex to the National Infrastructure Protection Plan, 2012, p. 13; The White House, Economic Benefits of Increasing Electric Grid Resilience to Weather Outages, August 2013, p. 3.

²³ American Society of Civil Engineers, 2013 Report Card for America's Critical Infrastructure, p. 61.

²⁴ Ibid.

²⁵ U.S. Department of Transportation, The State of the National Pipeline Infrastructure, p. 1.

²⁶ Ibid.

²⁷ James R. Clapper, Statement for the Record: World Wide Threat Assessment of the U.S. Intelligence Community, Senate Armed Services Committee, February 26, 2015; Government Accountability Office, Cybersecurity: A Better Defined and Implemented National Strategy is Needed to Address Persistent Challenges, March 7, 2013, p. 2.

²⁸ Government Accountability Office, Cybersecurity: A Better Defined and Implemented National Strategy is Needed to Address Persistent Challenges, March 7, 2013, p. 1.

²⁹ National Security Strategy, February 2015, p. 12.

³⁰ Government Accountability Office, Cybersecurity: A Better Defined and Implemented National Strategy is Needed to Address Persistent Challenges, March 7, 2013, p. 1.

³¹ Ibid., p. 3.

³² Federal Emergency Management Agency, Strategic Foresight Initiative, January 2012, p. 8; Jennifer M. Ortman, Victoria A. Velkoff and Howard Hogan, An Aging Nation: The Older Population in the United States: Population Estimates and Projections, U.S. Census Bureau, May 2014, p. 1.

every three older Americans have chronic conditions.³³ Currently, treatment for this population amounts to 66 percent of the country's overall health care budget.³⁴ By 2030, health care spending in the U.S. will increase by 25 percent, primarily because of the aging population.³⁵ The cost of Medicare is projected to increase from \$555 billion in 2011 to \$903 billion in 2020.

In addition to the aging population, internal migratory shifts will also shape the country demographically. Currently, more people in the U.S. are living in metropolitan regions and along coastal areas.³⁶ Continued urbanization and coastal migration will result in the growth of "megaregions," which include not only cities, but counties that share interlocking economic systems, interrelated population and employment centers, cultures, natural resources and ecosystems, and common transportation systems.³⁷ Many of the identified megaregions are located along the country's coastal areas.³⁸ The concentration of the country's population into densely populated areas will have wide ranging ramifications. With changes to the climate, sea level rise could make homes and businesses congregated along coastal areas more prone to flooding.³⁹ Additionally, for emergency management, the concentration of the population in megaregions could make evacuations more difficult and access to medical resources could be strained.⁴⁰ The growth in the U.S. population will increase the stress on aging critical infrastructure and make densely populated areas potentially high terrorist targets.⁴¹

Beyond internal migratory shifts, international migration to the U.S. is projected to be the primary driver of the country's population growth between 2027 and 2038.⁴² This would mark the first time since 1850 that the primary driver of population growth is not the result of domestic births.⁴³ Higher international migration could result in a fast growing, more diverse, and younger U.S. population.⁴⁴

Food and Water Insecurity

Climate change, global population growth, and economic development have the potential to create water and food insecurity in the coming decades.⁴⁵ Food and water insecurity have the possibility of affecting the U.S. domestically and its relationships with numerous countries. Over the course of the next 10 years, many countries important to U.S. national security will experience water problems causing instability in those regions of the world.⁴⁶ In California, the ongoing drought caused the town of East Porterville to run out of water in late 2014.⁴⁷ Since

³³ Centers for Disease Control and Prevention, *The State of Aging and Health in America 2013*, p. ii and p. 5.

³⁴ *Ibid.*, p. ii.

³⁵ *Ibid.*, p. 5.

³⁶ Federal Emergency Management Agency, *Strategic Foresight Initiative*, January 2012, p. 8.

³⁷ Yoav Hagler, "Defining U.S. Megaregions," *America 2050*, November 2009, http://www.america2050.org/upload/2010/09/2050_Defining_US_Megaregions.pdf, p. 1-7.

³⁸ *Ibid.*, p. 7.

³⁹ Federal Emergency Management Agency, "U.S. Demographic Shifts: Long-term Trends and Drivers and Their Implications for Emergency Management," *Strategic Foresight Initiative White Papers*, May 2011, p. 5, <http://www.fema.gov/media-library/assets/documents/103600>.

⁴⁰ *Ibid.*, p. 6.

⁴¹ *Ibid.*, p. 5.

⁴² U.S. Census Bureau, *International Migration is Projected to Become Primary Driver of U.S. Population Growth for First Time in Nearly Two Centuries*, May 15, 2013, <http://www.census.gov/newsroom/press-releases/2013/cb13-89.html>.

⁴³ *Ibid.*

⁴⁴ *Ibid.*

⁴⁵ National Intelligence Council, *Global Water Security*, February 2, 2012, p. iii; United Nations, *Water and Food Security*, http://www.un.org/waterforlifedecade/food_security.shtml; The White House, *National Security Strategy*, February 2015, p. 12; World Bank Group, *Water and Food Security: Improving Agricultural Water Productivity*, <http://water.worldbank.org/WPP-Food-Security>.

⁴⁶ National Intelligence Council, *Global Water Security*, February 2, 2012, p. iii.

⁴⁷ No author, "East Porterville Residents Without Water as Wells Go Dry During California Drought," *CBS Sacramento*, August 27, 2014, <http://sacramento.cbslocal.com/2014/08/27/porterville-residents-without-water-as-wells-go-dry-during-california-drought/>.

California is a major producer of agricultural produce, including fruits and vegetables, the severe drought in the state has implications for U.S. produce supplies and prices.⁴⁸ Beyond fruit and vegetables, California also leads the Nation in dairy production and produces 21 percent of the Nation's milk.⁴⁹ The drought in California could increase the price and decrease the availability of alfalfa, which is the primary feed for dairy cattle.⁵⁰

Global Supply Chain

As globalization continues to shape nations socially, economically, and technologically, the global supply chain is an example of the growing interconnections that stretch across national borders. The efficient and secure movement of goods through the global supply chain is essential for the U.S. economy and security.⁵¹ The global supply chain is composed of a network of "suppliers, manufacturing centers, warehouses, distribution centers, and retail outlets"⁵² that involve transportation, postal, air, and shipping assets, which make the U.S. and worldwide trade systems possible.⁵³ Governments and multinational corporations play key roles in ensuring the functioning of operations across national borders.⁵⁴ As a result of its complexity and scale, the global supply chain is vulnerable to a variety of threats and hazards that can cause disruptions. Natural disasters such as earthquakes, tsunamis, and volcanic eruptions, as well as terrorist attacks and labor strikes can heavily impact the global supply chain.⁵⁵ The 2011 Japanese earthquake and tsunami provide an example of the global supply chain's vulnerability. After the earthquake and tsunami, General Motors, Toyota, and Subaru slowed down or halted production at plants in the United States because needed parts manufactured in Japan were delayed.⁵⁶

Homegrown Violent Extremists

The terrorist threat to the Nation remains significant and continues to evolve, most recently with the rise of the Islamic State in the Levant (ISIL).⁵⁷ Homegrown violent extremists are a persistent threat to the country.⁵⁸ Homegrown terrorist activity continues to grow as changing national and

⁴⁸ United States Department of Agriculture, "California Drought 2014: Farm and Food Impacts," September 12, 2014, <http://ers.usda.gov/topics/in-the-news/california-drought-2014-farm-and-food-impacts.aspx>. California is not the only region of the country susceptible to drought. Similar to California, the Midwest provides essential agricultural products for the country. Climate change has the potential to increase the likelihood of droughts in the Midwest alongside wildfires and heat waves. See Environmental Protection Agency, Climate Impacts in the Midwest, <http://www.epa.gov/climatechange/impacts-adaptation/midwest.html>.

⁴⁹ United States Department of Agriculture, "California Drought 2014: Livestock, Dairy, and Poultry Sectors," September 12, 2014, <http://ers.usda.gov/topics/in-the-news/california-drought-2014-farm-and-food-impacts/california-drought-2014-livestock-dairy-and-poultry-sectors.aspx>.

⁵⁰ United States Department of Agriculture, "California Drought 2014: Food Prices and Consumers," October 7, 2014, <http://ers.usda.gov/topics/in-the-news/california-drought-2014-farm-and-food-impacts/california-drought-2014-food-prices-and-consumers.aspx>.

⁵¹ The White House, National Strategy for Global Supply Chain Security, January 2012, p. 1.

⁵² Henry H. Willis and David S. Ortiz, *Evaluating the Security of the Global Containerized Supply Chain*, RAND Corporation, 2007, p. ix.

⁵³ American National Standards Institute, Department of Homeland Security, *Global Supply Chain Security Standards*, November 2012, p. 1; Department of Homeland Security, *2014 Quadrennial Homeland Security Review*, p. 25.

⁵⁴ Federal Emergency Management Agency, *Strategic Foresight Initiative, White Papers: Global Interdependencies*, January 2012, p. 2, <http://www.fema.gov/media-library/assets/documents/103600>.

⁵⁵ Department of Homeland Security, *2014 Quadrennial Homeland Security Review*, p. 25; The White House, National Strategy for Global Supply Chain Security, January 2012, p. 4–5.

⁵⁶ Associated Press, "Japan Disaster, Lack of Parts Forces General Motors to Halt Production," *Huffington Post*, March 17, 2011, http://www.huffingtonpost.com/2011/03/17/japan-general-motors-parts_n_837355.html.

⁵⁷ Nicholas J. Rasmussen, Current Terrorist Threat to the United States, Testimony before the Senate Select Committee on Intelligence, February 12, 2015. This section is primarily discussing Homegrown Extremists tied to and influenced by radical Islam that advocates attacks on the U.S.

⁵⁸ Jerome P. Bjelopera, American Jihadist Terrorism: Combating a Complex Threat, Congressional Research Service, January 23, 2013; James R. Clapper, Worldwide Threat Assessment of the U.S. Intelligence Community, Testimony before the Senate Armed Services Committee, February 11, 2014; Department of Homeland Security, *2014 Quadrennial Homeland Security Review*, p. 19; William L. Painter, Issues in Homeland Security Policy for the 113th Congress, Congressional Research Service, September 23, 2013; Federal Emergency Management Agency, Strategic Foresight Initiative, January 2012, p. 9; Government Accountability Office, *Strategic Plan 2014–2019*, p. 100; Nicholas J. Rasmussen, Current Terrorist Threat to the United States, Testimony before the Senate Select Committee on Intelligence, February 12, 2015.

international security dynamics will affect the Nation's safety, prosperity, and resilience.⁵⁹ Individuals (lone offenders) and small groups acting on their own initiative are a tenacious threat and difficult to counter.⁶⁰

The rise of ISIL during the past year and its adept use of media have created unprecedented opportunities for the organization to reach potential recruits or influence people.⁶¹ Social media and the Internet have the potential to play a critical role in the immediate future in radicalizing and mobilizing homegrown extremists towards violence.⁶² There is the possibility that a number of individuals traveling to Iraq and Syria to fight with ISIL will return to the country with field training to commit an act of terrorism against the Nation.⁶³

Future Risks

Artificial Intelligence

Artificial intelligence describes a branch of computer science that uses algorithms to mimic human intelligence. It "includes performing tasks that normally require human intelligence, such as visual perception, speech recognition, problem solving, and language translation."⁶⁴ Artificial intelligence offers many benefits and has evolved greatly within the past decade because of cheap computing, better algorithms, and the ability of computers to process and store increasingly larger and larger amounts of collected data.⁶⁵ Everyday application of artificial intelligence includes Netflix recommendations, Facebook's ability to identify users' friends, and the personal assistant Siri on iPhones.⁶⁶ Additionally, artificial intelligence is playing a larger role in cybersecurity by helping companies to identify risks and anticipate problems.⁶⁷

There are potential risks with artificial intelligence. There are concerns that there will be advanced computer systems with the possible ability to match or surpass human intelligence, resulting in unexpected outcomes.⁶⁸

⁵⁹ Federal Emergency Management Agency, *Strategic Foresight Initiative*, January 2012, p. 9 and p. 23.

⁶⁰ Department of Homeland Security, *2014 Quadrennial Homeland Security Review*, p. 18.

⁶¹ Nicholas J. Rasmussen, Current Terrorist Threat to the United States, Testimony before the Senate Select Committee on Intelligence, February 12, 2015.

⁶² Ibid.

⁶³ Ibid.

⁶⁴ Babak Hoojat, "Myth Busting Artificial Intelligence," *Wired*, February 2015, <http://www.wired.com/2015/02/myth-busting-artificial-intelligence/>.

⁶⁵ Kevin Kelly, "The Three Breakthroughs that have Finally Unleashed AI on the World," *Wired*, 27 October 2014, <http://www.wired.com/2014/10/future-of-artificial-intelligence/>.

⁶⁶ Babak Hoojat, "The AI Resurgence: Why Now?" *Wired*, March 2015, <http://www.wired.com/2015/03/ai-resurgence-now/>; Kevin Kelly, "The Three Breakthroughs that have Finally Unleashed AI on the World," *Wired*, 27 October 2014, <http://www.wired.com/2014/10/future-of-artificial-intelligence/>.

⁶⁷ Rachel King, "The Security Download: Anticipating Cyberattacks with Machine Learning," *Wall Street Journal*, 9 March 2015, <http://blogs.wsj.com/cio/2015/03/09/the-security-download-anticipating-cyberattacks-with-machine-learning/>.

⁶⁸ Rory Cellan-Jones, "Stephen Hawking Warns Artificial Intelligence Could End Mankind," *BBC News*, 2 December 2014, <http://www.bbc.com/news/technology-30290540>; Paul Smith, "Apple Co-founder Steve Wozniak on the Apple Watch, Electric Cars, and the Surpassing of Humanity," *Australian Financial Review*, 23 March 2015, <http://www.afr.com/technology/apple-cofounder-steve-wozniak-on-the-apple-watch-electric-cars-and-the-surpassing-of-humanity-20150323-1m3xxk>; Baum et al, 2011, "How Long Until Human-Level AI? Results from an Expert Assessment," *Technological Forecasting & Social Change* 78(1) 185–195; Vinge, Vernor, "The Coming Technological Singularity: How to Survive in the Post-Human Era," *Whole Earth Review*, Winter 1993, <http://www-rohan.sdsu.edu/faculty/vinge/misc/singularity.html>; Eliezer Yudkowsky, "Artificial Intelligence as a Positive and Negative Factor in Global Risk," in *Global Catastrophic Risks*, edited by Nick Bostrom and Milan M. Cirkovic, London, UK: Oxford University Press, 2008, p. 331–333. For contrary views from different perspectives, see Stephen F. DeAngelis, "The Upside of Artificial Intelligence Development," *Wired*, February 2015, <http://www.wired.com/2015/02/the-upside-of-artificial-intelligence-development/>; Kurzweil, Ray, 2005, *The Singularity is Near: When Humans Transcend Biology*; Viking Press; Lanier, J, "One-Half of a Manifesto: Why Stupid Software Will Save the Future from Neo-Darwinian Machines," *Wired* 8.12 (2000), http://www.wired.com/wired/archive/8.12/lanier_pr.html.

Cognitive Enhancement

Cognitive enhancement involves the “amplification or extension of core capacities of the mind through improvement or augmentation of internal or external information processing systems.”⁶⁹ Medical and scientific efforts at cognitive enhancement cover a range of drugs and technologies. With some brain disorders and developmental conditions, the use of drugs has become established in clinical practice. Many of these medications, which can also be used to enhance cognitive functions in healthy people above their normal baseline, have been used in the past for military applications and are drugs of abuse in the civilian population.⁷⁰ In addition to the use of medical drugs, good nutrition, education, mental training, transcranial magnetic stimulation, increased and better human-computer interaction, and regular exercise have been used to produce long term cognitive improvements.⁷¹ More unconventional and experimental forms of cognitive enhancement include gene therapy, and neural implants.⁷²

Cognitive enhancement raises a number of ethical issues and there are a few risks. There are side effects from the use of pharmacological drugs.⁷³ Ethically, there are concerns about the use of genetic enhancements raising fears about crossing the line into eugenics,⁷⁴ and the impacts upon society of human enhancement technologies more generically.⁷⁵ The improvement of human-computer interaction touches on privacy and data protection.⁷⁶

Nanotechnology

Nanotechnology holds great potential for a variety of fields, but also has potential risks. Nanotechnology involves the “creation of structures, devices, and systems on the atomic scale.”⁷⁷ In general, nanotechnology is used as a component part in larger manufacturing products, which limits their scope and impact as the manufacturing process and non-nanotechnology components influence the way nanotechnology can be used.⁷⁸ The benefits of nanotechnology include a more efficient drug delivery systems, medical imaging for diagnosis, and new cancer therapies.⁷⁹ Additionally, nanotechnology is used to improve energy efficiency, desalinate water, clean up hazardous waste, and detect contaminants.⁸⁰ Nanotechnology is now used in over 1,000 consumer products, which marks a 379 percent increase from 2006.⁸¹

⁶⁹ Nick Bostrom and Anders Sandberg, “Cognitive Enhancement: Methods, Ethics, Regulatory Challenges,” *Science and Engineering Ethics* 15 (2009), p. 311.

⁷⁰ JASON (MITRE Corporation), *Human Performance*, March 2008, <https://fas.org/irp/agency/dod/jason/human.pdf>; Masud Husain and Mitul A. Mehta, “Cognitive Enhancement by Drugs in Health and Disease,” *Trends in Cognitive Sciences*, no. 1, 2011 January 15, p. 28.

⁷¹ Nick Bostrom and Anders Sandberg, “Cognitive Enhancement: Methods, Ethics, Regulatory Challenges,” *Science and Engineering Ethics* 15 (2009), p. 313-321; Hannah Maslen, Nadira Faulmuller, and Julian Savulescu, “Pharmacological Cognitive Enhancement – How Neuroscientific Research Could Advance Ethical Debate,” *Frontiers in Systems Neuroscience* no. 8, 2014, p. 107.

⁷² Nick Bostrom and Anders Sandberg, “Cognitive Enhancement: Methods, Ethics, Regulatory Challenges,” *Science and Engineering Ethics* 15 (2009), p. 312.

⁷³ Masud Husain and Mitul A. Mehta, “Cognitive Enhancement by Drugs in Health and Disease,” *Trends in Cognitive Sciences*, no. 1, 2011 January 15.

⁷⁴ Nick Bostrom and Anders Sandberg, “Cognitive Enhancement: Methods, Ethics, Regulatory Challenges,” *Science and Engineering Ethics* 15 (2009), p. 324-328.

⁷⁵ National Intelligence Council, *Global Trends 2030: Alternative Worlds*, December 2012, http://www.dni.gov/files/documents/GlobalTrends_2030.pdf.

⁷⁶ Nick Bostrom and Anders Sandberg, “Cognitive Enhancement: Methods, Ethics, Regulatory Challenges,” *Science and Engineering Ethics* 15 (2009), p. 324-328.

⁷⁷ National Aeronautics and Space Administration, “Nanotechnology at AMES,” http://www.nasa.gov/centers/ames/research/technology-onepaggers/ames_nanotech.html.

⁷⁸ Chris Phoenix and Mike Treder, “Nanotechnology as Global Catastrophic Risk,” in *Global Catastrophic Risks*, edited by Nick Bostrom and Milan M. Cirkovic, London, UK: Oxford University Press, 2008, p. 482-483.

⁷⁹ Daniel J. Fiorino, *Voluntary Initiatives, Regulation, and Nanotechnology Oversight: Charting a Path*, Woodrow Wilson International Center for Scholars, November 2010, p. 12.

⁸⁰ Ibid.

⁸¹ Ibid.

There are different types of possible risks with nanotechnology. Nanotechnology could be used to manufacture weapons on a mass scale.⁸² “Uncontrolled aggressive nanotechnology is a scenario in which humanity unleashes weapons that it cannot subsequently bring under control, which go on to have independent negative impacts on the world.”⁸³ In utilizing nanotechnology, there is a fear that robots could self-replicate, thus putting humanity in danger.⁸⁴

It is difficult to provide exact risks from the use of nanotechnology because of the diverse uses and complexity of nanomaterials.⁸⁵ There are few studies on the environmental fate of nanomaterials in soil, atmosphere, and water.⁸⁶ Nanomaterials could possibly transform in the environment and become toxic to human health.⁸⁷

⁸² Global Challenges Foundation, *Global Challenges: 12 Risks that Threaten Human Civilization*, February 2015, p. 117.

⁸³ *Ibid.*

⁸⁴ Bill Joy, “Why the Future Doesn’t Need Us,” *Wired*, April 2000.

⁸⁵ U.S. Environmental Protection Agency, *Nanotechnology White Paper*, February 2007, p. 29; Global Challenges Foundation, *Global Challenges: 12 Risks that Threaten Human Civilization*, February 2015, p. 117.

⁸⁶ U.S. Environmental Protection Agency, *Nanotechnology White Paper*, February 2007, p. 33.

⁸⁷ *Ibid.*