



Research Methods in Science in Engineering

Science & Research

Slide 1

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Lecture Outline

- Science and engineering
- Art of science and engineering
- How to go about doing your graduate research

Slide 2

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Science & Engineering

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Science

Logic and reason drive
the scientific method.

Systematic study of the structure and behavior of the
natural world through *observation and experiment*.

Not the supernatural
world.

Evidence based

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Engineering

Engineering is science!

Branch of *science* primarily concerned with *applying* science.

Engineers build things to improve the world.

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Origin of Scientific Ideas

Ideas can come from anywhere!

The origin of an idea does not have to be justified.

However, in *science* it is necessary to be ready to abandon those ideas if evidence proves the ideas are wrong.



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Scientific Hypothesis

A proposed explanation about what might be true.

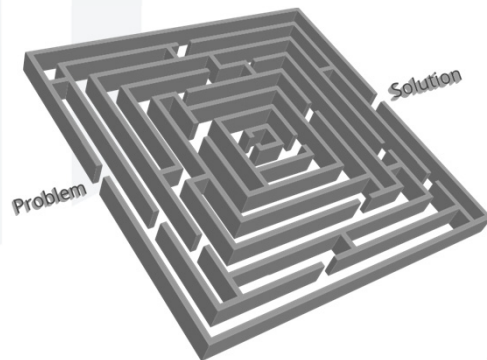
Usually, a hypothesis used as a starting point for scientific research.



Engineering Problem Statement

Engineering research very often does not have a hypothesis.

Many times what is true is already known. Engineers get that true thing to work in a way that is useful and convenient.

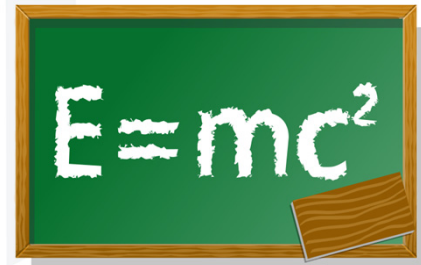


Scientific Theory

A well-established explanation of an aspect of the natural world that can be repeatedly verified by experiment.

Galileo Galilei argued that a scientific theory must make predictions that can be tested by experiment. Theories must be disprovable.

Kurt Gödel stated that a formal logical system cannot prove itself consistent. Theories cannot explain everything.



Facts

There are no *facts* in science.

There are only things assumed to be true in order to get other things done.

It is necessary to be willing to abandon what we think is true (facts?) when evidence suggests otherwise.

Art of Science & Engineering

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Creativity

Can creativity be taught or learned?

The most creative people tend to be the most *curious*, most *playful* and the *least bothered by peer pressure*.

Society does an incredible job of beating creativity out of people.

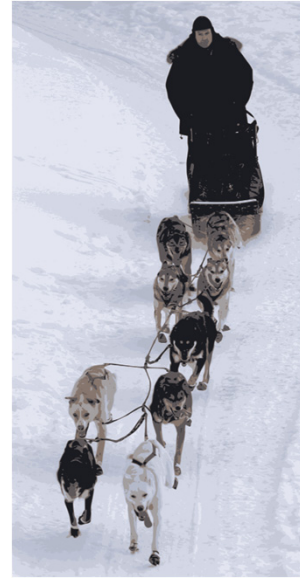


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Brains or Stamina?

Getting your PhD is much more about *stamina* and *dedication* than it is about intelligence.

A PhD is an *independent researcher* who has demonstrated an *insane level of commitment* to research.



Failure

Failure is your most powerful tool for *success*.

If you are *not failing*, you are likely *not trying* or not pushing yourself hard enough.

Fail *fast*. Fail *cheap*.

Fail for the *right reasons*.



How To Go About Doing Your Graduate Research

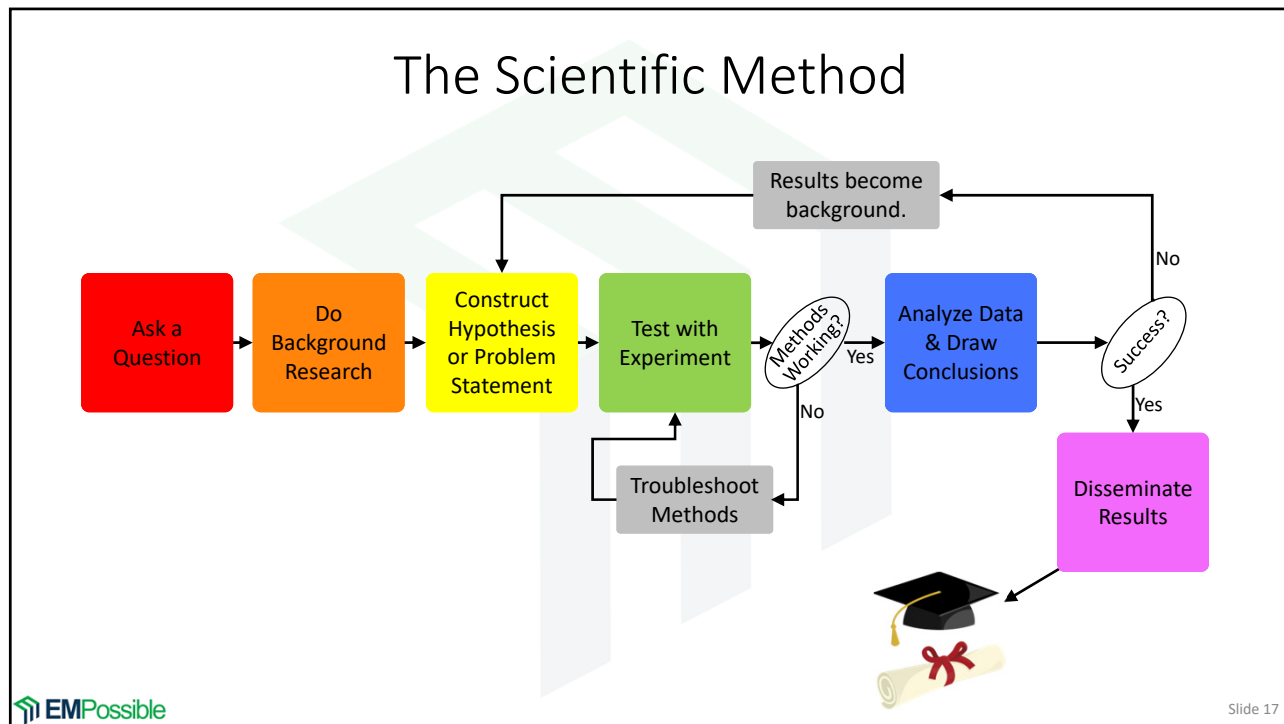
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One-Slide Summary of Grad School

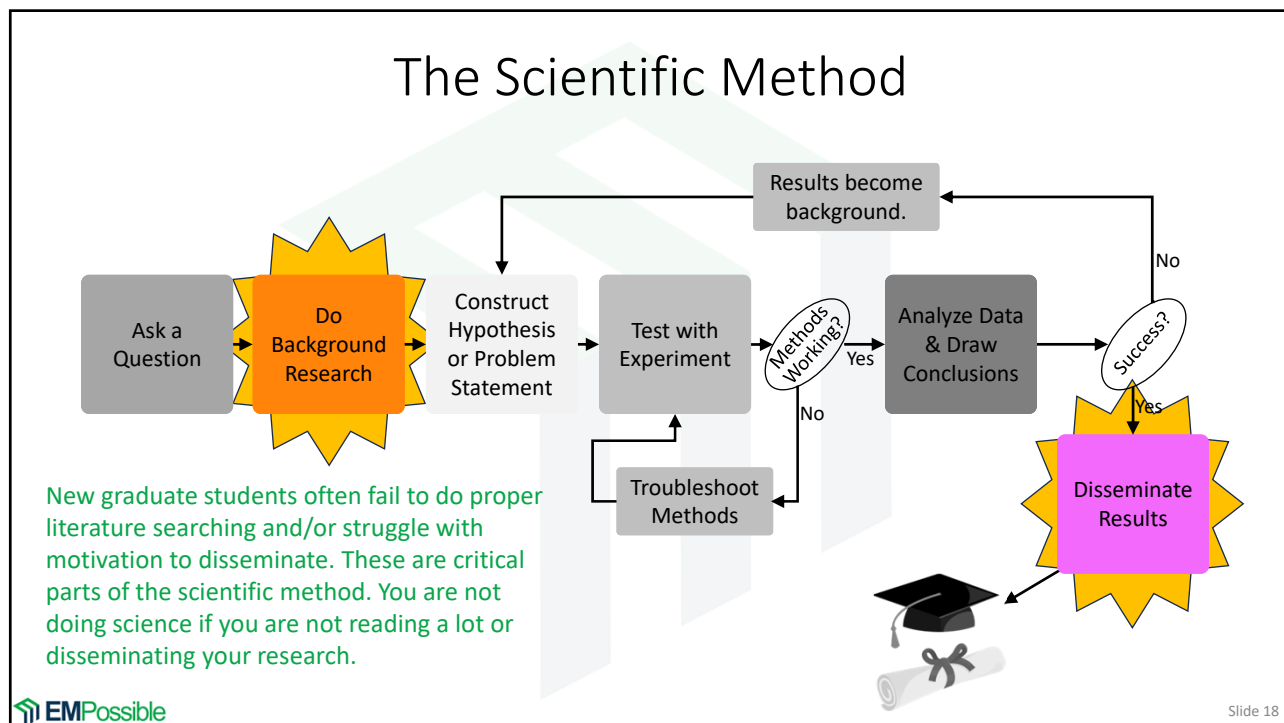
Get a Job
 ↓
 Branding
 Materials
 Search
 Apply
 Interview
 Accept

- Find a good advisor and let them guide you
- Read everything and become a subject matter expert
- Identify a research topic
- **Perform preliminary research to better understand your topic and perhaps prove feasibility**
- Propose your topic to your committee
- **Finish your research**
- Disseminate and defend your research.

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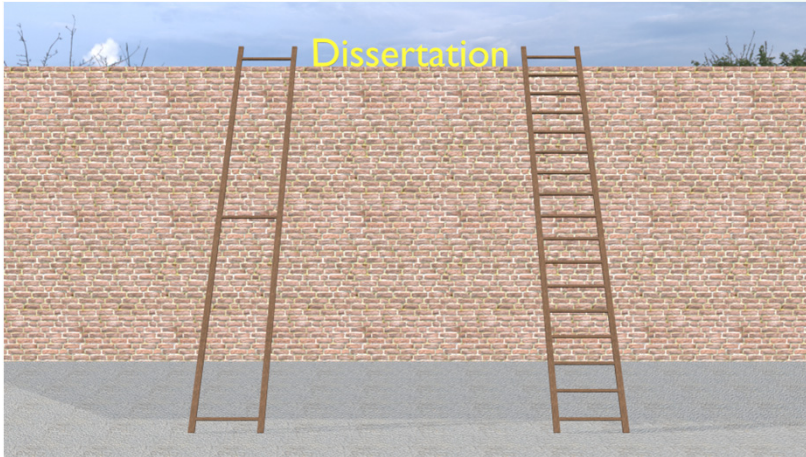


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Plan Your Research Wisely



Break large and difficult problems down into a series of smaller and simpler problems.

Follow the Advice of Your Advisor

Your advisor has seen and been through many common traps that graduate students fall into.

They understand the game and what it takes to be successful.

Choose your advisor wisely and follow their advice.

