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Gaming to Predict Human Responses to Mass Casualty Events:

An Approach for Quick Look Tools for Pandemic Influenza

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Social Intelligence in Applied Gaming

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Abstract

There is a need to better understand and describe social intelligence in the realm of dealing with mass casualty events, such as pandemic influenza, earthquakes, or other natural or manmade disasters. This social intelligence is needed to be able to accurately feed and drive models and simulations that attempt to describe and quantify human responses to such mass casualty events and potential mitigation strategies that might be used to minimize their impacts by reducing numbers of deaths, injuries, and other societal (e.g., economic) consequences. We propose to attempt to gain a better understanding of social intelligence and socially driven human responses through the use of games and game-like interfaces with an application toward infectious diseases.

Agenda

- Introduction
- The challenge and potential impact
  - Previous work
- Approach
- Gaming to support development concept
- Conclusions

It [gaming] is the child of avarice, the brother of iniquity, and the father of mischief.

-- George Washington

You have to learn the rules of the game. And then you have to play better than anyone else.

-- Albert Einstein

All my games were political games; I was, like Joan of Arc, perpetually being burned at the stake.

-- Indira Gandhi

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Introduction

- Game-based solutions are already providing compelling results to improve health and healthcare
- Desire to build on this momentum in order to better understand and describe social intelligence in realm of mass casualty events
- Social intelligence is needed to be able to accurately feed and drive models and simulations that attempt to quantify human responses and potential mitigation strategies
- We propose to attempt to gain a better understanding of social intelligence and socially driven human responses through use of games and game-like interfaces with an application toward infectious diseases
- End goal: respond to critical need to equip public health officials responsible for mass casualty event planning and response with sophisticated, yet easy to use tools that:
  - Capture complex elements of such events – especially individual social behaviors
  - Adjust as additional information is attained and conditions evolve over time

Introduction (cont'd)

- Via gaming, research will explore modeling constructs that include fundamental dynamics of social interactions as a function of varying beliefs, cultures, education, and other social science information and community demographics
- Gaming methodology and underlying developed algorithms will attempt to mimic observed patterns of social behavior in various communities under recent and historical mass casualty event settings
- Our initial focus will be on pandemic influenza
  - Recent and on-going Swine Flu outbreak
  - Historical pandemics such as the 1918 Spanish Flu
- Example: if CDC recommends school closures due to Swine Flu:
  - How will students within a specific set of demographic attributes react? Stay home, go to the mall, etc.
  - How will adults within a specific set of demographics react? Stay home from work to care for their children/families, gather with neighbors, hibernate, etc.
  - These and many similar issues that drive the overall effectiveness of potential mitigations can be explored through gaming

The Challenge and Potential Impact

- Federal, State, and local community public health officials must prepare and exercise complex plans to deal with a variety of potential mass casualty events
- However, officials responsible for developing such plans must often rely on information and trends provided via:
  - Complex, supercomputer modeling
  - And/or modeling that has incorporated drastic simplifying assumptions
- Moreover, such plans often contain only a few specific scenarios or pre-event concepts
  - Often ignore fact that optimal solutions to deal with a pandemic are very dependent on its underlying traits and actual characteristics
  - Cannot be known with any certainty a priori

Microsoft Excel - ISPIPT_v2.xls

Select county for detailed summary

High level output for selected county and detailed output for entire state

Indiana State Pandemic Influenza Planning Tool

County Specific Scenario Plot for Display	
Selected County:	Adams

Spread Rate

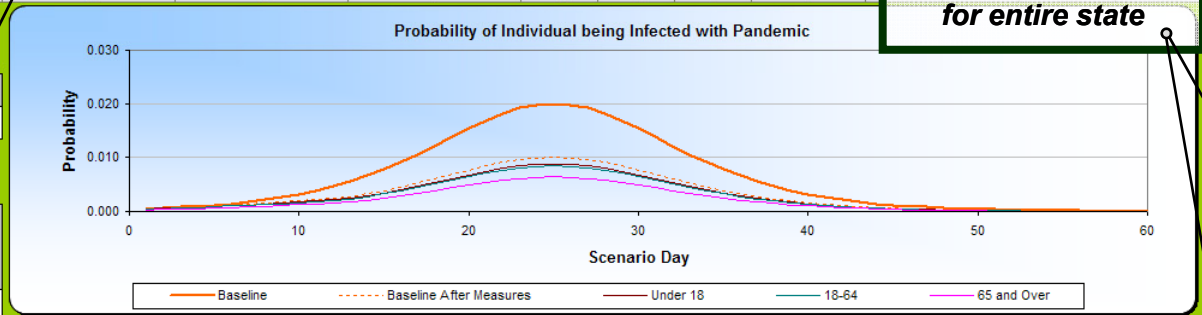
Point of Origin (currently Chicago, IL)	
Latitude	41.879536
Longitude	-87.624333
Miles/Day Traveled:	25.0

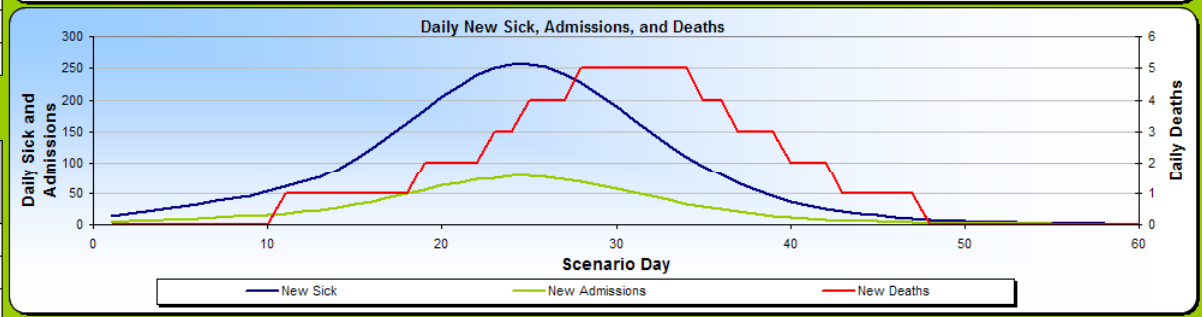
County Type Impact

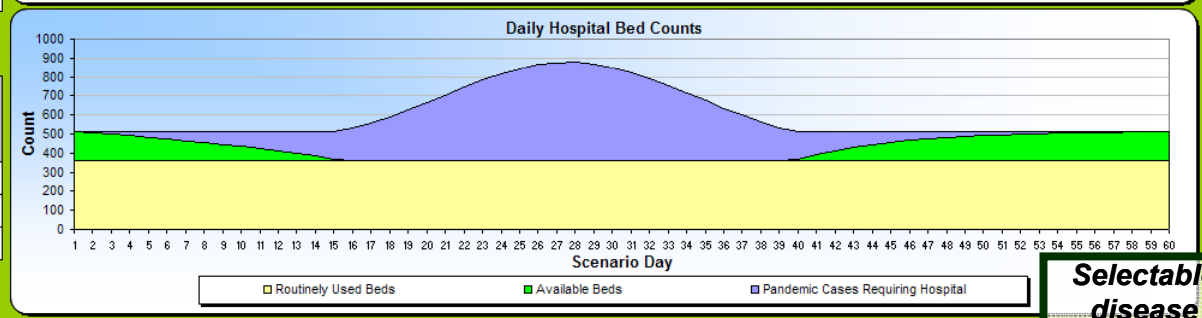
County Density Category	Modification to Baseline Pandemic Influenza Infection Probability
1 = Rural	0.80
2 = Small Towns	1.00
3 = Major Metropolitan	1.20

Demographic Impact

Demographic	Modification to Baseline Pandemic Influenza Infection Probability
Under 18	1.10
18-64	1.05
65 and Over	0.80







Adams

Population:	33,625
# Beds:	514
County Type:	1

Scenario Summary

Category	30 Day Totals	60 Day Totals
Infected	3,885	4,985
Admitted	1,165	1,497
Deaths	49	97

Output Data for Selected County

Output Data for All Counties

Reset Master Value Defaults

Disease	Default R0
Cholera	2.70
Diphtheria	2.00
Hemorrhagic Fever Viruses	1.80
Infectious TB	2.00
Pandemic Influenza	2.50
Plague	3.00
SARS	2.40
Smallpox	3.50
Yellow Fever	2.90

Selectable disease "palette"

Decision Measures

Measure	Meaure On (1) or Off (0)	% Reduction in Infection Probability	Day Implemented (from delay time of pandemic reaching county)	Number of Days to Achieve Full Impact (number of days after being implemented)
Media	1	10.00	2	2
Close Schools	1	15.00	4	5
SNS	1	25.00	6	7

All controls can be selected by user

Hospital Bed Model (Enter 1 or 2)	
Enter Choice:	2

Global Parameters (these can be overriden county by county by going to the specific county tab)	
Mortality Rate:	2.0%
Recover Rate:	98.0%
Hospitalization Rate:	30.0%
Typical Hospital Capacity:	70.0%
Mean Time to Recover (days):	10
Mean Time in Hospital (days):	6
Mean Time to Die (days):	6

Center of Curve for Initial County

Day
20

Output GAR for 60 Days

14.8%

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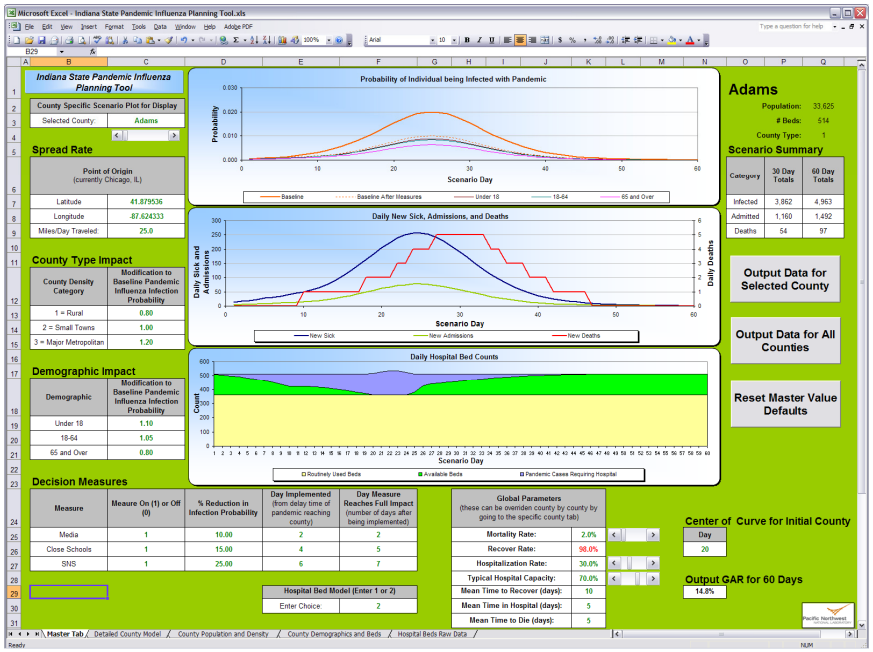
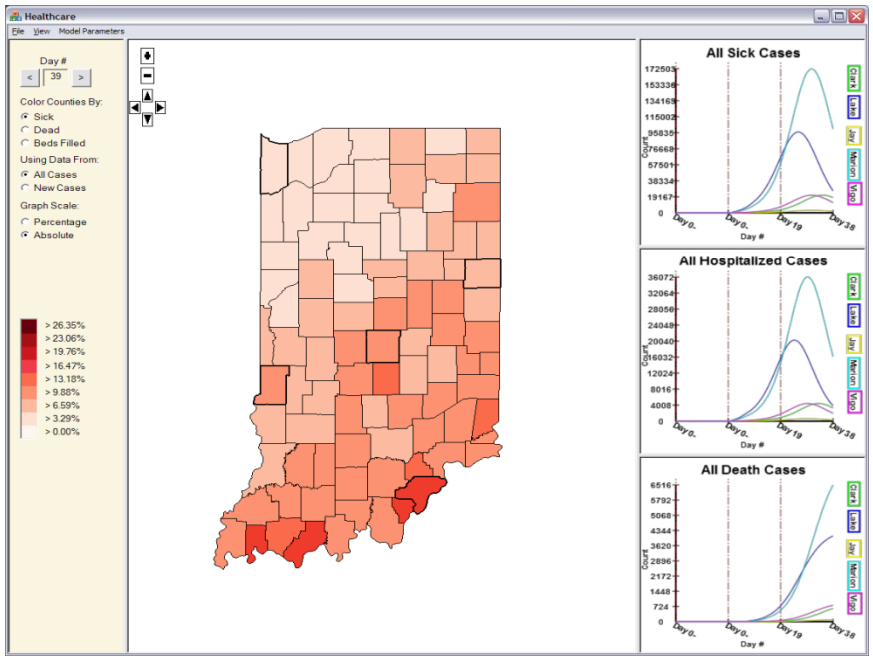
Master Tab / Detailed County Model / County Population and Density / County Demographics and Beds / Hospital Beds Raw Data

Pandemic Influenza Planning Tool and Visual Interfaces



PanViz (state level visualization)



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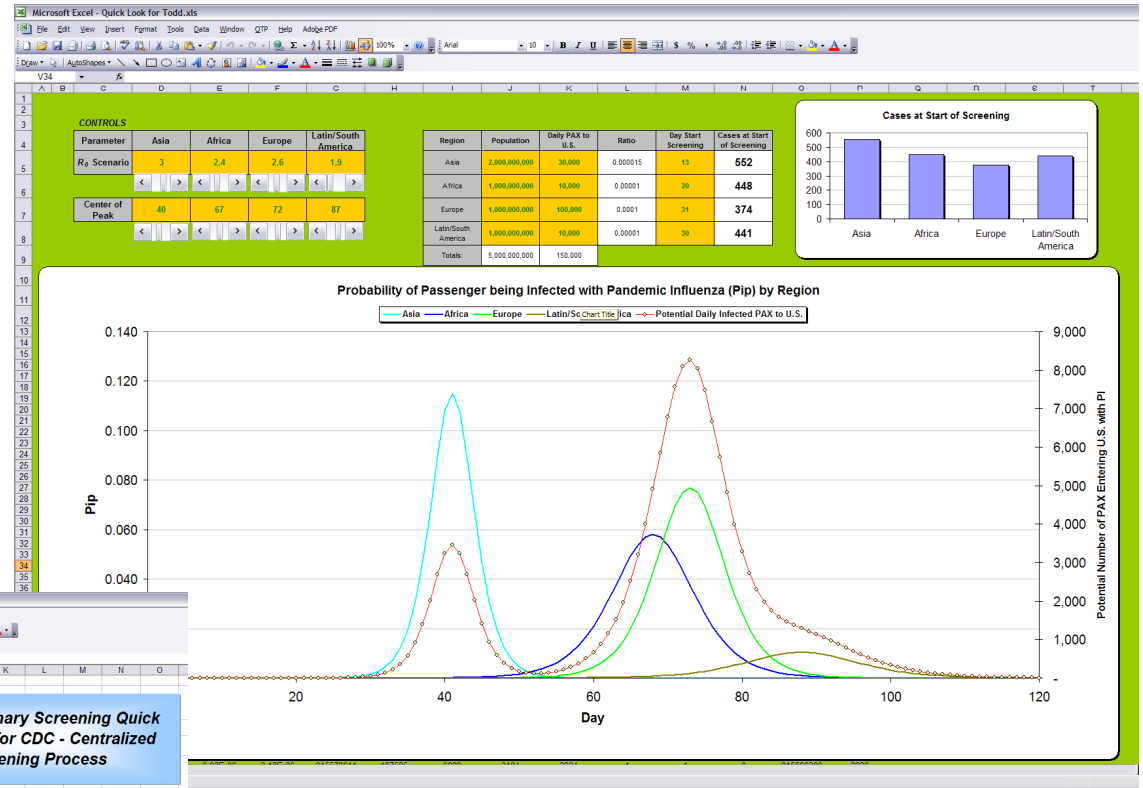
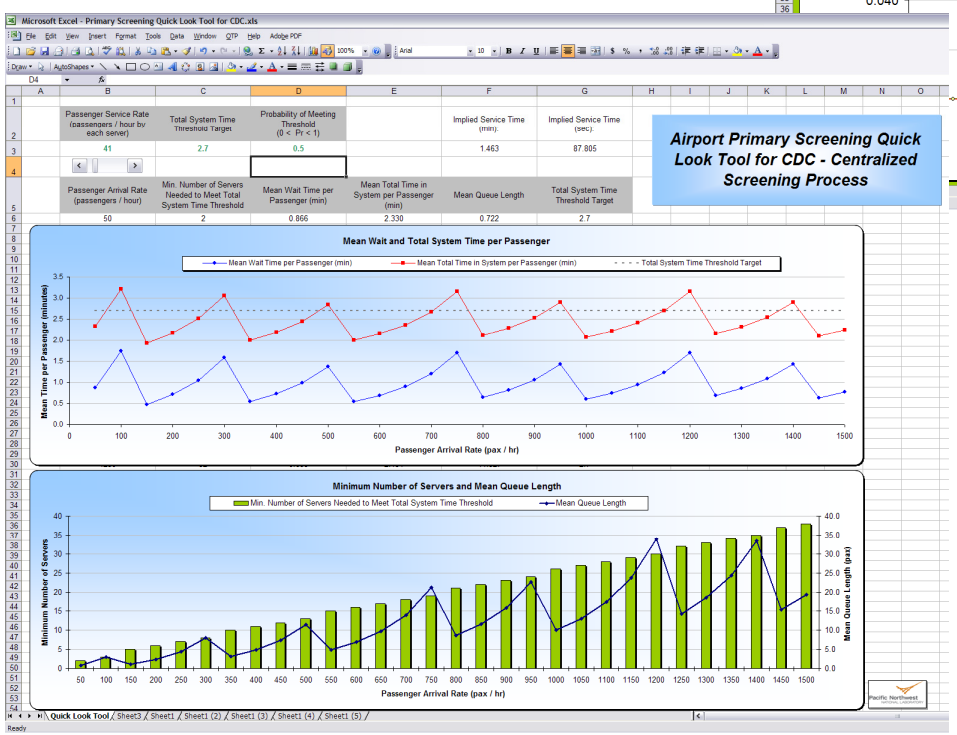
Additional Pandemic Influenza Quick Look Tools

- Tools can be customized for planning/impact analysis related to pandemic influenza or other infectious diseases
- Can allow user to do easy “what-ifs” and identify “best” solutions





PI planning tool for estimating infected passengers arriving to U.S. – “palette” available for other diseases

Operations analysis tool – expected waiting times and queue lengths for different arrival rates and service characteristics

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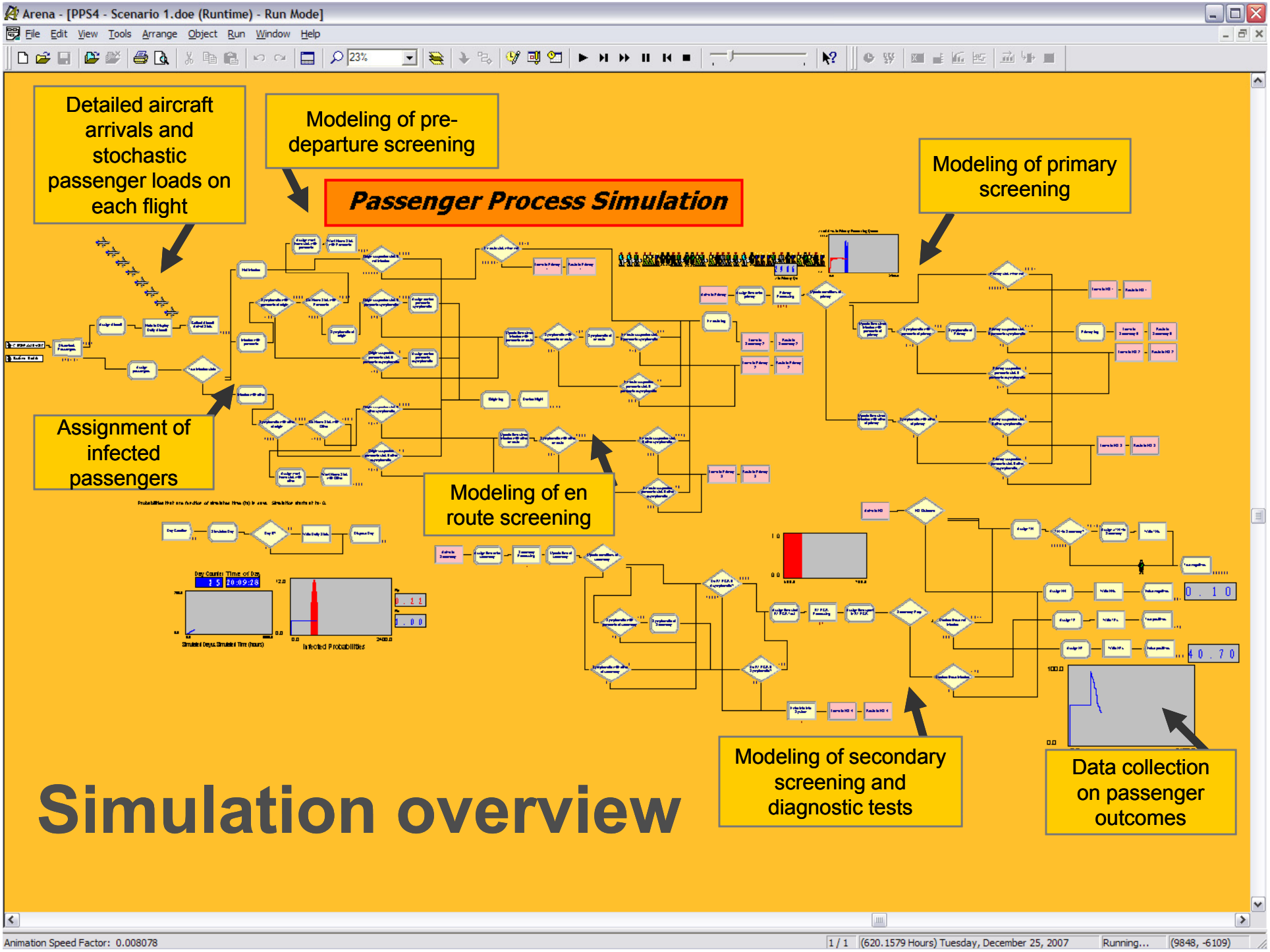
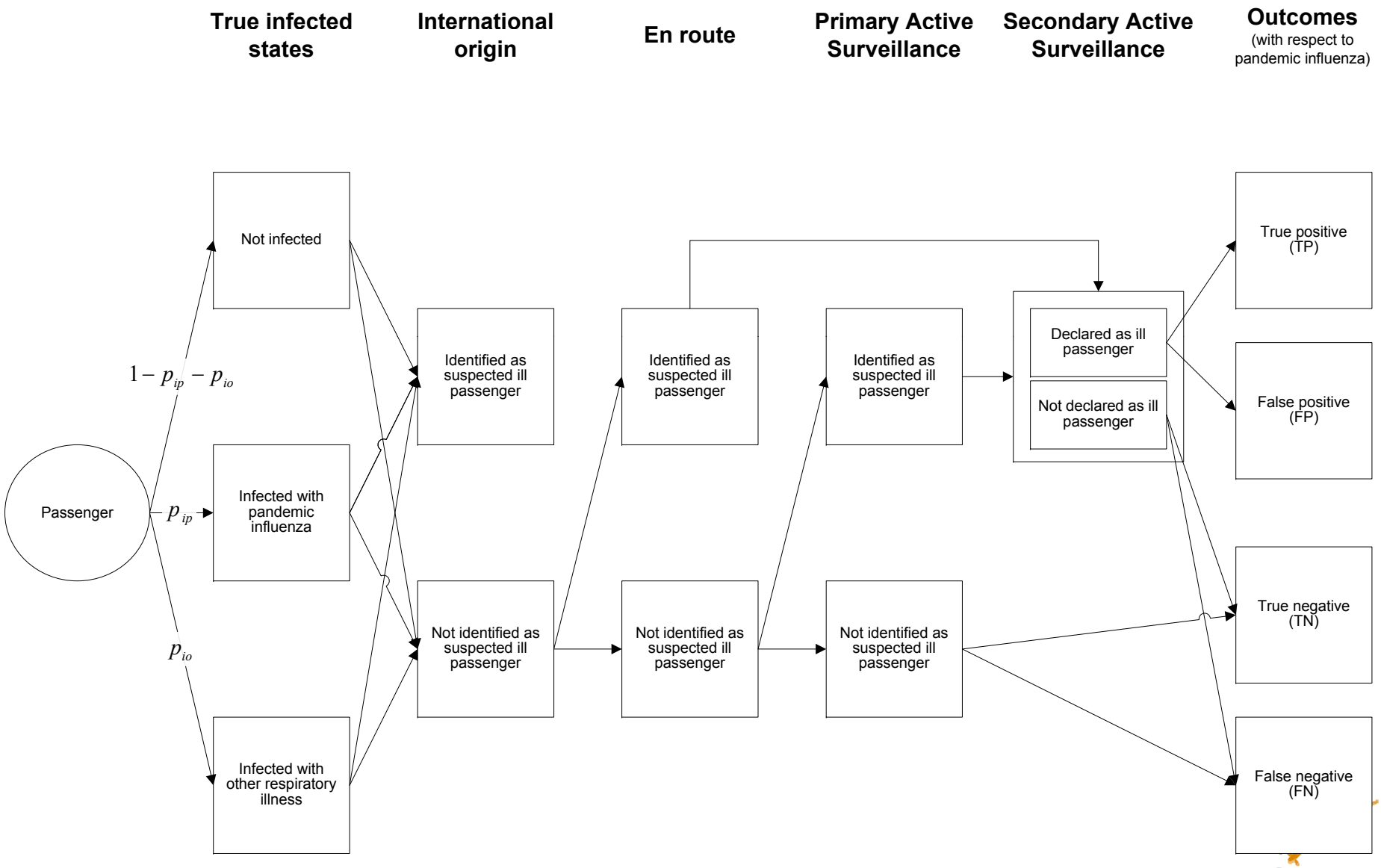
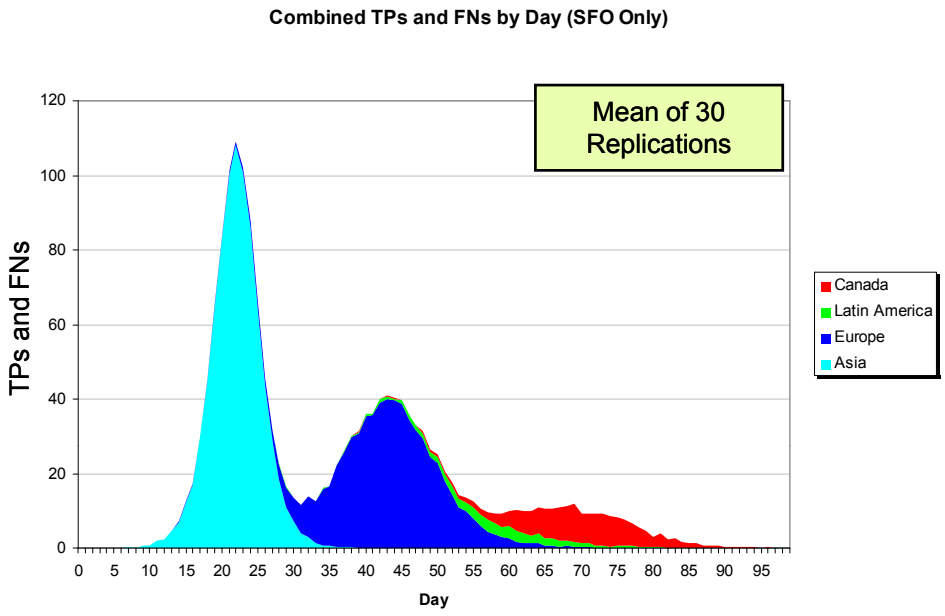
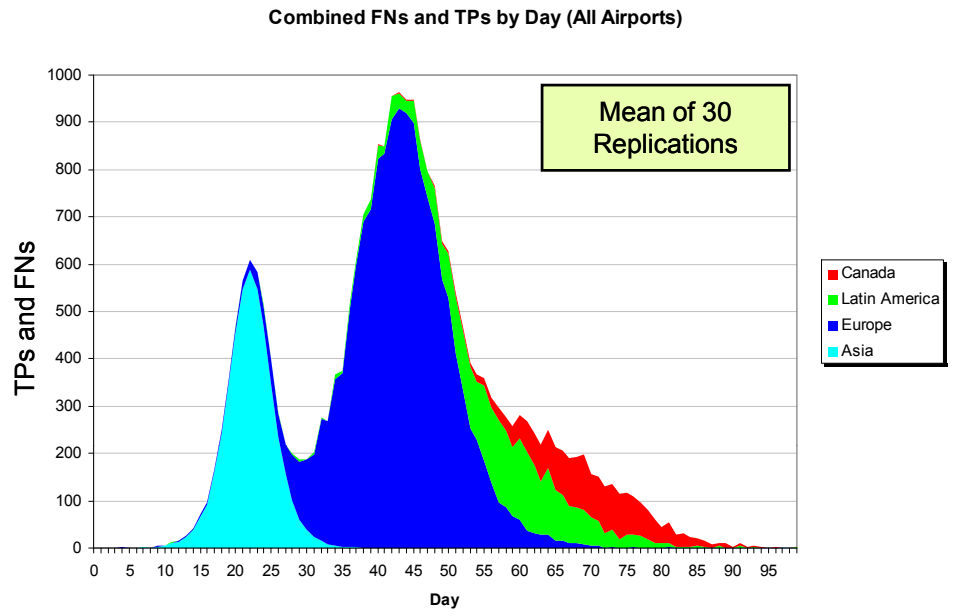

Arena - [PPS4 - Scenario 1.doe (Runtime) - Run Mode]
File Edit View Tools Arrange Object Run Window Help
Detailed aircraft arrivals and stochastic passenger loads on each flight
Modeling of pre-departure screening
Passenger Process Simulation
Modeling of primary screening
Assignment of infected passengers
Modeling of en route screening
Modeling of secondary screening and diagnostic tests
Data collection on passenger outcomes
Simulation overview
Animation Speed Factor: 0.008078
1 / 1
(620.1579 Hours) Tuesday, December 25, 2007
Running...
(9848, -6109)

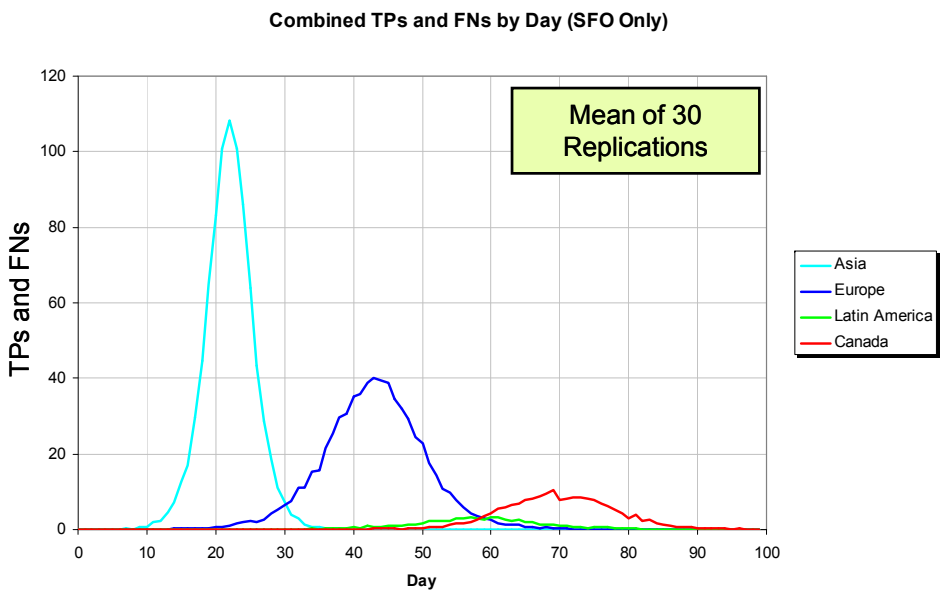
Simulation logic summary

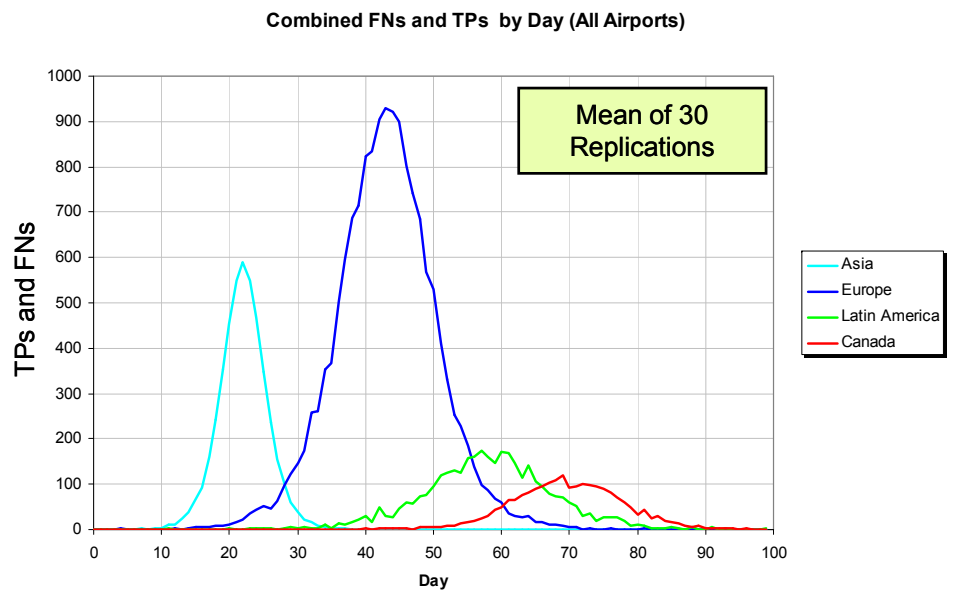


Daily Combined FNs and TPs: SFO vs. All Airports









The Challenge and Potential Impact (cont'd)

- Major challenge with previous examples and other tools needed for effective planning is: *how to characterize and invoke an individual-based model (IBM) construct of social behavior for community encompassing traumatic events?*
- The unique and difficult part of this research then is capturing the individual characteristics of humans as they respond to a pandemic
  - And then other mass casualty events
- Thus, a key objective of the proposed research is to identify the most significant aspects of individual behavior and social interactions in response to traumatic events

Can Gaming Do This?

The Challenge and Potential Impact (cont'd)

- Rationale is that mass casualty event planning can be done with higher accuracy and more realism
- If an event happens, optimal mitigation strategies can be invoked to minimize casualties as the event unfolds
- Potential impact of proposed research is a reduction in number of casualties associated with a mass casualty event and overall health of U.S. citizens

Approach

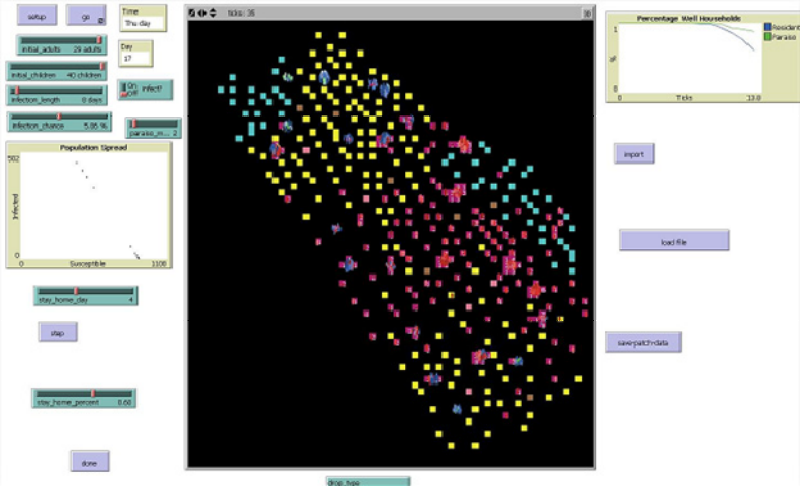
- Specific Aim 1: Identify most significant aspects of individual social behavior in response to traumatic events
- Specific Aim 2: Develop a mass casualty event planning and response tool that can be used by planners, first responders, and decision makers

Approach (cont'd)

- Sub-aim 1.1: Understand actions of individuals and then similar group of individuals in the context of the actions and behaviors of individual elements who make up group
  - In classical context of individual-based models, groups have been defined as humans who make decisions and whose behavior is modeled
  - This is one area where gaming might be used to help delineate the most important aspects of social behaviors as related to pandemic influenza.
- Sub-aim 1.2: Explore use of cognitive mapping to help describe human behavior under stress/trauma and related individual-based characteristics
- Sub-aim 1.3: Delineate specific IBM rules for individuals that can be captured and brought into agent based model (ABM)
  - The IBM rules here will include mechanisms for irrational or emotionally based behavior of individuals
- Sub-aim 1.4: Research parameters and corresponding statistical data that can be used to assesses and describe these parameters
  - Gaming can be used to help estimate model parameters in order to define disease traits

Approach (cont'd)

- Sub-aim 2.1: Work with local/state public health officials to identify key input parameters and output performance metrics of interest
- Sub-aim 2.2: Develop a specific basic agent based model that incorporates the IBM rules/algorithms
  - Provide a simulation of individuals as they go about their daily routines when confronted with a pandemic influenza outbreak
- Sub-aim 2.3: Develop and incorporate ABM outputs into quick look tool (QLT) for real-time feedback
  - With different selectable parameters and disease traits, there exists the potential to provide for optimal decision measures, resource levels, and timings
  - These might be carried out through inherent quick look tool architectures, such as the optimization tool within Microsoft Excel called Solver or the more powerful Excel add-in called Premium Solver



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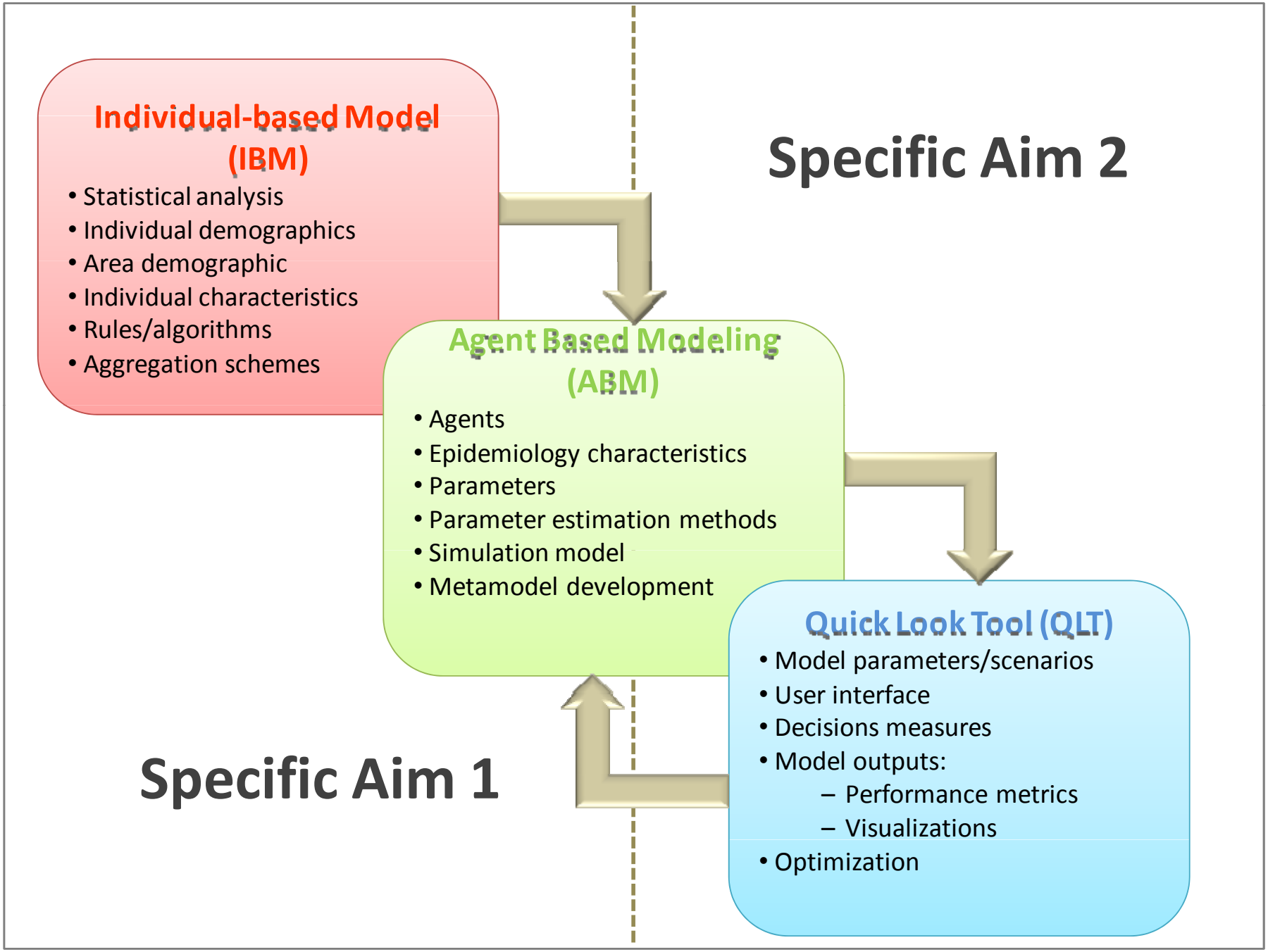
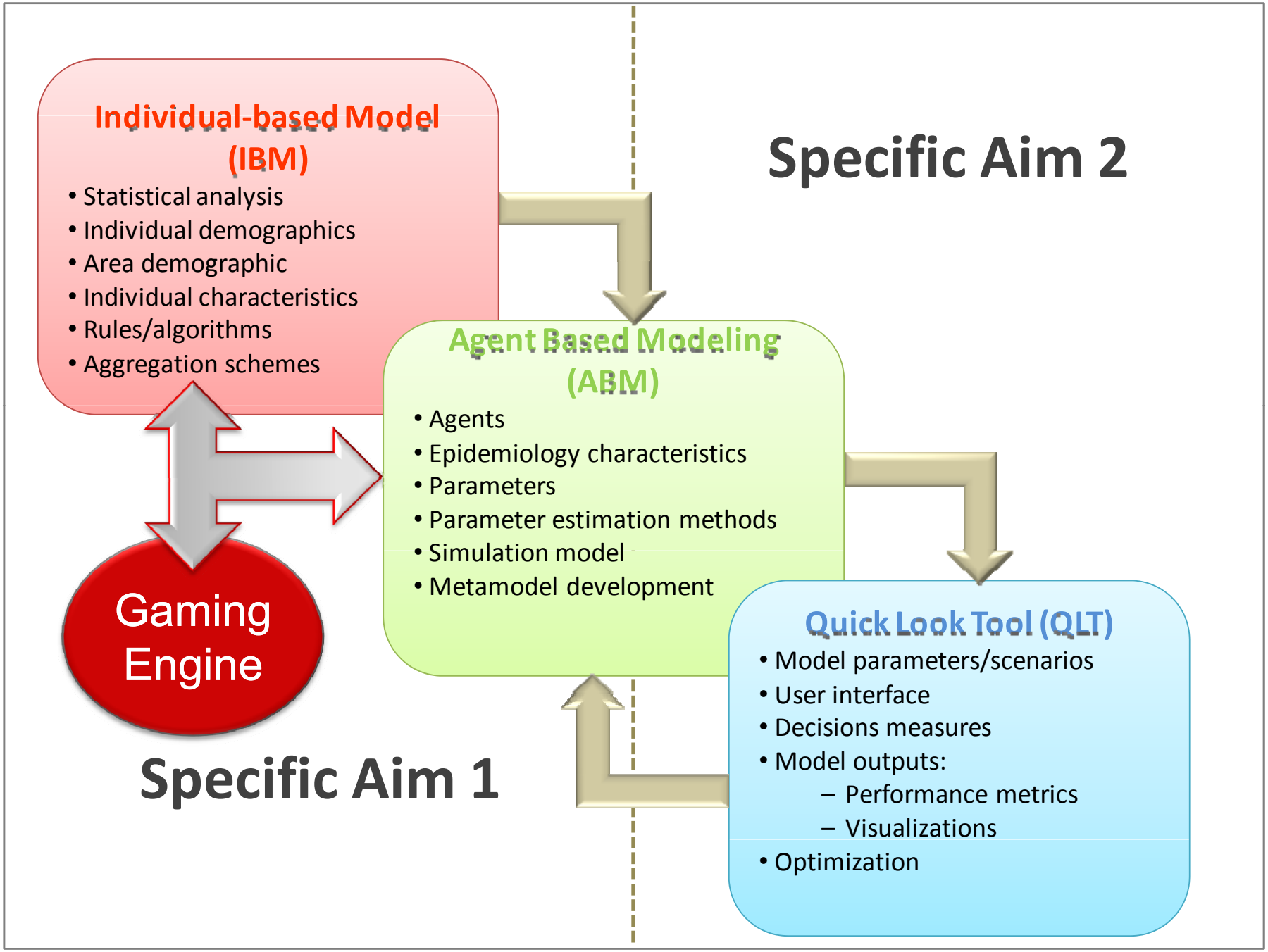

Individual-based Model (IBM)
• Statistical analysis
• Individual demographics
• Area demographic
• Individual characteristics
• Rules/algorithms
• Aggregation schemes
Specific Aim 2
Agent Based Modeling (ABM)
• Agents
• Epidemiology characteristics
• Parameters
• Parameter estimation methods
• Simulation model
• Metamodel development
Quick Look Tool (QLT)
• Model parameters/scenarios
• User interface
• Decisions measures
• Model outputs:
– Performance metrics
– Visualizations
• Optimization
Specific Aim 1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Gaming Engine
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• User interface
• Decisions measures
• Model outputs:
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• Optimization
Specific Aim 1

Questions and Dialogue

- Your suggestions on how to incorporate gaming?

Contact Information

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