Ph.D. - Path to a Career or to a Job?

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What is a Career?

- Webster: "General course of action or conduct in life, or in a particular part or calling in life, or in some special undertaking.
- Hieftje: "Something you would do for nothing but for which, amazingly, somebody pays you."

What is a job?

- Webster “(1) A piece of chance or occasional work; any definite work undertaken in gross for a fixed price; as, he did the job for a thousand dollars.” (2): “Any affair or event which affects one, whether fortunately or unfortunately.”
- Hieftje: “(1) An employment position tolerated principally for financial gain but otherwise largely unrewarding or unsatisfying. (2) Employment that makes you feel like Dilbert”

DILBERT® by Scott Adams

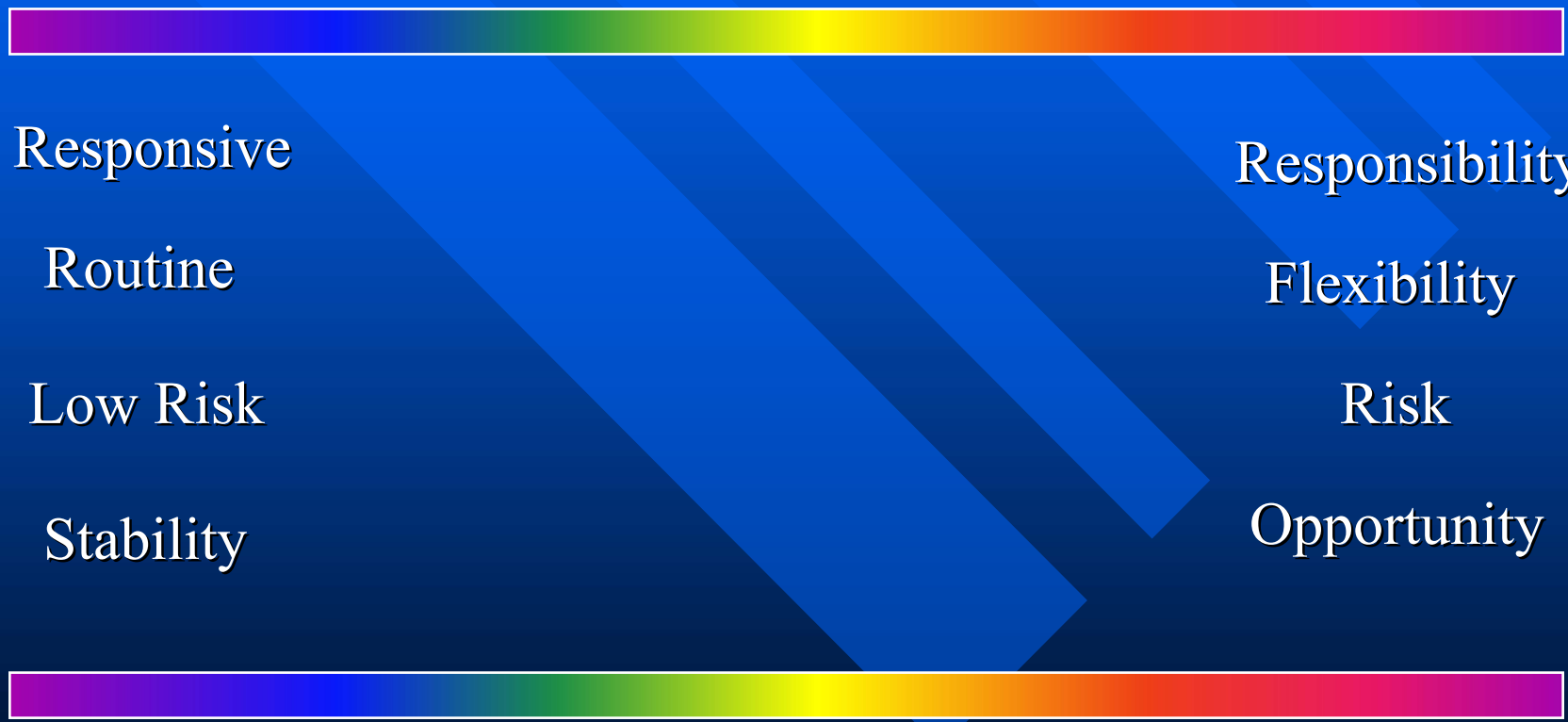
Distinctions — Job *vs.* Career

- A job's main function is to provide income
  - A career's main function is to provide satisfaction
- A job keeps you from enjoying life
  - A career makes life enjoyable
- A job offers stability
  - A career offers flexibility
- A job is "safe"
  - A career encourages risk-taking

A Job — Examples

- Teaching Instrumental Analysis for 20 years (from the same lecture notes)
- Analyzing routine soil samples for PCB contamination
- Managing a Control Laboratory
- Being Department Head at a Big-10 institution

The Job/Career Continuum



Industry, University or Government Lab?

Job vs. Career ≠ Industry (x) *vs.* University (•)

Job • x x • x•x• x x••• x Career

Relationship to Academic Degree

Career vs. Job ≠ Ph.D. (x) *vs.* B.S. (•)

Job • x x • x• x• x x •• • x Career

Is a "Career" for you?

- Is everything you tried in science interesting?
- Do you prefer routine or variety?
- Do you feel more comfortable being directed by others or directing yourself?
- Do you find yourself thinking about your research away from school? Do you resent it?
- Are you willing to take responsibility for your own mistakes? (You will make them.)
- How important is salary to you in job choice?

Is a Career *in Research* for You?

"If we knew what we were doing, we wouldn't call it research"

-anonymous

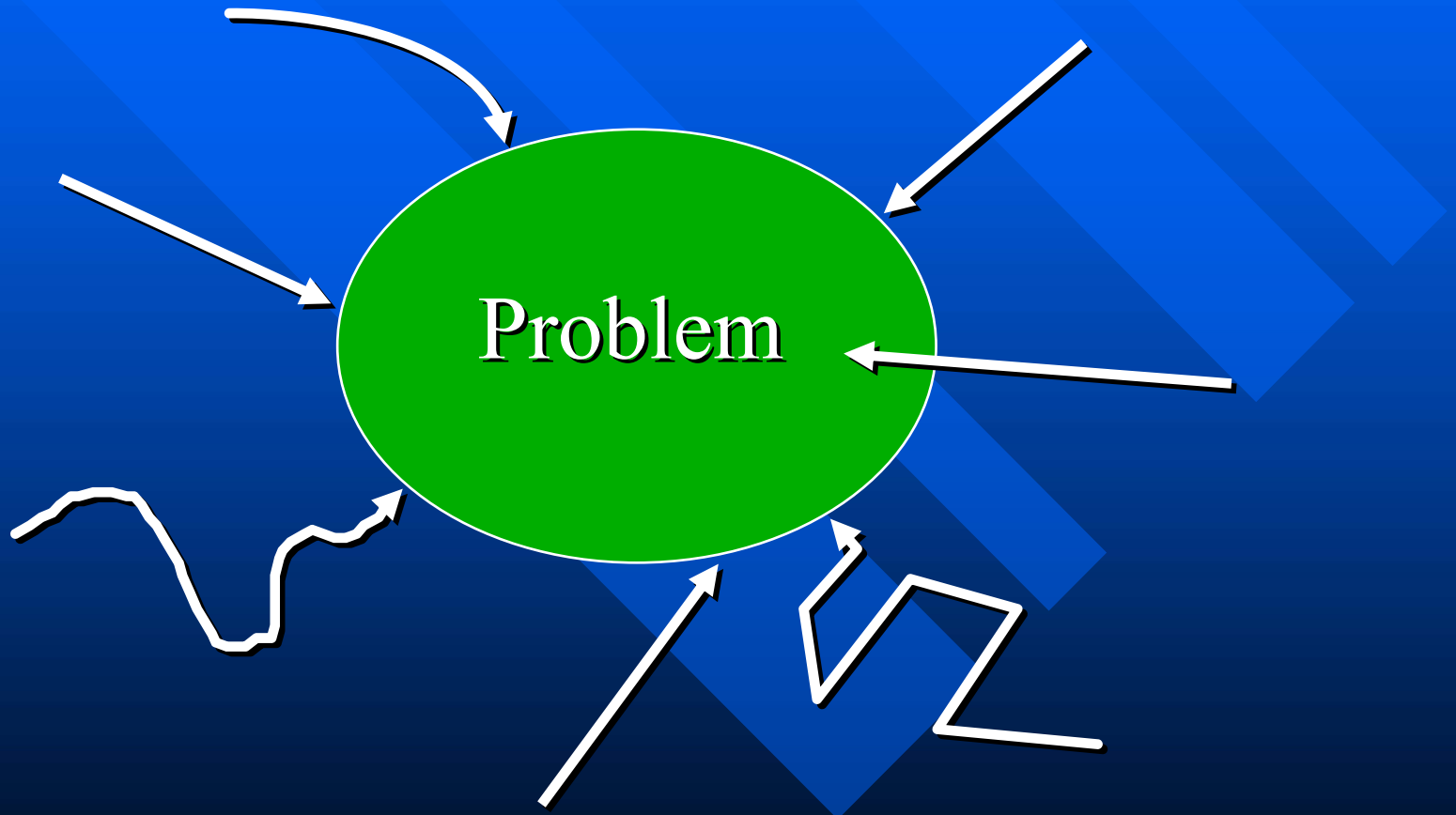
Two facets of Research

- Solving recognized problems
  - Applying tools of the trade
- Recognizing unsolved problems
  - Requires broader knowledge, scope of field

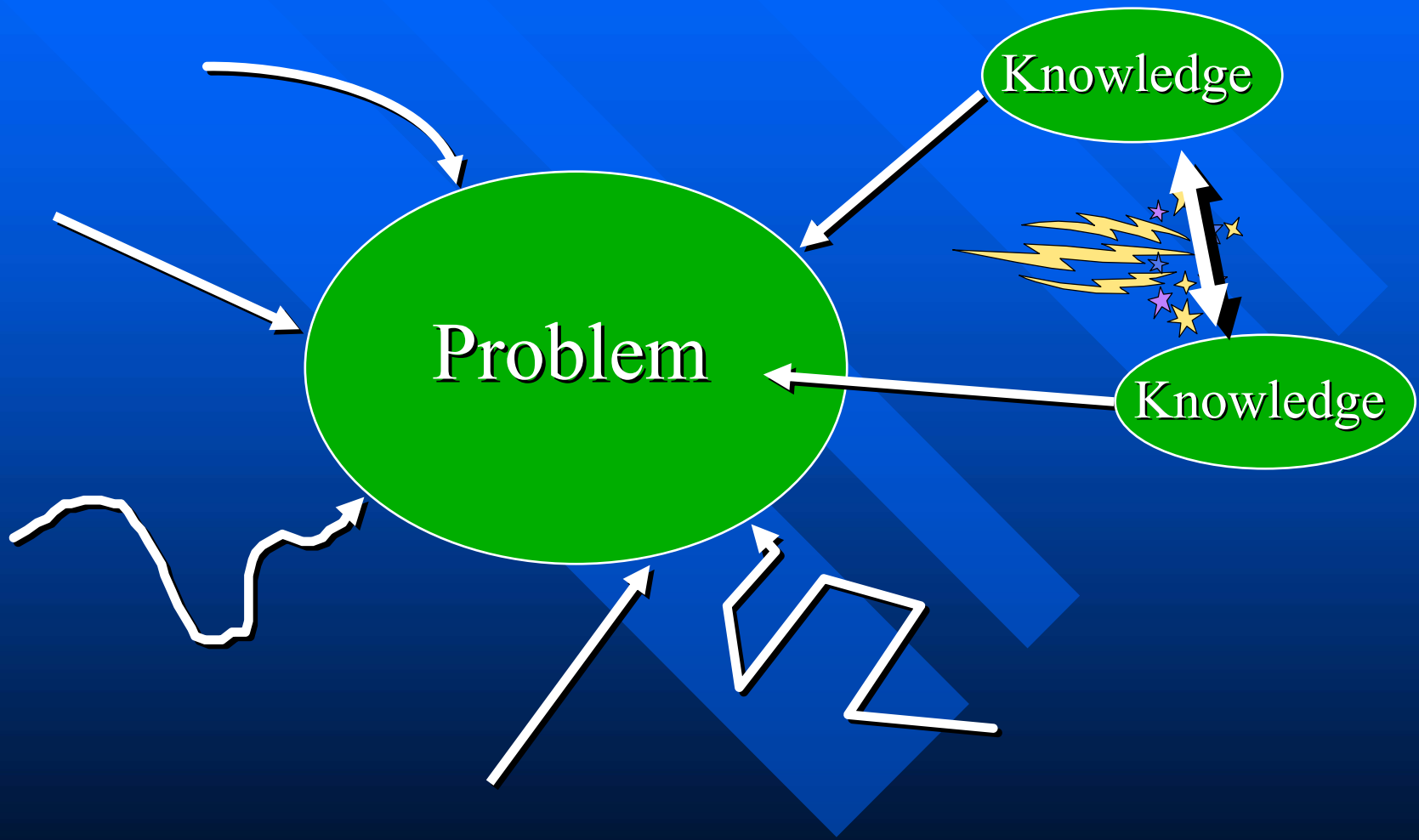
“Research is to see what everybody else has seen, and to think what nobody else has thought.”

— Albert Szent-Györgyi

Effective Problem Solving



Innovation and Problem Solving



Paths to innovation

- Avoid prejudices (don't know *too* much)
- Figure things out for yourself
- Try to relate everything you hear to your current work (research)
- Try to apply your own work or ideas to everything you hear
- When captive, daydream
- Keep paper & pen handy

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“Maybe that’s why young people make success. They don’t know enough. Because when you know enough it’s obvious that every idea that you have is no good.”

— Richard Feynman

That is, don’t read *too* much

However . . .

Six months in the laboratory can save as much as an hour of library time

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Figure things out for yourself

- Develop a scientific framework
- Identify cross-cutting principles (e.g. correlation)
- Learn how things happen
- Make analogies (electrical/mechanical/quantum)

“Scientific creativity is imagination in a straightjacket”

— Richard Feynman

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“When I am . . . entirely alone . . . or during the night when I cannot sleep, it is on such occasions that my ideas flow best and most abundantly.”

— Wolfgang Amadeus Mozart (1756-1791)

Elements of □Research Innovation

- Need breadth of experience
  - e.g. STM
- Need challenge
  - dig deep inside
- Need trigger
  - New data, devices, concepts
  - largely by “accident”, but we can improve odds

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Challenge Fosters Innovation
(personal examples)

- H. V. Malmstadt: time resolution, "think digitally"
- Jack Frazer: stochastic processes, correlation methods
- Writing an abstract (really a research proposal)

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Triggers for Innovation
(personal examples)

- Droplet generator
- Background correction
- Scheeline remark (Thomson scattering)
- Benninghoven lecture (TOFMS)

Research Progress

- The "Scientific Method"

  Hypothesis → Test → Conclusion

  (As we describe the work in the literature)

- Most real research

“If you don’t know where you’re going, you’re apt to end up somewhere else”

— Yogi Berra

Problems due to Scientific Trendiness

- Discourages pursuit of new research directions
- Fosters only incremental research gains
- Necessitates short-term goals and thinking
- Stifles innovation and creative thinking

"In a less crowded field, among shorter yardsticks, a novelist would not just have seemed bigger. He would have been bigger."

— James Gleick, in *Genius*

(i.e. he could attack bigger, less fragmented problems)

“Creative minds always have been known to survive any kind of bad training”

— Anna Freud

"As an adolescent I aspired to lasting fame, I craved factual certainty, and I thirsted for a meaningful vision of human life — so I became a scientist. This is like becoming an archbishop so you can meet girls."

— Matt Cartmill.

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