University of Massachusetts Lowell

Structural Engineering Research Group (SERG)
Summer Seminar Series #1
Lowell, Massachusetts
May 30, 2014

# *About Research – A Very Brief Introduction –*


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SERG

# Outline

- What is research?
- How to do research?
- Key research skills
- Common mistakes in young researchers
- Few other words
- Summary

# What Is Research?

- Must be something new/original.
  - *How do you know what you are doing is new/original?*
  - *How do you know no one has done it before?*
- Must be done through a strictly logical approach.
  - *How do you know it's logical?*
  - *How to you know it's strictly enough?*
- Must be publishable.
  - *How do you make it publishable?*

# How To Do Research?

- Need a specific, well-defined **topic**.
  - *What are the variables considered in your research?*
  - *What is your hypothesis for the research?*
  - *How do you know the result is good or bad?*

- Need an **approach**.
  - *How do you solve your research problem? Analytical, numerical, experimental, or combinations of two or all?*
  - *How do you know the approach you chose can lead you to the correct answer/solution to your problem?*

# How To Do Research?

- Need a logically sound **plan**.
  - *How to solve the problem in a step-by-step process?*
  - *How do you know the order of steps is appropriate?*

- Need orthodox, academic **training/education**.
  - *Are there appropriate level courses to take? If yes, take the course. If not, study the subject by reading books and research papers.*
  - *If studying the subject by oneself, an advisor is necessary.*

# How To Do Research?

- Need a qualified **advisor** (or few advisors)
  - *How do you know an advisor is knowledgeable on your research topic?*
- Need be serious about **your research**.
  - *Start the loop and finish it properly. Don't give it up in the middle of the journey.*
- Measures for successful researchers:
  - **Attitude**
  - **Ambition**
  - **Ability**

# Key Research Skills

- Know how to write scientifically.
  - *No one can appreciate your work if you don't know how to write.*
- Find the papers you have to read.
  - *Use Internet, libraries, whatever way to get them.*
- Need to know:
  - How to do math
  - How to write computer codes
  - How to design and conduct experiments

# Key Research Skills

- Summarize your research work.
  - *Do you know what you have found?*
  - *What does the result mean to you? Does it agree with your hypothesis? If yes, why? If not, why??*

- Present your research work.
  - *Can you explain your research and findings in a clear and logical way to your colleagues and peers?*
  - *Can you give a time-limited seminar talk?*
  - *Do you know how to prepare slides for your work?*
  - *Do you know how to arrange the time in each slide?*

# Common Mistakes In Young Researchers

- Forgetting about your research problem while reading papers or processing data
  - Do not leave any research problem unanswered. No matter how small it is.
  - Always remind yourself *why you are reading this paper* and *what information you are looking for*.
- Not documenting everything you did in numerical simulations or physical experiments.
  - Think about publishing your work. You never know what you might need later on. Keep everything, especially specimens.

# Common Mistakes In Young Researchers

- Not approaching the problem in a logical way.
  - *If you don't have **A** to get **B**, you cannot investigate **B** without studying **A** first.*

- Losing track of time when focusing on detail work.
  - *Develop a timeframe for everything you plan to do.*
  - *Setup deadlines with the help from your advisor.*
  - *Stick to the plan and do not miss a deadline.*
  - *Everything is time sensitive. If you don't know the due date for the assigned task, the plan is not complete.*

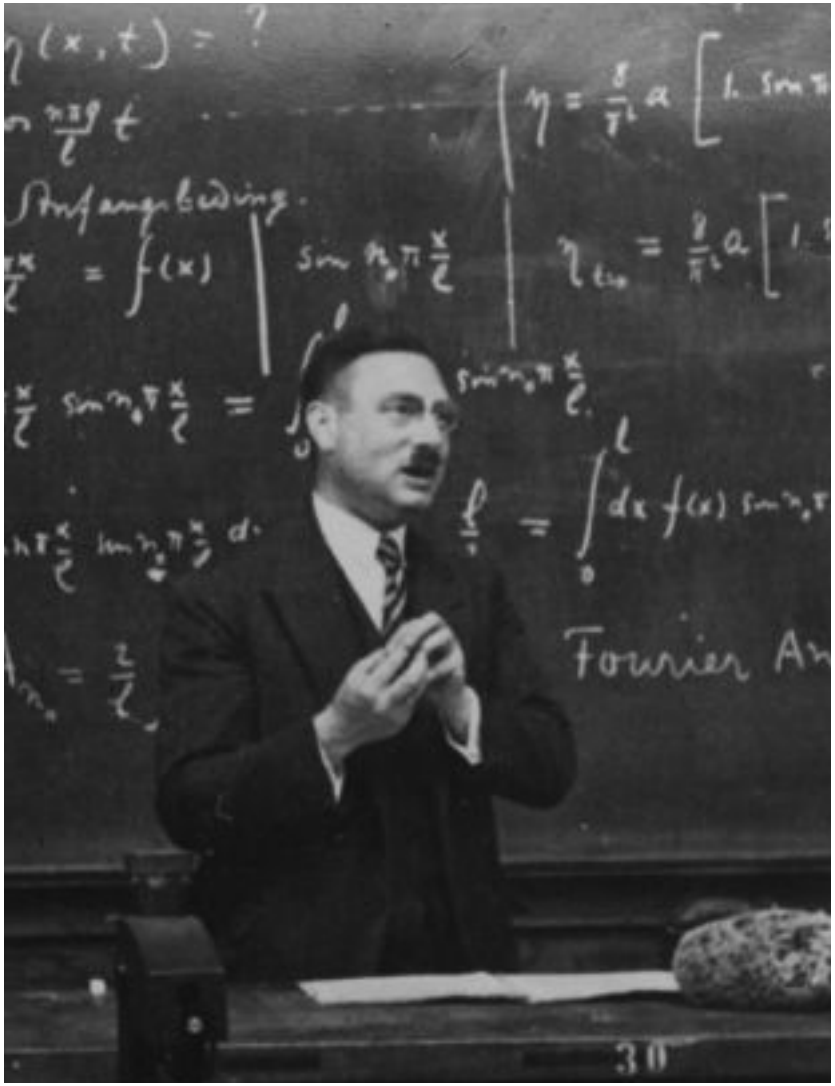
# Few Other Words

- About problem definition:

*"…. If a problem is already clearly stated, it has no further interest to the physicist"*

– Peter Debye (1884~1966)

**(Founder of Dielectric Theory)**



# Few Other Words

- About literature review:

  *"Read not to contradict and confute,*

  *nor to believe and take for granted,*

  *but to weight and consider."*

  – Francis Bacon (1561~1626)

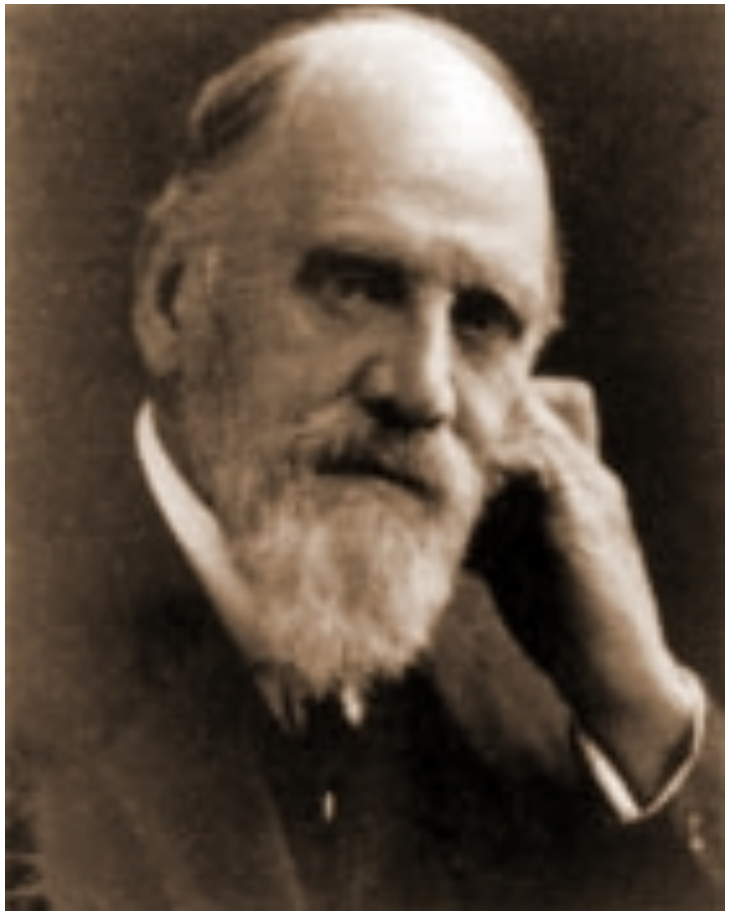

(British philosopher, statesman, scientist, jurist, orator, essayist, and author)

# Few Other Words

- About publication:

*"…in science the credit goes to the man who convinces the world, not to the man to whom the idea first occurs."*

– Francis Darwin
(1848~1925)



(Botanist, son of Charles Darwin)

# Few Other Words

- About mathematics:

"…There cannot be a language more universal and more simple, more free from errors and obscurities...more worthy to express the invariable relations of all natural things [than math]. [It interprets] all phenomena by the same language, as if to attest the unity and simplicity of the plan of the universe, and to make still more evident that unchangeable order which presides over all natural causes."

– Joseph Fourier (1768~1830)

(Mathematician and physicist)

# Summary

- Research is the last challenge any *homo sapiens* individual can ask for.
  - Like your daily exercise for training your muscles, research trains your brain cells.

- Doing research is basically a problem solving process.
  - The more problems you solved, the more skillful you become and the less difficult your future problems may appear to you.

# Summary

- A true researcher knows the boundaries between the known and the unknown.
  - You don't have to know everything, but for the things you claim to know, you should know it very well (and better than others).
- Your professors can only teach you how to learn, how to reason, and how to do research. Your very own achievements depend on how well you learn from your professors.
  - This is why students from the same class achieved very differently many years after their graduation.

# Summary

- If you don’t know who you want to be, you usually end up where you don’t want to be.
  - Doing research is a challenge to your intelligence, persistence, integrity, and ability to recover from failures.

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