Fall 2009 Operations Research/ Management Science Seminar Series
Friday, September 18, 2009 • 11:00 am – 12:00 pm
Isenberg School of Management • UMass Amherst Campus

Lecture:
Food Safety in a Global Supply Chain

Mary Helander, Ph.D. • IBM T. J. Watson Research Center • Business Analytics and Mathematical Sciences

Lecture Outline

Current Issues in Food Safety

Food Safety in the Context of Supply Chain Risk Management

Food Safety and the Role of Digital Media and Social Networking

Wrap Up

Introduction:

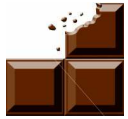
Recent food contaminations and recalls erode consumer trust, change consumer perceptions and impact purchasing behaviors

- 42% of consumers buy different brands today versus 2 years ago … because they are looking for safer products
- 47% are more concerned today about food safety than they were 2 years ago

FORTUNE
Wal-Mart: the new FDA


Rice *GMO*


Lettuce *E. Coli*


Chocolate *Salmonella*


Chocolate *Salmonella*


Spinach *E. Coli*


Chocolate *Nuts*


Onions *E. Coli*


Mushrooms *E. Coli*


Chicken *Listeria*


Snack food *Salmonella*


Dog treats *Melamine*



Tomatoes> Jalapeños *Salmonella*


Chicken *Bird Flu*


Cantaloupe *Salmonella*


Gr. Beef *E. Coli*


Toothpaste *Diethylene Glycol*



Cantaloupe *Salmonella* Toys *Lead*


Peanut Butter *Salmonella*


Baby Food *Botulism*


Pet Food *Melamine?*


Canned Chili *Botulism*


Gr. Beef *Coli*


E. Beef *E. Coli*

Pork *LIsteria*

2006	2007	2008

Source: IBM Institute for Business Value research, IBM survey of U.S. and UK consumers; Fortune, July 16, 2008

Some recognized contaminants that threaten food safety

- Bacterial pathogens (e.g. E coli, Salmonella, Clostridium Botulinum)
- Viral pathogens
- Mycotoxins
- Allergens and allergen cross-contact
- Protein Boosters (e.g. melamine)
- Flavors and off loaders
- Banned ingredients (e.g. banned dyes)
- Overdosing of nutrients
- Pesticides
- Metals
- Nonmetal foreign bodies (e.g. glass)

- Unknowns

Background

- **Food Safety** – The handling, preparation, and storage of food in ways that prevent food-borne illness (i.e. resulting from the consumption of food). Includes the insurance that food is free of accidental or intentional contaminants that may cause harm.

- **Food Security** – The availability of food (as a source of essential nutrition) as well as an individual's access to it. Examples of threats to food security include nutritional deficiencies, unsafe food, land degradation, plant disease, et cetera as well as certain political and economic conditions.

- **Food Quality** – Characteristics of food that make it acceptable to consumers. These include appearance (size, shape, color, gloss, and consistency), texture, and flavor, as well as other factors such as expected nutritional content.

Relationships

  – Safe food is a necessary, but not sufficient, condition for assuring food quality.

  – Safe food is a necessary, but not sufficient, condition for assuring food security.

Economic Adulteration of Food

Omitting or substitution of an ingredient for financial gain

§ **Examples**

- Diluting draft beer (i.e. artificially increasing volume, bulk or weight)
- Using food coloring to conceal defects or lack of freshness

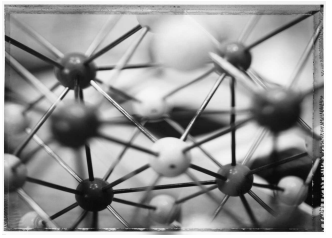
§ **Historical Perspective**

- "Swindled: The Dark History of Food Fraud, from Poisoned Candy to Counterfeit Coffee," by Bee Wilson, Princeton University Press, 2008

- Correlates attention to food safety with the rise of chemistry applied in everyday life

- Recent attention to food safety also coincides with a rise of technologies:
  - digital media, social networking, and advanced analytics

Insuring Safety within the Global Food Supply Chain



Existing Practice

- Regulation, oversight e.g. FDA, USDA
- Standards e.g. HACCP*
- Processes such as sterilization, pasteurization and decontamination
- Inspection, quality control
- Packaging
- Product recall
- Outbreak tracking

New, Developing Approaches

- Regulation, oversight e.g. FDA, USDA
- Advances in Food science
- Supply chain traceability
- Advanced risk management analytics
- Front-Gate Detection and Material Characterization Technologies
  - E.g. Mass Spectroscopy, Remote Sensing, Imaging Technology
- Advances in medical science

**Hazard Analysis and Critical Control Points*

Hazard Analysis and Critical Control Points (HACCP) General Principals

- Conduct hazard analyses
- Identify critical control points where food safety hazards may occur
- Establish critical limits for control points (e.g. amount of detectable pesticide on a head of lettuce)
- Establish control point monitoring
- Establish corrective actions for events of hazard detection
- Perform record keeping
- Validate that the HACCP system is working

Mandatory in some food industries (e.g. meat, seafood) and voluntary in others

The food industry is a complex, global collective of diverse businesses that together supply food consumed by the world population

- Directly includes businesses that produce, process and deliver food:
  - Agriculture
  - Consumer Products (specifically, food manufacturers)
  - Transportation (specifically, distribution of the food)
  - Retail and Wholesale (i.e. sellers of the food, such as grocers and restaurants)

- Indirectly includes:
  - Government (e.g. regulation, public health, judicial system)
  - Manufacturing (e.g. farm machinery, seed producers)
  - Financial Services (e.g. credit, insurance)
  - Research and Development (food technology)

The Trickle Effect of a Salmonella Outbreak

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Peanut Butter Cracker Lawsuit Filed Against Kellogg Over Salmonella

February 9th, 2009 • Filed Under: News • No Comments

SHARE

One of the first food poisoning lawsuits filed against Peanut Corporation of America as a result of the recent ***Salmonella typhimurium*** **outbreak** has been amended to add Kellogg Co. as a defendant, as they manufactured the **peanut butter crackers** which caused the plaintiff's illness.

The lawsuit was originally filed on January 20, 2009, in the U.S. District Court in Georgia, against Peanut Corporation of America (PCA), which is the company which sold thousands of pounds of salmonella contaminated peanut butter, peanut paste and chopped peanuts that were used by hundreds of companies like Kellogg in over 1,500 different products.

The **peanut butter cracker lawsuit** was filed by a Vermont family on behalf of their 7 year old son who was hospitalized for five days with the same strain of salmonella associated with a nationwide outbreak that has sickened over 550 people and caused 8 deaths.

The boy fell ill on November 25, 2008 after eating Keebler Cheese and Peanut Butter Sandwich crackers which were manufactured by Kellogg with peanut paste produced by Peanut Corporation of America at their Georgia processing plant that is at the center of the outbreak.

The Tomato / Pepper Scare (2008)

- An outbreak of salmonella saintpaul was associated with multiple raw produce items in 2008
- Thought to be related to tomatoes sourced in Mexico
- Eventually linked to Serrano peppers, also grown in Mexico
- Point of contamination never determined with 100% certainty
- Trade bans created unnecessary tension and trust issues between the US and Mexico

Tracing tainted produce isn't easy

By Julie Schmit, USA TODAY
McALLEN, Texas

USA TODAY

Post a Comment

When government investigators found a hot trail to a potential cause of the salmonella outbreak that had confounded them for weeks, it led them to the "Pink Palace."

Nicknamed for its pink paint job, the palace is the McAllen Produce Terminal Market, a 42-acre wholesale market 5 miles north of a major border crossing point for Mexican fresh produce entering the USA.

From concrete loading docks, 100 small distributors and importers peddle tons of fresh produce a day — including Mexican-grown peppers, limes, mangoes and watermelon — mostly to supermarket and restaurant buyers. Need a new TV or lawnmower? They're here, too.

It was jalapeno peppers that drew Food and Drug Administration investigators. Last month, they found Mexican-grown jalapenos at a small distributor here that were contaminated with the same strain of salmonella saintpaul that's sickened 1,405 people nationwide and in Canada.

Whether those peppers, or others from a different farm in Mexico, caused the outbreak is uncertain. The investigation continues. Mexico says its tests show none of the strain on suspect farms.

Exercise:

Can a contamination outbreak be considered a “rare event” ??

- Number of “eaters” in the US as of September 2009:
  - In the US, ~307 Million
  - Source: U.S. Census Bureau, population clock estimate

- A typical US “eater” over their lifetime:
  - Consumes ~70K meals
  - Consumes ~60 tons of food
  - Source: Contemporary Nutrition, 6th Edition, by Gordon Wardlaw and Anne Smith, McGraw Hill, 2007

- Number of Americans who regularly enjoy Campbell's® Tomato soup
  - ~25 Million
  - Source: Press release by Campbell's®, August 2009

- Amount spent by Americans on fast food
  - $110 billion in 2000 (compare to $6 billion in 1970)
  - Source: Fast Food Nation, by Eric Schlosser, Houghton Mifflin Co, 2001

Lecture Outline

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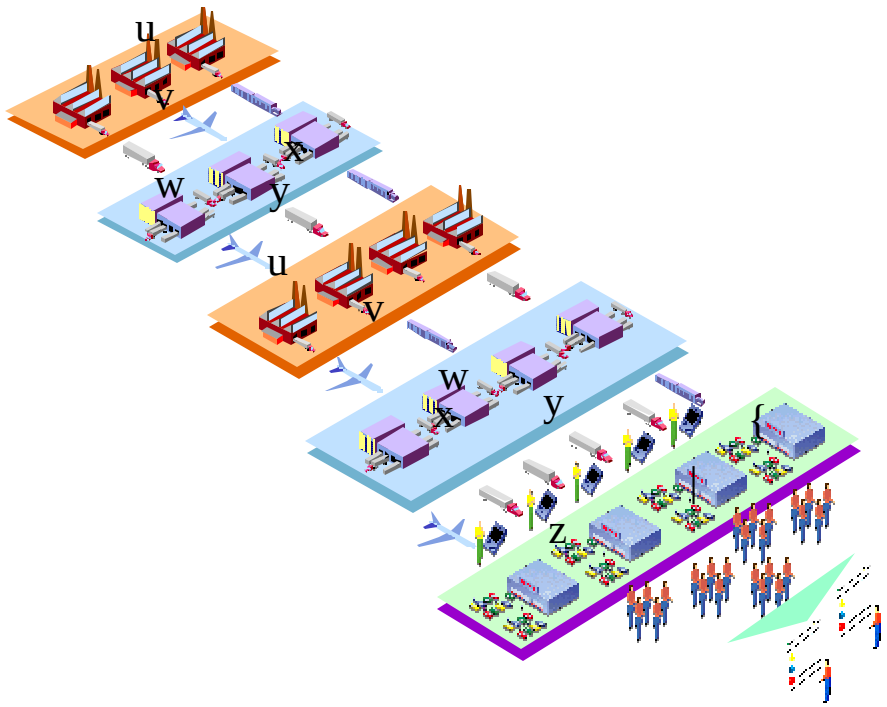
Wrap Up

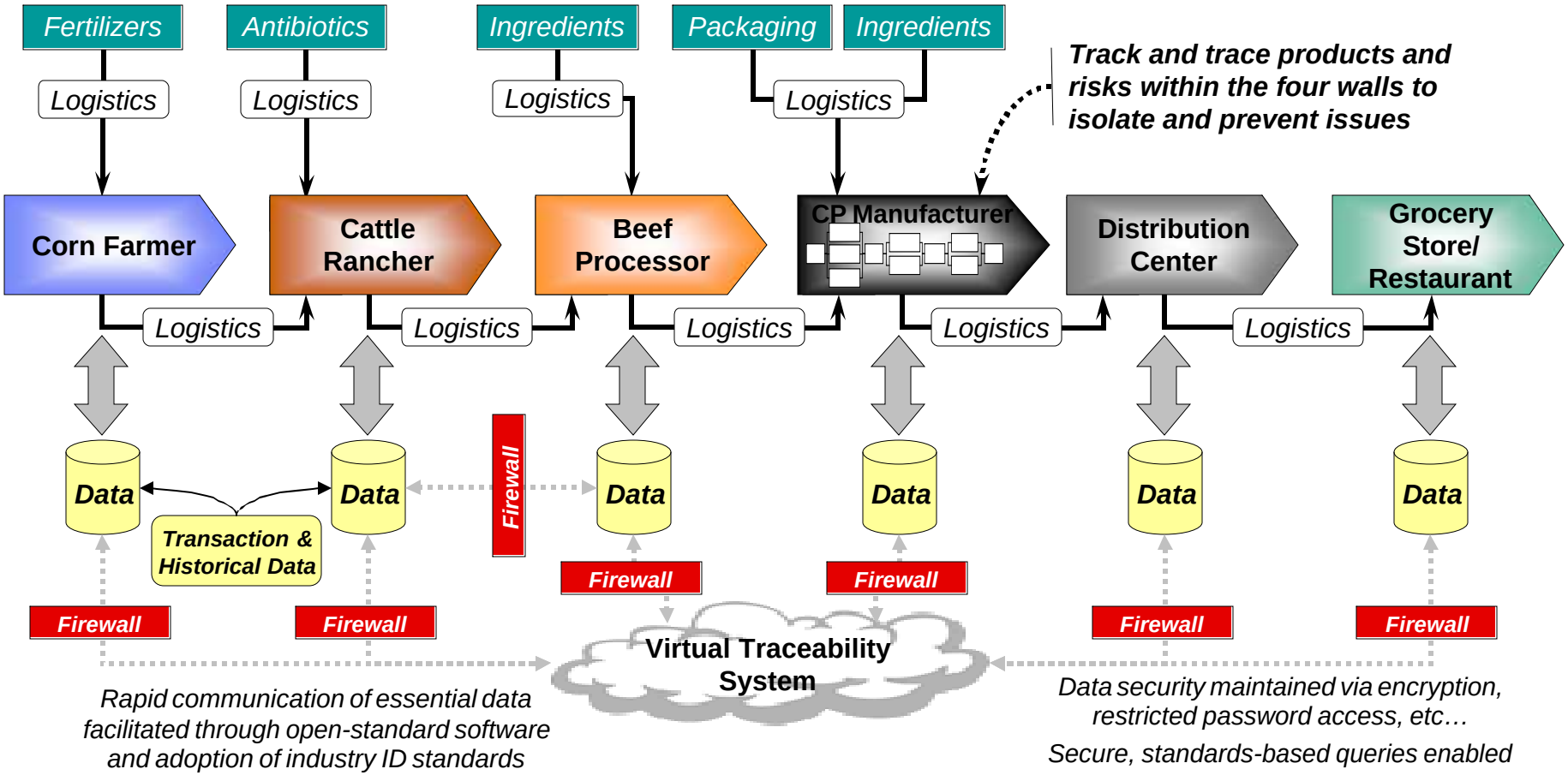
Advanced supply chains allow the ability to track and trace entities through a multi-enterprise supply chain. Supply chains for food present unique challenges

- Complex networks of trading partners, including global sourcing
- Heterogeneous technological capabilities
- Non-homogeneous data
- Non-digital, incomplete, or unreliable data
- Disparate data sources
- Benefits not gained by trading partners who incur costs
- Difficult governance

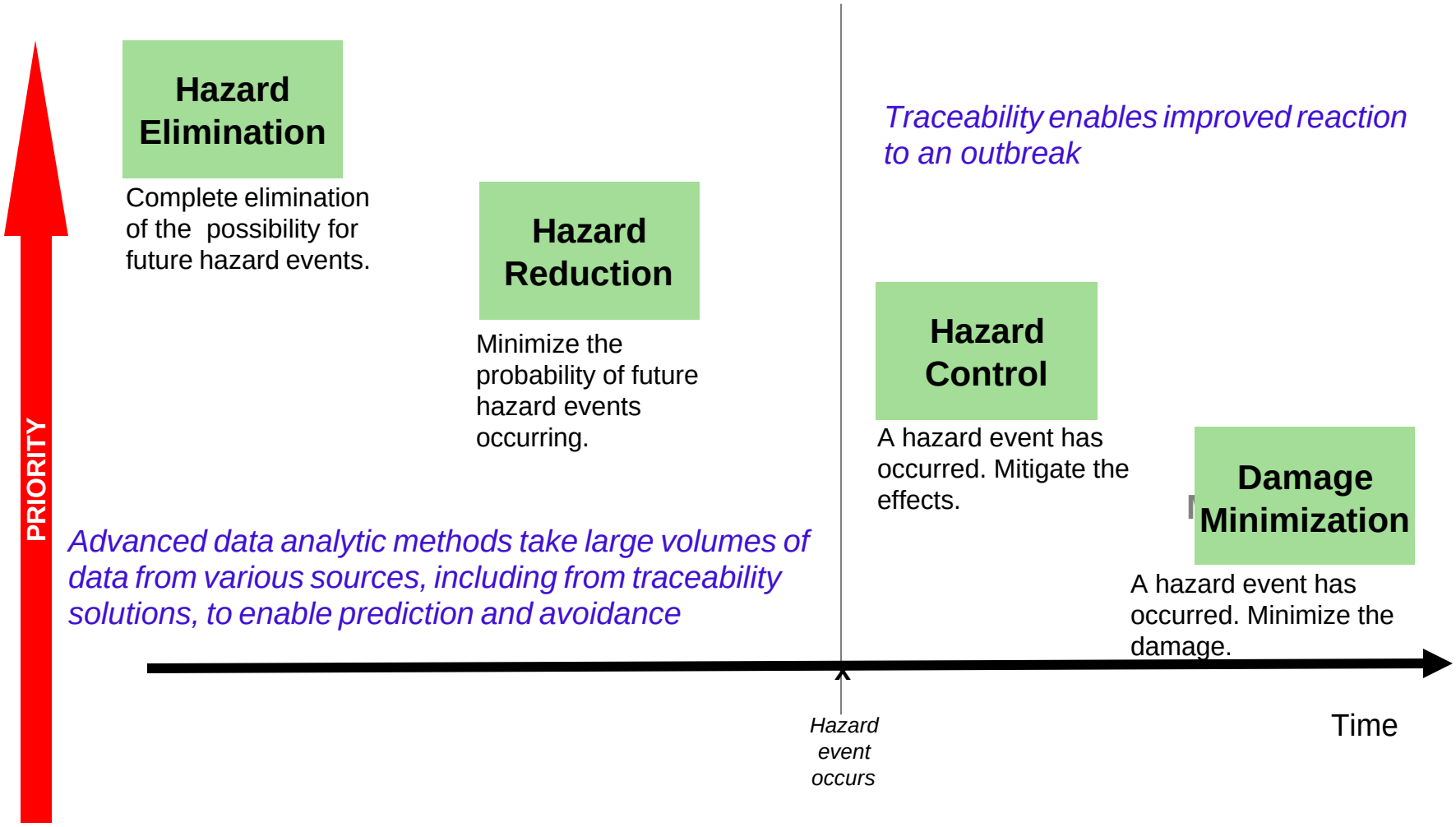


A track and trace system that supports food safety must capture, structure and integrate data on movements, attribute changes, and processing activities from across and within the supply chain

Example: Beef - Each company maintains its own product information and record of transactions, making that information available on a permission basis to stakeholders

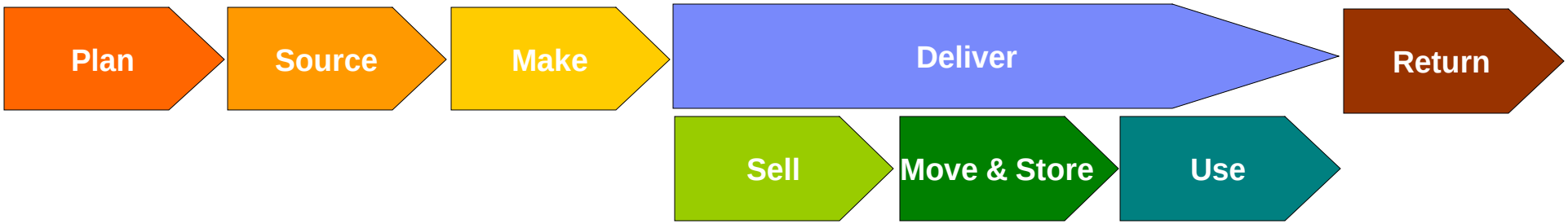


In system design for safety, the highest priorities are assigned to hazard prevention



* Reference: N. Leveson's adaption in Safeware: System Safety and Computers, Addison-Wesley, 1995 of the safety precedence described by W. Hammer, Handbook of System and Product Safety. Prentice-Hall, Inc. Englewood Cliffs, NJ, 1972.

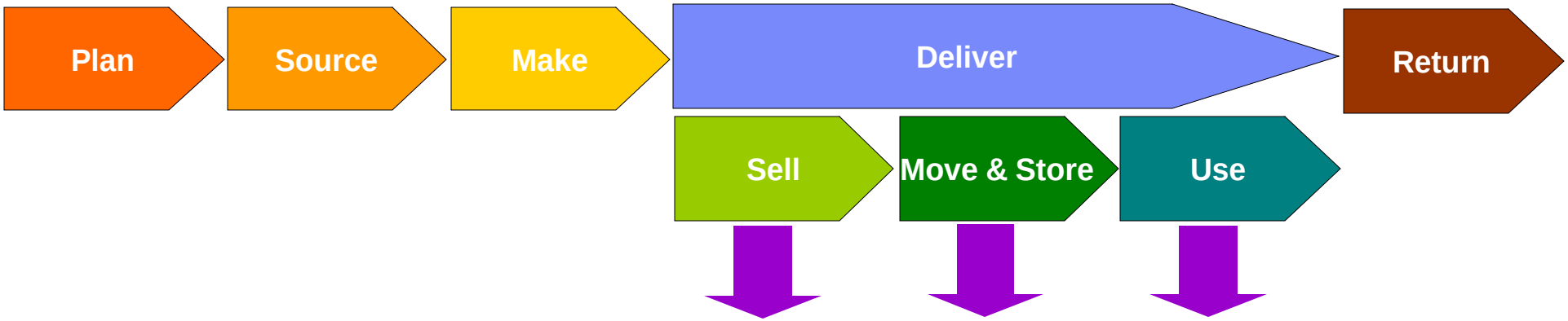
Overview of the SCOR-Model
Supply-Chain Operations Reference-Model*



•Balance resources •Establish communication plans •Manage data collection, plan inventory, assets utilization •Align with financial plan	•Identify sourcing alternatives •Evaluate suppliers •Schedule and execute procurement and deliveries •Manage inventory, supply network, and supply risk	•Schedule production activities •Collect data and monitor make processes •Manage supply chain make risk	•Sales and marketing •Manage customer fulfillment •Customer invoicing	•Warehouse management •Transportation management	•Handle and store •Consume	•Manage defeat returns •Recall management •Recycling

*Supply Chain Council, 2008, http://www.supply-chain.org/resources/scor

Most food-borne illnesses are caused by contaminations introduced via improper storage and handling



Decision maker: The consumer; the retailer

Decisions: What to eat; how to store; how to handle

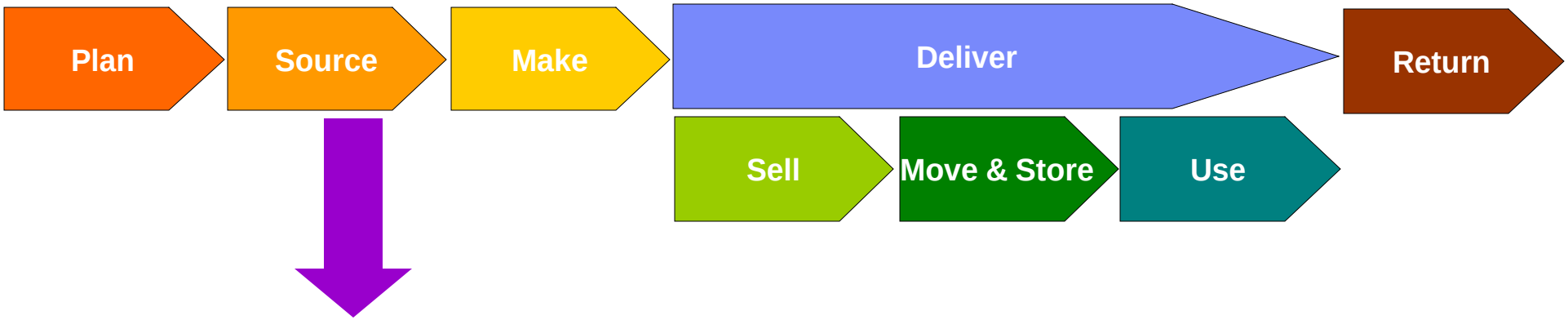
Risk: Food-borne contamination

Impact: Illness, death due to improper storage or handling

Reward: Health

Exercise: How would you estimate the probability of a consumer introducing a contaminant? As a food manufacturer, how would you use this probability estimate to decide how much money to spend on educating end consumers about safe storage and handling procedures?

Supply chain sourcing is one of the most frequently noted cause of food contamination



Decision maker: The food manufacturer

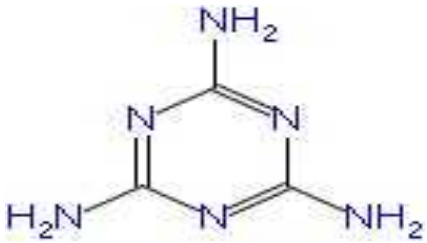
Decisions: Suppliers (when alternatives exist) and terms; investment in contamination screening

Risk: Contaminated ingredients from suppliers

Impact: Possible illnesses and death of end consumers; brand impact; financial impact of lawsuits.

Rewards: Reputation, cost avoidance

Example: The Melamine Scare in China, 2008



Melamine Structure

§ **A supply chain sourcing risk example**

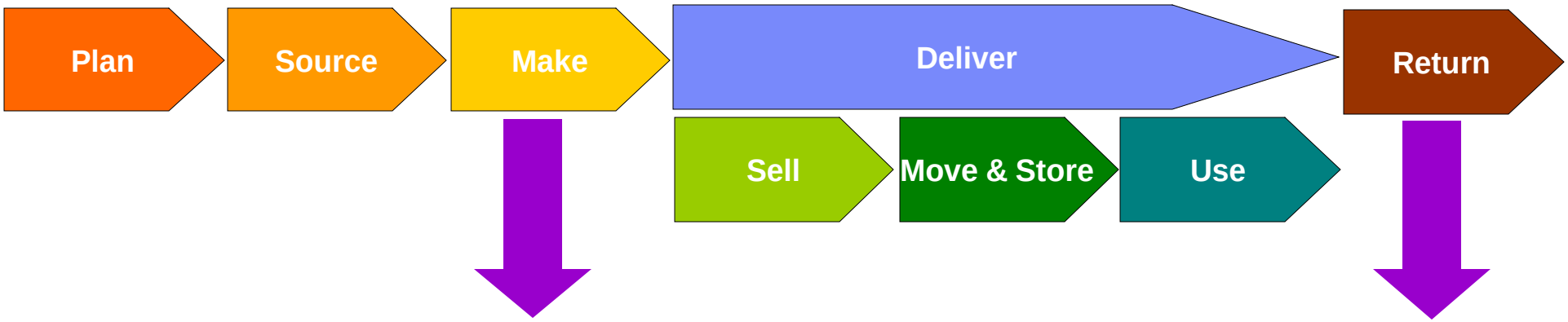
– Several suppliers to milk and infant formulae companies used melamine as an artificial protein booster (i.e. economic adulteration)

§ **Impact**

– Melamine combines with Cyanuric Acid to form crystals that accumulate in the kidneys, which can result in acute renal failure.

– ~300K illnesses, ~50K infant hospitalizations and 6 infant deaths

Example of Food Supply Chain “Make” Risk



August 2006 -- First cases of Salmonella Tennessee are reported.

August 2006 – A roof leak and fire sprinkler system leak in a Sylvester, GA food plant. These are later blamed as the source of moisture helping salmonella bacteria grow and contaminating peanut butter product

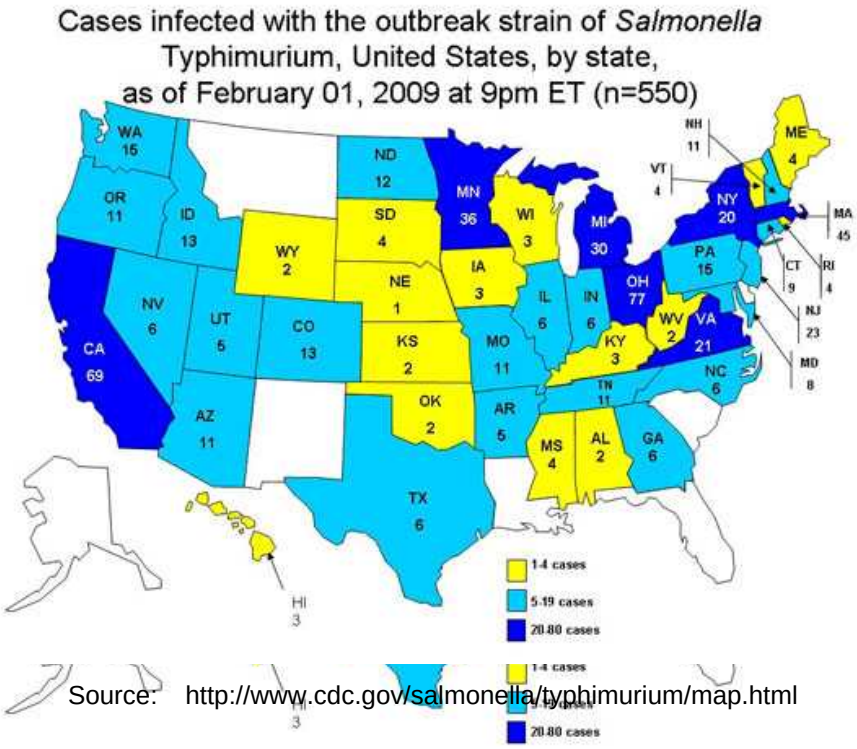
Feb. 14, 2007 -- The CDC announced that the salmonella outbreak is linked to Peter Pan peanut butter.

Feb. 14, 2007 – A recall is issued by the manufacturer for peanut butter made at the plant.

Feb. 20, 2007 – The PB manufacture estimates that its nationwide recall of peanut butter cost between $50 million and $60 million.

The Peanut Scare (2009)

- January 2009 – The FDA confirmed sources of a Salmonella outbreak are peanut butter and peanut paste
- Produced by the Peanut Corporation of America (PCA), Blakely, Georgia processing plant.
- Specifically noted were improper handling, preparation and storage.
- As of 9PM EDT, Sunday, February 1, 2009, 550 persons infected with the outbreak strain of Salmonella Typhimurium, and 8 deaths, had been reported



Source: http://www.cdc.gov/salmonella/typhimurium/map.html

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Wrap Up

Food Safety meets Digital Media and Social Networking

§ The internet …

– Is changing the profile of how and when we receive news about local, national and world events

– Is changing the way we view availability and credibility of information

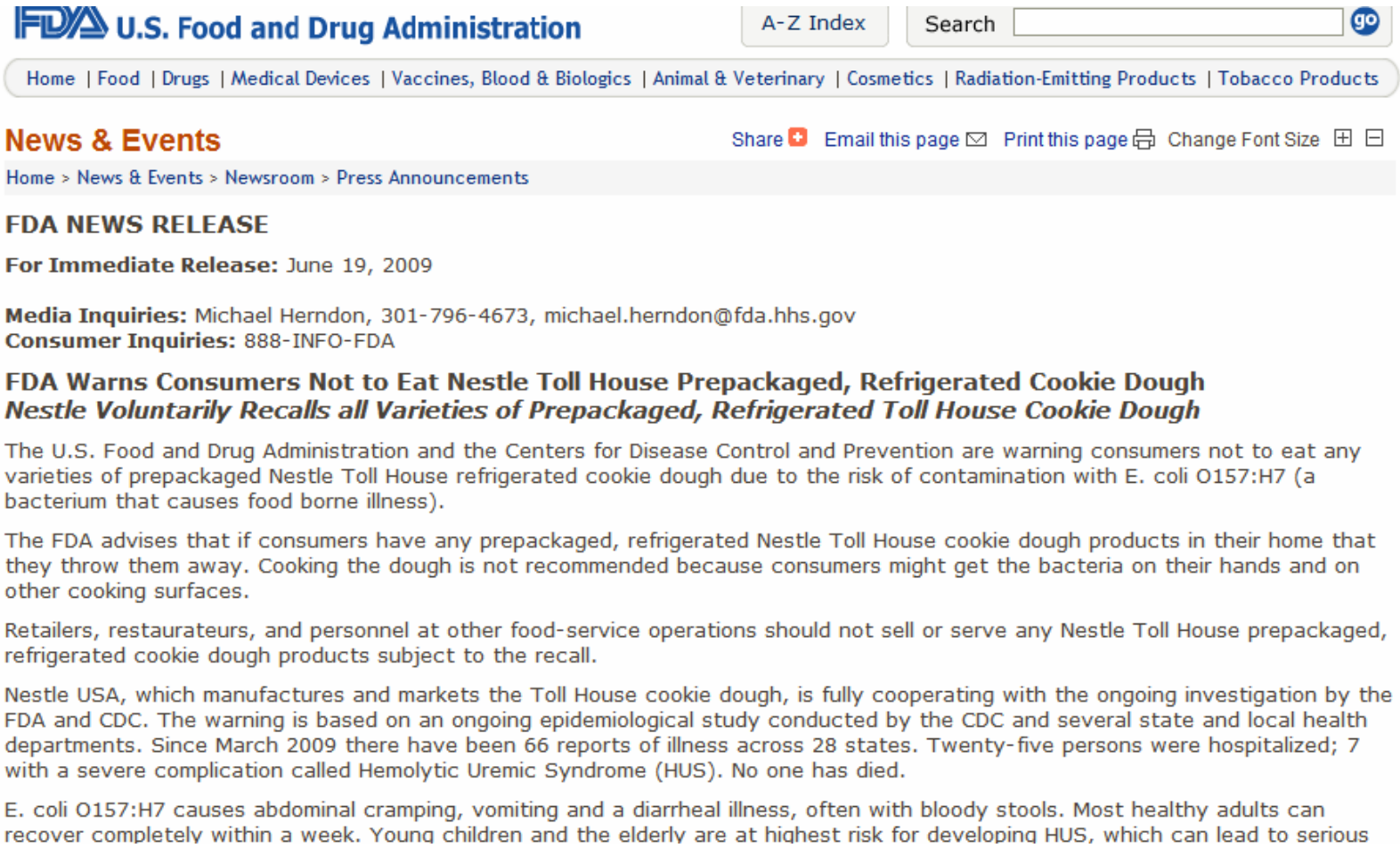
– Is changing the pace at which we reflect on and react to events

– May contribute to the magnitude of an event's impact

– Connects people across the globe / shortens the "average degrees of separation"

– Provides new approaches for social connection: 1-1, 1-many … e.g. email distribution list, FB wall posting, or even posting a comment to a news article (which is 1 to an anonymous group of many)

In late Spring of 2009, E Coli 0157:H7 was detected in a global consumer product company's pre-packaged cookie dough



FDA U.S. Food and Drug Administration

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FDA NEWS RELEASE

For Immediate Release: June 19, 2009

Media Inquiries: Michael Herndon, 301-796-4673, michael.herndon@fda.hhs.gov
Consumer Inquiries: 888-INFO-FDA

FDA Warns Consumers Not to Eat Nestle Toll House Prepackaged, Refrigerated Cookie Dough
Nestle Voluntarily Recalls all Varieties of Prepackaged, Refrigerated Toll House Cookie Dough

The U.S. Food and Drug Administration and the Centers for Disease Control and Prevention are warning consumers not to eat any varieties of prepackaged Nestle Toll House refrigerated cookie dough due to the risk of contamination with E. coli O157:H7 (a bacterium that causes food borne illness).

The FDA advises that if consumers have any prepackaged, refrigerated Nestle Toll House cookie dough products in their home that they throw them away. Cooking the dough is not recommended because consumers might get the bacteria on their hands and on other cooking surfaces.

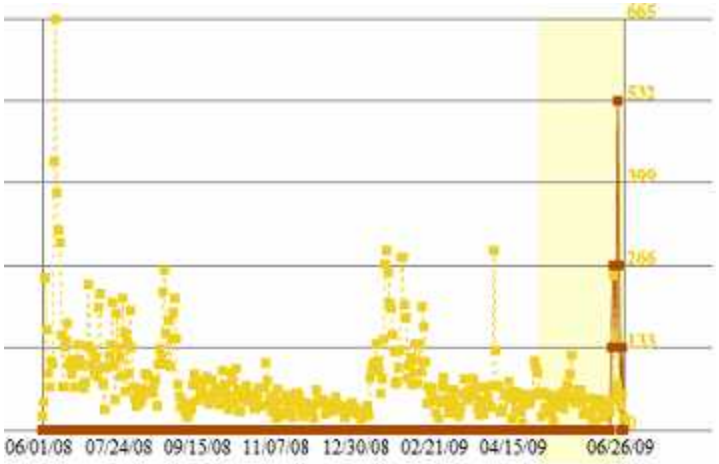
Retailers, restaurateurs, and personnel at other food-service operations should not sell or serve any Nestle Toll House prepackaged, refrigerated cookie dough products subject to the recall.

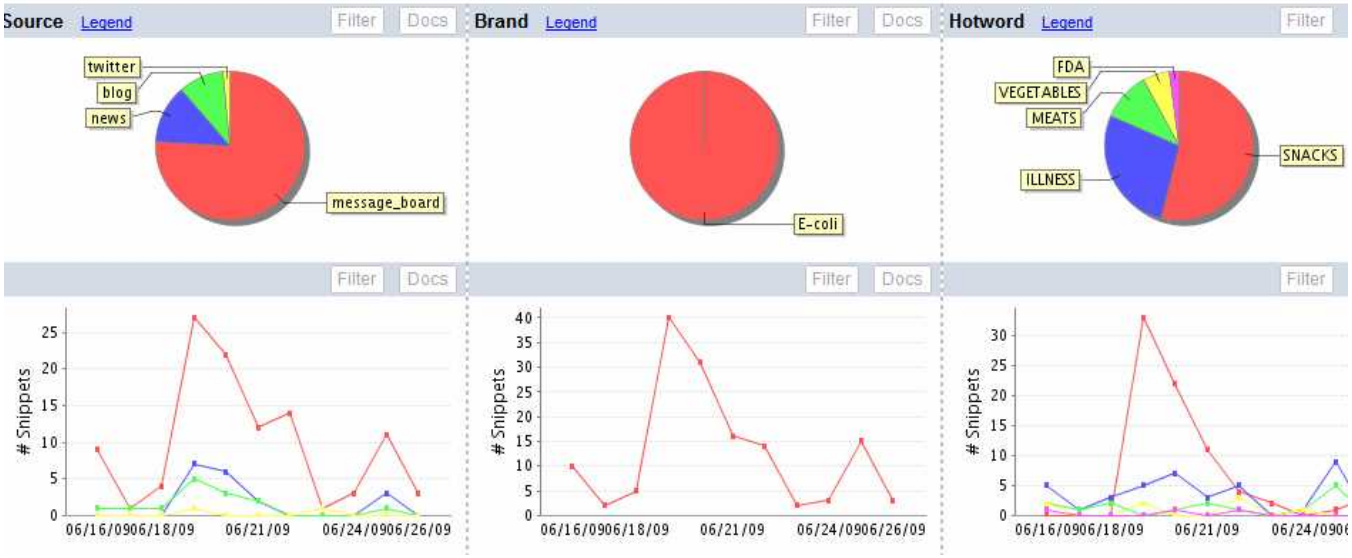
Nestle USA, which manufactures and markets the Toll House cookie dough, is fully cooperating with the ongoing investigation by the FDA and CDC. The warning is based on an ongoing epidemiological study conducted by the CDC and several state and local health departments. Since March 2009 there have been 66 reports of illness across 28 states. Twenty-five persons were hospitalized; 7 with a severe complication called Hemolytic Uremic Syndrome (HUS). No one has died.

E. coli O157:H7 causes abdominal cramping, vomiting and a diarrheal illness, often with bloody stools. Most healthy adults can recover completely within a week. Young children and the elderly are at highest risk for developing HUS, which can lead to serious

*http://www.fda.gov/NewsEvents/Newsroom/PressAnnouncements/ucm167908.htm

Public sentiment trends based on analysis of information from the internet showed a spike of activity coinciding with the FDA news release.

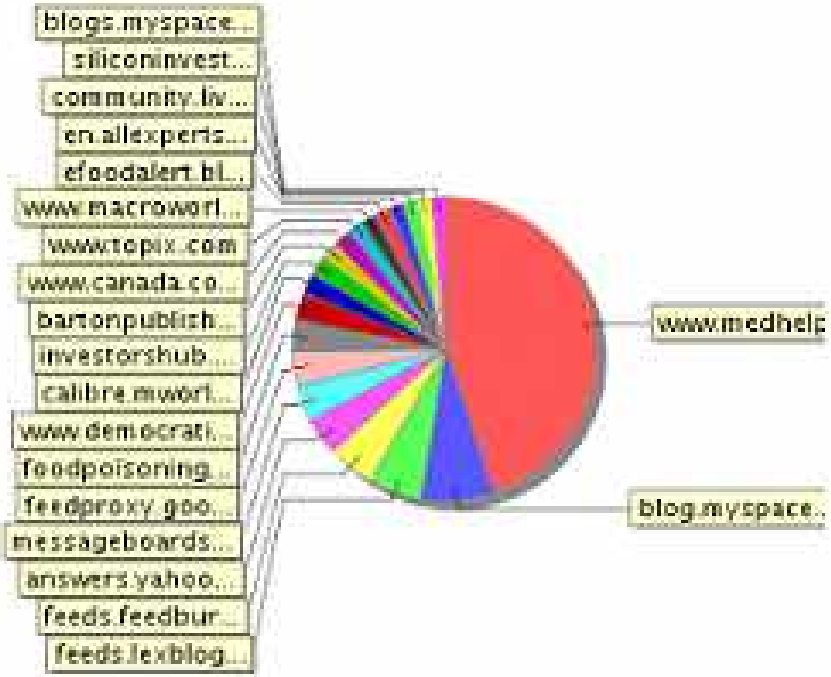




* COrporate Brand and Reputation Analysis – COBRA, a technology developed by the IBM Almaden Research Center

Almost 50% of internet snippets related to the 2009 cookie dough E coli outbreak were posted to a site called *www.medhelp.com.* This pattern of symptom queries and questions provide an outbreak alert

Class Name	Class Size
www.medhelp.org	3165
blog.myspace.com	548
feeds.lexblog.com	400
feeds.feedburner.com	368
answers.yahoo.com	279
messageboards.aol.com	277
feedproxy.google.com	261
foodpoisoning.pritzkerlaw.com	233
www.democraticunderground.com	210
calibre.mworld.com	154
investorshub.advfn.com	142
bartonpublishing.wordpress.com	137
www.canada.com	136



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The potential for a disease outbreak alert based search engine data was observed in November 2008. Google took notice of the flu season arrival well before the CDC, where patterns indicating outbreaks may not be recognized for days or weeks due to reporting procedures and delay

Google predicts spread of flu using huge search data

- Site claims it beats existing services by two weeks
- Technology could be used to warn of other illnesses

Ed Pilkington in New York and **Alok Jha**
The Guardian, Thursday 13 November 2008
Article history

Google has applied its massive data-collecting power for the first time to prediction of the spread of disease, with the launch of a site that claims to be able to raise the alarm over flu outbreaks up to two weeks in advance of existing public services.

Google Flu Trends takes the general search tracking technology pioneered by Google Trends and applies it specifically to influenza. The firm's engineers claim to have devised a way of analysing millions of individual searches related to the disease that in tests proved to correlate closely with the actual incidence of illness. That gives them the potential ability to predict rises in flu cases - information that could be used by health professionals to warn the public or plan their responses.

Google found that if it assembled a cluster of queries people used when they were worried about flu - such as "flu symptoms", "chest congestion" or "where to buy a thermometer" - the aggregated trends were a strong indicator of flu levels across America.

http://www.guardian.co.uk/technology/2008/nov/13/google-internet

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Wrap Up

Burning Questions

- How can we build more intelligence into food supply chain management?
- Are we dealing with **“rare”** (albeit possibly high impact) events?
  - How can we effectively estimate occurrence probabilities to support decision making under uncertainty in supply chain risk management?
  - How can we predict (and prevent) such events?
  - How should limited resources (detection, inspection, regulation and oversight, etc) be used to maximize food safety?
  - Overall, how do we more effectively manage the food supply chain risk?
- Can we / should we consider human illness caused by accumulated bad eating choices over time to be food safety issues?

THANK YOU