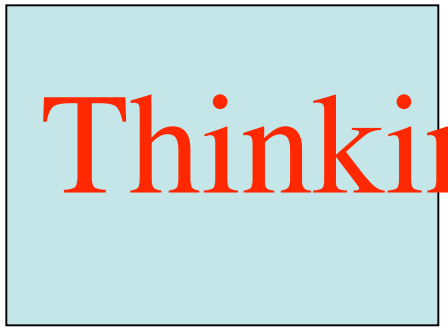
Thinking Outside the Box:

Part 2: An informal discussion of research methodol
is not necessarily contained to only engineering topi
or only to phd work, but mostly with that perspectiv



Part 1: Viktor Prasanna
Part 2: Michael J. Neely

First an example:

Tutoring in math…

Joe Pasadena, Homeroom 103

Math Homework. Grade 6. Mrs. Smith.
Page 15 of math book, questions #1-16.

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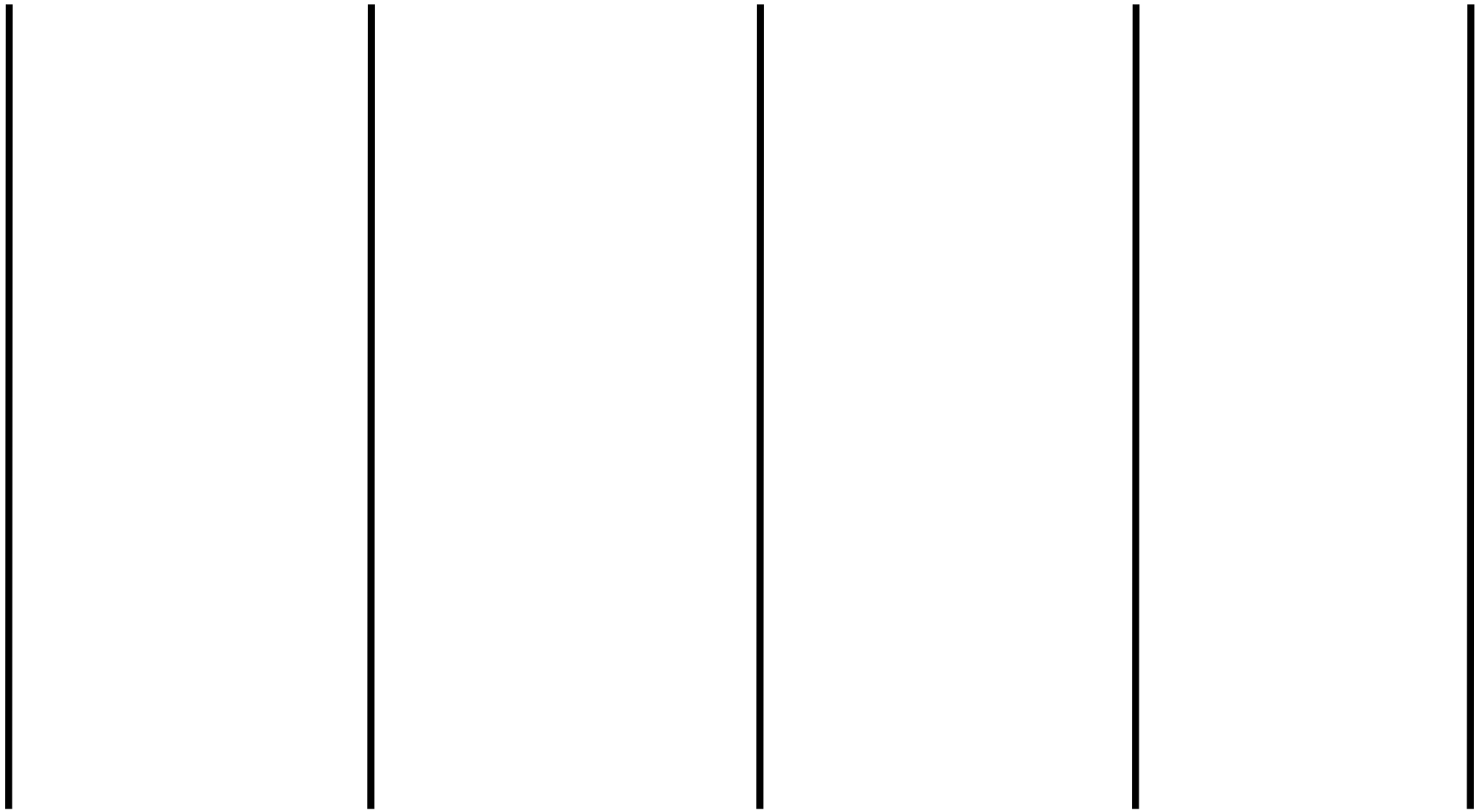

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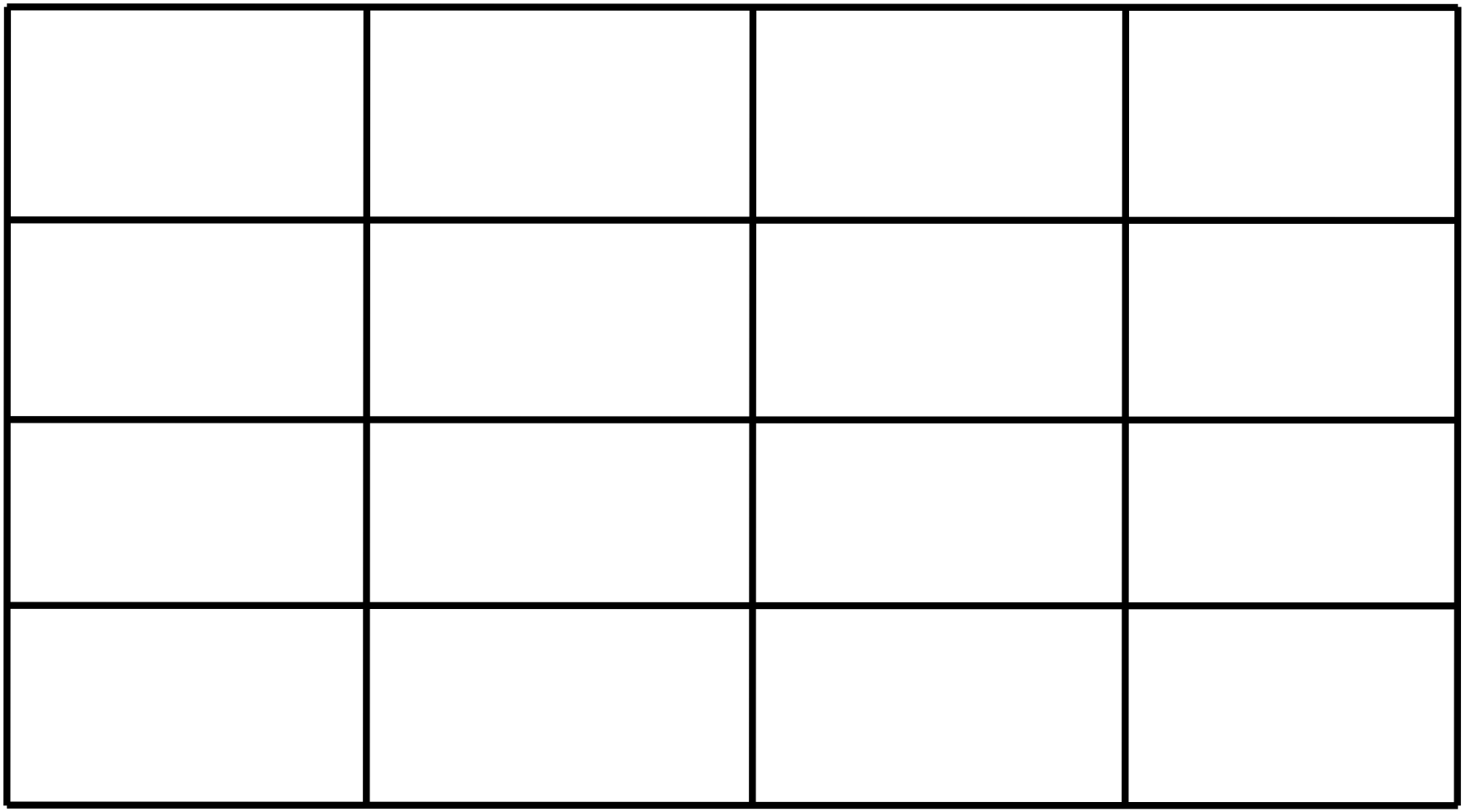

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Math Homework. Grade 6. Mrs. Smith.
Page 15 of math book, questions #1-16.

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16

Joe Pasadena, Homeroom 103

Math Homework. Grade 6. Mrs. Smith.
Page 15 of math book, questions #1-16.

1 5/(2*3) = 5/6	2	3	4
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Joe Pasadena, Homeroom 103

Math Homework. Grade 6. Mrs. Smith.
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Joe Pasadena, Homeroom 103

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5 5/3 + 1 = 5/3 + 3/3 = 8/3	6 3x + 2 = 4 3x = 2 x = 2/3	7	8
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Joe Pasadena, Homeroom 103

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13	14	15	16

In Research, there is a tension between:

- Natural Repetition Required for Learning
- Mastery of “Standard” Techniques
- Application/Development of New ideas

(what is the “recipe”??)

Outline of the remaining slides:

- Multiple Ways to Succeed
- Standard Research Methodology
- Don’t put Arbitrary Constraints on yourself
- Two Suggested “out-of-box” strategies
- Confidence is Needed

Multiple Ways to Succeed

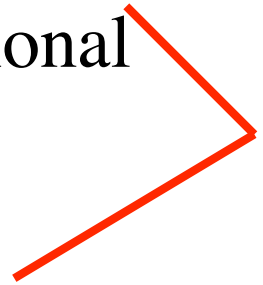
"Out-of-Box" thinkers in the field of literature:

1)The Little Prince, by Antoine de Saint Exupery

1)Gertrude Stein:

"Rose is a Rose is a Rose is a Rose"

-unconventional
-repetition
-simplicity



Are these "praises" or "criticisms"?

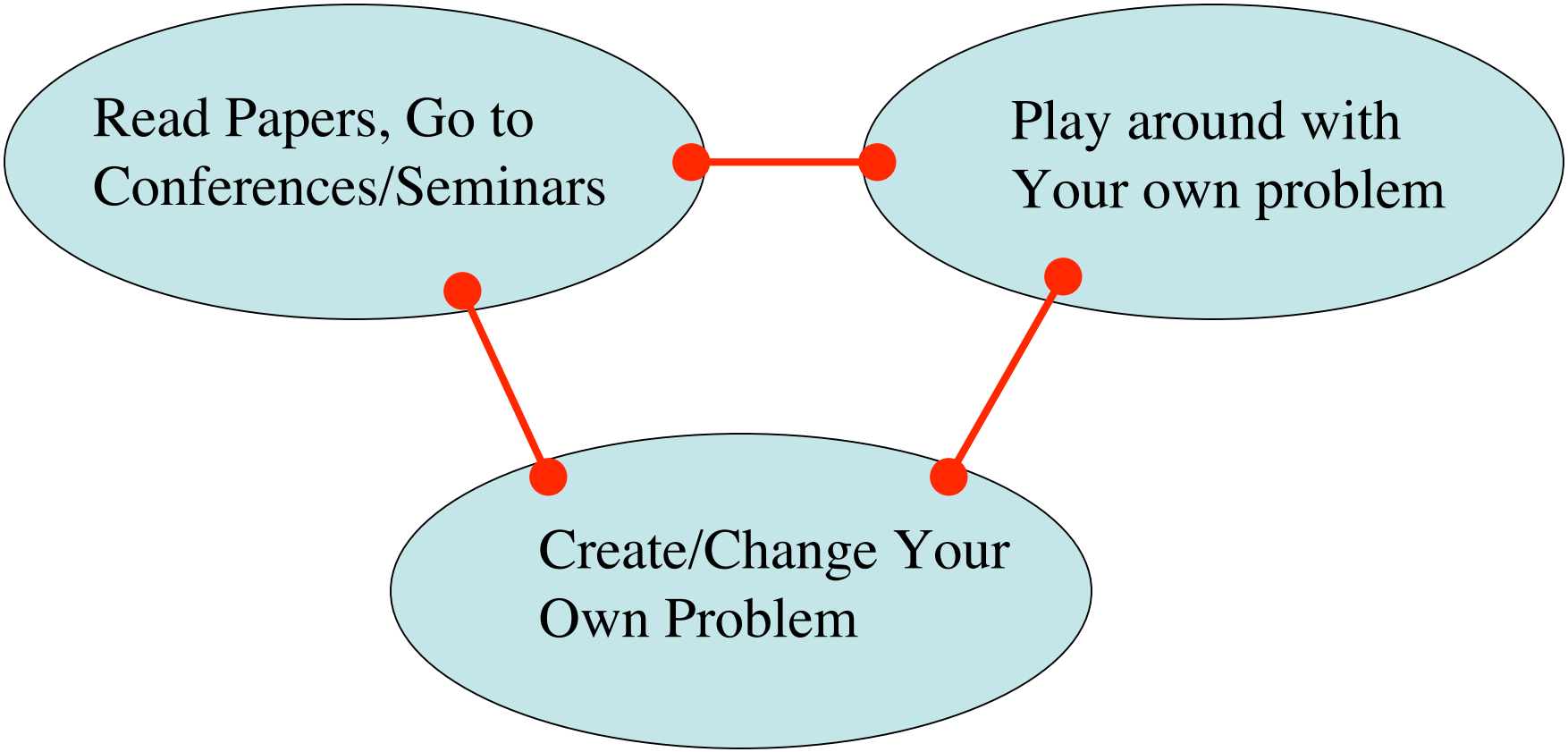
3) Alan Moore: *"V" for Vendetta , Watchmen*

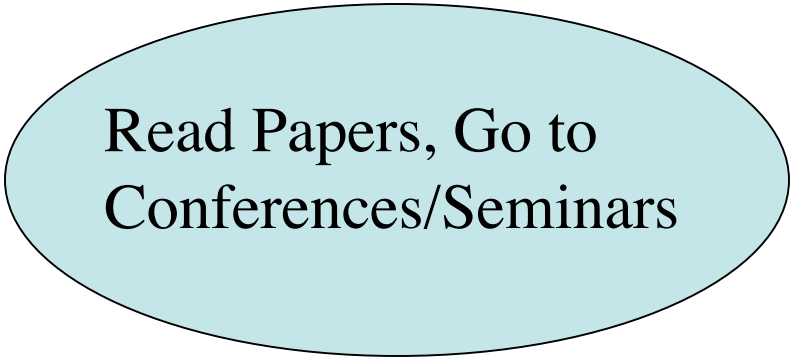
The "**graphic novel**":

On Time Magazine's list of "100 best novels"

Standard Research Methodology

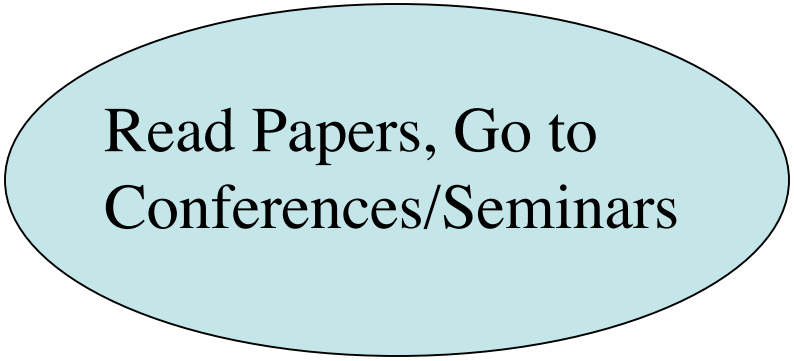
How to do research?





1. Shows you what problems are known
2. Shows you what problems are interesting
3. Gives techniques for problem solving

Can be inspiring for your own problems and solutions…



1. Shows you what problems are known
2. Shows you what problems are interesting
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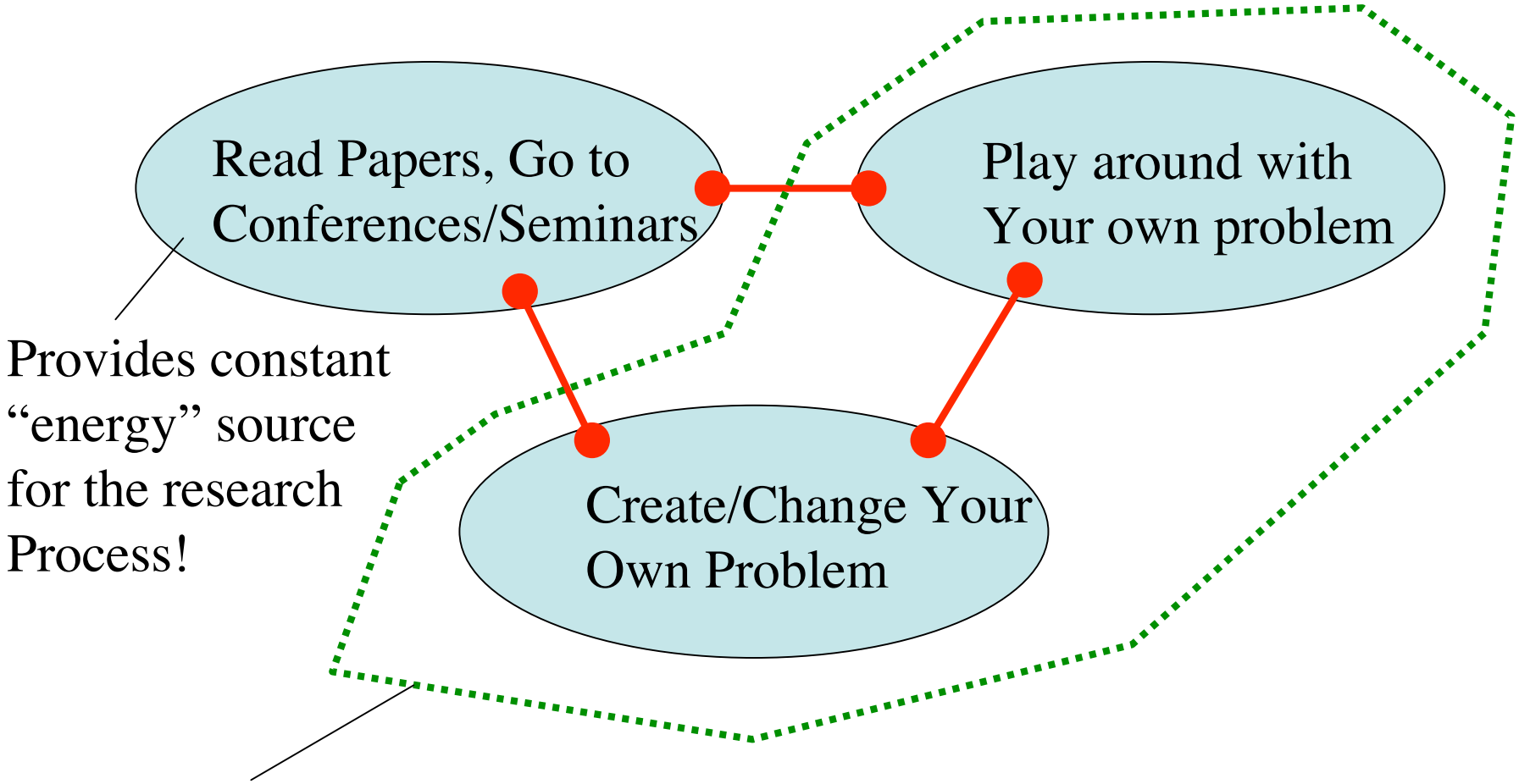
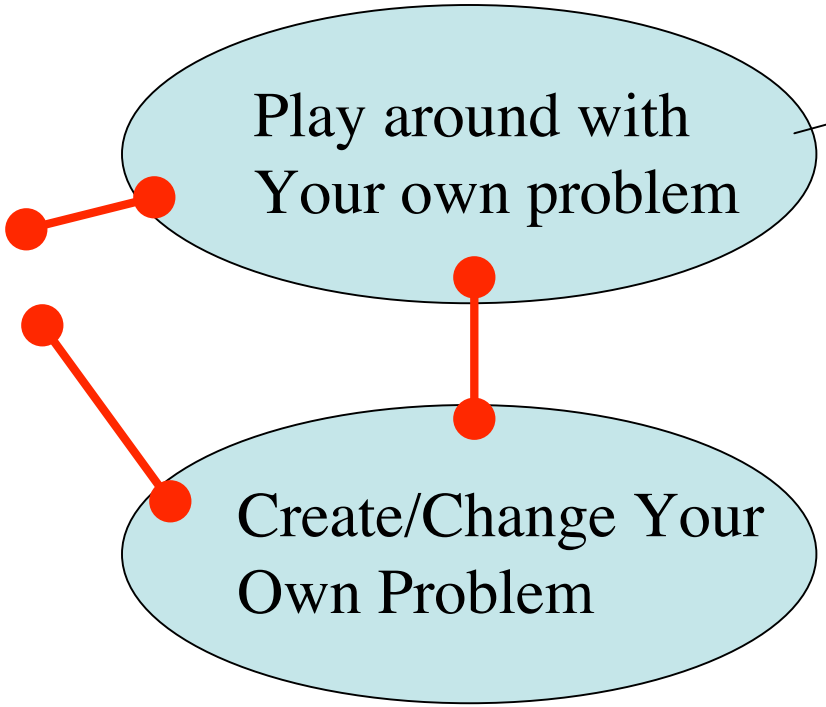
Can be inspiring for your own problems and solutions…but you also need to do the other steps!

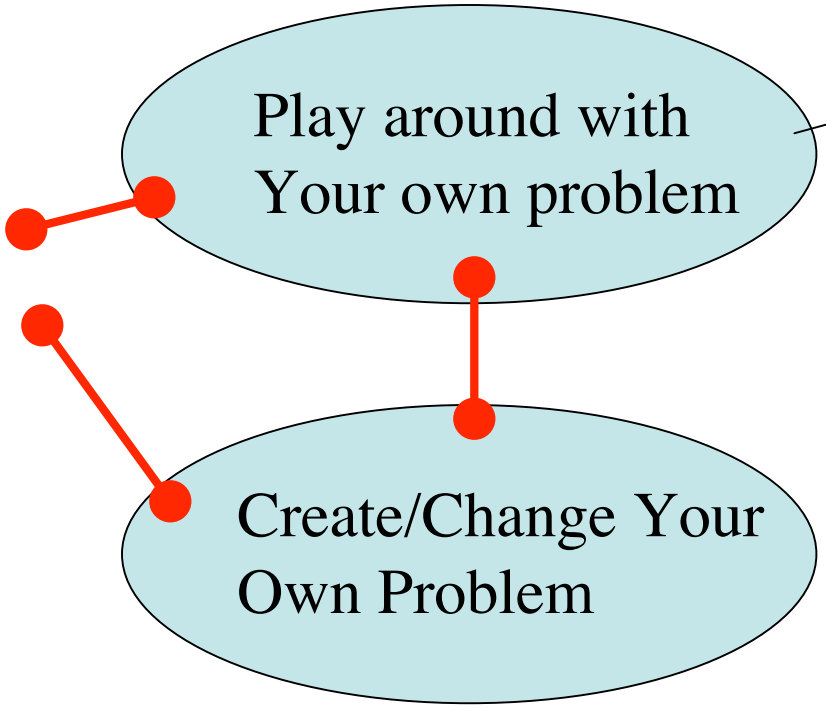


Draw me a sheep!



"Problem Sets":
-Problem given to you
-You know there is an answer
-Solution technique is usually given (in class, in book, etc.)

Problem Set Problems
were good research problems
at one point! (interesting problem,
interesting/clean solution).
You have seen Many examples.



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Good Research Process:
Design your own Problem Set Questions!
Iterate on the process (ask questions, do analysis, make hypothesis, generalize, focus, read papers, etc…)

- Don’t be afraid to change the problem or question.
- Don’t be afraid to solve “trivial” problems first.
- Invent “toy” problems to get understanding:
  - Try to find the simplest possible non-trivial instance of your problem, and see if you can solve it!

Ask good questions…

Don’t Put Arbitrary Constraints on Yourself

- Everyone does this, sometimes unintentionally
- Especially New Students
- Even Faculty
- Including Me =)

What do I mean by "arbitrary constraints"?

Natural Constraints for a problem (Not what I am talking about)	Silly Psychological Constraints! (Is what I am talking about)
•Timeslots •Poisson Arrivals •Treat Interference as Noise •Etc. These were useful to the researcher. They helped make a hard problem simpler to think about.	•All problems must have timeslots •All problems assume we are given x,y,z, and we must solve for w •All algorithms must be… •My advisor is only interested in… •My thesis is only about…

One example from my grad school days working on thesis…

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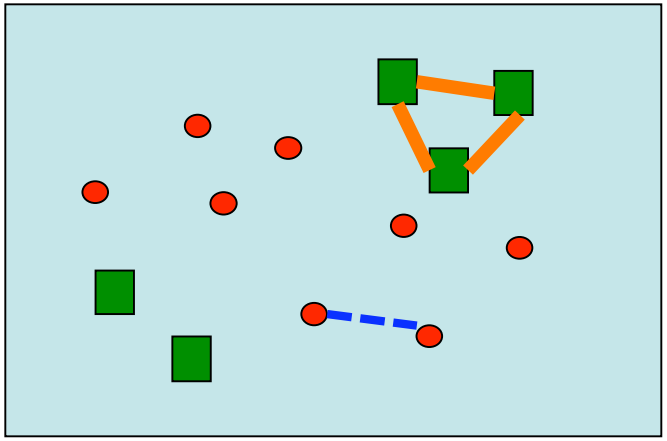
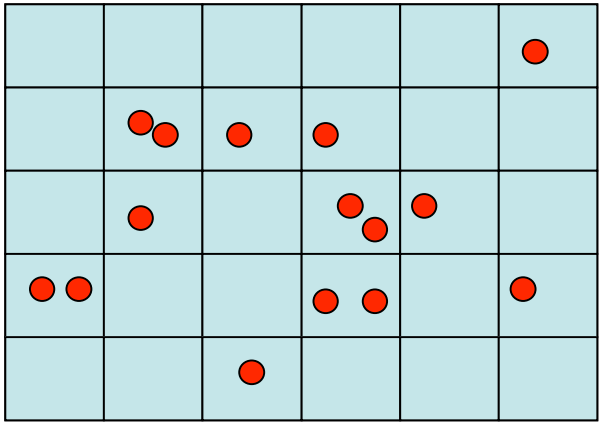


Was working on:

- General Networks
- General Interference
- General Mobility Patterns
- Using Lyapunov Drift.



Had idea for a "simple" mobile network with specific rules. Could get exact capacity and delay. But…

- "too simple"
- "advisor won't like it"
- "not part of my thesis"
- "doesn't use Lyapunov drift"

After overcoming these artificial constraints, I found that my advisor loved the idea, and it became Ch. 6 in my phd thesis! "Capacity and Delay Tradeoffs For Ad-Hoc Mobile Networks"

2 Suggested "Out-of-Box" Strategies:

1) Change the existing problem. Get the "Low Hanging Fruit" by ***asking a question that nobody has asked before***. *Examples:*

   - Grossglauser-Tse: Can we exploit mobility?
   - Syed Jafar: Can we "align" interference using propagation delay?
   - "Sensor Networks"
   - Can we solve other problems over a network?

2) Use Skill Set from one area in another area.

   You have a great chance of making a significant contribution!

Examples: Turbo Codes from VLSI, Economics from Data Compression, etc. Can we use an M/G/1 queue for PHY Layer comm?

You Need to Have Confidence!

Final Observation:

- Ph.D. Students typically take 5-6 years to graduate.
- After graduation, some get post-doc positions.
- They then do the same amount of work (or more) in just 2 years!

Why?