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ANTHRAX 2001: A Scenario for Bioterrorism

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Abstract

The purpose of this project is to examine bioterrorism. In this project, a review of natural plagues that devastated the world was undertaken. Biowarfare through the years was examined. Finally, a step-by-step development of a chimeric biological weapon and a dispersion method was reviewed as a cautionary scenario. Weapon systems similar to the one described in this project are very dangerous because of the unpredictable nature of the biological components. I truly hope that this project is never attempted.

Acknowledgements

I would like to thank Dan Gibson for his advise, his mentoring, and allowing me free range to be as creative as I wanted to be in the writing of this project. Keep up the great work. I would also like to thank Ray Welsh for the personal interview he granted me at the University of Massachusetts Medical School.

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PREFACE

This project may seem like a biological "anarchist's cookbook," but that is not its purpose. This project is meant as a warning, not as a threat. I have no intentions to attempt to design, engineer, or disperse a biological weapon of any kind. In addition, I hope no one else uses any ideas written in this project for a biological weapon. This project was designed as a warning of what could be done with some basic knowledge of biology and willingness to research weapons. All resources used to design this biological weapon system are easily available to the public with a library card and an Internet connection. Some biological materials can be ordered by mail and delivered to your home. Others may be slightly more difficult to obtain but where there's a will, there's a way. If someone really wants to make a biological weapon, they will!

NATURAL TERRORS

The first recorded plague was in 431 BC in Athens, Greece. It is still unknown to this day what the cause was but it ravaged the area, leaving dead bodies and a social breakdown in its path. People began to think that there was no point in worshipping God or following laws because the disease would strike them down regardless. (Kolata, 1999) Naturally occurring plagues have been around for many centuries. They usually strike with little or no warning and can destroy societies. There will always be survivors of plagues that will pass on their immunity until the disease is no longer dangerous. Plagues do not kill everyone; they simply thin the herd. (Preston, The Cobra Event, 1997) Another major plague was *Yersinia pestis*, the Black Death. It began around 1331 in China and marched through Europe, North Africa, and the Middle East in the late 1340's. In Florence, Italy, between 45 and 75 percent of the inhabitants were killed by the Black

Death. *Yersinia pestis* was so horrific because it was spread two ways. Initially people were bitten by fleas that carried the bacteria, which is bad enough, but also those infected people developed a pneumonia and would spread it by coughing and sneezing. In addition, the animal that carried the bacteria was black rats that traveled from port to port on ships. This allowed the disease to be widespread. From 1347 to 1351, *Yersina pestis* killed a third of the European population. (Kolata, 1999) Having an animal that carried the bacteria around with it on the only major route of long distance travel is an excellent way to spread a disease. In addition, having two ways to transmit the disease adds to the ability of the disease to affect. Both of these factors made the Black Death a truly horrific natural killer. Plagues did not only arise from new bacteria or unknown sources; some were extremely virulent strains of known diseases. For example, cholera has swept the world on several occasions. *Vibrio cholerae*, the microorganism that causes cholera, killed at least 140,000 people in England in 1832. (Kolata, 1999) Plagues can even be caused by what people consider innocuous today, like influenza. The flu of 1918 cut a path of death across the world. It is estimated to have killed anywhere from 20 million to 100 million people worldwide in a year. The flu was so devastating that the life expectancy for that year dropped 12 years from the surrounding years. (Kolata 1999) The newest diseases of most concern are more exotic like Ebola virus and AIDS. Ebola hasn't killed as many people as some of the most famous plagues but it is a very horrible, bloody killer. In addition, it kills with amazing frequency. (Ebola Virus) In 1976, Ebola ripped through Zaire killing 90 percent of the people it infected. This was the most lethal strain of the virus, known as Ebola Zaire. (Preston, The Hot Zone, 1994) To put the lethality of Ebola Zaire in perspective, the 1918 flu that killed between 20 and 100

million people only killed 2.5 % of its victims. (Kolata, 1999) AIDS has infected 22million people worldwide. (Harley, et al., 1999) AIDS has killed 1.2 million people through 1997. (Kolata, 1999) For people diagnosed before 1987, the mortality rate was about 92 %. (Harley, et al., 1999) AIDS is a slower killer. An infected person does not die in a week or so, like Ebola, but over months and years. All these terrible diseases were naturally occurring and just as horrible as the fictional engineered terrors.

PRODUCERS AND CARRIERS

Another major concern about diseases is the species-jumping and cross-species infectivity. It is believed now that AIDS may have originally been a monkey virus that jumped species to humans. (Harley, et al., 1999) The Ebola Reston strain was very lethal to monkeys but was harmless to humans. (Preston, The Hot Zone, 1994) A slight mutation allowed the Ebola Reston to recognize the differences in humans and monkeys. Another mutation could push the pendulum in the other direction and be as lethal to humans as the Zaire strain. The next major plague will probably be a disease that jumps species. In 1998, a Hong Kong boy was killed by an avian disease. It was an isolated case but it proves it can happen relatively easily. (Glausiusz, 2000) In 1976, the swine flu crossed over to the human race killing one out of four victims on an army base in New Jersey. For unknown reasons it did not spread beyond that venue, but it provoked countermeasures (vaccine production, public health warnings) of unprecedented scope in the United States. (Kolata, 1999) The 1918 flu is now believed to be a combination of human flu virus, an avian virus, and a pig virus all mixing together in a living bioreactor, the pig itself. (Glausiusz, 2000) This is the future of natural diseases: not only jumping species but also mutating in other species and then being passed. There will always be

diseases, some horrific, some innocuous. Some disease helps to keep a species strong. If there were no diseases, something as simple as a cold could come along and destroy a population.

Another concern is the carriers of the diseases. Anthrax is carried by cattle and other farm animals and is very deadly to humans. (Harley, et al., 1999) Hantavirus is carried by mice and passed in their droppings. (All about Hantavirus, 2001) *Yersinia pestis* was carried by rats and passed on by fleas to humans. (Kolata, 1999) West Nile virus is passed by mosquitoes to humans. (West Nile Virus Questions and Answers, 2001) The concern is not only about the disease itself but about also how the disease can be spread. It adds a whole new dimension to the diseases. These extra vectors specifically the insect vectors make diseases that much scarier. A person can be infected and never even know they were exposed. If Ebola could be spread by mosquitoes that fed on Ebola infected blood, the disease would most likely have devastated the world. This is nearly like having an airborne Ebola virus.

BIOLOGICAL WEAPONS

Biological weapons may have just emerged recently in the public consciousness, but they have actually been around for centuries. The first recorded usage of a biological weapon was the sixth century BC. Assyrians poisoned enemy wells with rye ergot. (Hardy) Ergot is a disease caused by the Ascomycota division of the fungi parasitizing rye or other grasses. If the rye ergot is consumed by humans, usually in contaminated flour, or animals a disease called ergotism occurs. Ergot is a strong vasoconstrictor that diminishes blood supply and causes uterine contractions. It is often accompanied by gangrene, psychotic delusions, and convulsions. This was very common death in the

Middle Ages. In the year 943, 40,000 people died of ergotism in France. (Harley, et al., 1999) The Solon of Athens used skunk cabbage to contaminate the water supply of the enemy during the siege of Krissa. (Hardy) These crafty warriors probably didn't care if the poison killed or just weakened their enemies. One major use of biological weapons is to incapacitate, not necessarily kill. This is an important reason biological weapons are very useful for armies. They can be used as a piece of the attack puzzle or they can be used as the sole attack. The biological weapon may not make everyone sick but it will affect enough to make the attack much easier. A typical aerial bombing attack would destroy many valuable resources leaving the area in ruins. When using a biological weapon, there is no massive physical destruction. (Hardy) A virus or bacteria would kill many people and do no damage to the physical edifices. This is a valuable strategy. If an army is invading, the invaded areas' factories remain intact for use to make valuable products once the invasion is complete. If the goals do not include occupation, eventually the country will be allowed to resume its normal activities, at which time they will not have to rebuild everything. This means the attacking force will not have to contribute copious resources to help.

Biological weapons may be designed with frightening specificity in the near future. One reason biologicals that attack with specificity is frightening is the possibility that a genocidal biological weapon could be created and destroy whole races at time. However, specific biological weapons could mean countless innocent civilians can be spared. At this time targeting just military or soldiers is out of the realm of possibility but it could be a concern in the future. Bombs cannot blow up a building and make sure only

certain people are killed in the blast. This is another major advantage over standard weapons.

Standard mass-destruction weapons are usually large and expensive. Biologicals can be made relatively inexpensively and can be carried in the tiniest tubes and be just as deadly as their more traditional counterparts. This fact has caused people to dub biological weapons the poor man's nuclear bomb.

Biological weapons are even more deadly than chemical weapons. Some are more powerful. Botulinum toxin is said to be three million times more deadly than sarin nerve gas. In addition, biologicals are more deadly a threat as a whole. They can self-perpetuate and mutate, whereas chemical weapons dissipate and become less deadly with time and dispersion. (Hardy) Biologicals can be as big a threat several days after administration as on the day of delivery.

Biological weapons have been recently accepted by the general public as being a legitimate threat especially with the advances in biotechnology. The world's governments believed in them since the early 1970's as reflected by the 1972 Biological Weapons Convention. (Hardy) Even the public believes in the deadliness of biological weapons. Some believe that they are more of a threat than nuclear weapons, and they probably are. In 1972, Advanced Concepts Research Corporation postulated that Anthrax in the spore form released as an aerosol attack over New York City could kill 600,000 people. In March of 1977, the U.S. Law Enforcement Assistance Administration reported that an ounce of Anthrax spores released into an air conditioning unit of a domed stadium could kill 70 to 80 thousand people. (Hardy) The media has produced

many stories of such attacks, such as *Outbreak*, The Cobra Event, *Twelve Monkeys*, along with many others. Most people now agree that biological weapons are a major concern.

Very few groups can use biological weapons since they are prohibited by international treaty. Terrorist organizations, rogue nations, and lunatics are the only real threat to use biological weapons. The unscrupulous countries would most likely use their weapons for war. Terrorists, domestic or foreign, could either be interested in getting a proverbial seat at the table, a new-world order, or just trying to invoke chaos. I will focus mainly on terrorists in the remainder of this project. The terrorists will have an agenda of some sort. They may be of the mind set that they don't care about what happens to themselves, but this is very short ranged thinking. They may be willing to die for their cause but it's not reasonable to risk your entire group to produce and release a biological weapon. Even if the group plans on only producing chaos, they would like to survive to produce more chaos. If they are looking for a seat at the table, it doesn't help to get a seat if you have no one to sit in it. Finally, if they are trying to start a new-world order they need someone to propagate their message. So most likely, precautions would need to be taken if the campaign is to be anything other than a suicide mission.

Table 1. Some current pathogens that could be used for biological warfare.

	Mode of Killing	Method of Infection	Mortality Rate
Anthrax	Release of exotoxins (LF, PA, and EF)	Ingestion or inhalation of spores	86%
Ebola virus	Liquefies organs, bleeding from orifices	Direct contact of infected body fluids	50- 90%
Eschericia coli	Bloody diarrhea, severe cramps	Ingestion of infected meat	Unknown
Hantavirus	Impairment of vascular endothelium	Contact with body fluids of infected Mice	38% Since 1993
West Nile Virus	Interferes with central nervous system causing inflammation of brain	Infected mosquito Bites	3-15% of Severe illness (<1% are severe)

Many current existing biologicals could be used as weapons. Several of the entities that could conceivably be used are *Escherichia coli*, Venezuelan equine encephalitis (VEE), and smallpox along with many others. Many of these have no known cure or vaccine making them very deadly. (Hardy) Sequestering the sick may be the best way defend against such an attack. That's why a genetically engineered weapon should be considered. Ebola virus produces a horribly violent and bloody death in about a week after infection. (Preston, The Hot Zone, 1994) An Ebola vaccine is currently being worked on and has been successful on macaque monkeys but a human version is far off. ("Ebola Vaccine") Anthrax is a very lethal organism, killing in three excruciating days as it destroys the membranes of the lungs and intestines. (Hardy) A vaccine for Anthrax exists but it is not readily available. Ebola is usually only transmissible by contact with blood and not through the air. (Ebola Virus) Anthrax is not transmissible from person to person at all. (Harley, et al. 777) These are drawbacks for using either as a biological weapon. Ebola virus could be very difficult to obtain. In addition, it is

quite unpredictable and since there is no human vaccine currently, it is best to not work with Ebola. However, if anthrax could be engineered to be transmittable from person to person, it would be a truly horrific weapon.

Table 2. Classifications of possible biological weapons.

	Anthrax	Ebola
Type of Organism	Gram-positive bacterium *Bacillus anthracis*	RNA Virus *Filoviridiae*
Mode of Killing	Exotoxin	Hemorrhagic fever
Vaccine	Yes, but not plentiful.	None.
Natural Occurrence	Infected animals, such as cattle	Unknown, possibly monkeys

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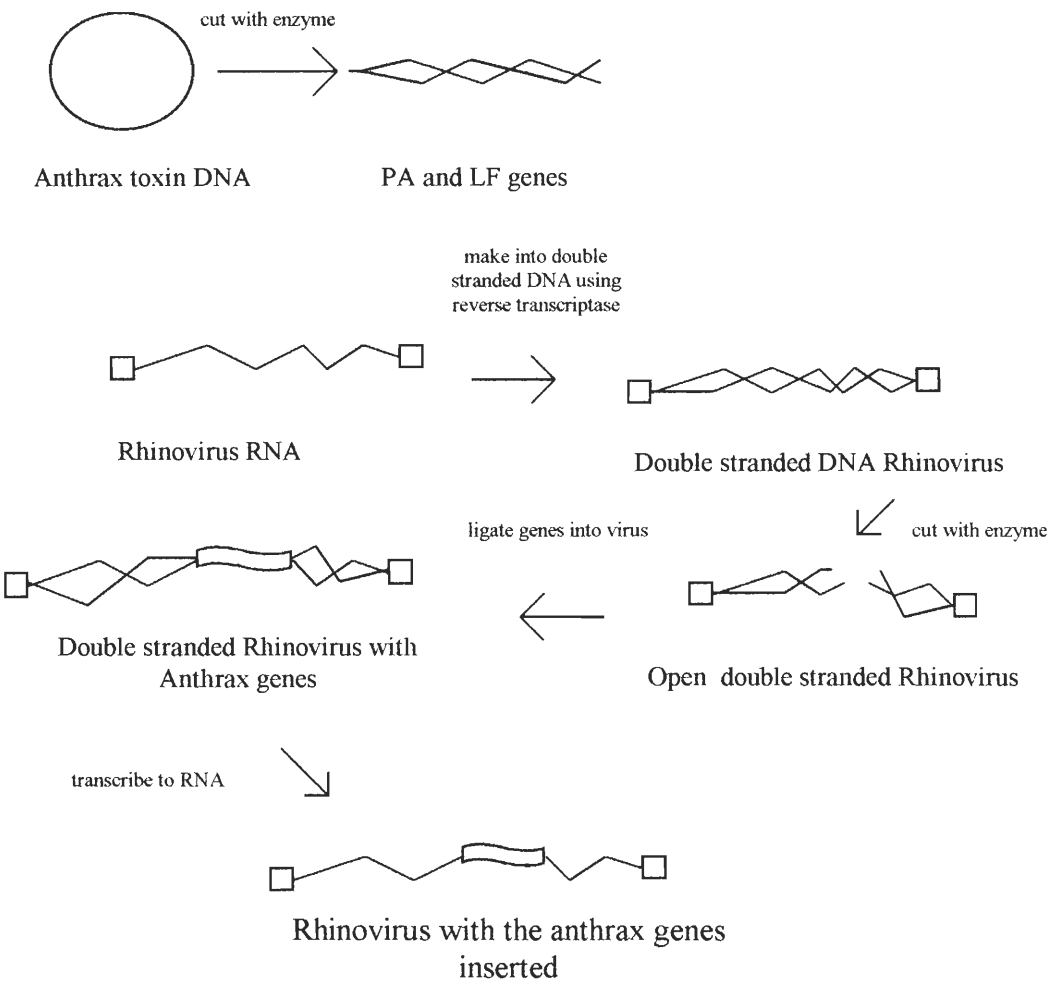
Three factors make anthrax deadly. Factor I produces edema activity (edema factor); factor II induces protective antitoxic antibodies (protective antigen); and factor III is essential for lethal activity (lethal factor.) Different combinations of these factors produce different results. All three together produce edema, necrosis, and death. The edema factor and the protective antigen together produce just edema. The edema factor and lethal factor together are inactive. The protective antigen and lethal factor are lethal. (Anthrax Toxins) Only these two factors need to be put into a system that makes them transmittable for an airborne killer. If a terrorist wanted to use Anthrax as a weapon, then a vector for this killer needs to be found.

The vector needs to be something that is very infectious and highly contagious. The two obvious choices are the flu or common cold. These are both very contagious from person to person. However, recently there has been a big push for people to be vaccinated against influenza. This could have detrimental effects to the spread of the weapon. Since there is no known vaccine for the common cold, most people think

Figure 1. Inserting PA and LF into Rhinovirus.



nothing of having it, and it is one of the most common infections, this is the ideal backbone for the killer. Rhinoviruses cause about 50% of all common cold infections. (Harley, et al., 1999) The protective antigen and lethal factor genes need to be cut from the plasmid that contains them. The rhinovirus needs to be converted to double-stranded DNA by reverse transcription. Then the DNA version of rhinovirus needs to be cut with a restriction enzyme. The anthrax toxin genes (lethal factor and protective antigen) need to be ligated into the DNA rhinovirus and the new DNA construct needs to be transcribed to RNA. The sequences of the protective antigen and lethal factor should then be inserted into the rhinovirus genome making sure not to disrupt the airborne and replicating properties of the virus. See figure 1. Presumably, by using two instead of all three factors, the sickness will be much tougher to trace because it will just look like a normal cold and then several days later the patient will die. If all three factors are used the symptoms would look more like anthrax which would most likely lead to the stopping the spread of the virus quicker. If the virus appears to be an ordinary viral respiratory infection, health professionals would most likely "let it run its course," which, unfortunately for the patient, would be death. Anthrax is very rare in the United States. (Harley, et al. 778) Presumably, the victims will not be around a typical source of anthrax (i.e. farm animal hair.) So many health care professionals would not think of anthrax causing their sickness. If a quite ingenious doctor does decide to test for anthrax, it will, most likely not show up. Lab criteria for diagnosis is: isolation of *B. anthracis* from a clinical sample, a fourfold or higher rise in either anthrax enzyme linked immunosorbent assay (ELISA) or electrophoretic immunotransblot (EITB) titer between the acute and convalescent phase serum specimens obtained greater than or equal to two

weeks apart, anthrax ELISA titer greater than 64 or an EITB reaction to the protective antigen and or lethal factor bands in one or more serum samples obtained after onset of symptoms, or demonstration of B. anthracis in a clinical specimen by immunofluorescense. (Anthrax Clinical Description) This means the diagnosis by these definitions becomes very hard. There are no spores so a clinical sample can not be found. For the ELISA and EITB the titer must be from serum samples from at least two weeks apart, more than likely the patient will be dead by then. Only one clinical diagnosis will yield the correct response that anthrax is the killer. Having only one way to detect this particular killer will most likely allow the virus to infect for a longer period before the truth is discovered.

Since the deaths are being caused by the anthrax toxins genes inserted into a vector, the protection should be relatively easy. The anthrax vaccine should be administered well before the anthrax and rhinovirus are manipulated. The vaccination should protect the terrorists when releasing the virus and if any mishaps occur during the construction phase of the killer.

WEAPON DISPERSION

The next major concern is the release of the weapon. Weather can affect biological weapons both positively and negatively. If the wind blows the correct way, the killer could be spread over vast areas. However, if the wind shifts the killer could be blown to a sparsely inhabited area. The sun can damage viruses rendering them useless, as well. (Welsh) All these things have to be taken into consideration. The virus if released out doors would most likely have to be done at night. However, the weather would still need to be perfect. Wind and chances of precipitation along with others

factors would have to be taken into account. If an outdoor release is to be attempted a more rugged virus may be considered. Rhinovirus is a single stranded RNA virus without an envelope. An enveloped virus such as influenza should be considered if an exterior release is planned. (Harley, et al., 1999) In addition, a double stranded nucleic acid virus may be more stable and resist UV damage. Finding a virus that infects humans with the regularity of influenza or rhinovirus could be a problem. Another consideration, if deciding to use a different virus is genetic size. A much larger genome will allow for more chance of mutation and cause a possible killer that has no cure. Another reason rhinovirus is such a good candidate is the virulence is low which allows the sufferer to contact others and spread the disease. (Harley, et al., 1999) A major way to circumvent all these drawbacks is by releasing the virus indoors. UV damage would be at a minimum. It should spread just as well. It will be kept in a smaller initial area but those infected will begin to spread it around quickly.

The next thing to take into consideration is where indoors to release the virus. Several possible locations were considered. A major indoor sporting event, an airport or airplane, a college campus, and a train or subway station were all considered. All these release points would allow the disease to be widespread because of the diverse location where people are from. For example, a typical college has students from all over the world. The sports event would have to be an extremely important event, like the Super Bowl, a major bowl game for college football, or the Olympics. The inherent problem with these events is the fact that the sheer magnitude of the event will draw extra security and an unnecessarily high risk. The Olympics draw a very international crowd. These

hypothetical terrorists would have no reason to show their power in foreign countries. They are trying to make an impact in the United States.

College campuses are known for having outbreaks of diseases, however, epidemic management is usually mobilized against the most serious threats, e.g. meningitis. Nevertheless, illness on a campus might be contained unless the release was done just before a large semester break like Christmas. This would insure that the disease is broadcast, although this may pull in foreign countries unnecessarily. It may also be difficult to find an end-of-the term event where enough students will attend.

A train or subway station would be an excellent place to spread the disease in a particular city but would not have the national coverage that others would have. However, it would limit the risk of foreign countries getting involved.

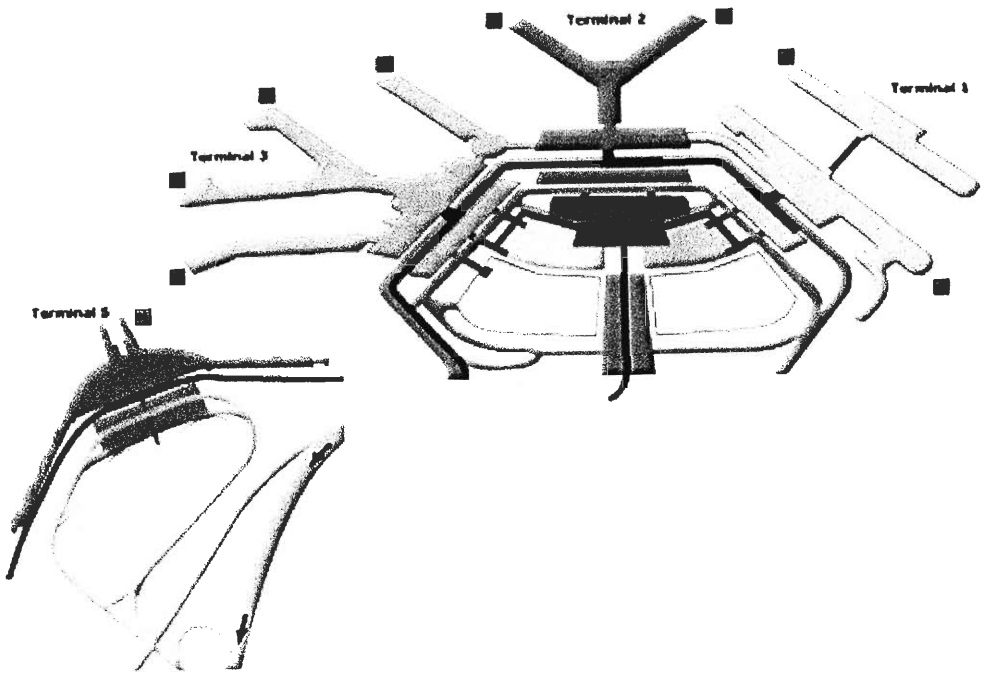
An airplane is a great way of spreading a disease. Although the terrorists are protected, sitting on a plane for several hours and breathing a deadly virus is probably not the best idea. Finally, an airport was considered. This does run the risk of going international, but that could be limited by releasing in specific locations within the airport. An airport would give the quickest widespread coverage, which is worth the risk of the international infection. This would be similar to the rats with *Yersinia pestis* travelling from port to port spreading the disease on a major long distance artery.

What airport to choose? Atlanta's Hartsfield was the busiest in 1999 with 77 million plus passenger going through it. (Airport Statistics) Releasing the virus in the city where the Center for Disease Control and Prevention is would be a nice irony, but this would insure a quick reaction too. This is not good for the spread of the disease. This would not be a boon for the spread of the disease, either.

The next busiest airport is O'Hare international in Chicago. In 1999, 72,609,191 passengers went through O'Hare. That is about 192,000 per day. (O'Hare International Airport) It appears to be a good choice. The airport layout must be examined. There are four terminals. Terminals 1, 2, and 3 are almost exclusively used for domestic travel. Terminal 5 is used strictly for international flights. This is beneficial in limiting the virus spread to foreign countries. Another beneficial factor about terminals 1, 2, and 3 is that they are connected to terminal 5 only by a tram type ground transportation system. (O'Hare International Airport) This will limit significantly the amount of agent that is spread internationally. There will inevitably be passengers that cross over from the domestic terminals to the international terminal. This is unavoidable. The best location within O'Hare depends on several things. First, trying to avoid international incident would be best served by releasing in terminal one, which is furthest from terminal five, the international terminal. However, terminal one is a bit isolated and only services two airlines. Seven airlines use terminal 3's gates. In addition, it is closest, via tram, to terminal 5. Terminal 2, on the other hand, services 11 airlines and is centralized. Terminal 2 is the best release point. The area of shops and services below the "Y" of terminal 2 is an ideal release spot. See figure 2. It is directly connected to terminals 1 and 3 and is very close to the tramline. (O'Hare International Airport) All these factors will aid the spread of the virus.

There are several ways to disperse the virus within the airport. A vaccinated carrier could be sent in to interact with as many people as possible. The carrier would be infected and have the virus on his hands to help spread the virus. Another possible way is to release the virus into the ventilation system. Both possible methods have drawbacks

Figure 2. O'Hare International Airport.



and benefits. In considering the carrier, it would probably be very difficult to find someone that would be willing to be the carrier even if vaccinated. There is always a possibility that the carrier could become very sick and possibly die. In addition, this plan requires a terrorist to interact with the crowds that he will be infecting. This could lead to an easy identification. It is also much more difficult to infect a large number of people. The carrier must interact with many people. Releasing the virus in the ventilation system allows for a broader range of infection and no direct contact with people. However, trying to release it in the ventilation could be a greater risk with security. Care need be taken. Another possible concern is not enough of the virus making it through the ventilation to infect a large number of people. This virus is not like normal anthrax spores, which are extremely tough and will survive through virtually anything. It is a single stranded RNA virus, believed to be the oldest kind of virus. Rhinovirus has been able to survive for a long time so this will most likely not be a problem. Taking all these things in to consideration, the best way to disperse the virus would probably be in the ventilation system. This allows it blow into the air where people can breathe it and become infected.

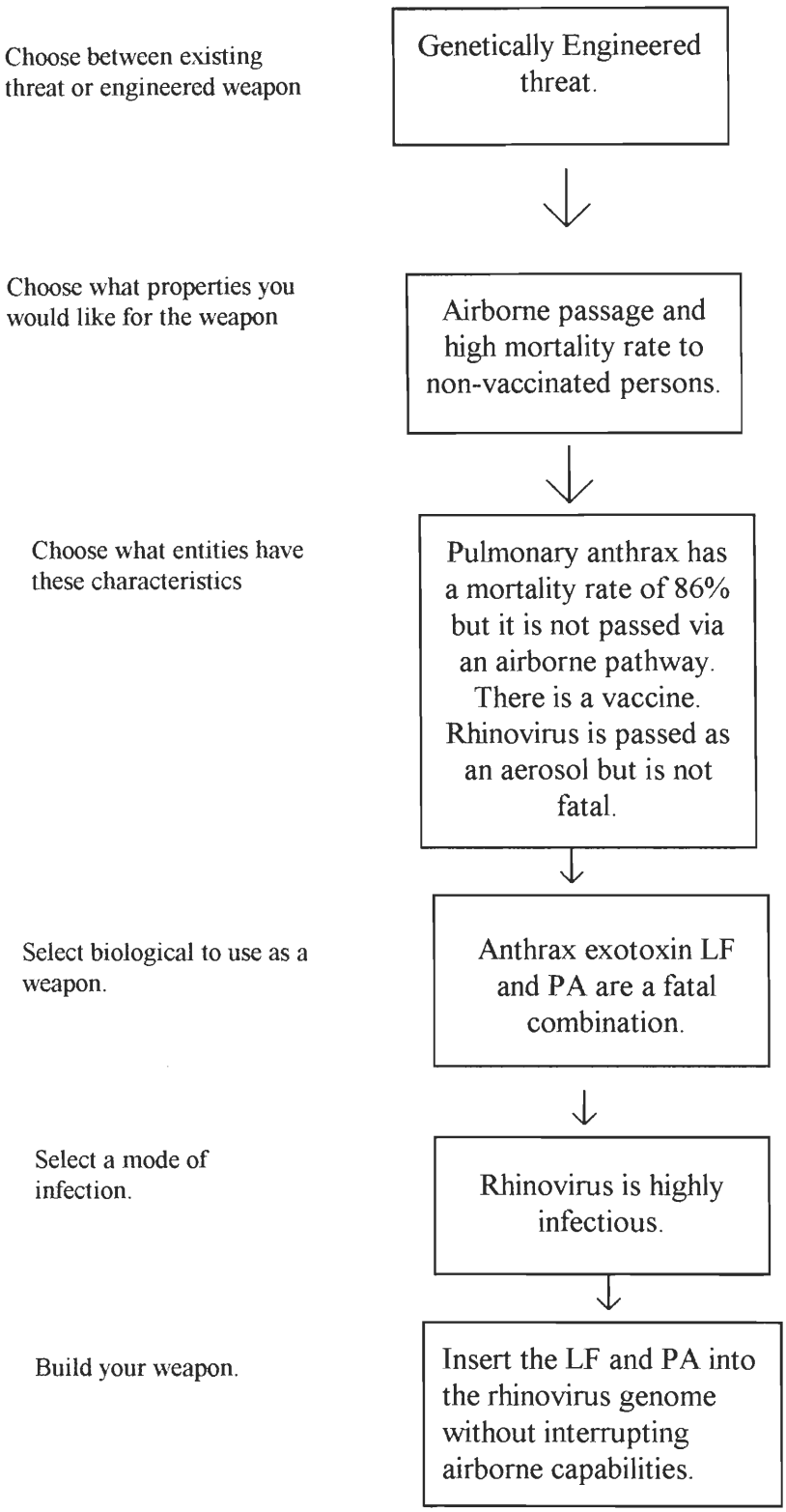
CONCLUSION

Although relatively new in the public eye, biological weapons have been around for centuries and are a bigger threat now more than ever before. With numerous anti-government militias forming and a plethora of foreign terrorists existing, biological weapons are the future of war and terrorism. They can self-perpetuate and mutate making a killer that even the protected can't defend against. The information is very easily accessible for anyone attempting to make a horrific biological weapon, which is

the point of this project. This is not meant as a guide but more as a warning as what could be done with some knowledge, some time, and some bad intentions.

Biological weapons similar to the one proposed in this work would be very unpredictable. By using this or similar weapons, Pandora's Box is opened. So most likely Anthrax 2001 would not be made. Only madmen would use this and similar weapons. However, there is no guarantee the men in charge of countries and armies worldwide are sane. So Anthrax 2001 is a real concern and caution need to be taken when examining it and any other biological weapon.

Figure 3. Creating a biological nightmare.



Choose location of dispersion.

O'hare International Airport

Find ideal release point within the dispersion location.

Terminal 2 is centralized and ideal.

Decide which way is best to release the weapon.

Release in the venitalation system would allow a large number of people to be infected.

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This was a personal interview with Dr. Welsh regarding virus survival in the air and damage by UV light.

West Nile Virus Questions and Answers. The Center for Disease Control and Prevention. 18 Feb. 2001. <www.cdc.gov/ncidod/nvbid/westnile/q&a.htm>

This C.D.C. site had a lot of information about the West Nile virus specifically the outbreak in New York.