

The Goals of Analysis are Understanding, Decisions, and Influencing Policy

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"I am not bound to please thee with my answer."

Shakespeare, Merchant of Venice 4(1)b

Why are You in OR?

- Love mathematics?
- Enjoy designing algorithms?
- Like to solve puzzles?
- Think it's cool to be called "Professor?"
- Or, do you want to influence policy?

US Navy?

- Bretton Woods accords, 1944
- The US announced a global, liberal trading system that constitutes the heart of the US maritime approach to security. It is based on the free movement in the maritime domain and on the workings of the market.
- **The last 70 years have been the most peaceful maritime epoch in recorded history.**



Naval Postgraduate School?

- What do we do?
- In OR, we do military OR.
- We are a trusted source of analysis for our government.
- This work has influenced over a trillion US dollars of investment, and saved lives.

Naval Postgraduate School?

- You might optimally design a network,
and we might be interested in degrading it,
or destroying it.
- We might be concerned that someone else
could degrade or destroy our network.

Example Applications

- Replenishment at Sea (US Navy)
 - Increase operational presence, save money
- Air Tasking (US Air Force)
 - Save lives

Replenishment at Sea Planner

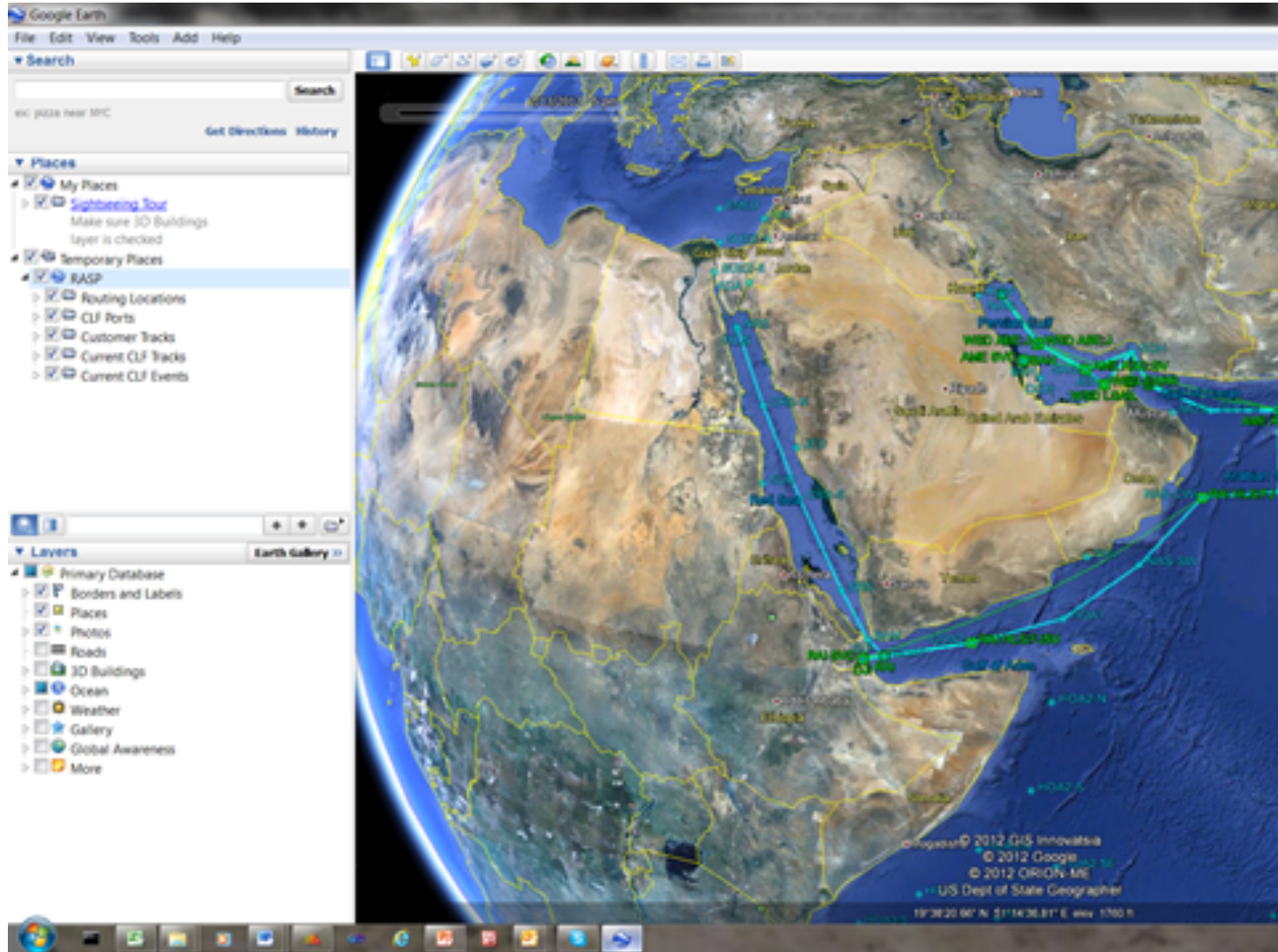
The US Navy operates worldwide, and cannot assume access to port facilities.

US Navy is the only navy that can sustain itself deployed at sea virtually indefinitely.

But, Navy ships need fuel, ordnance, and dry stores.

We go to our ships to deliver these with underway replenishments.

Replenishment at Sea Planner



Replenishment at Sea Planner



9,000 ton ships connected close abeam at 20+ knots

Navy Helo pilots operate in all weather and all sea states – this is pretty sporty flying



Air Tasking

- US Air Force uses cargo planes to move personnel as well as cargo
- Keeping personnel out of ground convoys avoids Improvised Explosive Devices
- US Air Force called us and asked
“can you improve our efficiency?”

Air Tasking



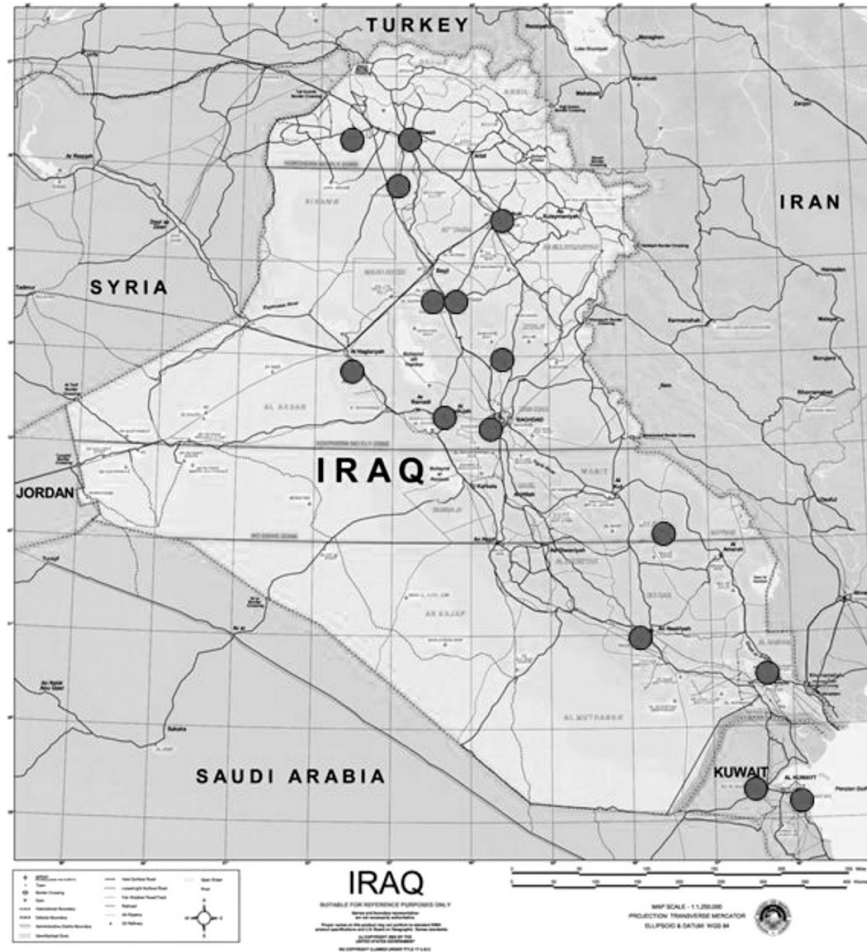
Rob Dell gets his own executive jet, but has to haul his own bag.

Air Tasking



For scale, that's Rob Dell on the C-17 cargo ramp.

Air Tasking



Part of our airfield network, used by our aircraft every night.

Air Tasking

- It's pretty gratifying to get a letter from a General,
- thanking you for “fixing” things,
- and saving an estimated X casualties,
and Y KIA's (fatalities) per month.

Now Back to Our Topic Today

If you track the consequences of (too) much of OR research...

- Immediate consequence is exceedingly rare
- Intermediate-term consequence is rare
- Significant policy change is extremely rare, and usually appears only after longer delays than most analysts can afford

If you track the consequences of much of our research...

- "The fault, dear Brutus, is not in our stars,
but in ourselves, that we are underlings."

Shakespeare, Julius Caesar 1(2)

- Our scholarly training does not prepare us to
influence policy.

Problem and Analysis Types

- This is agnostic about the analysis method(s):
simulation, stochastics, optimization, ...
- Prescriptive, Descriptive, Normative
- The goal is influencing policy

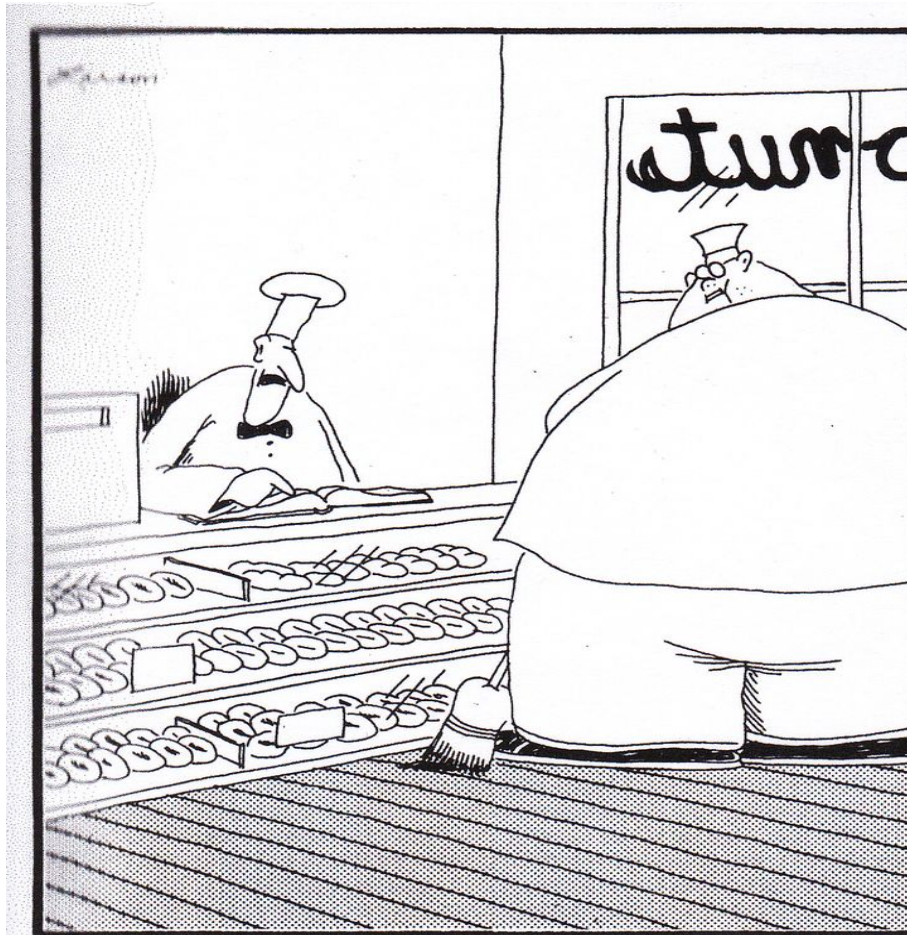
Qualifying a Worthy Problem

- How will you solve this problem?
- What is the problem?
- Why is this problem important?
- How is this problem now solved?
- How will you solve this problem?
- How will you know when you have succeeded?

What is the problem?

- The client *never* gives you an unambiguous problem description.
- The client uses vernacular that must be developed into a lexicon of clearly developed terms.
- Often the problem has not been isolated, but its symptoms are evident.
- Sometimes this step is the last.

Often the problem has not been isolated,
but its symptoms are evident.



**"Well, shoot. I just can't figure it out.
I'm movin' over 500 doughnuts a day,
but I'm still just barely squeakin' by."**

Why is this problem important?

- Is this problem worthy of analysis?
- What is the cost of ignoring it?
- Who owns the solution of this problem?
- Sometimes this step is the last,
and that is embarrassing.

How is this problem now solved?

- Rare is the problem not already being solved.
- Thumb rules, marker pens and white boards, spreadsheets, tribal wisdom, ... can be very effective.
- Does the solution change the problem?
- Are there domain limits of an acceptable solution?
- Sometimes this step is the last,
and that is embarrassing.

How will you solve this problem?

- This is the fun part,
but not the only part of qualifying a problem.
- Is the path to solution clear, or is this new ground?
- Sometimes this step is the last,
and that can be embarrassing.

How will you know when you have succeeded?

- Recall, we're answering all these qualifying questions *BEFORE* commencing analysis.
- Set the bar for success a priori, and be wary of anybody moving it (up or down).
- Sometimes this step is the last, and when it isn't, this can be embarrassing.

Why Not Brief An “Optimal” Solution?

- Is the “why” as clear as the “what?”
- Is the solution intuitive, or magic?
- Does this solution “change everything?”
- Is this solution fragile, or robust?
- Will the client still be in charge?
- Moderation is a virtue.

Good Reasons for Less Than “Optimal” Advice

- Understandable.
- Actionable.
- Legal.
- Persistent.
- Monotonic.
- Robust.
- Resilient.

Understandable

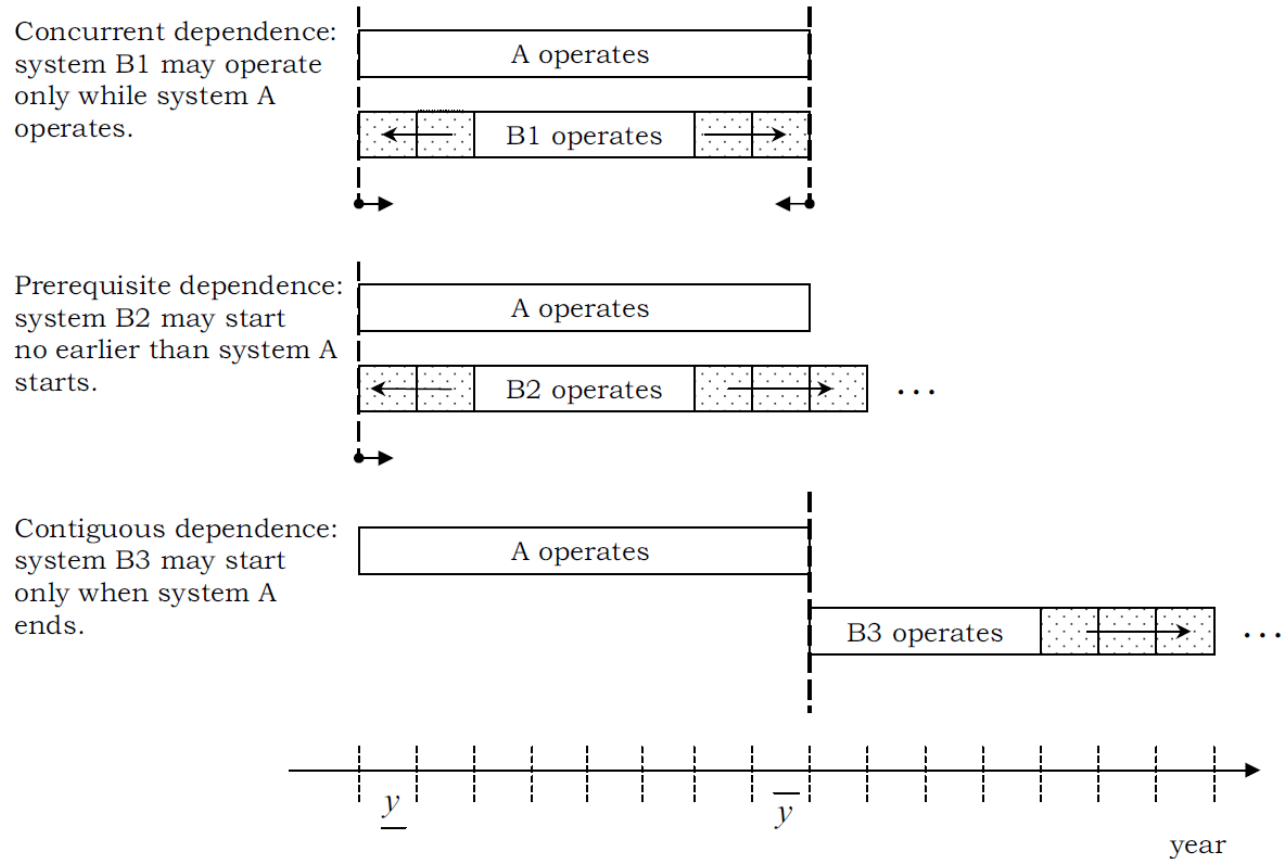
- Good luck convincing a decision maker to adopt a policy that is not understandable
- Sometimes you need to introduce a solution incrementally
- Sometimes you need to demonstrate with many examples

Actionable

- The solution must be in the domain of the permitted
- Or, you may be suggesting replacing a worthy problem
by another, harder one

Actionable

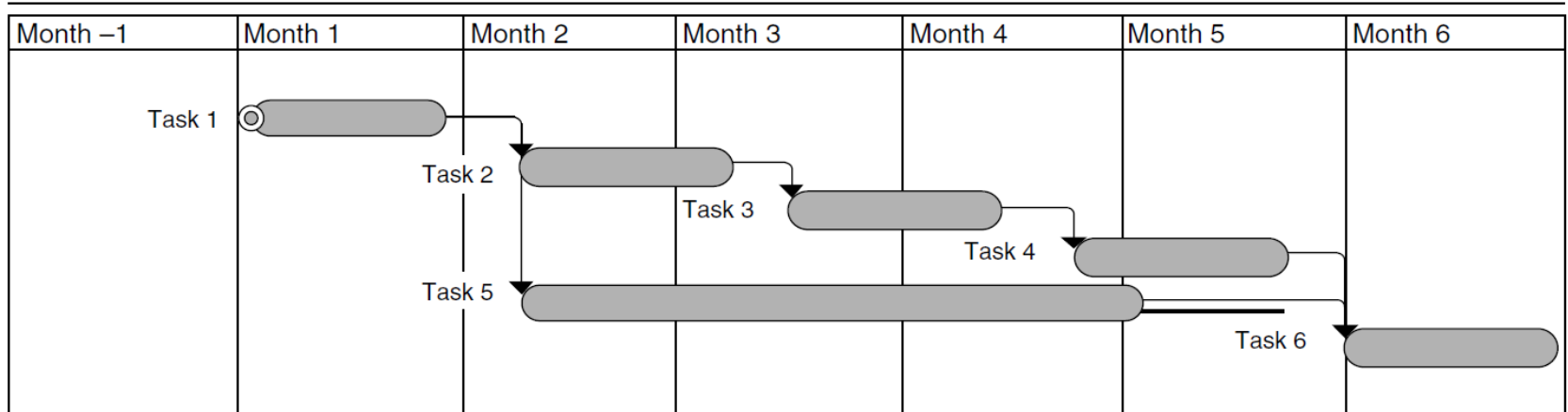
We suggested really efficient launch schedules for the US Air Force Space Command, but neglected some essential details.



Actionable

Non-intuitive answers can be a challenge to explain.

We discovered a single key component for a first nuclear weapon that could be interdicted. This was not on anybody's "critical path."



Interdict a Non-Critical Activity

Legal

- See “Actionable”
- This comes up more often than we’d like

Persistent

Expect resistance

if an answer suggests a wholesale scramble of pre-existing, announced decisions.

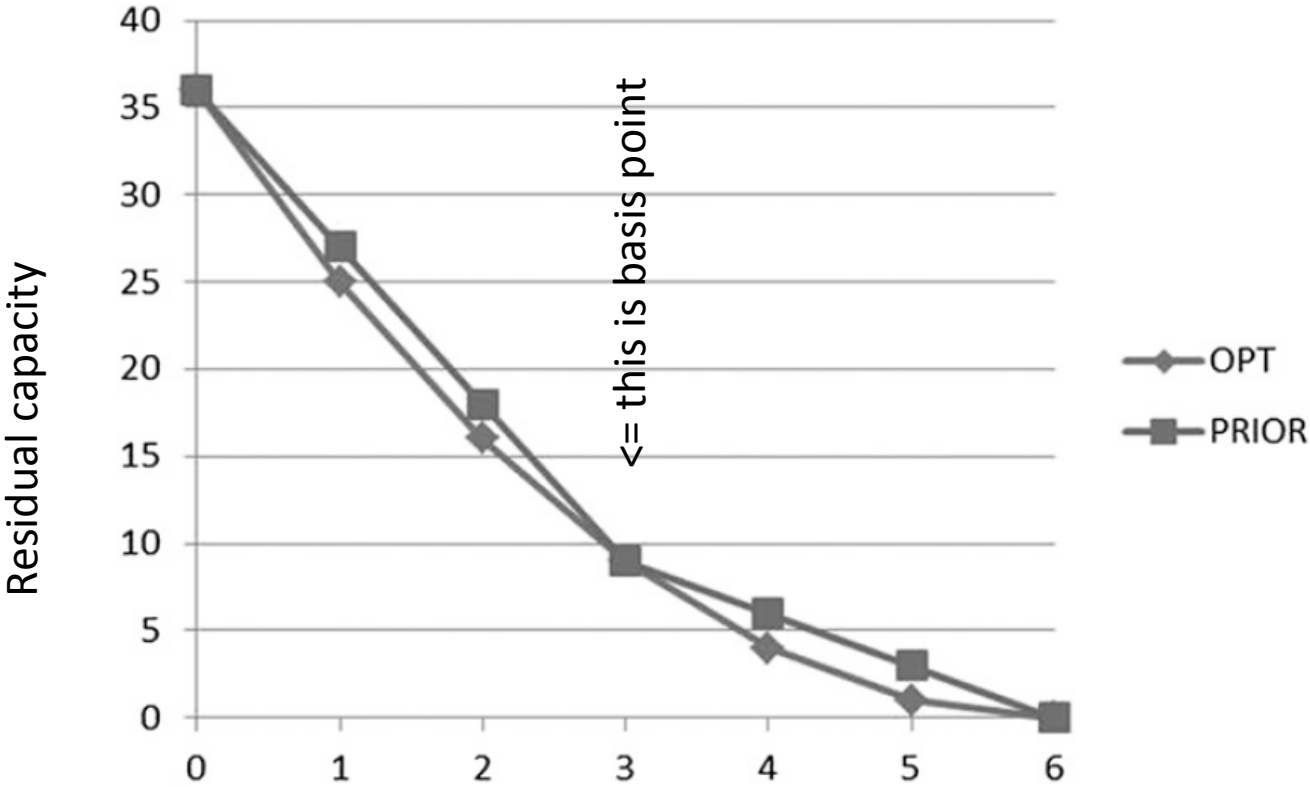
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Sanibel	Δ		Δ					Δ		Δ	Δ		Δ			δ					δ		δ	δ	δ	
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Pt-Jackson			Δ									Δ	Δ	Δ												
Pt-Hannon	Δ	Δ						Δ		Δ	Δ	Δ								δ						
Pt-Turner	Δ		Δ					Δ			Δ													δ		
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Penobscot																										
Sturgeon																										
Thunder																										

This is not optimal,
but is persistent

Monotonic

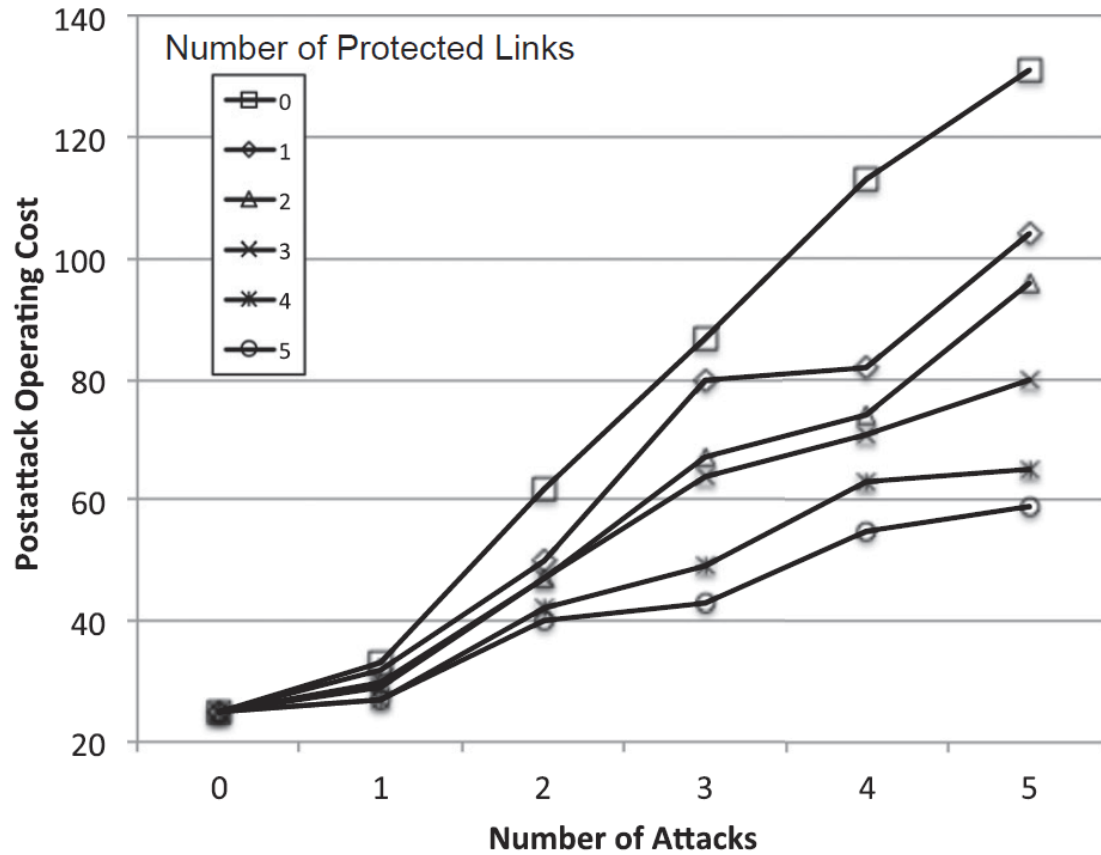
- As a budget increases, optimal incremental investments do not necessarily appear monotonically
- A1; A1,A2; A1,B1; A1,A2,A3; B1,B2; ...
- This drives policy types nuts.

Monotonic

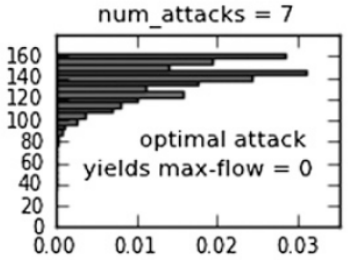
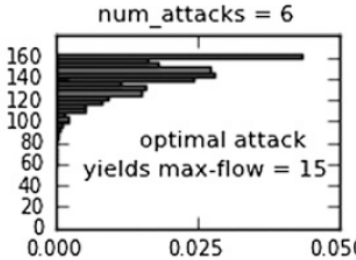
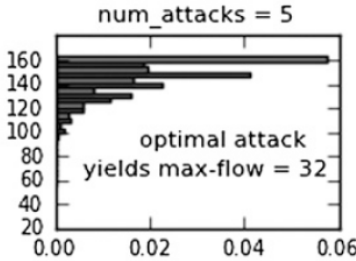
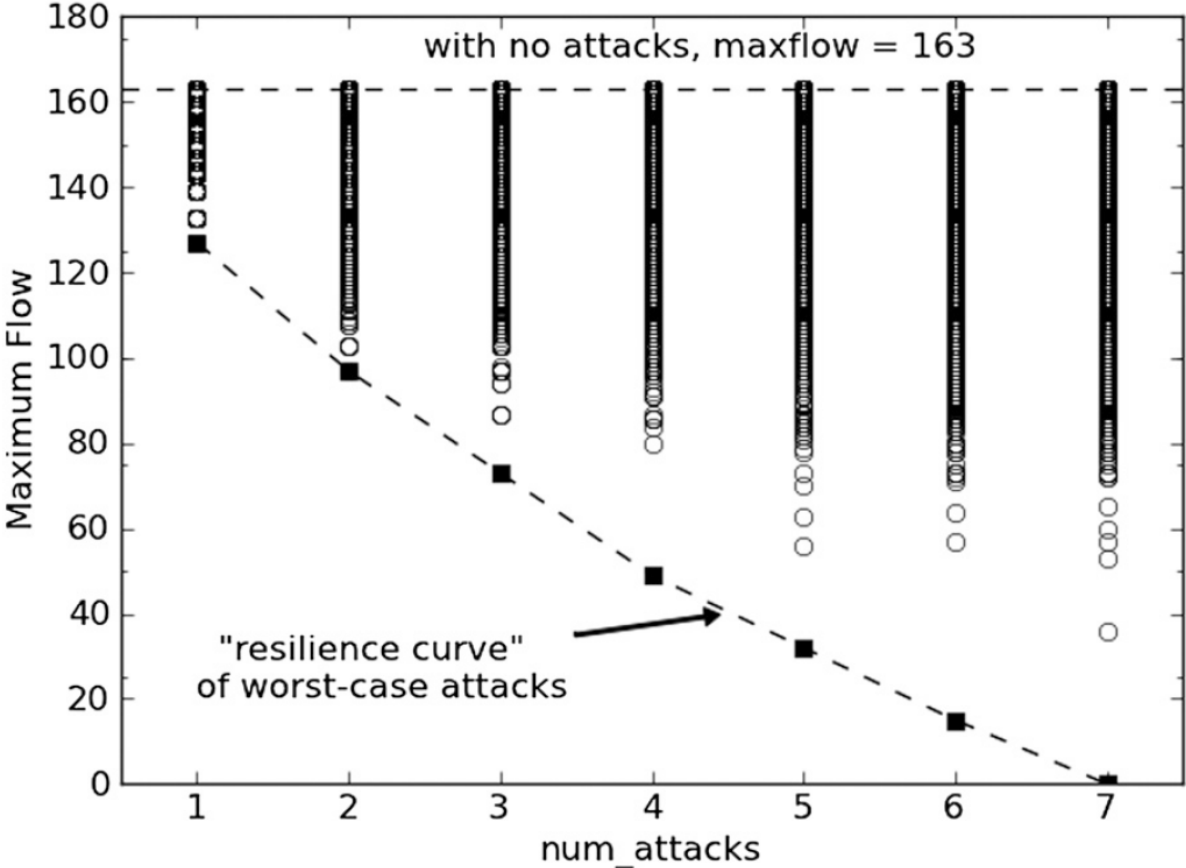


Optimal vs. Prioritized (Monotonic) Attacks

Resilient



Robust



Combining Everything

The best executive summary

Is 3-10 pages long

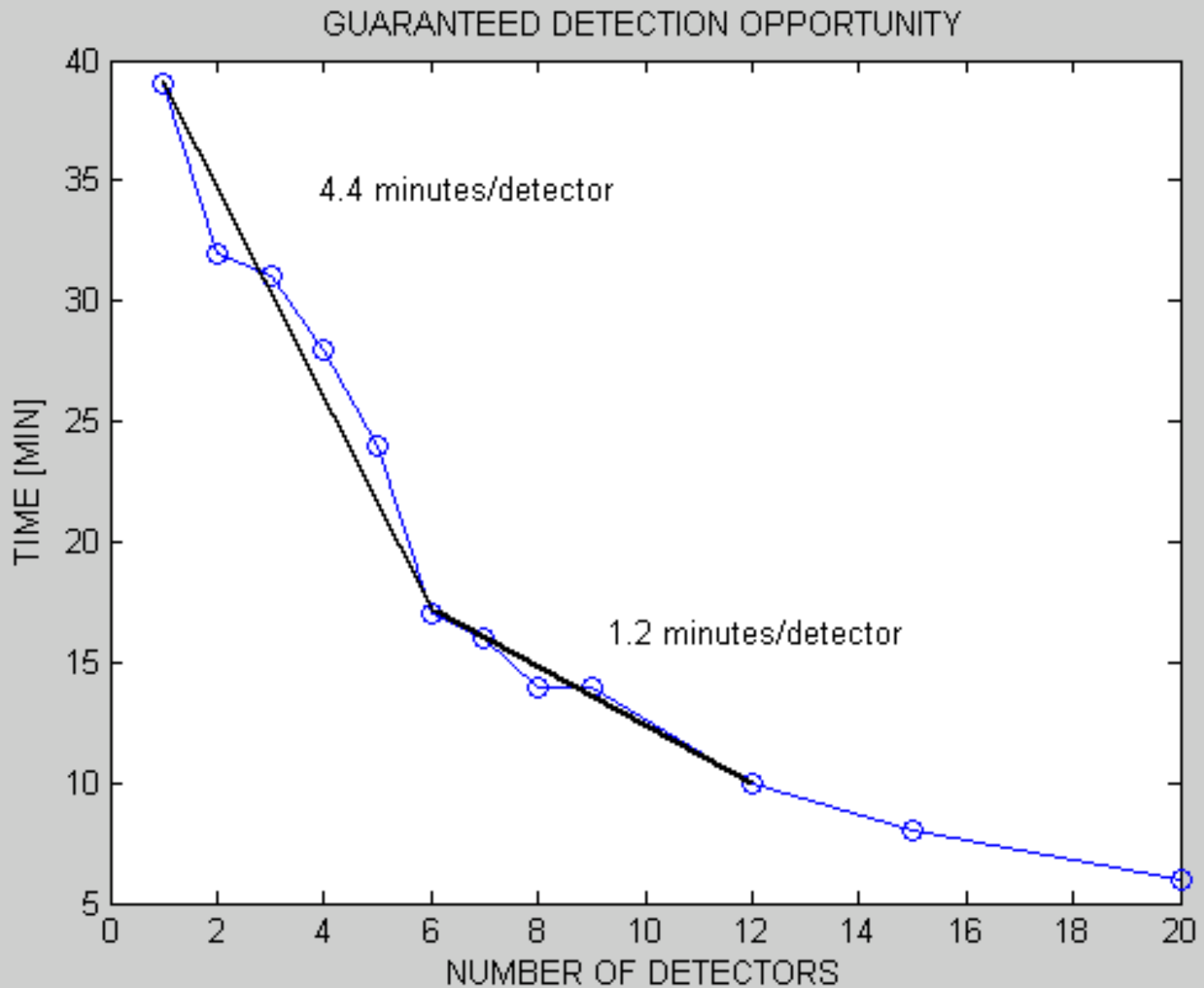
employs simple graphics with technical legends

(see Scientific American, or American Scientist)

Combining Everything

The best executive presentation
is 5-10 slides in length
and includes a “Money Slide”

Money Slide



Why are You in OR?

- Love mathematics?
- Enjoy designing algorithms?
- Like to solve puzzles?
- Think it's cool to be called "Professor?"
- **Or, do you want to influence policy?**

Questions?

Full background materials:

<http://faculty.nps.edu/gbrown/>

Copy of this presentation or correspondence:

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- “I can no other answer make, but, thanks, and thanks.”
Shakespeare, 12-th Night 3(3)