The World and the Threat of Nuclear Science

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In the early days of August 1945, an event took place which would change human history forever. The U.S. dropped two atomic bombs, Little Boy and Fat Man, on Hiroshima and Nagasaki in an attempt to force Japan to exit the war. The Japanese surrender put an end to WWII, the bloodiest conflict in human history. The Trinity Test, the first detonation of nuclear weapons in July 1945, marked the beginning of a new threat of warfare with unimaginable possibilities of destruction. The world was plunged into an age of uncertainty with nuclear superpowers such as the USA or USSR boasting arsenals of thousands of nuclear warheads (*Status of World Nuclear Forces*, Federation of American Scientists). Bombs that could wipe out metropolises such as Paris or Manhattan. The prospect of human extinction became a reality, and not a dystopian fantasy. Although the investigation into nuclear science has brought a few positive outcomes, such as radiation therapy being used to combat diseases such as cancer, the negative aspects far outweigh the positive. Ultimately, the advancement of nuclear weapons and science will inevitably bring us closer to either total annihilation or an unlivable planet.

The dropping of the atomic bombs on Japan was a display of brute force by the Americans. It was a naked attempt to make the Japanese bend to their will, and it worked. The devastation wrought by the bombs hastened Japan's surrender and put an end to World War II. Brute force would become a reoccurring theme in the American military strategy, whether it was necessitated or even successful. Examples to support would be the use of napalm and Agent Orange in Vietnam to burn jungles and villages, and rout enemy guerilla fighters (*The Horrific Usage of Napalm and Agent Orange in the Vietnam War*, ThoughtCo.). In Japan, the bombing of Hiroshima killed an estimated eighty thousand people immediately, and destroyed around ten square kilometers of the city. The bombing of Nagasaki killed an estimated forty thousand and destroyed around a third of the city (*Hiroshima & Nagasaki*, BBC). Although, the curiously titled bomb Little Boy, that was dropped on Hiroshima had less destructive yield than Fat Man which was dropped on Nagasaki, the geographical landscape of Nagasaki prevented more destruction. Hiroshima is very flat which allowed the explosion to decimate with ease, whereas Nagasaki is surrounded by hills which contained the destructive blast. These weapons were strong enough to bring Imperial Japan, a heavily militaristic nation, which enshrined doctrines of honour to its knees. The strength of these weapons was unfathomable at the time, yet they marked the beginning of decades of development and testing of weapons that lead to the creation of exponentially more powerful armaments. Throughout the span of the Cold War, the two dominant nuclear superpowers of the world -- the USA and USSR -- began an arms race to develop more powerful nuclear bombs. Nuclear weapons reached new destructive capabilities with the development of the hydrogen bomb, also known as the thermonuclear bomb in 1952. The hydrogen bomb incorporates nuclear fusion into the detonation process (*Thermonuclear bomb*, Encyclopedia Britannica). Thermonuclear bombs use the initial energy from nuclear fission to smash hydrogen isotopes together to form helium and produce vast amounts of energy. The potential to create astronomical amounts of destructive energy is up to a thousand times greater with fusion than fission. The development of thermonuclear bombs paved the way for weapons such as the Soviet made "Tsar Bomba" or American made "Castle Bravo". Castle Bravo is the strongest thermonuclear weapon ever detonated by the USA, with a destructive yield of fifteen megatons of TNT, a thousand times more powerful than Little Boy dropped on Hiroshima (*Castle Bravo*, Atomic Heritage Foundation). For reference, the destructive yield of nuclear weapons is measured in either kilotons or megatons of TNT, comparing the explosion to however much TNT would be required to recreate it. In the ten years following WWII, the development of weapons like Castle Bravo that rendered Bikini Atoll virtually uninhabitable, continued to escalate. This weapon was dwarfed by the Soviet made Tsar Bomba. Detonated in 1961, this bomb still holds the record for strongest nuclear weapon ever employed. The Tsar Bomba boasts a destructive yield of fifty megatons of TNT, over three thousand times more powerful than the bomb Little Boy. This bomb produced a mushroom cloud taller than the Red bull stratosphere jump. The mushroom cloud was visible from a thousand kilometres away, and sent a shockwave that circled the globe three times. The Soviets theorized that they could develop a bomb that was double in size of their record-making bomb, and achieve a one hundred megaton detonation (*Tsar Bomba*, Atomic Heritage Foundation). This bomb was so gargantuan that if it was dropped on Paris or New York City, it would obliterate the entire city and casualties would number in the millions. A fantastic tool to help visualize these theoretical scenarios is the website "NUKEMAP", created by Alex Wellerstein, a historian of science and more specifically the history of nuclear weapons (*NUKEMAP*, NUKEMAP). This website allows the simulation of a detonation of any destructive yield on any location in the world. It provides useful data such as effect radii which includes firebomb size or radiation zone and other statistics such as estimated casualties.

Both the Castle Bravo and Tsar Bomba, and especially the former, could be defined as last resort weapons. Basing off the fact that these weapons are massive and would most likely be used to flatten large cities, they would probably only be used as a final solution. In addition to such major bombs, both superpowers boasted large stockpiles of weapons that were also immensely destructive. An example of a common warhead in the current American arsenal is the B-83 nuclear bomb. Having a destructive yield of one point two megatons of TNT, it pales in comparison to the mighty Tsar Bomba or Castle Bravo, yet it is still eighty times stronger than Little Boy (*B83 nuclear bomb*, Wikipedia). It isn't the strength of nuclear weapons that is so terrifying, as the sheer proliferation and accessibility of the technology used to create them. Although the world is steering towards a less nuclearized society, there is still a frightening amount of world-ending weapons that could be deployed at any time. As of June 2018, there are approximately 14485 nuclear warheads in the world and both the USA and Russia have 1600 deployed strategic warheads (*Status of World Nuclear Forces*, Federation of American Scientists). Meaning that they have 1600 warheads mounted on missiles or ready to be flown with heavy bomber planes. The combination of nuclear warheads and inter-continental ballistic missiles is staggering to say the least. They require no pilot, and can be sent *en masse* to nearly any location in the world. In 1986, global nuclear stockpiles reached a peak during the Cold War with an estimated 70,000 warheads (*Status of World Nuclear Forces*, Federation of American Scientists) at the ready. Although, the threat of nuclear weapons was used as a form of deterrence, the threat of global annihilation has become ever more publicized through the media. The current U.S. president, Donald Trump is an advocate for nuclear weapons, tweeting that America must increase their nuclear power, and even boasting of his nuclear launch button in opposition to North Korean leader, Kim Jong Un (*Donald Trump's Nuke Button Tweet Raises Concerns, Again*, Time). The development of weapons of mass destruction by North Korea, as well as their development of an inter-continental ballistic missile that deliver these weapons of mass destruction across the world is of international concern. The use of nuclear deterrence has been prevalent ever since the Cuban Missile Crisis in 1962, and has been defined as MAD (mutually assured destruction). The idea is that if one nuclear superpower were to attack another, the defending nation would strike back, assuring mutual destruction. But the concept of deterrence is becoming increasingly uncertain, with displays of carelessness and bravado around the use of weapons of mass destruction. A current example would be Trump bragging of the

USA’s nuclear might on social media with little regard to what the American nuclear arsenal is truly capable of. Humanity has lived with the threat of nuclear annihilation since the development of nuclear weapons in 1945 but that threat has metastasized in recent decades, with specific incidents where the fate of the world has hung in the balance. Even in an age where armed conflict is at an all-time low, the government officials and elected leaders toy with the fate of humanity.

Along with the development of nuclear weaponry, the world harnessed the energy produced from nuclear fission to power our homes and cities. The process is relatively simple. Heat from nuclear fission is used to turn water into steam, and power a big turbine to generate electricity. Nuclear power has the potential to produce phenomenal output with very little environmental impact, as compared to the environment costs of the fossil fuel industry. A downside, is the occasional meltdown due to overheating in the reactor core where the fission occurs. Catastrophic outcomes can occur from nuclear meltdowns, including explosions, and leaching of radioactive substances into the nearby area. The most famous example of a nuclear disaster would be the meltdown of reactor 4 at the Chernobyl nuclear power plant in 1986. The resulting explosion released large uncontrolled amounts of radioactive substance into the nearby atmosphere which would spread across Ukraine, Russia, Belarus and even some of Northern Europe. The accident caused the surrounding area to become uninhabitable due to radioactive contamination, and it is not expected to return to normality for thousands of years (*Chernobyl Accident 1986*, World Nuclear Association). Chernobyl is regarded as one of the worst nuclear power plant accidents in history, next to events such as the Fukushima meltdown in 2011. Once again, the schematics of a nuclear reactor are not complicated, but poor maintenance can wreak disastrous results.

This was the case with the story of David Hahn, also known as the radioactive Boy Scout. David was a typical American boy, but his life was forever changed when he received the *The Golden Book of Chemistry* at the age of ten. David was consumed by the world of chemistry and quickly became something of a novice expert in science. He breezed through college science textbooks, and even earned an Eagle Scout merit badge in atomic energy. His experiments quickly became dangerous due to his use of toxic chemicals and lack of safety procedures. At the age of fourteen, David succeeded in producing nitroglycerine, a component in dynamite. Various experiments such as igniting red phosphorous, caused his father to banish David's experiments from the family home. David moved his lab into his mother's potting shed, a site that would act as the final stage for his most ambitious experiment. Prompted by the idea that the world would eventually run out of oil, David set out to use his fascination with science and knowledge to build a breeder reactor in his backyard. A breeder reactor is defined as a nuclear reactor that produces energy and replenishes its radioactive fuel supply in an ever-sustaining cycle. Posing as a physics instructor at his local high school, David contacted various organizations such as the American Nuclear Society and the Nuclear Regulatory Commission to gather information on how to create a sustainable reaction. He established a list of the elements and materials needed to sustain a reaction, all that stood in his way was a means of obtaining these materials. David was able to find some radioactive elements from smoke detectors. The remainder of the radioactive materials, found on common objects such as luminous paint on antique dial clocks, an ore called pitchblende and gas lanterns, were easily procured. Using these, he was able to build a crude neutron gun that could bombard elements with neutrons and create fissionable elements. David came very close but never achieved his dream of building a successful breeder reactor due to him having to disassemble it after becoming too radioactive. Later, authorities would find large amounts of various radioactive material taped together in the trunk of his car, which they initially believed was a makeshift nuclear bomb. After long periods of bureaucracy and questioning, radiology experts surveyed David's potting shed laboratory to find radiation levels over a thousand times higher than normal background radiation levels, despite not finding the majority of radioactive material. This was due to David's mother ransacking the shed and throwing out whatever she deemed bad in fear that the government might take her house because of her son's experiments. Months later, the shed and its contents would be taken apart and sealed in large barrels so they could be shipped away and stored in some nuclear waste facility. Using various false fronts such as a high school science instructor and his own scientific research, David was able to gather the information and materials to build a nuclear reactor. What is so startling about this story is the carelessness and severe lack of safety procedures, as well as the relative ease with which an ordinary person was able to acquire the basic elements of a nuclear device. David put his own life and thousands of his neighbours in severe danger (*The Radioactive Boy Scout*, Harper's Magazine). This story is only one example of the reckless use of knowledge that can produce dangerous and disastrous results.

Any assumption that the world would be more careful nuclear weapons would quickly be proven very wrong. Multiple nuclear weapons accidents have occurred over the past half century and a few came very close to having catastrophic consequences. An example of such an accident is the 1961 Goldsboro B-52 crash where a B-52 bomber broke apart mid-flight and dropped their nuclear payload of two Mark 39 nuclear bombs onto North Carolina. Although, the parachute for one bomb properly deployed, only one fail safe kept it from detonating. The device was recovered hanging from a tree due to its parachute being caught. The parachute for the second bomb failed to deploy and the bomb plummeted to the ground at terminal velocity. The plutonium and uranium core was found eighteen feet below ground in the mud during the excavation recovery. The arm/safe switch, discovered near the core, was found to be switched in the “armed” position yet somehow the bomb didn’t detonate (*The 1961 Goldsboro B-52 Crash*, Stanford University). Because of one or two fail safes and a miracle, somehow a large crater wasn’t etched into North Carolina in 1961. Other examples of such accidents include the 1950 British Columbia B-36 crash where a B-36 bomber jettisoned a bomb filled with conventional explosives and uranium yet no plutonium core necessary for nuclear detonation, before crashing into the Pacific Ocean off the coast of northern British Columbia (*The Lost Nuke of Bomber 075*, Times Colonist). These are just a few incidents from history, but the reality is that nuclear accidents can easily spell destruction and have a much higher probability than nuclear war. The greatest threat isn’t full scale nuclear war but really the possibility of horrific nuclear accidents due to the aging technology that supports the American nuclear arsenal. Most nuclear missile silos were built with primitive technology. They were built and operated during an age of technology that required floppy discs and many silos still run on this same technology (*America's Aging Nukes Are as Anachronistic as the Floppy Disks That Control Them*, Motherboard). Not only is the technology that controls the U.S. arsenal of weapons of mass destruction very outdated, it comes with a hefty price to maintain and supervise. The silos required constant supervision that was covered in 24-hour shifts often done by underqualified Air Force personnel. The Air Force has to deal with drug use, cheating on standardized safety and preparedness tests, and inappropriate behaviour when it comes to the shenanigans of the atomic force missileers. Lt. Colonel Jay Folds, the commander of the nuclear missile wing at North Dakota’s Minot Air Force Base, described this behaviour as “rot” within the atomic force. Studies determined that typical missileers were found to be distracted, cynical, and exhausted while on the job. Long shifts in the confined space of the silo control room, coupled with relentless periods of boredom, waiting for launch orders that would never come, created an atmosphere of malaise and poor morale -- all factors could easily bring about an accident and disaster. Nuclear weapons are operated by humans and humans are prone to error, a factor that when dealing with weapons of mass destruction (*Hanging out with the Disgruntled Guys Who Babysit America's Aging Nuclear Missiles*, Mother Jones) could bring on unmitigated tragedy.

Nuclear sciences forever changed the world, but when those sciences were introduced into warfare, the world entered an uncertain state of peril. Although, nuclear sciences have brought some good, such as developing nuclear medicines that are used to fight diseases such as cancer, there is some irony that small amounts of ionizing radiation can fight cancer, while large amounts of specific radiation cause cancer. But do the benefits brought about by nuclear science outweigh the world-ending destructive potential of nuclear warfare? What is the point of eradicating cancer and disease if we are entirely obliterated by an atomic bomb? The threat of nuclear war may have subsided somewhat, but the echoes and lessons of the Cold War are still relevant. With an aging world nuclear arsenal, the threat of a nightmarish accident has almost superseded the threat of military escalation. Ever since 1945, humanity has had a questionable fate, and the question remains, will we inevitably see a nuclear apocalypse?

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