Network Reliability and Resilience – Example Research

Mark S. Daskin
Dept. of IE/MS
Northwestern University
Example research:
1. Facility hardening

- In a supply chain, **how much should be hardened?**
  - Cost of hardening facilities against attack
  - Probability of facility failure
  - Transportation costs to reliable and unreliable sites
Key Tradeoffs

![Graph showing Key Tradeoffs]

- **Total Fixed Cost**
- **Total Transport Cost**
- **Total Cost**
- **% over Optimum**

**Y-axis:** Cost
- 0.0E+00 to 2.0E+08

**X-axis:** Number Reliable
- 0 to 50

**Legend:**
- Black line: Total Fixed Cost
- Pink line: Total Transport Cost
- Red line: Total Cost
- Purple line: % over Optimum
Results from top 1500 counties
25 non-hardened; 10 hardened

All 35 sites

10 hardened sites
Lessons

- As the number of reliable sites increases
  - Facility costs go up
  - Transport costs go down
  - TRADEOFF in total cost
  - Can over-invest in reliability
Example Research:
2. Production flexibility and fragility

- How much flexibility is needed/desirable?
- What impact do failures have?
Example Research: Flexibility and Fragility

Total Flexibility ≈ One chain < Two chains < Four chains

Limited flexibility is almost as good as total flexibility
One long chain is better than multiple short chains
Example Research: Flexibility and Fragility

- **Fragility** – lost sales when something fails *minus* lost sales when all is working
- Measure of **system degradation** due to failure
- Would like **small fragility**
Example Research: Flexibility and Fragility

One long chain is **WORSE** than multiple short chains
In terms of **fragility**
Primary Modes of Collaboration

- Sponsored research
- PhD Internship
- MMM Group Project
- Undergrad Group Project
- Coop