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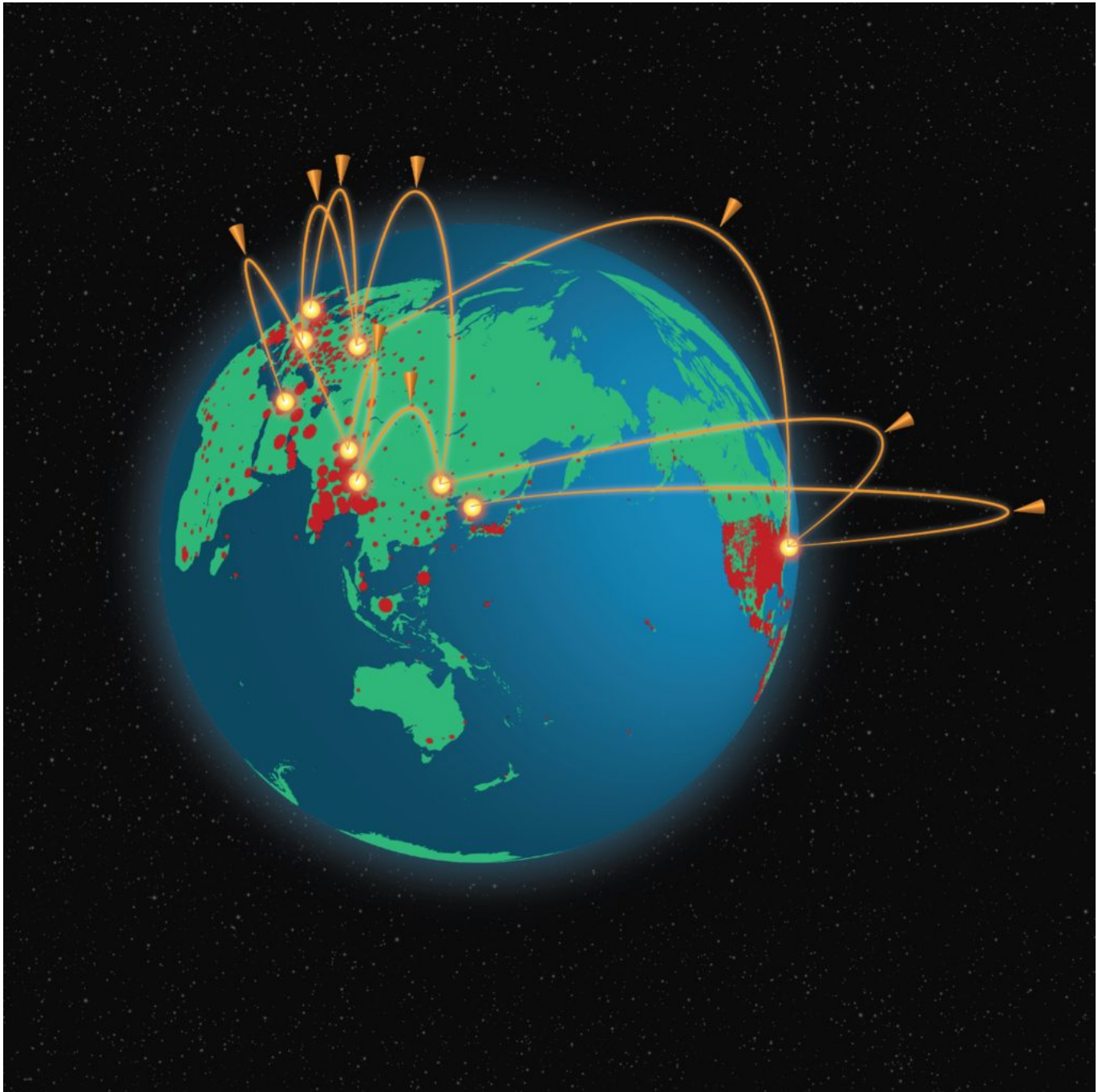
U.S. PLANNING FOR PANDEMICS AND LARGE-SCALE NUCLEAR WAR

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LYNN EDEN

NOVEMBER 25, 2020

I. INTRODUCTION

In this essay, Lynn Eden concludes: "It is puzzling that the Trump administration did not prepare for a pandemic. It is puzzling how those who develop U.S. nuclear war plans understand what they are planning."

The essay may be downloaded in PDF format **here**

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Banner image: Sophia Mauro for Nautilus Institute. This graphic shows the pandemic distribution from COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU) on September 25, 2020; and the nuclear threat relationships between nuclear armed states.

II. NAPSNET SPECIAL REPORT BY LYNN EDEN

U.S. PLANNING FOR PANDEMICS AND LARGE-SCALE NUCLEAR WAR

NOVEMBER 25, 2020

Summary

This paper focuses on the United States and examines how developing plans to understand, prevent, prepare for, and mitigate disasters that may occur infrequently—for example, *pandemics*, is different from developing plans to fight and "prevail" in a large-scale *nuclear war*. We could say that preparing for pandemics makes sense, but that developing—and implicitly threatening to carry out—nuclear war plans only makes sense if such plans are *not* carried out.

Both kinds of plans involve anticipating large numbers of deaths—but at very different orders of magnitude. And, although the language of prevention and mitigation may be common to both, the probability of a pandemic depends to a considerable degree on human knowledge and social/political action. On the other hand, the reason for developing highly detailed "executable" plans to fight and

"prevail" in a nuclear war is to threaten an enemy so "he" will not attack you or your allies. One cannot threaten a pandemic in hopes of deterring it from attacking. But if nuclear war plans do not deter an enemy, carrying out those plans in the hopes of destroying enemy forces will almost certainly lead to the incomprehensible destruction of all.

It is puzzling that the Trump administration did not prepare for a pandemic. It is puzzling how those who develop U.S. nuclear war plans understand what they are planning. I explore both below.

Planning for the Possible

Planning for the future, especially calculating risk, is essential, and impossible to get just right.[1] *Preparing* for pandemics, as well as floods, oil spills, very large forest fires, etc. requires funding and serious scientific and human behavioral research; to know what plans have to be drawn up and practiced before a disaster; what must be done immediately during, throughout, and immediately after; and learning from experience how to mitigate the effects of future disasters.

Beginning in the George W. Bush administration—largely in response to the terror attacks of September 11, 2001, and, the later catastrophic flooding of New Orleans and Houston caused by Hurricane Katrina in late August 2005—the United States government developed new robust preparedness programs of research, planning, and rehearsals of what could happen in a variety of situations, including pandemics.

Under the Department of Homeland Security, the National Exercise Program rehearsed what to do in the event of various disasters and catastrophes. Exercises could be small or large. These could be high-level, local-level, or multi-level "table-top" exercises, which are just what they sound like: a group of people more or less seated around a table, working through a scenario or scenarios with the help of professional facilitators and pre-written scripts that are likely to be unpredictably revised (these changes are termed "injects") during the course of the exercise.

Much larger exercises use, or try to use, what is called a "whole of government" approach. These are not "table-tops," and can involve fire departments, police departments, military personnel, radiological teams, medical personnel, governors, federal department personnel, and lawyers expert in various areas, along with "subject matter experts" and, perhaps, a national television news reporter playing him- or herself.

The whole of government approach is both vertical and horizontal. It is especially necessary in the sprawling multi-level federal system that governs the United States of America. "Vertical" means *hierarchical* communication and directives from presidential and federal department levels to state and local levels of government. To do this well requires listening to and taking into account the needs and demands of lower levels of government, and also not taking responsibility for, or dictating, actions better taken at more local levels. "Horizontal" means communication and *coordination* across government institutions, including a relatively clear division of labor and adherence to the law among the office of the president, executive departments, and Congress. This is an ideal that can be strengthened through practice, including participants thrashing out sometimes competing historical prerogatives and powers, referred to as "equities," to the specific laws and regulations ("authorities") that apply or may apply, and even to the specific people federal employees should call at the state and/or local levels, and vice versa.

Of course, the United States had developed numerous preparedness exercises at least since the end of World War II—think of "duck and cover" exercises as schoolchildren dived under their desks to prepare to survive an atomic attack.[2] The wide-ranging whole of government exercises became much more prominent early in the Bush administration,[3] and they continued during the presidency

of Barack Obama.

As the United States transitioned from the Obama administration to the Donald Trump administration, the U.S. government was quite well-prepared to deal with a possible future pandemic. During the formal transition to the Trump administration, large packages of documents across the government were put together for the incoming administration. One of those sets of transition documents was on how to prepare for a pandemic. One week before Trump took office, a high-level exercise involving several dozen people from *both* administrations was carried out. According to one account,

> The Trump team was told it could face specific challenges, such as shortages of ventilators, anti-viral drugs and other medical essentials, and that having a coordinated, unified national response was "paramount"—warnings that seem eerily prescient given the ongoing coronavirus crisis.[4]

Of course, as we know, the personnel turnover from the beginning of the Trump administration was unprecedented. In addition, within the White House's National Security Council staff, the specific suborganization responsible for preparing for a pandemic or deliberate biological attack was dismantled by then National Security Advisor John Bolton. Discontinuities in staff and in organization were not the only problems. In this situation, the Trump administration did not believe in exercising the power of the federal government itself, for example, in directing or mobilizing the public sector. The president did not believe his medical doctors and scientists. The president saw political opportunity in discouraging the wearing of masks. Many in the Republican party professed to believe that COVID-19 was a hoax. In certain parts of the country, strongholds of support for President Trump, it became fashionable to resist public health measures.

The tragic bungling of the ongoing pandemic was not inevitable. It is a case study of how *not* to run a government.

Planning for the Impossible: Nuclear War

U.S. planning to fight and prevail in a nuclear war has been far less buffeted by changing administrations. The question I ask here is not about incompetence, but rather is moral and social/psychological: what has enabled U.S. military officers to make highly detailed plans to fight and "prevail," in President Ronald Reagan's words, in "a nuclear war [that] cannot be won and must never be fought"?[5] Developing a plan, including various options, does not mean that state officials *want or intend* to go to war; it means that *if* a state goes to war, planning options are already prepared for military use. We expect such plans to be developed for conventional armed conflict and war. Although hard to comprehend, such plans are also developed for nuclear war.[6]

Stated otherwise, what are the governmental and organizational processes that have made it possible for dedicated, hard-working, and generally good people to plan actions that, if realized, would cause calamity on an incomprehensibly vast scale? How are those involved in detailed nuclear war planning able, to some degree, to avoid thinking, and having "some pretty strong feelings" about the consequences of nuclear war, at least enough to get on with their work of planning it? What are the social, in this case, mostly organizational, mechanisms that *enable* officers to plan the end of the world, at least the world as we know it?

For example, toward the end of the Cold War, a government official working in strategic nuclear war planning told me that it was

> [an] emotional burden to read the war plans. You begin to lose sight that you're talking about

the *end of civilization*. You look at this and think you might actually have to employ one of these [plans] some day and it's just mind boggling.... I thought, "My God, [it] isn't just an abstraction, it's *real*. This is what we intend to do in x, y, or z situation." So that was incredibly overwhelming and.... It was actually hard to work during the first couple of weeks. Hard to take any of them seriously because I ... wanted to shake them and say, "Are you fucking kidding me?.... Are you out of your *mind*? How can you possibly consider an attack option that looks like *that*?".... I think that when you work long enough on targeting, you ... *at a certain point [you] have to stop thinking about what executing one of those options really means.* Because I don't know how you could live with yourself if you did.[7]

How do people in an organization stop, or avoid, thinking about the results of the very thing they are planning?

Below, I briefly describe the specific nuclear war planning organization to which I refer. I then describe five organizational processes that enable war planners to carry out their tasks. Underlying most of these explanations is that as war planners do their jobs, they generally do not focus on the human and civilizational consequences, that is, they *"stop thinking about what executing one of those options really means."* Does this make war planners different from others who work in bureaucracies? We will see that, in general, the answer is no.

Organization. I focus here only on the most detailed tier of U.S. nuclear war planning, the place where the actual detailed nuclear war plans are updated and revised. For most of the Cold War these planners worked in a multi-service ("joint") planning group called the Joint Strategic Target Planning Staff (JSTPS). The group was joint, but it worked under the legendary military command, the Air Force's Strategic Air Command (SAC), located at Offutt Air Force Base, adjacent to Omaha, Nebraska. SAC personnel dominated nuclear war planning; they were "dual hatted," SAC officers who also worked at JSTPS. There were officers at JSTPS from other services, particularly the Navy, but also from the Army, Marines, and NATO members. After the Cold War more or less ended, in 1992 the name of the planning group changed, but the functions did not. (JSTPS changed to the more generic J-5: J for Joint, 5 for planning, a standard designation across all U.S. military services).

These planners use and must follow increasingly detailed guidance: first, broad presidential guidance, then more detailed Department of Defense directives, and yet more detailed instructions from Joint Chiefs of Staff planners on how to "build" war planning options. In addition, planners developed their own translation of instructions, known as the "Blue Book," for many years unknown at higher levels to even exist. As the Cold War ended, SAC was reconfigured as a joint command now known as the Strategic Command (STRATCOM). From the mid-1950s, nuclear war planners have worked in the same set of offices in an underground annex to SAC/STRATCOM headquarters. This annex is located three stories below ground under the front lawn of what for decades was the SAC/STRATCOM headquarters building. It could be reached from inside headquarters by underground stairs and an industrial-style ramp. It was known informally as the "basement," or the "mole hole." Most of the planners are active military officers. Over time, some planners stayed on or came back as retired military working for, or as, contractors. These former military may have considerable expertise, and, as well, provide important continuity.

What Enables? First, planners understood, and continue to understand, that the purpose of nuclear weapons and nuclear war plans is, above all, to *deter* an opponent, or enemy, from taking actions antithetical to American and America's allies' interests. How do plans, capabilities, and willingness to act if necessary, deter? They demonstrate what *would* await an enemy should it attack what it must not. However, should deterrence fail, and U.S. nuclear weapons use were deemed both legal and necessary, under presidential order the war plans could be implemented to get the best political-military results possible, whether through options based on first use, retaliation, massive

attack, or limited or "tailored" use. For most of the Cold War, Air Force leaders generally thought nuclear war could be meaningfully won. Military leaders do not say that today, though for some, depending on the circumstances, choosing some options over others could, or even would, make a significant difference, a better outcome for the United States and its allies.

Second, nuclear war planners (and military officers who would launch weapons under authenticated orders) do *not intend* to kill civilians. Planners do have options, measures, and procedures to "withhold" attacks against major urban areas. Planners do know that many civilians would be killed in nuclear war—but only when unavoidable. Civilians *per se* are not an objective of war planning, or, as planners say, civilians are "not objective to" the plan.

Third, military career paths can make dissent extremely costly. The criteria for career success in the military is different from those in the civilian world. In the civilian world, one can move, and "move up the ladder," by switching job sectors, or employers, possibly many times. Or if one is self-employed, one may have flexibility in what one does, where, and how. By contrast, a full career in the military requires at least 20 years of service; a substantial number serve longer. Every service member takes an oath of office to defend the U.S. Constitution, to act honorably, and to obey legal orders, including the laws of war. Only rarely do service members formally question the legality of orders given or of actions taken. Service members are obligated not to act illegally; the issue is who decides what is legal, and what will questioning legality do to a military career?[8]

In addition, military careers will be greatly enhanced by serving honorably in armed conflict and war. Few civilian careers require such bravery and/or excellence in command, at times under remarkably fast-paced and exceptionally dangerous conditions. (Emergency workers and managers, including those who work on oil derricks or explosion containment, police, fire fighters, and medical personnel, are among such civilian careers—though they *generally* are not as dangerous or soul-shattering as being in sustained combat.)

The continuity in career commitment requires that for those who are ambitious, as many are, excellence must be reflected in performance reviews. In addition to what I have discussed above, sheer hard concentrated work is required, including serious study in the evenings; paying attention to detail; repeated practice of what must be mastered, and successful performance in various kinds of tests. One should be highly capable as a team player and leader. One has an obligation to report poor compliance and bad conduct. At the same time, in some circumstances, it is prudent not to express thoughts that go against widely accepted political or other views or to raise hard questions that really cannot be answered. In all, career service officers face more difficult choices when assigned to do something one might rather not, such as planning nuclear war. Officers have pledged loyalty. In most circumstances, they cannot modify the work they do. And exit is a radical, career-changing, option.[9]

Fourth, to succeed at nuclear war planning, officers must focus on highly prescribed analytic tasks. Mathematical abstraction—specifically, the process of optimization—provides the planning framework. Within this framework, linear programming techniques are used to achieve a goal optimally. The goal is termed the *objective function* and is expressed as a maximum or minimum quantity, subject to constraints.[10] For example, for an investor, the objective could be to maximize expected return on a financial portfolio or to minimize tax payment on given financial investments—subject to constraints of law and regulation. For a package delivery company, the objective function could be to minimize the time of arrival of packages at specified locations, subject to constraints of handling so that packages do not arrive with battered contents.

For nuclear targeting, the objective function is to maximize the achievement of specific damage goals to classes or categories of targets. These goals are termed *damage expectancy (DE)*. Achieving

damage expectancy requires most efficiently *allocating* several types of nuclear warheads carried on intercontinental ballistic missiles (ICBMs), submarine launched ballistic missiles (SLBMs), and aircraft to types of targets; *assigning* specific warheads to specific targets and timing their launches for particular times of arrival and heights of burst, in order to achieve, with specified probabilities, designated damage goals. For example, for a specific class of massive industrial structures, the damage expectancy could be severe damage with 90 percent probability. In other words, on average, for every 100 such targets, the goal would be to completely destroy no less than 90. To make such structures functional again, each would have to be entirely rebuilt (a broad definition of severe damage). Using Monte Carlo methods, targeteers then simulate these planned courses of action to *assess*, evaluate, the degree to which they have succeeded in achieving their goals. Perhaps in the above example, once tested, on average, "only" 70 targets would be severely damaged. This could require, for this class of weapons, using different warheads, more warheads, or moving the locations above which the weapons would be detonated, that is, the Designated Ground Zeroes (DGZs).

The above hints at the level of abstraction and what is left out: images of people, a sense of daily and cultural life, places as they would be experienced by sight, sound, smell, and movement beyond what is represented on navigation maps. Except for "withholds" against certain urban areas, under specified conditions, there is no hint of the violence being planned, nor would we expect there to be. The purpose is seemingly pragmatic: to enable the United States military to take specific actions to achieve specific damage effects, for example, "light," "moderate," or "severe" damage.[11] Civilian deaths are not included in the categories and formulae used because, as noted above, civilians are "not objective" to the plan. In nuclear targeting procedures and officers' required focus, it is *as if* people, and civilization, do not exist. They certainly do not count.

What me worry? Fifth and finally, one might think that people who plan nuclear war would be an unusually sober bunch. What could be more catastrophic, more morally disturbing for a nuclear war planner than having the government use, actually "employ," a nuclear weapon or nuclear weapons according to options he or she may have helped develop?

Yet It is precisely in situations of past, present, or possible destruction, injury, and death that "dark," or "sick" humor flourishes—for example, among meat packers, accident and crime scene investigators, pathologists, surgeons, and, of course, nuclear war planners. "Sick humor" is a slap at euphemism. In humor and jokes, people with shared experiences can say what they cannot say otherwise. Doing so unmasks the technical labelling and the abstract concepts required for the job. Sick humor provides moral distance. From this perspective, joking restores a sense of self.

Planners may refer to targets as "ping pong balls," "paddle manufacturers," "shoe factories," "tennis shoe factories," "toy production," "toy manufacturers," and "makers of baby rattles." For example, one officer said:

> Let's say I want you to be able to hold at risk and attack, if necessary, the ability of the Soviet Union to hit ping pong balls. One target set will be the manufacturers of paddles. There may be only one or two manufacturers of paddles. I'll have to hit them. So there's no leeway there. But let's say the guidance says that you have to attack toy production. There will be a lot of different toy manufacturers and a lot of leeway. We can say we can get the makers of baby rattles but not some other toy manufacturers.[12]

What do these substitutions mean? At first glance, installations such as paddle manufacturers or tennis shoe factories, or toy manufacturers, appear trivial. On the one hand, this triviality conveys that the speaker is not talking about *real* nuclear war planning, because there would be no military purpose in trying to destroy toy factories. Thus, such terms allow both speaker and listener to distance themselves from the enterprise of planning nuclear war by saying: This is not real, this will

not come to pass.

On the other hand, and much more important, the triviality implies that much *more* will be destroyed than is officially acknowledged. A phrase not quoted above, "three and four holers," refers to outhouses and connotes a *vast* level of destruction throughout the land, including in impoverished rural areas. These substitutions also point to the *types* of things that would be destroyed: not only official categories of targets such as military assets and "war supporting" industries, but activities related to leisure, to play, particularly by children—"ping pong ball manufacturers," "tennis shoe factories," "toy production"—and even babies—"makers of baby rattles."

These terms connote "targets of opportunity," targets of less than vital interest. According to one officer: "In applying a weapon, you may see that you will damage an installation that you had not intended to damage originally. But if it falls within the guidance, you include it" and say things like "Oh, this will make Soviet [children] very unhappy."[13]

Targeteers' humor is a devil's brew that says what cannot be said otherwise. Callousness, bad taste, wise guy, and sick humor acknowledge all that has been expunged and, with a straight face, must not be said in "serious" situations.

In sum, I have tried to explain how decent and ordinary—if unusually committed and hard-working—people can plan the worst thing in the world, nuclear war. The answer is multi-fold, but the essence is that as they work, planners strip out the human meaning of the consequences of the hypothetical actions they are planning. They do this because the complex and detailed tasks that command their attention have already removed vivid references to human society and appear to be about matching objects (warheads and bombs) to other highly coded objects (targets) to cause predesignated levels and types of damage—all of this to be done as efficiently as possible using abstract mathematical techniques encoded in numerous computer programs. Targeteers are constrained by the laws of physics, number of weapons, organizational rules, and time pressure. They do not have time on the job to dwell on the human consequences of execution.

At the same time, they are aware that the specific and broad consequences would be horrific. Through inappropriate labeling, exaggeration, and saying the opposite of what official words and phrases mean, they indicate to themselves and to others that they are (and this is generally true) decent and good human beings.

III. ENDNOTES

[1] Risk comprises three things: first, the probability that an adverse event may be caused in a specified way; second, the vulnerability of an asset to the specified threat; and, third, the impact, particularly the loss, or cost, if the threat were realized. For example, the risk of the 2019-2020 pandemic is, first, the probability that a specific coronavirus would migrate to humans in a province in China in 2019; second, the high transmissivity of this coronavirus, especially if serious precautions are not taken; and, third, the spiraling economic and social costs of ineffective isolation of people with Covid-19.

[2] The scholar Lee Clarke has insightfully explained how U.S. government publications on civil defense from nuclear weapons, and other events such as nuclear reactor explosions and oil tanker accidents, are "fantasy documents." Lee Clarke, *Mission Improbable: Using Fantasy Documents to Tame Disaster* (Chicago: University of Chicago Press, 1999); and see Lee Clarke and Charles Perrow, "Prosaic organizational failure," *American Behavioral Scientist*, Vol. 39, no. 8 (1996), pp.

1040-1056.

[3] I participated as a member of a team from Stanford University that formally observed a large national exercise called TOPOFF-2 (TOPOFF for Top Officials) in 2003. TOPOFF-2 involved simulating a deliberate attack using a large radiological dispersal device in Seattle *and* a serious outbreak of plague in Chicago. The response to both was in large part coordinated by the federal government in Washington D.C.—in concert with its state and local partners. I learned several things: Civilian exercise programs are largely modeled on military scenario planning and exercises. Scales of exercises vary, from "table-top," where a dozen or more experts talk through a given hypothetical situation, to large multi-city exercises in which a number of groups and agencies at the municipal and regional levels (for example, fire-fighters, police, medical personnel, mayors, local newscasters, and "subject matter" experts) to state and federal government officials or stand-ins for such officials—for example, stand-ins for the president or very high-ranking officials. The value of such exercises generally is not in specific solutions, since what is anticipated is very unlikely to be precisely what will occur. Rather, participants may discover the specific offices and even personnel they should be interacting with at different levels of government, and more important, participants become sensitized to some of the issues that may be encountered. Analysis by participants is likely to occur immediately after the exercise in what is called a "hot wash." More in-depth analyses will also occur under longer time frames. An example of how exercises can be helpful was one known as Hurricane Pam, which took place in July 2004, just over a year before Hurricane Katrina. Participants worked out plans to change traffic from two-way in and out of New Orleans and points further south to only one-way: north, out of the area. This contraflow plan was implemented just before the hurricane hit, and it was highly successful. Other aspects of the exercise were not so successful. See the U.S. government report on exercise Hurricane Pam, "A failure of Initiative," https://biotech.law.lsu.edu/katrina/govdocs/109-377/pam.pdf

[4] Quoted in Nahal Toosi, Daniel Lippman and Dan Diamond, "Before Trump's inauguration, a warning: 'The worst influenza pandemic since 1918," *Politico*, March 16, 2020. And see Dan Diamond and Nahal Toosi, "Trump team failed to follow NSC's pandemic playbook," *Politico*, March 25, 2020; and David E. Sanger, Eric Lipton, Eileen Sullivan and Michael Crowley, "Before Virus Outbreak, a Cascade of Warnings Went Unheeded," *New York Times*, March 22, 2020.

[5] See Joint Soviet-United States Statement on the Summit Meeting in Geneva, November 21, 1985, at: https://www.reaganlibrary.gov/archives/speech/joint-soviet-united-states-statement-summit-meeting-geneva

[6] See, for example, David Alan Rosenberg, "The Origins of Overkill: Nuclear Weapons and American Strategy, 1945-1960," *International Security*, Vol. 7, No. 4 (1983), pp. 3-71; the concise synthesis on U.S. nuclear war planning from the late 1940s through the 1980s by Scott D. Sagan, *Moving Targets: Nuclear Strategy and National Security* (Princeton: Princeton University Press, 1989), pp. 10-57; William Burr's published work and his analysis and historical documents online in the National Security Archive's Nuclear Vault—for example, Burr's "To Have the Only Option That of Killing 80 Million People is the Height of Immorality: The Nixon Administration, the SIOP, and the Search for Limited Nuclear Options, 1969-1974," National Security Archive Electronic Briefing Book No. 173, posted November 23, 2005, at https://nsarchive2.gwu.edu/NSAEBB/NSAEBB173/index.htm. For somewhat more technical discussions see Theodore A. Postol, "Targeting," in Ashton B. Carter, John D. Steinbruner, and Charles A. Zraket, eds., *Managing Nuclear Operations* (Washington, D.C.: Brookings Institution, 1987, pp. 373- 406; and George J. Seiler, Captain, USAF, *Strategic Nuclear Force Requirements and Issues* (Maxwell Air Force Base, Alabama: Air University Press, February 1983).

[7] Anon, Eden conversation with, September 19, 1988. *"At a certain point…"*: emphasis added.

[8] See General Russell E. Dougherty's account of a major whom Dougherty forced to leave the Air Force because the major insisted on the relevance of his own moral judgement, in Dougherty, "The Psychological Climate of Nuclear Command," in Carter, et al, eds., *Managing Nuclear Operations*, pp. 407-425; at pp. 413-414. See Alex Wellerstein's further research and comment on Colonel Harold Hering, the colonel referred to anonymously by Dougherty, in Wellerstein's blog, *Restricted Data, The Nuclear Secrecy Blog*, "The President and the Bomb, Part III," April 10th, 2017, at http://blog.nuclearsecrecy.com/2017/04/10/president-bomb-iii/ .

[9] See Albert O. Hirschman, *Exit, Voice, Loyalty: Responses to Decline in Firms, Organizations, and States* (Cambridge, MA: Harvard University Press, 1970). These choices hold in the case of a non-declining organization, the U.S. Air Force, as well as in most military organizations.

[10] See Donald J. Albers, Constance Reid, George B. Danzig, "An Interview with George B. Danzig: The Father of Linear Programming," *The College Mathematics Journal*, Vol. 17, No. 4 (September 1986, pp. 293-314). A very good brief historical overview and lightly technical explanation of optimization is Stephen J. Wright, "Optimization," *Encyclopaedia Britannica* (entry dated October 24, 2016).

[11] The damage criteria are regarded by some as grossly understated. For example, the standard handbook on nuclear weapons effects defines "moderate" damage to a multistory reinforced concrete building, three to eight stories, as "exterior walls several cracked. Interior partitions severely cracked or blown down. Structural frame permanently distorted…." (Samuel Glasstone and Philip J. Dolan, *The Effects of Nuclear Weapons*, Third Edition (Washington, D.C.: U.S. Government Printing Office, 1977, p. 214. Damage criteria are part of the larger damage expectation formula, Damage Expectancy (DE). DE = Probability of Arrival (PA) x Probability of Damage (PD), which is applied and calculated for broad categories of targets. PA includes the probabilities of arrival and detonation. In other words, PA is "scenario dependent" and is composed of several probabilities. The most important is the probability that the weapon is available to launch—that is, that it has not already been destroyed *before* being launched. This probability is termed the pre-launch survivability (PLS), and it is particularly salient for the land-based ICBM force. Another part of Probability of Arrival is the weapon system reliability (WSR), and the probability that the weapon will penetrate to its point of detonation, that is, the probability to penetrate (PTP). In other words, PA = PLS x WSR x PTP. The Probability of Damage (PD) has to do with the interaction of weapon types and target types. Weapon characteristics include yield, accuracy, and height of burst. Targets are characterized by the strengths of their materials and structures to various forces produced by specific weapons effects. This encoding of types of targets and their vulnerabilities to particular effects is called the "Vulnerability to Kill," or VNTK system. I have drawn here particularly from Seiler, *Strategic Nuclear Force Requirements and Issues*, pp. 11-13; also see Postol, "Targeting," in Carter, et al, eds., *Managing Nuclear Operations*; and see Lynn Eden, *Whole World on Fire: Organizations, Knowledge, and Nuclear Weapons Devastation* (Ithaca: Cornell University Press, 2004) on the development of the VNTK system.

[12] Anon, Eden unattributed interview with, Washington, D.C., July 10, 1989.

[13] Anon, Eden, unattributed interview with former targeting officer, January 17, 1990.

IV. NAUTILUS INVITES YOUR RESPONSE

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