How to Do Research?

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Outline
- Introduction
- Finding Research Topics
- Planning a Research Project
- Conducting a Research Project
- Presenting and Publishing Research Results
- Conclusions

Motivation
- Few Taiwanese students have experiences on doing researches before entering the graduated institute.
- Give a man a fish and you feed him for a day; teach him how to fish and you feed him for a lifetime.
- No specific research topic will be given in this lab.
- You have to know how to do research independently to survive.

Objective
- Give a guideline on how to do research such that you may follow and make necessary adaptation.

Four Stages in Doing Researches
- Finding research topics
- Planning research projects
- Conducting research projects
- Presenting/publishing research results
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Self Assessment
- Know yourself
  - Life dream, interests, talent, skills, accomplishments, weakness
- Social Needs and trends
- Career planning
  - Begin with the end in mind
  - 20-5-1 planning
  - A plan not realized is better than no planning

Good Books
- Stephen R. Covey
  - The Seven Habits of Highly Effective People
- Sean Covey
  - The Seven Habits of Highly Effective Teens

Brainstorming
- Write down as many as ideas (no matter how crazy they are) you may be interested in without criticizing yourself
- Try to eliminate ideas not fit to your career planning, your self assessment, and social needs
- For the ideas left, collect more information to keep elimination until only about 5 areas are left

Setting Research Goal
- Collect more information and study to try to narrow down the ideas such that you can create something new
- Assess/scale your new ideas by the resources you have
- Arrange priorities of these ideas
- Form your research goal

Thinking and Learning are Equally Important
- 學而不思則罔，思而不學則殆
- Just learning without thinking leads to confusion. Just thinking without learning leads to danger.
- 孔子, Confucious
- It is important to form your new idea while reading the collected literatures
Reference Management Software: EndNote

Good Books about EndNote
童國倫, 潘奕萍, 張鼎祥, 《EndNote & RefWorks 論文與文獻寫作管理》, 五南
童國倫, 潘奕萍, 張鼎祥, 《研究你來做論文寫作交給EndNote Word》, 五南

An Example of Research Topic Setting

An SBR/Image Approach for Radio Wave Propagation in Indoor Environments with Metallic Furniture

A pioneering work in channel modeling and base station planning
1998 Outstanding Research Award of National Science Council
Cited 56 times up to 2010/6 (Google Scholar)

Self assessment
– Experienced in EM scattering modeling and ray-tracing
Social needs and trends
– Cell phone systems just became popular in late 1990
– Channel modeling/base station planning is important for cell phone systems
Two approaches in literatures
– Measurement and statistical model
– Site-specific model

Previous Approach: Ray-Tracing / Reception Sphere

New Idea: SBR-Image
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(Invalid) Waterfall Model

Iterative Model

Basic Principles of Doing Works

80/20 principle
- Pareto principle
- For many events roughly 80% of the effects come from 20% of the causes
- 80% of progress come from 20% of project items
- Put first things first
- Things I should do vs. things I like to do

Basic Principles of Doing Works

- Any created thing has its root and branches. Any affair has its end and beginning. If you know what is the first and the last, you will come near the Way. ([http://tw.myblog.yahoo.com/iplusmyfather123iplusmybrother12/article?mid=3&l=f&fid=6](http://tw.myblog.yahoo.com/iplusmyfather123iplusmybrother12/article?mid=3&l=f&fid=6))
Planning Research
- Core/key part vs. nice to have
- Setting priority
- Simplify the problem
  - Legend of late Professor Y. T. Lo
- Starting from a simplified scenario
  - Learning by doing

Research Goal

Core Idea: SBR-Image

Version 0.1: Generating Ray Tubes

Version 0.2: Reflection from a PEC Ground Plane
Version 0.3: Multiple Reflection between PEC Planes

Version 0.4: Multiple Reflection between Coated PEC Planes

Version 0.5: Reflection from a Dielectric Slab

Version 0.6: Diffraction

Version 0.7: Room with Single Closet

Version 1.0: Room with Multiple Closets
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Batch vs. Time-Sharing
- Batch system
  - If A is not finished, I can not start B
  - Prepare your exam in just one night
- Time-sharing
  - Do multiple tasks at the same time
  - Bookkeeping system
  - A research project can not be finished in a very short period
  - 10~40 hours/week is reasonable

Quadrant II
Time Management

Recording Your Research
- Use research notes to write down everything about your topic
- Prepare Power Point slides for important literatures or stable results
- Report your progress periodically
  - Power point file (group meeting)
  - Brief summary (every semester)
- Final results
  - Thesis, PPT file for oral exam, paper

Example of Research Notes
Verification, Comparison, Explanation

- Verification
  - Power of evidence
  - Reliability of your contribution

- Comparison
  - Value of your contribution
  - Knowledge comes from comparison and explanation

Version 0.4: Multiple Reflection between Coated PEC Planes

Version 1.0: Room with Multiple Closets

Room with Multiple Closets

Example of Parametric Study: Ma and Jeng, 2005

What can you think and do when results do not check?

- Is it a key/core problem?
- Is there anybody else who has similar problems before?
  - Search for literatures in same/different fields
- Ask for the help of friends/advisors/other researchers
- Writing emails to authors
- Can we try different approaches or bypass the problem?
It doesn't work!

Find the reason
- Is the difficulty possible to be eliminated in the near future?
- Find the range that you can handle
- Can we modify the problem?

Risks of failure
- Inevitable
- Legend of Edison
- A research failed still has its contributions

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Publishing and Presenting Research Results

The goal of research is to find something new and useful to other people
Results must be published for someone else to use them
Thesis, journal, conference, web
Attending conferences
- Financial aid

Preparing a Presentation

Motivation
Objective
Results
Evaluation
- Reliability
- Completeness
Significance
- Novelty
- Range of possible applications

Preparing a Presentation

If you can show just 1~3 slides for your major contributions...
Tree structure
Magic number 7

Writing a Paper/Thesis

Running title
Brainstorming
Identify key ideas
Outline
Start writing
Allow 3-4 weeks for me to revise your paper/thesis
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Conclusions
- Find a topic fitting your interest and career planning
- 80/20 principle, put first things first, Prototyping and evolution
- Work by time-sharing, not in batch; quadrant II Time management
- Keep records for your research
- Verification, Comparison, Explanation
- Present/publish: M. O. R. E. S.