Institutional Options for Robot Governance

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Robots, which are generally understood as systems that take in information about the world, process that information, and can then act on the world, represent an enormous technological and economic opportunity that will change society in innumerable and unpredictable ways. Because they are non-human but can act on the world, new legal frameworks will be needed. Because people may identify with them in ways they would not identify with an inanimate object, they may re-shape families and organizations. Robots change the world of work.[1] Massive changes will bring an array of equally unpredictable challenges and potential crises. Ryan Calo, a professor of law, has thought extensively about how robotics will change law and society and makes a compelling argument that this new technology (as new technologies have in the past) requires a new government agency—a Federal Robotics Commission.[2]

This paper builds on Calo's work and examines the kinds of government institutions needed to allow policy-makers to develop and implement policy for the revolution in robotics.[3] A new

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[1] This working definition includes disembodied autonomous systems. Ryan Calo, "Robotics and the Lessons of Cyberlaw," *California Law Review*, 103, #3 (2015): 513-63.

[2] Ryan Calo, *The Case for a Federal Robotics Commission* (Washington, DC: Brookings Institution, September 2014),
http://www.brookings.edu/research/reports2/2014/09/case-for-federal-robotics-commission.

[3] As opposed to the institutions that will be established after the robot revolution to govern humanity, which will be discussed in a subsequent paper.

stand-alone agency is one institutional option, but there are many other non-mutually exclusive institutional options. This paper surveys some of the different options and identifies the strengths and weaknesses of these different approaches based on the political science literature on organizations and bureaucratic politics. This paper cannot resolve the question of what institutions should be established, but rather provides a menu of options for policy-makers. (Summarized in a table at the end of the paper.)

This paper has four parts. The first part of the paper provides a brief overview of the academic literature on bureaucracy, including foundational work on the field of public administration, organizational theory, and the work of renowned political scientists James Q. Wilson (author of several seminal works on the practical limitations on bureaucratic efficacy) and Graham Allison,[4] who studied the space where politics, policy, and organization meet. In considering the types of institutions relevant to addressing the challenges presented by robotics, it is essential to have a grounding in what government agencies actually do, how they make and implement policy, and how they adapt or fail to adapt to changing issues and circumstances.

The second part of the paper examines what the government actually needs to be able to do in the face of an emerging, and soon to be pervasive, technology. Broadly there are four areas where the government will have a role: 1) research, 2) regulation, 3) crisis management, and 4) adjusting to broad social change.[5] There may be other necessary government functions, but these four categories cover a vast range of activities.

The third and fourth parts of the paper discuss some of the potential institutional arrangements for governing robotics, both within the broader bureaucracy (part three), but also in the White House and Congress (part four). Different needs may be addressed more or less optimally by different types of institutions. Further, many of the capabilities for addressing different challenges may already exist, but need to be better linked to the policy process.

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[4] James Q. Wilson, *Bureaucracy: What Government Agencies Do and Why They Do It* (New York: Basic Books, 1989); Graham Allison and Philip Zelikow, *Essence of Decision: Explaining the Cuban Missile Crisis*, 2nd Edition (New York: Addison-Wesley Educational Publishers, 1999).

[5] This paper focuses on domestic policy. The national security aspects of robotics are not discussed. The author's background is in national security affairs, but if the paper sought to incorporate these issues, it would never, ever be completed.

1. Robotics Bureaucracy I: What is Bureaucracy

The root word of bureaucracy is bureau, from the French for office, or literally desk—rule by desk or office—that is a series of offices that coordinate to manage affairs. It's initial use sarcastic.[6] More practically, bureaucracies underpin modern society. In the words of Graham Allison, "[O] rganizations are collections of human beings arranged systematically for harmonious of united action…. Secondly, and most importantly, organizations *create* capabilities for achieving humanly-chosen purposes and performing tasks that would otherwise be impossible."[7] Allison goes on to describe the classic Adam Smith analysis of a pin factory in which, through coordination, division of labor, and routine operations, a few workers can produce exponentially more pins than a single person could on their own. Allison, in his classic study of the Cuban Missile Crisis, was showing that government actions could be understood as the output of their constituent organizations that are made up of programs, which in turn are bundles of routines or Standard Operating Procedures (SOPs).

In his seminal 1919 lecture, Max Weber outlined the fundamental characteristics of a bureaucracy. These characteristics include: 1) hierarchy with demarcated lines of authority; 2) division and specialization of labor; 3) codified rules; and 4) impersonality (i.e., that the specific person in a role does not fundamentally change the organization's output).[8] These characteristics enable an organization to effectively carry out its routines.

At the same time, despite their fundamentally relying on routines, organizations can show significant autonomy. Given broad goals to accomplish, an organization may find interesting and creative responses. For example, a study of the EPA described how, given the broad task of protecting the environment, the organization's leadership determined that "protecting the environment" meant developing and enforcing regulations on polluting industries.[9] In another example, a study of the development of nuclear missile guidance systems, sociologist Donald MacKenzie found that the research group, given broad goals, decided that developing missile

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[6] Jos C. N. Raadshelders, *Handbook of Administrative History* (Piscataway, NJ: Transaction Publishers, 1998), 142.
[7] Allison, *Essence of Decision,* 145
[8] Max Weber, *Rationalism and Modern Society,* trans. and ed. Tony Waters and Dagmar Waters (Baginstoke, UK: Palgrave-Macmillan 2015), 114.
[9] Mark Moore, *Creating Public Value: Strategic Management in Government* (Cambridge: Harvard University Press, 1995), 70-99.

guidance systems was the optimal way to reach these objectives; they proceeded to organize the research project along those lines. *But the project did not have to evolve that way.*[10] In another example of interpreting broad goals, Caspar Weinberger, as chairman of the Federal Trade Commission in the early 1970s chose—of the many issues the organization is permitted to regulate—to focus on deceptive advertising.[11]

However, agencies cannot do anything. The U.S, Civil Rights Commission cannot regulate nor criminalize pesticide use. The Army Corp of Engineers does not investigate smuggling. Agencies define specific outputs linked to their broad goals and then begin turning them into programs and routines.

Aside: Bureaucracy as a Robot?

Bureaucracies are bundles of programs and routines, carrying out systematic operations. Bureaucracies, given broad goals, have the ability to act autonomously and develop programs and responses. This raises an interesting question: are bureaucracies robots?

Bureaucracies take in information about the world. They process that information. They can then act on that information, sometimes in surprising and unexpected (and occasionally counter-productive) ways.

Adam Elkus, a fellow at the New America Foundation's Cybersecurity Initiatve, writing on how the "tyranny of algorithms" is essentially a manifestation of the values and priorities of bureaucracies, explains:

> Today's automation and data-driven programs are merely the latest and greatest of a long movement toward the automation, optimization, and control of social life—and this story begins not with a revolution in computing but a revolution in human understanding of social relations and governance. Sometime around the mid–19th century, scholars believe, the basic technology of social relations and governance shifted dramatically. …political governance became dominated by attempts to achieve social and political control through quantification, measurement, and rational bureaucratic

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[10] Donald MacKenzie, *Inventing Accuracy: A Historical Sociology of Nuclear Guidance* (Cambridge: MIT Press, 1990), 398-99.
[11] Wilson, 207.

processes…. Such a shift also explains, after all, the origin, nature, and folkways of modern bureaucracy and how governmental and corporate *metaphorical* machines became slowly infiltrated by *real* machines.[12]

This metaphor of bureaucracies as enormous embodied artificial intelligences can be taken too far. Operators in bureaucracies can exercise a great deal of discretion in ways that autonomous systems cannot. Nonetheless, it is a useful metaphor for this discussion.

Bureaucracy Unbound!

Since their emergence in the mid-19th century, bureaucracies have allowed human beings to achieve astounding things, from launching people and objects into space to allowing the rapid movement of goods and services across the globe. They have also achieved monstrously terrible things, enabling mass murder on a previously unimaginable scale. Weber worried about the efficiency of bureaucracies, which would re-engineer society and place humanity in an "iron cage," in which human freedom and potential would be crushed.[13]

Bureaucracy Bound

Yet our newsfeeds and daily experiences are filled with tales of bureaucratic ineptitude from "bridges to nowhere" and other stories of wasteful spending, to mistaken identities leading to denied services or false incarceration, to maddening rules and requirements. Bureaucracies may have put a man on the moon, but our interaction is more likely to be the DMV. That the banal reality of bureaucracies is very different from the rational ideal of the pioneers of field of public

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[12] Adam Elkus, "You Can't Handle the (Algorithmic) Truth: People are Blaming Algorithms for the Cruelty of Bureaucracy," *Slate*, May 20, 2015, http://www.slate.com/articles/technology/future_tense/2015/05/algorithms_aren_t_responsible_for_the_cruelties_of_bureaucracy.single.html. Elkus develops the idea further; see Adam Elkus "The Manhattan Project Falacy," *Essays*, http://aelkus.github.io/essays/ai_manhattan_project.html. Accessed March 13, 2016. Also, it is hardly original. Nobel Laureate Herbert Simon, a pioneer in the study of both public administration and artificial intelligence, saw this connection as well. Herbert Simon, *Strategies of the Artificial* (Cambridge, MA: MIT Press, 1995).
[13] Peter Baehr, "The 'Iron Cage' and the "Shell as Hard as Steel": Parsons, Weber, and the Stahlhartes Gehäuse Metaphor in the Protestant Ethic and the Spirit of Capitalism," *History and Theory* 40, # 2 (May 2001): 153–69.

administration. That the real and the ideal are not in accord is no surprise, but understanding what specifically underpins this disconnect is useful to this project.

A dated, yet oddly timely example illustrates the constraints under which bureaucracies must operate. On May 28, 1986, a New York real estate developer offered to reconstruct the ice-skating rink in Central Park. He promised to have it done within six months. The city had been trying to renovate the rink for the past six years and it had cost nearly $13 million, so the mayor took the offer and appropriated $3 million on the condition that the developer would have to pay for any cost over-runs. Donald Trump finished the job 6 months ahead of schedule and $750,000 under budget.[14]

In his masterful *Bureaucracy: What Government Agencies Do and Why They Do It,* James Q. Wilson investigates the example of the Central Park skating rink highlight what government agencies contend with in carrying out their missions. In the case of the Central Park ice rink, New York City's Department of Parks and Recreation, in order to treat all citizens fairly, was required to give every contractor an equal chance at *each part* of the job and accept the lowest bid. They were forbidden by law from hiring a general contractor who could then select subcontractors. Trump was free to hire his preferred contractors. At the same time, the city had to provide detailed plans to each of these contractors and any changes required a contract renegotiation. Trump could allow the contractors to work out the details. In addition, the city had initially committed to using a new energy efficient system that did not work properly, Trump dispensed with this requirement. Finally, all of these factors created a cumbersome process with over a dozen players between the contractors and the government, all of whom had to agree on any changes. Given those conditions, it was no surprise that the project was stalled.[15]

But the government restrictions were not arbitrary or pointless. They were installed to ensure accountability and prevent corruption. In the words of Herbert Kaufman, "Every restraint and requirement originates in somebody's demand for it."[16] Wilson goes on to explain that the government is accused of inefficiency when critics are focused on one particular output—the construction of skating rinks in the above example. "But," Wilson notes, "government has

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[14] *New York Times,* November 21, 1986, B1
[15] Wilson, 316
[16] Herbert Kaufman, *Red Tape* (Washington, DC: The Brookings Institution, 1977), 29.

many valued outputs, including a reputation for integrity, the confidence of the people, and the support of important interest groups."[17] If ensuring that city officials do not engage in corrupt contracting practices is the most critical output, then the government might be considered very efficient.

However, it is very hard to measure many of these outputs. *Most accusations of government inefficiency are because of different values placed on these constraints.* Developers may see concerns about endangered species as inefficiently holding up construction. Advocates of tough-on-crime policies may interpret excessive concern for the rights of suspects as inefficiently stymying crime-fighting efforts. Budget requirements, are often seen as not merely a limit on resources, but rather limits on how resources can be used, and may lead to suboptimal use of these resources. Similarly, advocates of more efficient government might bridle at cumbersome hiring practices that hamper the ability of agencies to attract and quickly hire talent. But government personnel practices and mandates, such as granting veterans preferences in hiring, reflect important priorities in their own right.[18]

Bureaucracies also operate in political contexts. There are usually influential interest groups with a significant interest in the decisions and operations of the agency. For example, the Occupational Safety and Health Administration (OSHA) is urged by organized labor to be more vigilant in regulating workplace safety. Businesses, conversely, press OSHA to consider the costs they will have to bear in implementing new labor standards. Both of these groups can make their stands on issues known, through direct communication with the agency, but also through Congress and the White House. Agency capture by a particular interest group is an oft-cited phenomenon. But, more commonly, the agency is subject to *multiple* competing interests, which, in turn, shape agency actions.

Wilson writes, "Government agencies are not billiard balls driven hither and yon by the impact of forces and interests."[19] This because they usually have their own internal ballast reflected in their standard operating procedures, organizational culture, and professional standards. The programs and routines of an agency shape what it does on a day-to-day basis, and how it approaches challenges. These routines can change, but will not change enormously or quickly.

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[17] Wilson, 318
[18] Wilson, 318.
[19] Wilson, 88.

A robot vacuum cleaner can learn how to clean a new location with different surfaces. But changing it to mow the lawn would require significant modification, and rebuilding it to run errands would result in an entirely different device. Further, these routines and programs shape the people who carry them out, *creating an organizational culture.* The people who work in a bureaucracy will frequently share a sense of mission and values about what their organization does.

Finally, many bureaucracies consist of professionals who adhere to the standards of their profession. Statisticians, economists, and attorneys in the government will want their work to adhere to the standards of statisticians, economists, and attorneys in academia and the private sector, and, as a result, will resist political or other pressures to do work below their professional standards. This ballast can be a source of stability, but one man's stability is another man's inflexibility. The reliance on routines and the worldview of the organizational culture may lead an organization to be inflexible and resist change.

Turf & Autonomy – Coordination vs Centralization

Turf wars are a well-known term in bureaucratic politics and to anyone following public affairs closely. Bureaucrats scramble to grab parts of one another's authority and budget. But, as Wilson explains the real issue is not, strictly speaking, bureaucratic imperialism (although that certainly happens) but rather *autonomy*—that is, an agency obtaining as much freedom to carry out its mission with limited external interference. The ideal government agency has a popular mission, with strong public support that shapes an esprit de corps for the agency personnel, that is also unique and not shared with other agencies. NASA, in its heyday, was an agency that could operate with a fair degree of autonomy; it was popular, faced no bureaucratic rivals, and performed a unique and inspiring mission leading to strong funding and relatively little interference from congress or the White House. On the opposite end of the spectrum are agencies that face fierce competition, for example when a controversy involves multiple federal criminal investigation agencies including the FBI, DEA, Secret Service, HSI, and ATFE. There are also agencies that are responsible for fundamentally unpopular tasks, which do not have strong support (e.g., USAID, the IRS), and agencies that are subject to regular political interference and carry out extremely difficult tasks (e.g., State Department).

An important corollary to this is that agencies will certainly want bigger budgets and may be interested in expanding their jurisdiction in areas related to their mission. But they may resist new missions and tasks if they are not related and/or could result in high costs to the agency or greater political scrutiny, or will bring them into conflict with other agencies. (It is worth noting that a single agency may include multiple, very different, subcultures that may come into conflict.)

Wilson outlined six rules for government executives to follow to minimize turf wars:

1. "seek out tasks that are not being performed by others"
2. "fight organizations that seek to perform your tasks"
3. "avoid taking on tasks that differ significantly from those that are at the heart of the organization's mission"
4. "be wary of joint or cooperative ventures"
5. "avoid tasks that will produce divided or hostile constituencies"
6. "avoid learned vulnerabilities"[20]

If only every government executive consistently obeyed these rules (or as they often put it "stayed in their lane"), issues of turf would not be an issue. But most serious policy issues require multiple agencies, both because of overlapping jurisdictions but also because of different organizational capabilities. While having multiple agencies dealing with the same problem can create redundancies and lead to friction, not all redundancy is bad. It can provide multiple options for policy-makers and some protection against system failure (just as airplanes have multiple back-up systems).[21] However coordinating multiple agencies creates slower, more time-consuming practices. Further, this redundancy diffuses responsibility, which in turn can lead key issues to go unaddressed and create failures.[22]

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[20] Wilson, 181-95.
[21] Michael M. Ting, "A Strategic Theory of Bureaucratic Redundancy," February 27, 2003, http://www.columbia.edu/~mmt2033/redundancy.pdf
[22] Allison, 163.

At the working level, many agencies are reasonably good at developing formal and informal *modus operandi* when jurisdictions overlap.[23] As issues become more complex and contentious and cannot be resolved at the working level, they require coordination, which Henry Seidman described as:

> …[the] twentieth century equivalent of the medieval search for the philosopher's stone…. If only we can find the right formula for coordination, we can reconcile the irreconcilable, harmonize competing and wholly divergent interests, overcome irrationalities in our government structures, and make hard policy choices to which no one will dissent.[24]

Wilson finds that in general bureaucracies bridle at efforts to interfere with their operations. Coordinating committees coordinate; they referee turf disputes. But most significantly, to function most effectively, they require high-level attention—which is always in short supply.[25]

In facing complex multi-dimensional, inter-agency problems, one reaction is centralization—to give a key figure or agency the authority to get the job done. Unfortunately most truly complex issues involve multiple agencies that cannot possibly be placed under one central authority. Further, most of the agencies involved will have a number of priorities so that centralizing them under one roof will only cause problems in other aspects of their operations. In the case of the Department of Homeland Security, the most recent instance of establishing a new overarching bureaucracy,[26] several agencies that patrolled the borders and carried out emergency response were merged into one department, for the purpose of preventing terrorism. But many of these agencies such as the Coast Guard, the Federal Emergency

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[23] Jody Freeman and Jim Rossi, "Agency Coordination in Shared Regulatory Space," *Harvard Law Review* 121 #5 (March 2012): 1131-1211, http://discoverarchive.vanderbilt.edu/bitstream/handle/1803/6600/Agency%20Coordination%20in%20Shared.pdf?sequence=1.

[24] Henry Seidman and Robert Gilmour, *Politics, Position, and Power* 4th ed. (New York: Oxford University Press, 1986), 219

[25] Wilson, 272-73.

[26] Just to clarify, although the author is an AAAS Policy Fellow at the Department of Homeland Security, he has been there for all six months. **Nothing written here should be taken as the view of DHS or any of its components, or for that matter, an opinion about DHS.** Rather, it reflects the academic literature on this major new government re-organization. It is an apt example because it is the most recent large-scale reorganization of the U.S. government and therefore offers insight into the dynamics of changing and establishing bureaucracies.

Management Agency, and the Border Patrol had a huge range of other missions not linked to terrorism, from maritime safety to hurricane response and counter-smuggling. At the same time, many agencies with a significant counter-terror role, most notably the Federal Bureau of Investigation, but also the Centers for Disease Control, were never going to become part of the Department of Homeland Security.[27]

Robotics offers a similar challenge. *As autonomous systems become ubiquitous, more and more components of the government are going to have a role in the issue.* Centralizing them will be extremely difficult. While the Federal Aviation Administration, the National Highway Transportation Safety Administration, and the Food and Drug Administration will all have a stake in robotics, they will also continue to have numerous other responsibilities.

Exploring the ways in which bureaucracies function is an essential backdrop to considering the institutional needs when facing a new issue. In crafting institutions or institutional capabilities, just as in everything, balances will need to be struck. Turf issues mean that an all-powerful robotics agency that can address every issue is unlikely. Various political concerns mean that pure scientific merit or otherwise optimal outcomes cannot always trump all of the other issues. The requirements of routine and SOPs will, at times, stymie needed flexibility. In constructing institutions, the perfect cannot be the enemy of the good and sometimes the least bad must do.

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[27] Ivo Daalder and I.M. Destler, "Advisors, Czars and Council: Organizing for Homeland Security," *National Interest* 68 (Summer 2002): 66-78.

2. Robotics Bureaucracy II: The Mission

Never take a government job without an inbox.

Henry Kissinger[28]

If a government agency is a kind of robot, what exactly are we tasking it to do? In discussing this paper casually and formally in interviews, government executives kept asking, "What's the mission?"

This section, based on interviews as well as literature reviews, examines four main areas in which the United States government will be playing a role vis-à-vis robotics and where there may be gaps in the government's activity. Given the scale of the challenges and the size of the U.S. government, this survey touches on a few, limited areas and cannot hope to be comprehensive. But it should point to at least several areas worth consideration.

Research

By most measures, one area in which the U.S. government has been successful is in fostering research. The United States continues to be the world leader in science and technology. The federal government sponsors an enormous range of basic and applied research, through a panoply of agencies and mechanisms. The Small Business Innovation Research Program, for example, shows that virtually every component of the United States government has sponsored at least some research covering a vast range of issues.[29]

The federal government research community includes powerhouse agencies (at least in terms of funding research) such as the Defense Advanced Research Projects Agency (DARPA) and the National Science Foundation (NSF). The former works on military programs but includes a great deal of "blue-sky" research that has had vast, world-changing civilian applications (most famously the Internet). Other government components have sought to emulate this approach, including IARPA (serving the intelligence community), ARPA-E (serving the Department of

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[28] Cited by John Bolton, *Surrender is Not an Option* (New York: Simon & Schuster, 2007), 49.
[29] Small Business Administration, *SBIR-STTR America's Seed Fund*, Sbir.gov

Energy), HARPA (serving the Department of Health and Human Services), and HSARPA (serving the Department of Homeland Security).[30]

The NSF supports civilian research and has several distinct differences from DARPA.[31] NSF grants are the major source of funding for basic research in the United States. They are based on academic peer review, but the NSF also provides opportunities for program managers to identify gaps in research programs.[32] At the same time, there are innumerable other players in the government research space. Each military service funds research, as does the National Institutes of Health (NIH) and the National Institute of Standards and Technology (NIST). Robotics in particular has been highlighted as a crucial field and there is a National Robotics Initiative, led by the NSF but including several cabinet departments, intended to spur innovation.[33]

Government research and policy is coordinated through the National Science and Technology Council, which has numerous sub-committees and working groups, which help foster collaboration and information-sharing.[34] At the same time, much of the U.S. research environment is in the private sector and academia.

This diffuse research and development environment may appear inefficient, but historical research has indicated that it is in fact the optimal approach. Centralized, planned research agendas can enjoy short-term gains. But over the long-term, the decentralized approach will have greater achievements. When there are centralized national research agendas, priorities are set but often do not change when necessary and only a few key areas tend to be subjects of focus. A case study on the U.S.-Japanese competition in the 1980s and 1990s illustrates this phenomenon. Japan, playing catch-up in the post-World War II period, made important strides by adopting and adapting international research. It appeared poised to overtake the United

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[30] Which also provides employment for the author of this paper.
[31] Jeffrey Mervis, "What else makes DARPA tick," *Science*, February 5, 2016
[32] Interview with Dr. Lynne Parker, National Science Foundation, Division Director for Information and Intelligent System, January 20, 2016
[33] National Robotics Initiative: The Realization of Co-robots Acting in Direct Support of Individuals and Groups, November 7, 2006. http://www.nsf.gov/pubs/2015/nsf15505/nsf15505.htm
[34] "National Science and Technology Council," September 2015, https://www.whitehouse.gov/sites/default/files/microsites/ostp/NSTC/nstc_org_chart_-_external_-_09092015.pdf . The author has the privilege of participating in a steering group for Big Data (several levels below the NSTC) on behalf of HSARPA.

States. But, while the Japanese government had been adept at adopting technologies, it was less successful at choosing winners in cutting-edge technologies. When the Japanese government sought to adapt, key bureaucracies effectively could veto initiatives and stymie changes. In the United States, by contrast, at least in terms of funding research, one bureaucracy usually cannot exercise a veto over another. If one agency's research approach is unsuccessful, another agency's might succeed.

Further, given our federal system of governing, the states have a fair degree of autonomy in funding research and establishing legal environments to encourage research. If a state has successfully fostered a research environment, other states may follow its lead, such as the many attempts to replicate Silicon Valley's success as a technology incubator.[35]

However, government funding is only a small part of the research equation. The other half is the legal and regulatory environment. While the first priority of regulation (at least in theory) is keeping the American people safe, regulation also establishes the research environment.

Regulation

The regulator's challenge was aptly summarized by acting director of the FDA's Office of Device Evaluation, William Maisel at the FDA Public Workshop on Robotically-Assisted Surgical Devices:

> [T] he first prong of our vision is that patients in the U.S. have access to high quality, safe and effective medical devices of public health importance first in the world. …if we set our evidentiary bars to high, then a lot of really great ideas will never make it. And so, we have to appropriately balance the availability of these technologies, getting these technologies to market and also make sure that they remain safe and effective. …[W] e also need to think about what is the cost of the development of the technology… [I] f

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[35] Daniel Drezner "State structure, technological leadership and the maintenance of hegemony" *Review of International Studies*, 27 (2001): 3-25.

the cost of developing a technology is too high, then many of those technologies will never make it to patients. And so, striking the right balance important.[36]

Weighing the evidence to determine that a medical device is safe and effective can be a significant technical challenge. But this must be done under time constraints. Maisel observes that many of the companies producing new devices are small, and additional time spent on studies can have a significant financial impact. The concern is not only for specific companies, but also for the industry as a whole. Evidentiary standards set too high can stifle a new industry. But, that is not the extent of the FDA's concerns. Medical devices are increasingly online and part of the "Internet of Things" (and could soon meet the working definition of a robot), raising cyber-security and privacy concerns. Further, the FDA needs to be aware of the economics of the health care industry and the emerging realm of healthcare information technology.

Robots complicate the challenge of regulation even further. They will require new tools for evaluation and testing. There are existing standards for verifying system safety and security but, as a roboticist explained, robots "are not amenable to these techniques. We are working on new techniques. Think about it this way, you have a teenager and you want to give him a driver's license. You can't get into his brain but you can test his behaviors."[37]

But the technical challenges of ensuring that autonomous systems—that is, systems in which the specific behavior in any given instance cannot be predicted with complete confidence—are only the beginning. They will raise new legal, regulatory, and policy questions that will require new kinds of legal and regulatory expertise to address. Following are just a few of the broad policy and legal questions raised:

- Since robots are autonomous systems that affect the world and can act in unpredictable ways, who will be at fault when they act in an unpredictable manner and cause harm?

[36] Food and Drug Administration (FDA), Center for Device and Radiological Health (CDRH), "Robotic Assisted Surgical Devices" (July 27, 2015), http://www.fda.gov/downloads/MedicalDevices/NewsEvents/WorkshopsConferences/UCM459367.pdf
[37] Interview with Parker, January 20, 2016

- Technical means will be used to reduce the possibility of harm, but what policies can reduce or mitigate potential harms?
- What are the best ways of communicating these risks to the general public and stakholders so that they can make informed decisions?[38]

For the FDA, true autonomous medical systems are in their infancy, but the agency has the personnel and resources to regulate the new technology. The Center for Devices has 1800 employees, including a Laboratory at the Office of Science and Engineering with several hundred employees focused on regulatory science. They are beginning to study how to evaluate autonomous systems. The FDA teams reviewing new devices have long been interdisciplinary and include specialists based on the product, from biomedical engineers and statisticans to materials scientists and medical doctors. Because of the growing importance of the computational aspects of medical devices, the Office of Device Evaluation has been increasing its expertise in software. Recognizing the cyber-security challenges medical devices presented, the FDA worked "in a very compressed timeframe" to develop a guidance document to assist industry in identifying issues related to cyber-security that manufacturers should consider in the design and development of their medical devices as well as in preparing premarket submissions for those devices.[39] As appropriate, the FDA has worked with other agencies, such as working with the FCC to discuss expanding its radio spectrum service for wireless devices.[40]

Cooperation with other agencies is typically on a case-by-case basis because the FDA handles proprietary information, which can inhibit more systematic collaboration. At the working level the FDA has the resources to keep its people up to date on technology, hire people with new skills, and, when needed, bring in outside expertise through advisory panels. The FDA has a collaborative approach with industry, urging manufacturers to "bring even a figment of an idea to us so we can develop regulatory frameworks. They can come talk to us at any point."[41]

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[38] Ryan Calo, "Robotics and the Lessons of Cyberlaw," *California Law Review*, 103, #3 (2015): 513-63. I won't discuss these issues in detail as the rest of this conference is devoted to them.

[39] "Content of Premarket Submissions for Management of Cybersecurity in Medical Devices," Guidance for Industry and Food and Drug Administration Staff, October 2, 2014 http://www.fda.gov/downloads/medicaldevices/deviceregulationandguidance/guidancedocuments/ucm356190.pdf

[40] Interview with Allison Kumar, Senior Manager, Emergency Preparedness/Operations and Medical Countermeasures Program, Food and Drug Administration, January 11, 2016

[41] Interview with FDA officials, names withheld, February 4, 2016.

Medical devices affect a single individual. The challenges expand exponentially in domains in which the autonomous device interacts with the world more broadly. The FAA has wrestled with how to integrate drones into the U.S. airspace. Culturally, the FAA priority is safety, so that introducing drones—lots of new systems—into U.S. airspace vastly complicates their work and could potentially endanger commercial aviation.[42] Under the FAA Modernization and Reform Act of 2012, the agency was supposed to develop a comprehensive plan for integrating drones and begin implementing it by October 2015. This deadline has passed. While the FAA has made some progress, (for example, issuing proposed rules for drones between 4 and 55 lbs.), many issues remain unresolved. These regulations are supposed to be finalized in April 2016, although the GAO found that they are unlikely to meet this deadline. Commercial drone operations are still approved by the FAA on a case-by-case basis. This creates uncertainty for potential commercial drone users that could stymie innovation. Further, some gaps are being filled by state and local governments that are passing legislation about drones.[43] In addition, drones raise complex privacy concerns that are very different than the FAA's traditional domain focusing on safety (the lead on privacy issues around drones is being taken by the National Telecommunications and Information Agency).[44] FAA officials have granted that the agency has been slow to respond to the rapidly changing technology, and recognize the technology's tremendous potential, but also the tremendous complexity of issues that drones raise for safety, security, and privacy.[45]

Autonomous cars raise different, but still challenging regulatory issues. While "no one wants to stand in the way of this new technology," the Department of Transportation coordinates multiple in-house agencies *and* all 50 states in developing regulations for new technology.[46]

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[42] Interview with Dr. Mark Lewis, Director, Science and Technology Policy Institute, January 14, 2016
[43] Bart Elias, *Unmanned Aircraft Operations in Domestic Airspace: U.S. Policy Perspectives and the Regulatory Landscape* (Washington, DC: Congressional Research Service, January 27, 2016), https://fas.org/sgp/crs/misc/R44352.pdf
[44] "NTIA Looks for UAS Answers," *The Spec: What's Next in Federal IT*, March 6, 2015, https://fcw.com/blogs/the-spec/2015/03/ntia-uas-answers.aspx
[45] "FAA Pledges More Guidance, Faster Pace in Drone Rule-Making," *FedScoop*, March 13, 2016, http://fedscoop.com/faa-pledges-more-guidance-faster-pace-in-drone-rule-making
[46] Interview with Fred Wagner, former General Counsel FHWA, December 27, 2015

The NHTSA's recent ruling, that an autonomous system can be considered the "driver" of a vehicle, moves the discussion forward but, also opens a host of complex questions.[47]

The FAA and NHTSA are relatively large regulatory agencies with extensive expertise and capabilities. Regulating autonomous systems will become central to their missions. They can grow into their new roles of regulating robotic systems, although there will be difficulties. But there are also smaller agencies with fewer resources that, as robots become increasingly ubiquitous, may find themselves regulating autonomous systems. The cognitive radio, regulated by the FCC, may be a harbinger, in which a robotic system that is not central to the agency comes under its regulatory purview.[48] While larger agencies can develop the capabilities to regulate robotics and smaller agencies can certainly grow to face new technological challenges,[49] how will smaller agencies with limited resources cope with new technologies that are peripheral to their primary functions?

Hiring the necessary expertise will also be a challenge for regulators. Computer scientists and roboticists are in high demand—public sector careers may not be attractive. Agencies have substantial autonomy in making hiring decisions and there are numerous mechanisms by which government agencies can bring in specialized talent outside of the traditional government pay scale (although they are not being used fully).[50] Further, although the government cannot match private sector salaries in the most sought after fields, the unique missions are often an important recruiting advantage.[51] However, technical standards are only part of regulation. Attorneys and social scientists who have sufficient background on these technical issues will also be required. But such expertise is also in short supply as the field is still emerging. Developing this expertise will take time.

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[47] Alex Davies, "Feds Say They'll Count Commuters as Human Drivers," *Wired*, February 10, 2016, http://www.wired.com/2016/02/feds-say-theyll-count-computers-as-human-drivers/
[48] Calo, *Federal Robotics Commission.*
[49] Federal Trade Commission, "FTC Seeks Technologists for New Research, Investigations Offices," March 23, 2015, https://www.ftc.gov/news-events/press-releases/2015/03/ftc-seeks-technologists-new-research-investigations-office; Andrea Peterson, "FCC Cracks Down on Verizon Wireless for Use of 'Supercookies'," *Washington Post*, March 7, 2016, https://www.washingtonpost.com/news/the-switch/wp/2016/03/07/fcc-cracks-down-on-verizons-supercookies/
[50] Vanessa Pena and Michael C. Miniero, *History of the Critical Position Pay Authority and Options to Support Its Use* (Washington, DC: IDA Science & Technology Policy Institute, March 2014), https://www.ida.org/idamedia/Corporate/Files/Publications/STPIPubs/2014/ida-d-5159.ashx
[51] Interview with Lewis, January 14, 2016

Calling for agencies to develop the capabilities to regulate robotics does not necessarily mean that an intense regulatory scheme is required. A more laissez-faire approach may be appropriate to best encourage growth in this still young field, but that framework should be a conscious decision from an informed position, rather than completely *ad hoc*. Thus enacting and enforcing even a limited regulation scheme requires some organizational knowledge.

Agencies charged with regulating robots (and many, many regulatory agencies will in some way or another find robots under their purview) face a tremendous challenge in assuring public safety while also creating a regulatory environment that fosters innovation. It is almost certain that there will be failures and these failures could spark crises.

Crisis

It is not easy to define exactly what constitutes a crisis. Something that overwhelms the standard operating procedures and programs of an agency is one definition. Or, more properly, a crisis is whenever a significant portion of the general public feels that the government is not functioning properly. In short, a crisis is a bit like pornography; you know it when you see it.

Robotics crises are inevitable, and the very nature of autonomous systems operating in ways that are not predicted will exacerbate faults and failures that might otherwise be tolerated. Often crisis management is *ad hoc*. In some cases, crises are common enough that there are specialized programs and even agencies to address them. An airplane crash is a significant system failure, but there is a highly specialized independent agency, the National Transportation Safety Board, that investigates them. Similarly, the Federal Emergency Management Agency responds to natural disasters and has developed routines and programs for disaster response. Some regulatory agencies have internal crisis management capabilities. The Food and Drug Administration is empowered to pull medical products from the shelves and, in conjunction with the Department of Agriculture, to impound unsafe food.

Presumably, agencies with oversight of robotic systems will develop the appropriate capabilities to manage failures before they become crises, for example, pressing automobile manufacturers to update systems in response to traffic incidents involving autonomous vehicles. But it is reasonable to assume that there will be crises involving robotics that will

exceed what these bureaucracies can manage on their own, and because the systems are robotic, there may be a much lower threshold before public confidence begins to waver.

Putting aside the nightmare scenario of artificial intelligence threatening human existence (the stuff of movies rather than science), there innumerable potential robotic crises. Because they can act in the physical world in ways that cannot necessarily be predicted, robots may cause harm or spark frustration or panic among the general public. Several potential types of crises suggest themselves:

- *Malfunction.* Robots have software and hardware which will contain bugs and defects that could lead to dangerous malfunctions;
- *Misfunction.* Robots may act in ways that were not predicted that cause harm;
- *Dysfunction.* Robots, acting as expected, may prove upsetting and spark general outrage;
- *Mis-Use.* Robots are used by criminals or other malefactors in an illegal and/or harmful manner.

It is not difficult to imagine possible crisis scenarios. To provide just a few examples, in a world of automated cars, a bug may cause the automated cars to detect a fatal error and stop and disembark passengers when there is no problem, stranding people at inopportune times. Automated cars may, based on their programming, stop at times and places where people would not stop, inadvertently causing accidents. Alternately, automated cars interacting with one another create traffic patterns, which inconvenience non-automated vehicles and pedestrians. Finally, automated cars may become a tool of criminals or terrorists.

Crises also vary in scale, which can occur in multiple dimensions:

- *Quantity.* How many people are affected by the robot crises? Tens of thousands of commuters in a major city stranded by mis-functioning autonomous vehicles will attract far more attention than a highly specialized mal-functioning robot;
- *Ubiquity.* How common are the devices? Misfunctions by autonomous vehicles which everyone uses may be more upsetting than a malfunction by a highly-specialized surgical device;

- *Strangeness.* How odd is the dysfunction? Autonomous drones systematically photographing people in bathrooms may be more upsetting than a comparable number of people affected in a traffic shutdown;
- *Violence.* Are people actually hurt or killed?

A commercial airline crashing because of unpredicted behavior by autonomous drones would prove high in terms of number (of people affected), violence, and ubiquity (many people fly.) An autonomous surgical system that performs an operation incorrectly and kills a person would not be high in terms of number of people, but would be high for its violence and strangeness. A national smart electric grid that malfunctioned and deprived major portions of the country of electricity would be high in ubiquity and number of people affected.

Looming over all of these factors is time. The longer a crisis continues, the more people will lose confidence in their institutions. Jason McNamara, former chief of staff to the head of FEMA, explained that there are three inter-locking challenges to crisis management: addressing the problem, mitigating the effects of the problem, and communicating to the public about how the first two are being handled. In the case of massive flooding, engineers may be working to drain the affected area while logisticians are ensuring the people in the affected area can obtain food and medical treatment. But these important tasks will be severely hampered if spokespeople cannot clearly explain what is being done to address the problem.[52]

Analyzing likely political behavior in the wake of comparable crises, Daniel Drezner notes that slow or inadequate initial responses will lead to public demands for action, a lack of confidence, and could spark potential over-reaction later. At the same time, an initial over-reaction can lead to public backlash against the government.[53] During the crisis, the bureaucracies will become more effective over time (and this organizational learning can happen quickly in a crisis). Drezner writes:

> If both domestic political pressures and bureaucratic politics play a role in affecting government policies, their combined effect could be doubly disastrous. Government agencies would have the most autonomy when they are most likely to make bad

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[52] Interview with Jason McNamera, former Chief of Staff to Director of FEMA, March 4, 2016

[53] Daniel W. Drezner, *Theories of International Politics and Zombies: Revived Edition* (Princeton: Princeton University Press, 2014), 80

decisions. By the time these bureaucracies adapt to new zombie exigencies, they would face political hurdles that could hamper their performance.[54]

Robots are not zombies (for starters they are real) but it is easy to imagine disproportionate reactions to robotics crises. Isolated incidents may not present major difficulties. But if robots are involved in critical functions, large-scale malfunctions and misuse could have cascading effects and spiral into crises. Additionally, if minor incidents explode into major crises, it could hamper the development of robotics as public mistrust grows and as burdensome, official over-reactions create a less welcoming development environment.

What kinds of capabilities will policy-makers need to manage and mitigate these crises? Since government capabilities exist in the form of institutions, what should these institutions be and what should they look like?

In actual crises, there is a great deal of improvisation. As one Administration official explained, "We have an ongoing deliberative process. If there were a complex emergency issue, we would surge to bring people in as we did with the Ebola and other crisis."[55]

Since robotics are a new domain, agencies will need to develop new capabilities for problem solving, mitigation, and communication, and new pathways for cooperation. These problem-solving networks will develop in the face of a crisis, but it might be useful to short-circuit the process and try to reduce the learning curve. One possibility would be a net assessment team that developed scenarios and carried out large-scale simulations that included computational modeling and human war-games. White House staffers and agency officials could participate in these sessions in order to prepare for potential crises. It is impossible to predict exactly what shape these crises will take, but as Eisenhower observed, "In war plans are nothing, planning is everything."

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[54] Drezner, 96
[55] Interview by author, name withheld, January 19, 2016

Change

Beyond specific crises, robots will spark vast changes to society, law, social arrangements, education, labor and work, and vast other realms. Predicting the future and developing policies that anticipate these changes is extremely difficult. Much of the effort will occur in the private sector and organically in response to events as they develop. For example, initiating a new welfare state and adult education policies to accommodate potential legions of workers displaced by robotics is difficult to do before this displacement actually begins. Similarly, determining policy and legal aspects to emotional attachments to robots and how they change families and organizations is difficult to consider before those attachments begin occurring on a large scale.

But these changes are require serious consideration.

In the immediate term, the best thing the government can do is foster research on these questions. There are many mechanisms wherein governments can sponsor conversations that bring together the public sector, academia, and the private sector, through workshops and/or formal advisory bodies.[56] The government also funds social science research, particularly through NSF, although this area is steadily cut and under constant political pressure.[57] In general, Congress has shown a preference for sciences with clearer payoffs such as medicine or engineering over social science. This is unfortunate, because, in the words of John Sides, professor of political science at George Washington University, "[T] he quality of our lives depends a lot on families, schools, and economic prosperity—to pick a few fundamental topics that social scientists study." Sides applies this argument to fighting disease, noting that without stable institutions the ability to deliver a new medicine is limited. Given how robots may change lives and society, these arguments apply to robotics as well.[58]

New initiatives to fund basic social science on how humans and human institutions interact with robots and are affected by them would be well worth considering.

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[56] Interview by author, name withheld, January 19, 2016
[57] Interview with Parker, January 20, 2016
[58] John Sides, "Why Congress Should Not Cut Funding to the Social Sciences," *Washington Post*, June 10, 2015, https://www.washingtonpost.com/blogs/monkey-cage/wp/2015/06/10/why-congress-should-not-cut-funding-to-the-social-sciences/

Mission Redux

From this brief survey of the government's missions regarding robots, some of the government's needs become clear. Research is an area of strength, but regulators are facing challenges keeping up with the rapid pace of technological change. Crisis management and broader societal change are difficult to address, as they have not really begun to happen although some early preparation is in order. Regulation however is the linchpin for developing policy. It is important in its own right, but it also shapes the research environment and the crisis management options. The remaining question is how best to build the capabilities.

3. Institutional Options

Before discussing different institutional options for developing robotics policy, another possibility has to be examined. *Do nothing.* Agencies will adapt and learn. Government agencies also have to go through painful periods of growth and innovation but, in the not too distant future, they will have developed the capabilities to respond to this new technology and have forged the inter-agency links needed to do so. Existing regulatory agencies have the authority needed to regulate new technology and will develop the expertise based on their existing experience. An Administration official asked, "We have in the NSTC a mechanism for debating technology policy. Does it make sense to replicate government policy mechanisms that already exist? Would a new stand-alone commission be able to balance regulation with commercial opportunity the way OSTP and the NSTC can, in collaboration with the other policy councils like the NEC and NSC? At this time I don't see the role for a Federal Robotics Commission."[59]

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[59] Interview by author, name withheld, January 19, 2016

A New Agency

Establishing a new agency *tabula rasa* to address a new set of problems has tremendous appeal. A new agency can bring in new ideas and fresh perspectives unfettered by the past. Robotics are a fundamentally new technology and require new kinds of institutional capabilities, not merely an update of current operations.

Based on the above analysis of the government's role in robotics, an independent agency could have several programs, for example:

1. To develop technical, legal, and policy expertise in robotics to advise other agencies;
2. To fund long-term research on robotics and society; and
3. To do deep simulations, war-games, and net assessment exercises to prepare for potential crises

There would be advantages to establishing a new agency. Ryan Calo makes the case:

> The time to think through the best legal and policy infrastructure for robotics is right now. Early decisions in the lifecycle of the Internet, such as the decision to apply the First Amendment there and to immunize platforms for what users do, allowed that technology to thrive. We were also able to be "hands off" about the Internet to a degree that will not be possible with robotics and systems like it that are organized not merely to relay information but to affect the world physically or directly. Decisions we make today about robotics and artificial intelligence will affect the trajectory of this technology and of our society.[60]

Nor is he alone. Lynne Parker, the NSF Division Director for the Information and Intelligent Systems Division, observed, "There is an advantage to having a central location that knows all of the challenges and has a common resource across all the agencies. Currently, everyone is solving the problem for their own mission, but this is no broader than their own mission."[61]

However, establishing a new agency can be a complicated endeavor. Legally, the president and even a cabinet official can establish a new agency. However, Congress would then have the

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[60] Calo, *The Case for A Federal Robotics Commission*, 15.
[61] Interview 1

option to defund it. Since it takes time for a new agency to develop its programs, the threat of being dis-established would be a significant barrier to the agency becoming effective.

The logistical challenges are more significant. A new agency would need office space and furniture. If the agency were actually doing research or the net assessment simulation/war-games discussed above, it would need unique and specialized facilities. It would need to establish hiring criteria, which for an agency hiring expert personnel might prove particularly complicated. The importance of providing a clear career path for attracting capable people to an agency cannot be overstated.[62] The new agency would also need to establish develop budget, procurement, and public affairs offices.[63] It might take the better part of a decade before the agency could make a positive contribution, although if its primary mission was longer-term research, this might not be an issue.

Once established, the new agency might quickly become embroiled in battles for turf. On the regulatory side, if it were not given a formal, statutory role, agencies might ignore it. If this new agency were given a formal statutory role, agencies might push back at this threat to their autonomy. While a new independent agency might whither on the vine with little attention paid to it, it could alternatively take a seat at an already crowded table.

At the same time as the new agency were struggling with other agencies for a role, in order to play a constructive role in crisis management, the agency would need to have strong working relationships with other agencies. Eventually this could be established; agencies do cooperate, but it might be a difficult and lengthy development.

The mission of supporting social science research on robots and society may appear to be a relatively minor challenge compared to regulation and crisis management. However, supporting research is a skill in its own right that the agency would need to develop. While the funds for this research are tiny in the context of government spending, a poor grant-making

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[62] Amy Zegart discusses in depth how the failure to develop career tracks for intelligence analysts specializing in terrorism contributed to broader counter-terror failures. Amy B. Zegart, *Spying Blind: The CIA, The FBI, and the Origins of 9/11* (Princeton, NJ: Princeton University Press, 2007).
[63] This was a component in the 9/11 Commission's decision to *not* recommend establishing a new domestic intelligence agency separate from the FBI. See *The 9/11 Commission Report: Final Report of the National Commission on Terrorist Attacks upon the United States* (Washington, DC: Government Printing Office: 2011), 424, http://www.9-11commission.gov/report/911Report.pdf.

decision can garner attention from the media or politicians who will rail against government funds supporting absurd academic research.

In establishing a new agency, one critical question is where it would be housed. It could be placed within a cabinet department, or it could be an unattached agency (like NASA), or alternately it could be an independent regulatory agency like the FCC or FTC. Each of these approaches has strengths and weaknesses. A cabinet department might not welcome a new agency that was in danger of getting into turf disputes with agencies from other departments. On the crisis management side, if it were placed in the wrong department it might not have sufficient access to top decision-makers to be useful.[64] However as an unattached agency, without a strong patron in the White House, might also struggle for access and relevance. Finally an independent regulatory agency can be an effective regulator, if given the appropriate authority. But these agencies are generally removed from the inter-agency process that would play a critical role in crisis management.

Establishing a new institution requires committment from a high-level political supporter, such as the president or a cabinet member. With those attributes, the difficulties presented above can be overcome. But there may be other routes to achieving the same results.

Establishing a Lead Agency

An alternative to establishing a new agency would be for an existing agency to develop relevant capabilities. Often new capabilities that are not closely related to the agency's core functions are held at arm's length and people in the new sub-unit may have limited promotion potential or access to the organization's leadership. This can lead to organizational dysfunction in crises or in pursuit of resources.[65] A telling example was the relative isolation of the FAA's intelligence unit from the agency's leadership prior to 9/11. The lack of threats, combined with the conflicting mandates of regulating security and safety while also promoting the civil

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[64] For example, Daalder and Destler presciently warned that placing FEMA in the Department of Homeland Security, rather than leaving it as an unattached agency with direct White House access, might hinder the agency's ability to respond to major disasters. Daalder and Destler, "Advisors, Czars and Council."

[65] Wilson, *225*

aviation industry, led to a general downgrading of that first priority.[66] And, established agencies will not seek out new responsibilities that will bring them into conflict with other agencies.

An established agency will already have office space, procurement and hiring policies, etc. This will reduce some of the difficulties in building an agency with a robotics analysis capability. An established agency will also have existing relationships in the inter-agency process that can be leveraged. However, if the robotics mission is added to an established agency, it will be less likely to bring the new and fresh perspectives of a new agency.

And which agency should be lead? No agency has the unique combination of skills needed for the robotics mission. NIST, for example, which sets standards for robotic systems, could play a useful role advising regulatory agencies on autonomous systems, but it is not engaged in the broader legal and policy issues around robotics, and it is generally not involved in crisis management. Alternately, the FTC, for example, has legal and regulatory experience and is playing a significant role on privacy issues. While it is developing capabilities to monitor emerging technologies, it would need to expand these capabilities dramatically to effectively become the government's premier robotics agency. The contrast between NIST and the FTC reflects the fundamental trade-off to be made in appointing a lead robotics agency. Some agencies have relevant technical expertise, while others have legal and policy expertise—which of those capabilities will be easier to build and attach to the agency?

Another agency with vast experience in science and technology issues is NASA, which currently builds and operates robots. NASA, like NIST, has experience with technical issues and, being larger than NIST, might find growing a new organizational capability less of a challenge. Further, NASA has a higher profile in the public eye and the inter-agency process. However, NASA does not have experience with the legal and policy issues surrounding robotics and may not be interested in this new mission.

This is, by no means, a complete analysis of agencies that could potentially take on the robotics mission – nor is it the final word on the agencies discussed above. Rather, it is intended to show the kinds of decisions and trade-offs that will have to be made in choosing a lead agency.

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[66] *9/11 Report*, 82-84

Appointing a lead agency for robotics will, in some regards, be easier than establishing a new agency. But it will still have challenges, exacerbated by the potential for an agency to reject this new mission.

A Potential Half-Measure

The regulation mission is the most important, but also the most contentious aspect of a robotics agency. It effectively makes the robotics mission a poison pill for any agency pressed into taking on the task. The crisis management preparation role, on the other hand, would not ruffle so many feathers. Net assessment projects generally make few bureaucratic enemies because they do not threaten any other agency's autonomy.[67] Establishing a unit that could organize sophisticated simulations and war games would still be challenging, but other agencies (particularly the Department of Defense) regularly have wargames and that expertise could be leveraged.[68]

A net assessment team could also be the first step towards growing a broader robotics analysis capability throughout the government. In the process of developing scenarios and meeting with the private sector and academia, the team would develop expertise and be better equipped to ask deeper social science questions about robotics, enabling them to sponsor longer-term research. The exercises could have a broader effect across the government. Exercises would include inter-disciplinary representatives from a range of relevant government agencies. Robotics crises will of course have technical aspects, but they will also have legal and economic aspects. Attorneys, economists, public affairs spokespeople, and other professionals would all have roles to play. This approach would create communities of interest throughout the government and begin building inter-agency bonds. In effect, these exercises could stimulate the bureaucracies to adapt to this new domain.

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[67] Interview with Elkus, January 5, 2016.
[68] The Department of Defense obviously has many of the relevant capabilities, but giving the DOD the lead on domestic issues can create civil-military problems. The DOD has more resources than any other Department in the government, but nonetheless cannot be expected to take the lead on every issue.

4. Pulsing the System

As White House Chief of Staff, Secretary of Defense, and Vice President, Dick Cheney was famous for "pulsing the system," that is reaching down into the bureaucracy to gather more information and generate more options.[69]

Returning to our metaphor of bureaucracies as vast autonomous systems, Cheney (and most effective government executives) recognized the need to not necessarily take the first answer the system provided but to "refine their queries."

This section examines the political leadership, Congress and the President, and how they interact with the bureaucracy. It also discusses some of the options they possess for pressing for the interests, for "pulsing the system."

Capitol Hill

Wilson describes Congress as both the architect that creates and sustains bureaucracies as well as being fire-fighters who rush to address problems.[70] For our metaphor of bureaucracies as robots, Congress is the system architect and they are also tech support.

Bureaucracies can be created by Congress as a matter of statute. Their actions are monitored by Congress and many of the constraints on their actions are due to rules placed on them by Congress. Congress usually gives an agency a broad, general mandate e.g., to ensure pharmaceuticals or automobiles are safe or that a particular community's needs are served. When there are problems with how an agency interprets its mandate, such as regulations a particular industry finds onerous, Congress will create rules shaping and constraining the agency's behavior. Congress can also change an agency's funding. Of course, given that this power exists, agencies will want to preserve their autonomy and not run afoul of the

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[69] Bob Woodward, *The Commanders* (New York: Simon & Schuster, 2007)
[70] Wilson, 236-37

legislature. Congress, through hearings or informal communications, can also influence an agency's behavior.[71]

The ultimate client for Congress's service-building and maintaining the bureaucracy is the public—the American people. However, the American people usually communicate their preferences via interest groups, not as a clear majority. Interest groups can be in conflict and Congress itself works through committees, which often have competing priorities and are themselves captive of particular interest groups. Committees are as turf conscious as any agency.[72]

One issue to consider is which committees will oversee robotics issues. The Department of Homeland Security offers a cautionary tale. Because its components were from various departments, DHS answers to over 100 congressional committees and subcommittees. Responding to the requests and needs of all of these committees consumes valuable energy. Returning to the robotics metaphor, a congressional hearing is a major system query. Large numbers of these queries place great demands on the system. In testament to the demands this intense congressional oversight places on the system, the 9/11 Commission Report and every DHS secretary has urged Congress to reduce the number of oversight committees. And in a testament to congressional committee turf consciousness, there has been no movement on this proposal. (This should not be construed as a criticism of Congress, which, as the ultimate representative of the American people, has every right to query the bureaucracy to ensure that an agency is fulfilling its role. However, many advocates of consolidating the oversight role note that it would actually strengthen congressional authority over DHS.)[73] In establishing new institutions, taking into consideration the organizational and political requirements of these institutions is essential. Multiple congressional committees will have a stake in robotics issues. An agency intended to deal with robotics issues across many domains will potentially face congressional scrutiny from multiple committees.

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[71] T. M. Moe, "The Politics of Bureaucratic Structure," in *Can the Government Govern?*, ed. J. E. Chubb and P. E. Peterson (Washington, DC: Brookings Institution Press), 267-330, and Herbert Kaufman, *The Administrative Behavior of Federal Bureau Chiefs* (Washington, D.C.: Brookings Institution, 1981), 164

[72] Wilson, 268

[73] Federal News Radio Staff, "With 108 Congressional Bosses, DHS at Oversight 'Tipping Point'," *Federal News Radio,* September 8, 2011, http://federalnewsradio.com/budget/2011/09/with-108-congressional-bosses-dhs-at-oversight-tipping-point/

Congress is itself a bureaucracy and is served by several, highly specialized agencies including the Congressional Research Service, the Congressional Budget Office, and the General Accounting Office (which conducts investigations). From 1975 to 1995, Congress was served by the Office of Technology Assessment, which provided objective information on science and technology issues. It was eliminated as part of Newt Gingrich's Contract with America. However, as technology and science issues have become increasingly complex, some re-instated version may be worth considering. Although there are a plethora of research institutes prepared to provide Congress information, curating these sources and providing information in a form that Congress finds useful is a unique task. This does not mean tailoring results according to political pressures, but rather providing results that focus on congressional decision-making needs in a timeframe appropriate to the congressional calendar. Unfortunately, beyond the logistical difficulties of establishing a new agency in any domain, in the current political *climate* a renewed OTA is unlikely.[74] Congress could also expand its access to independent science and technology information by expanding CRS and GAO, both of which already address some science and technology issues.[75]

The White House

The power of the presidency, Richard Neustadt, author of the classic *Presidential Power*, explained, "Is the power to persuade."[76] The president does have formidable institutional powers, but much of the president's power comes from leveraging these formal powers to informally press and persuade constituencies inside and outside of the government to support or carry out policies. President Truman observed that General Eisenhower would find the

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[74] Chris Mooney, "Requiem for an Office," *Bulletin of the Atomic Scientists* 61, #5 (September-October, 2005): 40-49, http://www.princeton.edu/step/seminars/previous/fall-2005/Mooneyreading2005No2Requiemforanoffice.pdf

[75] There is of course another branch of government that shapes the behavior of bureaucracies – the judiciary. However, since this is a conference on law, attended by many attorneys, this author thought it prudent to leave that issue to the experts (also, this paper needed to be finished). That being said, judicial access to impartial scientific and technical advice (i.e. not experts advocating on behalf of a client) is inadequate and exploring measures to increase it would undoubtedly be useful.

[76] Richard Neustadt, *Presidential Power and the Modern Presidents: The Politics of Leadership from Roosevelt to Reagan*, 5th edition (New York: Free Press, 1990), 11

presidency frustrating. "He'll sit here, and he'll say, 'Do this! Do that!' *And nothing will happen.* Poor Ike–it won't be a bit like the Army. He'll find it very frustrating."

Presidents find the bureaucracy, which as was discussed above, have a number of competing influences and constraints on their action, as frustrating as most (maybe more so). They are capable of pressing their writ on the bureaucracy, to some extent, but are hampered by their vast range of responsibilities and duties. As one Roosevelt staffer observed:

> [T] o get anything done, a president must ask for it three times. Bureaucrats fell that only one request from the president means that the matter can be safely ignored. Upon the second request, the president can be told that the matter is being investigated. The third time the president asks, the deed should be done. Presidents, however, rarely ask for anything three times.[77]

Over the past century, the White House has transformed into the Executive Office of the President, with several thousand employees. It has become a vast mechanism in its own right, intended to gather information from the federal bureaucracy and beyond on behalf of the president and cajole the rest of the government to carry out the president's wishes.

The White House can also be thought of as a sort of government in miniature. For much of U.S. history, the president was served by a modest staff of a few personal secretaries. The cabinet was the central body of the executive branch and the president dealt directly with Congress. Presidential staff began to grow around the turn of the 20th century, but it was still small. As the executive branch grew dramatically in the 1930s, as the federal government took on a vast new role in the national life, the president's staff grew as well. From a handful of professional staffers under FDR, the White House began adding staff and permanent attached bodies. Now, the Executive Office of the White House has several thousand staffers and, in effect, a parallel government with multiple bodies like the National Security Council staff, the Office of Management and Budget, the Council of Economic Advisers, the Council on Environmental Quality, the Office of Science and Technology Policy, Office of Public Engagement and Intergovernmental Affairs, and the Domestic Policy Council with counterparts in the bureaucracy. Turf can become an issue within the White House as well.

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[77] Jonathan Daniels, *Frontier on the Potomac* (New York: Macmillan, 1946), 31-32

White House bodies may offer a tool for "pulsing the system" and influencing policy. Broadly speaking White House offices have the advantage of proximity to the president, which means that it has a chance of breaking through bureaucratic logjams—if the issue has the president's attention. However, offices attached to the White House tend to be small and less able to undertake sustained analytical work. In the absence of presidential attention, they may struggle for influence, particularly when facing larger agencies guarding their turf.

A White House _council_ is a body established in the White House to coordinate policy and the interagency process and to directly advise the president on a broad range of issues. Examples include the National Security Council (NSC) and the Domestic Policy Council. These groups often consist of a formal council of department leaders and a staff that represents the White House and supports the president. On science and technology issues, two bodies work together to fulfill this function, the National Science and Technology Council, which has representatives from key departments and agencies, and the Office of Science and Technology Policy (OTSP), which staffs the NSTC and the president and coordinates the inter-agency process. OSTP, like many other White House entities, primarily derives its influence, not from money or formal authority, but from access to the president. It is however, again like many White House offices, small (particularly in relation to its mission space). In a practical sense, their work consists of responding to the president's concerns, bringing issues to the president, and ensuring the president's policies are implemented. All of these tasks involve interfacing with the broader bureaucracy (often through committees and sub-committees of the NSTC.) In responding to a presidential concern, OSTP would reach out to appropriate agencies for expertise to bring credible answers to the president. Agencies, in turn, may have issues they feel need presidential attention which they could bring to OSTP staffers. Finally, when policy is decided, OSTP staffers, working through the inter-agency process clarify the president's policy to agency and seek to address their concerns and bureaucratic logjams.[78]

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[78] See "About OSTP," *Office of Science and Technology Policy* website https://www.whitehouse.gov/administration/eop/ostp/about and National Science and Technology Council website https://www.whitehouse.gov/administration/eop/ostp/nstc. For more detail about staffing the president in general see David Rothkopf, *Running the World: The Inside Story of the National Security Council and the Architects of American Power* (New York: Public Affairs, 2006) or Ivo H. Daalder and I. M. Destler, *In the Shadow of the Oval Office: Profiles of the National Security Advisers and the Presidents they served from JFK to George W. Bush* (New York: Simon & Schuster, 2011)

Supporting OSTP is the Science and Technology Policy Institute (STPI), a federally funded research and development center (FFRDC) that serves as an independent think tank for OSTP. STPI produces in-depth reports on science policy and science for policy on behalf of OSTP and other agencies. The STPI was established after the OTA was disbanded. The White House recognized that it wanted its own in-house capability to do deep dives on science and technology issues. In writing its reports, STPI has at times resolved the issue it was studying through the process of bringing the relevant groups together.[79]

It is possible that the White House could establish a Robotics Council, but that might result in duplication with the OSTP and the NSTC, and interest groups might press for new and stand-alone councils for other emerging science and technology issues. OSTP is heavily engaged in robotics issues, it is an area emphasized by the president, and there is lively internal discussion within OSTP on robotics issues.[80]

While research organizations have a network of councils and working groups to facilitate exchange and collaboration, it does not appear that regulatory agencies are similarly served. The utility of these exchanges may be limited. The difference in domain between, for example, the FDA regulating medical robots and the NHTSA regulating autonomous cars may be too great for useful discussions. However, general comparisons on how to evaluate autonomous systems may be useful. Also, as cars, (to take one example) have increasing computational components, cyber-security and privacy will become issues to be addressed and the NHTSA may benefit from discussions with agencies that have already faced these challenges.

An alternative to a council, which coordinates, is a _czar_, which centralizes. Czars are generally established to address a major, cross-cutting inter-agency issue of national significance that requires high-level attention. It is not a formal term, but there are two types of "czars", those occupying statutory positions such as the Office of National Drug Control Policy versus informal positions in which a White House advisor is specifically tasked with a major issue. The formal "czars" are subject to Senate approval and can be called to testify before Congress. The informal czars in many cases are taking roles historically taken by lower-profile White House

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[79] Interview with Lewis, January 14, 2016
[80] Interview with Administration official, name withheld, January 19, 2016

staffers. But while staffers work in the shadows, appointing a czar is often a public signal that a particular issue is being treated seriously by the president.

Czars have a mixed record of success. They are generally efforts at centralization, but they lack the necessary authority over budgets. Shortly after 9/11, Pennsylvania Governor Tom Ridge was appointed Homeland Security Advisor, in effect the czar for homeland security. But, as former drug czar Barry McCaffrey warned, the office, "will turn into little more than the speaker's bureau for homeland defense."[81] The formal czars have generally not become significant players in their administrations. However, at times, particularly in response to a crisis, a czar with a specific mandate can play an effective and substantive role, as Ron Klain (a former chief of staff to the vice president) did as the Ebola czar.

Agency chiefs usually control significant budgets and personnel, and can exercise autonomy in identifying and pursuing new policy initiatives. White House staffers without presidential support can have, at best, limited influence. In terms of robotics, a formal Robotics Czar, say heading a White House Office for Robotics, might struggle to find a mission, being forced to contend with innumerable agencies and other White House offices, particularly OSTP. A shorter-term czar might be a response to a particular problem, but what immediate narrow robotics problem exists that requires this level of intervention? The robotics technology that is most public and relevant is the issue of drones, so a drone czar to press the FAA could have a role. But to be successful, the czar would require significant presidential support—something that is always in short supply.

One interesting note on this front is that since the 1980s Presidents have appointed vice presidents as "czars" on a wide range of substantial issues. George H.W. Bush oversaw a number of specialized committees, including a Task Force on Terrorism[82] and the administration's deregulation efforts. Vice President Gore co-chaired a series of bilateral commissions with other countries including Russia, Egypt, South Africa, and the Ukraine.[83]

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[81] "Ridge Defends His Role as 'Coordinator'," *Washington Post*, November 18, 2001

[82] Aaron Mannes, "Terrorism and Bush I: Assessing the Role of the Vice President's Task Force on Combatting Terrorism," Presented at ISAC/ISSS 2010
http://veepcritique.blogspot.com/2010/10/terrorism-bush-i-assessing-vice.html

[83] Aaron Mannes , "The Vice President and Foreign Policy: From 'the Most Insignificant Office' to Gore as Russia Czar," in *Project on National Security Reform Case Studies Working Group Report: Volume II*, ed. Richard Weitz (Carlisle, PA: Strategic Studies Institute, U.S. Army War College, 2012), 23-85.

Some of the commissions served as significant policy vehicles. Gore also ran commissions on terrorism and the re-inventing government initiative. Vice President Biden has overseen a number of formal Obama administration initiatives, most notably the stimulus package and, more recently, an effort to find new treatments for cancer. Vice presidents who possess the president's confidence can bring significant attention to an issue and play a unique coordination role. Should a high-profile robotics issue emerge, appointing the vice president as "robotics czar" may be a useful option.

Finally, there is the "blue ribbon" _commission,_ a temporary, semi-independent body that can be appointed by the president, a cabinet member, or mandated by Congress. These commissions have been established to address a vast range of issues, from relatively minor to major national crises and concerns, such as the Warren Commission on Kennedy's Assassination, the 1998 Hart-Rudman Commission, officially known as the U.S. Commission on National Security in the 21st Century, and of course the 9/11 Commission. These bodies have, in the past been derided, in the words of Amy Zegart, as "a blue ribbon panel of distinguished civilians, appointed directly by the president, that defuses, deflects, or delays presidential action on some controversial domestic issue without producing much in the way of substantive policy change." But, in surveying 20 years of blue-ribbon panels, Zegart finds that presidents establish these commissions strategically (and notes that their patterns of establishment are fairly consistent across different administrations). Presidents establish these commissions for a number of reasons, sometimes to gather public support for the agenda or break a political logjam, but also to identify and study new policy problems and generate new facts, analysis and options. She cites the Hart-Rudman Commission, for example, as providing a useful framework for thinking about national security organization for the 21st century.[84] A commission would be an accessible option for a president seeking new information on robotics, or any issue.

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[84] Amy Zegart, "Blue Ribbons, Black Boxes: Toward a Better Understanding of Presidential Commissions," *Presidential Studies Quarterly,* 34, #2 (June 2004): 366-93.

Conclusions

This paper attempts provides a tool-kit of governance options (summarized in a table on the next page) for political leaders interested in preparing the United States government to face the challenges of robotics. In considering which of these options to employ, it is important to consider that they are not mutually exclusive. A net assessment group could be stood up at an agency, while the White House facilitated collaboration among regulators, and appointed a blue ribbon commission to look at the impact of the emerging field of robotics. The president could also assign the vice president to deal with logjams around deploying a particular robotic application.

However, one factor that influences whether any of these options are employed is the problem of finite resources. This does not only mean money, although that is important; it also includes political capital, time, and expertise. Consolidating congressional committees around robotics would not be a significant budget item, but the political challenges could prove insurmountable.[85] A robotics council in the White House would become another applicant for the president's time and energy. Establishing a commission costs little, but it could make politically untenable recommendations and place the president in an awkward position.

Building and modifying bureaucracies is like constructing robots. There will be trade-offs in the design, and a certain amount of unpredictable, emergent behavior is to be expected.

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[85] For example, would the House Transportation Committee cede its authority over autonomous vehicles to a new Robotics Committee, or would instead those regulating autonomous vehicles now have to answer to an additional committee.

OVERVIEW OF INSTITUTIONAL OPTIONS FOR ROBOT GOVERNANCE

OPTION	Description	Advantages	Disadvantages
DO NOTHING	No institutional changes to dealing with robotics Allow agencies to grow organically to face challenges	No financial, political, or administrative costs Leverages existing relationships in the bureaucracy	Adaptation will be incremental and may not meet fast-moving challenges
BUREAUCRACY			
NEW AGENCY	Establish a new agency to address robotics issues	Centralized information and analysis on robotics Will bring new ideas and perspectives	High cost of establishing a new agency Will take new agency some time before it is effective Agency could become embroiled in turf disputes
LEAD AGENCY	Assign an existing agency to take the lead on robotics issues	Lower cost and less time than establishing a new agency Leverage already existing agency capabilities	New mission may not fit agency culture and could expose agency to turf disputes No agency has all the necessary capabilities, so new capabilities will still be needed
NET ASSESSMENT	Establish specialized net assessment group that models and war-games robotic crises	Lower cost than establishing full-scale robotics governance capability Will not threaten anyone's turf	Not immediate relevant to regulation or other governing concerns

OPTION	DESCRIPTION	ADVANTAGES	DISADVANTAGES
CONGRESS			
CONGRESSIONAL COMMITTEE	Establish a new Congressional committee (or subcommittee) for robotics	Develop Congressional expertise in robotics Gives Congress greater oversight of robotics	Places further demands on agencies to answer to Congressional queries
CONGRESSIONAL AGENCY	Establish a Congressional agency to provide timely advice on science and technology issues	Provides Congress has better information on science and technology	High cost of establishing a new agency
WHITE HOUSE			
COUNCIL	Establish a new coordination mechanism for robotics issues	Low cost Can better leverage existing expertise within bureaucracy	Could become embroiled in turf disputes with existing councils addressing related issues
CZAR	Establish a White House point person on a key robotics issue	Low cost Can press for responses to short-term challenges	Requires presidential support to be effective Will be less effective addressing longer-term, open-ended issues
COMMISSION	Enact a temporary panel to examine an issue	Low cost Can provide the president new information and options	May not address immediate concerns