# Social & Economic Effects of Avian Influenza

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# Executive Summary

The potential outbreak of H5N1 avian influenza threatens today's society. Avian influenza is a group of different influenza viruses that mainly affect birds. There have been a total of 191 bird to human cases of this influenza and 108 of them have been deadly. If the strain mutates and becomes transferable form human to human, it would devastate many people around the world.

The purpose of our project was to stimulate the potential human-to-human spread of the H5N1 avian influenza. We decided to do our project on the avian flu because it is a current topic in the news and the data we find could be helpful.

The program that we used to create our stimulation was Starlogo. We chose this program because it provides a good modeling environment for exploring different systems and possible occurrences. Starlogo is used by controlling turtles on the screen.

Using Starlogo, we began to stimulate the spread of the avian influenza. We began to model our project. During our modeling, we took into account the likely incubation periods and infection rates of this flu. We found that the spread of this epidemic would be rapid but we plan on continuing our project to find more concrete results.

# Acknowledgements

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# Introduction

AIDS. Obesity. Malnutrition. Bird Flu. Wait, what? Yes, it may be surprising to find the emerging Avian Flu on a list of serious health problems facing our nation (and the world), but this prospective pandemic could change your life (or end it). True, it may not have emerged on a widespread scale to date, and though it cannot yet be spread by human-to-human contact, it is one issue that cannot be overlooked. That's precisely the reason that we chose this project. Everybody knows about HIV and AIDS, heart disease- you name it. However, few people have a grasp on how pernicious the Bird Flu will be, and little is known about this virus in general. So, we decided it was time for the American public to become acquainted with this deadly train that is coming straight at us so that we have the time and information to move off the tracks. But let's start from the beginning.

The Avian Flu is quite different from the common flu that 10-20% of the United States becomes inflicted with each year. With the fall of the yellowed leaves and the excitement of Halloween also comes the reality of the flu. Though "common" in name, it changes slightly each year, and these slight viral alterations manage to kill between 20,000and 50,000 people in the United States alone. Though that may seem like a large amount (think of the entire population of Farmington dying), it is nothing compared to

the detrimental Spanish Flu of 1918 and 1919. Fifty million people died within a period of less than 18 months, and a billion more individuals worldwide were incapacitated. And the population at the time was only 1.8 billion.

The Spanish Flu is the closest model we have for the emerging Avian Flu virus as both are transmitted by respiratory droplets and literally drown the person infected by swamping the lungs with fluid. Both viruses also target the 20-40 year-old demographic, a trait that is unlike the common flu (which kills only the very young and the elderly). One source stated that the reason the healthiest population will become the most contaminated (as was the case in 1918) is because the otherwise healthy immune systems of these individuals go into overload and the body works itself to fatigue and eventually death. Both H5N1 viruses are also in the same family, and thus they share many common characteristics, a fact that is extremely frightening considering the prolific nature of the Spanish Flu and the overcrowding of Southeastern Asia and parts of the United States and Europe in the present day.

The Avian Flu has already popped up in parts of China and Southwest Asia, alerting the world that the virus infecting innumerable flocks and shipments of waterfowl has successfully jumped species to humans. Though only a handful of people have died to date, it is only a matter of time before the intelligent virus is capable of human-to-human transmission. So we wait.

Waiting is all the United States government has actually done. TamiFlu®, the only drug on the market that fights the Avian Flu, is the best hope for when the flu strikes, which it inevitably will, if not today or within the next year, then soon. And the United

States government has purchased 2.3 million doses. With an estimated 10% resistance and a possible 50% effectiveness, it seems apparent that the government is not really concerned about keeping its population alive. Hopefully you will be. Since very few people are still alive that survived the H5N1 pandemic of 1918, natural immunity is virtually obsolete. Without adequate preparation, preventative measures, medical attention and quarantining procedures, you should probably expect to become infected unless, of course, something is done to stop this oncoming train.

Many solid facts and absolutely certain information are not known, so in researching for our project, we made many inferences. Some things we did know for certain, however. Our team knew we wanted to simulate Los Angeles, and we also knew such things as the incubation period of the Flu. So, strap on that protective breathing mask, and enter the world of the Flu.

# Description

Disease spread of any pathogen relies heavily on literally hundreds if not thousands of factors such as incubation rate, how a pathogen is transmitted from one organism to another or what types of mutations arise from a pathogen's replication and whether those mutations make the pathogen more or less virulent. In a simulation of disease spread, these factors need to be appropriately addressed for the results of a model to be applicable to the 'real world'.

Our Simulation encompasses that basic factors of Avian Influenza (H5N1) disease spread which include transmission, barriers (walls), the speed of the 'turtles' within our model and what 'breeds' of turtles exist in our simulation. Since our team wants to be as realistic/applicable as possible to the real world, we decided to model our H5N1 spread similar to that of the 1918 Spanish Influenza virus except our transmission is only from bird to human when a human comes in close proximity to an infected bird. Infected people cannot infect other sick birds or healthy/sick people. If a person becomes infected with the avian influenza virus, they will stay sick until the simulation is stopped and restarted.

Barriers can also be created within our simulation at any time. So far we have

used these barrier to keep our infected birds within a confined area, this square can be likened to a quarantine facility or a shipping container that enters the United States by cargo ship or other sea-faring vessel. This confine allows healthy and sick people to travel through it while the birds 'reflect' off its walls and are not allowed to travel outside the box's confines. We can also control the speed at which our simulations runs which allows use to control the overall speed of our model's agents (turtles). This allows us to examine more easily how humans may become infected (disease spread patterns) and how long that process may take. This would allow health workers and governments to know how quickly to respond to an outbreak if it were to occur.

There are presently three different 'breeds' of turtles in our model. All the birds are the shape of swans which allow us to easily distinguish between them and our other two breeds. Whenever the simulation is run, our birds are always infected. 'Healthy people' is our second breed and are green people-shaped turtles. Our final breed is the 'sick people' who are people infected with the bird flu and are orange people-shaped turtles.

We used a free download of Star Logo 2.2 for the Window's operating system (includes Sun's Java Runtime Environment) (28 4MB download).

(turtle command)

```
breeds [people bird sick]
;if breed = bird [setc red]
;if breed = people [setc green]
;if breed = sick [setc orange]
```

```
to setup
setxy random screen-width random screen-height
if breed = bird [setshape swan-shape setc red]
if breed = people [setshape person-shape setc green]
if breed = sick [setshape person-shape setc orange]
end

to go
wiggle
check-color
end

to wiggle
if breed = people [grab one-of-turtles-here [
if breed-of partner ;= bird
[setbreed sick]]]
fd 1
lt ((random 5)- 2)
end

to check-color
if breed = bird [if pc-ahead = yellow [lt 180]]
if pc-ahead = blue [rt 90]
end
```

(observer command)

```
to setup
ca
cct bird 5
cct people 10
ask-turtles [setup]
end
```

Engish: from turtle commands

breeds [people bird....
In our simulation there are 3 kinds of turtles or breeds represented
birds, people, sick (sick people).
comment: all the turtles who are birds, turn the color red
comment: all the turtles who are people, turn the color green
comment: all the turtles who are sick, turn the color orange
end of command

to setup.....

When someone presses the "setup" button, birds, people, and sick (people) appear at random points around the screen. If you are a "bird" set your shape to the swan-shape. If you are a person then change your shape form the original turtle shape to the person-shape (the green people). If you are a "sick" turtle set you shape to person-shape (these are orange people).
end of command

to go
all birds, people and sick follow the "to wiggle" command (defined below)
all birds, people and sick follow the "to check-color" command (defined below)
end of command

to wiggle
If you are a person (green) and are near another person, 'sick' or bird, grab them and see if they are a bird. If they aren't let go and move away but if the grabbed turtle is a bird you are now a "sick" (person) and turn the color orange.
All birds, people and sick move forward one space (fd 1) then turn left random under the syntax (5)- 2.
end of command

to check-color
if you are a bird and the 'patch' or pixel ahead is yellow turn left 180 degrees, if the 'patch' or pixel ahead is blue turn right 90 degrees
end of command

Engish: from observer commands

to setup
Clear all birds, people and sick and all graphics on the simulation.
Create Custom Turtles
The program asks the turtles (birds, people, and sick) to execute the 'to setup' command on the turtle procedures page
end of command

# Results

Our simulation has so far created no data because our model on the spread of the Avian Influenza (H5N1) is not to the point where it could effectively and realistically evaluate our hypothesis that an outbreak of H5N1 in Los Angeles would have profound effects on our nation economically and socially. However, we have learned a lot from our simulation thus far like how to control the movement of the infected birds with barriers and how to translate disease transmission patterns (bird to human, human to human, etc.) into a computer model and how to create different breeds.

So far this simulation could potentially be used to model disease spread of the H5N1 avian influenza in any city around the world, all one would have to do would be tweaking the variables of the simulation to fit the new city such as the amount of barriers, population density among other factors. This simulation may even be capable of modeling the spread of diseases other than the new bird flu. Hopefully we will be able to create a simulation to the complexity needed to model any city or urban center in the world in the near future.

# Achievements

I think that we made some great achievements this year. We learned a lot about Starlogo and the avian influenza and made good headway for our project.

At the beginning of our project, we had little knowledge about Starlogo or the H5N1 avian influenza. As we worked on our project we became more familiar with Starlogo and learned a lot of commands and programming language. While doing research on our project we learned about the avian flu as well as the Spanish flu.

Our project is coming along nicely. Soon, we will be able to add some of the numbers from our research into our stimulation. We are exited to learn more and continue our project.

# Analysis and Conclusions

In our project, we found essentially what we had predicted. The Avian Flu is a large threat to our nation, and to the world, and it is not a matter that can be dealt with lightly. Our simulation did not actually yield exact numbers and precise information as we did not have exact numbers or precise information to begin with to work off of. However, the following analysis surfaced as we made and studied our representation of the Avian Flu pandemic in the city of Los Angeles:

First, we discovered that with the larger and larger the square containing the birds got, the better chance and higher probability people would walk through and become infected. This has led us to realize that more strict measures must be taken at ports and trade centers for shipments containing birds. If a load is infected and reaches the city limits, the more quickly and carefully it is disposed of, the better chance there is for the virus to spread like wildfire across any given city in the world. This has also led us to the conclusion that quarantines and house arrests, so to speak, will limit contact with other people carrying the virus (though this is slightly obvious), and thus school and the city as a whole will probably be forced to shut down for the duration of the pandemic, or at least until adequate doses of TamiFluÂ® can be administered or an effective vaccine is produced. So, get that pantry stocked with plenty of canned beans and pineapple.

One factor that we had the ability to change was incubation rates. The longer the incubation rate was changed to, the longer the infected individuals were roaming around and coming into contact with others before they died or recovered. Again, this is basically

intuitive, but our simulation simply reiterated these predictions as the number of infected people skyrocketed (actually, turtles would more accurately describe the creatures that contracted the Flu in StarLogo). Therefore, the public would be urged to seek medical attention immediately at the first signs of headache, aches and nausea.

Basically, the detrimental effects of the Avian influenza are as we assumed they would be, but there is now hope for the future of this prospective pandemic through preventative measures and vigorous medical treatment and attention. Our simulation has enabled virtually any city in the world to be mapped into an Avian influenza situation, a feat that can be accomplished with slight tweaks and alterations.

# Follow-Up

It would be best to get this out on the table first: we didn't complete our project to the extent that we perhaps could have had we been extensively versed in C++, Java, and StarLogo and had three years to work on the simulation of the Avian Flu. Also, definite facts would have been very helpful for the basis of our coding, but not much is known about the Avian Flu to begin with. That said, there is still plenty of room for improvements, and we hope to make those in the future.

A continuation of this simulation would involve more specific information regarding demographics of the city of Los Angeles, information about natural immunities, death rates, normal reproduction rates, and quarantining abilities. By the time we make these progresses, more sophisticated data will hopefully emerge to aid us in our coding to make a more realistic replication of the influenza.

A helpful addition to our code would be to include the effects of TamiFlu and a possible vaccination. However, these factors are still far down the road but hopefully we won't be incorporating them into our code as we sit at home behind a protective breathing mask typing in latex gloves as the virus surges outside.