System Thinking and Food Safety

Rep. Greg Walden, R-Oregon, holds up a container holding products made with peanut butter from the Peanut Corporation of America at a House hearing
By H. Darr Beiser, USA TODAY
Discussion Guide

• What is “Food Safety”? 
• The Scale of the Hazards 
• The Dynamics of the Hazards 
• The System and its Boundaries 
• Food Safety Control 
  – Current - Linear 
  – Proposed – Complex System 
• The Research Questions
What is “Food Safety”?

- **In** –
  - contaminants that cause known injury

- **Out** –
  - additives that are not known to cause injury
  - Effects from over consumption

- **Pathogens that cause illness**
- **Foreign Objects**
- **Chemicals**
- **GMOs**
- **Obesity**
The Problem

The Hazards

Microbiological
- Salmonella
- Campylobacter
- Listeria
- Botulism

Chemical

Foreign Object

S. Typhimurium

10/21/11
http://www.skyhighway.com/~multispecies/about.html
The Threat
The scale of the issue

3000 deaths/yr

300,000 hospitalizations

76 MM illnesses

1 CDC 2011, US only
FIGURE 2. Number of laboratory-confirmed cases (N = 529)* of Salmonella Typhimurium infection with the outbreak strain associated with peanut butter and peanut butter-containing products — United States, 2008–2009

By week of illness onset

By week of report to PulseNet†

* Cases reported as of January 28, 2009. Cases beginning in the most recent 3 weeks might not yet be reported.
† The national molecular subtyping network for foodborne disease surveillance.

The Dynamics

S-I-R
S-I-R Model

• Add system dynamics model here for illustration of the application of system dynamics tools to disease
The System and its Boundary
How to make food perfectly safe

Canned

Gloved
But this is how we really eat!
Current Food Safety Controls

• Control Strategies
  – Good Manufacturing Practices
  – Good Agricultural Practices
  – HACCP
  – Consumer Education

• Regulators
  – FDA
  – USDA
  – Local Boards
Strategies for increasing food safety

Identify root causes of food contamination
Conduct program evaluation and prevention research
Share data and information
Education on following safe food handling guidelines
Implement best practices and measure performance

CDC 2011
The Current Control Model:  
Break the Chain of Events

For want of a nail the shoe was lost,  
for want of a shoe the horse was lost;  
and for want of a horse the rider was lost;  
being overtaken and slain by the enemy,  

all for want of care about a horse-shoe nail.

Benjamin Franklin

The Way to Wealth (1758)
Chain of Events Models

**Determinism** is the philosophical proposition that every event, including human cognition and behavior, decision and action is causally determined by an unbroken *chain of events*.

Source: Wikipedia – Chain of Events

In aviation, a *chain of events*, often called the *error chain*, is a term referring to the concept that many contributing factors typically lead to an accident, rather than one single event. These contributing actions typically stem from human factor-related mistakes and pilot error, rather than mechanical failure. A study conducted by Boeing found that 55% of airline accidents between 1959 and 2005 were caused by such human related factors, while only 17% of accidents were caused by mechanical issues with the aircraft.

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Systems Approach to Safety
Prof. Leveson

• STAMP
  – System-Theoretic Accident Modeling and Processes
  – Retrospective
  – What happened in the system’s controls that resulted in a loss?

• STPA
  – STAMP Based Hazard Analysis (I know)
  – Prospective
  – How to design controls to keep system in safe state.
This Control Loop Worked

Regulatory Investigation

Peanut Butter Process

Corrective Action

Finished Product

Recall Information

Illness Reporting

At the cost of 9 lives

Pathogen Control Loop 6

FDA

CDC

Pulsenet

State Health Boards

Testing Labs

Physicians

Consumers

Dist/Retail

Customers

Peanut Butter

PCA MGT
Prevention Control Loop 4

Inherent Conflict

PCA MGT

Results

Third Party Auditor

Results

Customers

Corrective Actions

$}

Inspections

Peanut Butter Process
Pathogen Control Loop 3

PCA MGT

Pathogen Test Results

Pathogen Testing Labs

Finished Product Samples

In-process Samples

Inbound Peanuts

Peanut Butter Process

• Product Held
• Re-test/Sort
• Product Scrapped
• Product Released
• Process Sanitation
• Launch investigation
• In bound retains
• Env testing
• Equip testing

• Mental Model Errors

• Process	
  Held
• Re-test/Sort
• Product	
  Scrapped
• Product	
  Released
• Process	
  Sanitation
• Launch	
  investigation
• In-bound	
  retains
• Env	
  testing
• Equip	
  testing

Released For Sale

Scrap
Research Areas and Questions

• Application of CAST to Food
  – Does it reveal more information than current methods?

• How to increase effectiveness of Third Party Audits?
  – Lessons from the Financial Crisis of 2008?

• Mental models of ownership and food preparers
  – How to measure? Can they be changed?

MS Thesis

PhD Dissertation