

How to Do Research?

Shyh-Kang Jeng

Department of Electrical Engineering/
Graduate Institute of Communication Engineering/
Graduate Institute of Networking and Multimedia

1

Outline

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

2

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3

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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7

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



8

Good Books

- ✦ 柯維(Stephen R. Covey) 著，顧淑馨譯，《與成功有約》(The Seven Habits of Highly Effective People)，天下遠見
- ✦ 西恩·柯維(Sean Covey) 著，汪芸譯，《與青春有約》(The Seven Habits of Highly Effective Teens)，天下遠見



9

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

10

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



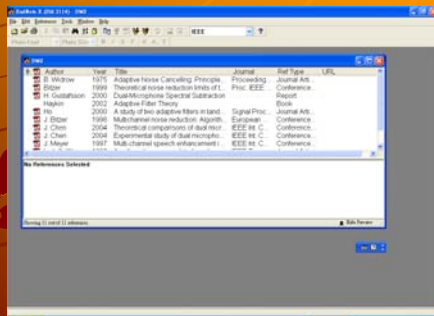
11

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，論語，Confucious
- ✦ It is important to form your new idea while reading the collected literatures

12

Reference Management Software: EndNote



13

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



14

An Example of Research Topic Setting



- 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)

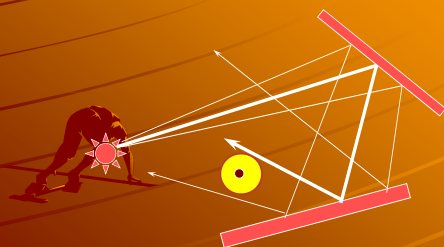
15

An Example of Research Topic Setting

- 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

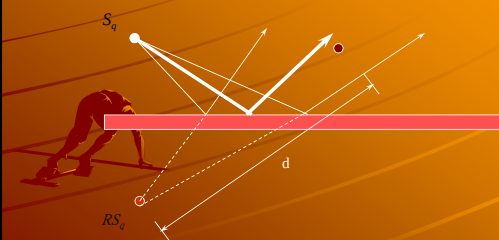


Previous Approach : Ray-Tracing / Reception Sphere



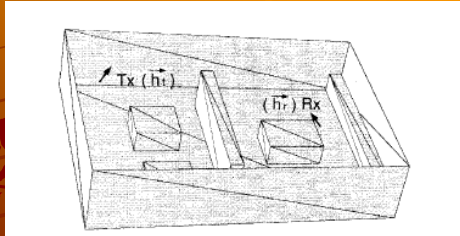
17

New Idea: SBR-Image



18

Research Goal



19

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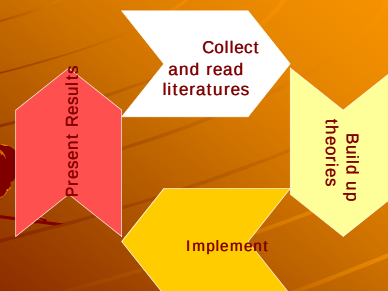
20

(Invalid) Waterfall Model



21

Iterative Model



22

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



23

Basic Principles of Doing Works

- ✦ 物有本末，事有始終，知所先後，則近道矣。
 - 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.
- 《大學》開宗明義, The Great Learning

(<http://tw.myblog.yahoo.com/jplusmyfather123plusmybrother12/article?mid=3&l=1&fid=6>)

24

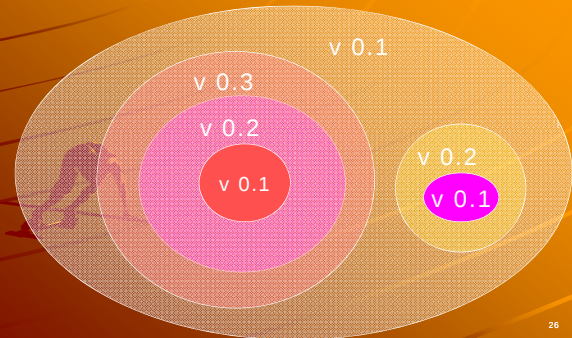
Planning Research

- 📌 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



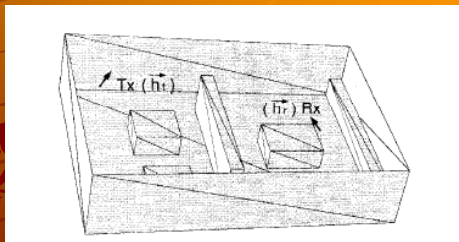
25

Fast Prototyping and Evolution



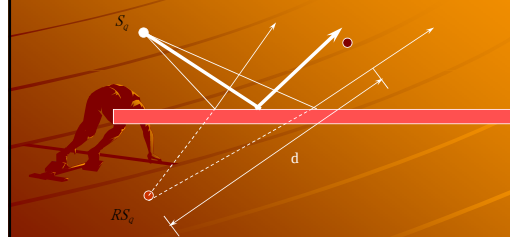
26

Research Goal



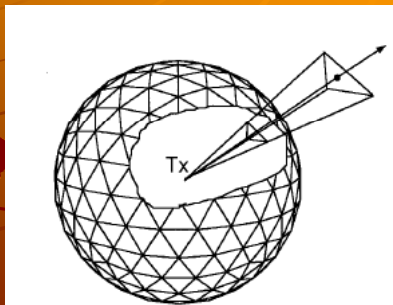
27

Core Idea: SBR-Image



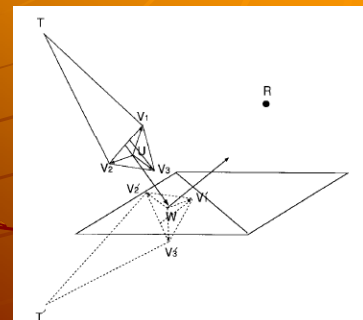
28

Version 0.1: Generating Ray Tubes



29

Version 0.2: Reflection from a PEC Ground Plane



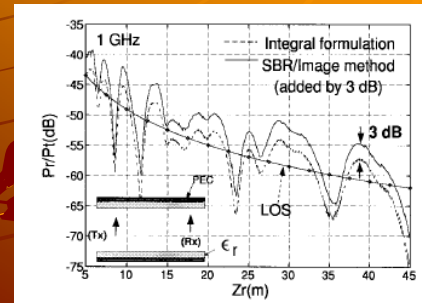
30

Version 0.3: Multiple Reflection between PEC Planes



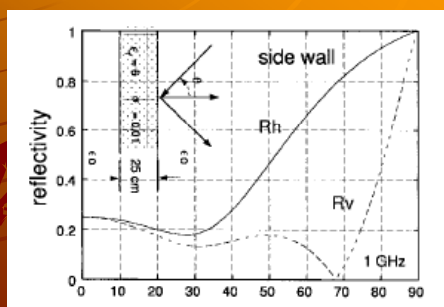
31

Version 0.4: Multiple Reflection between Coated PEC Planes



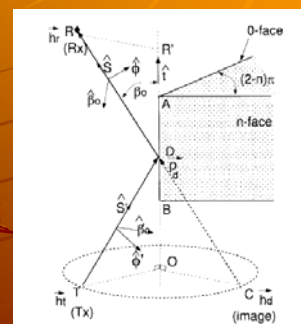
32

Version 0.5: Reflection from a Dielectric Slab



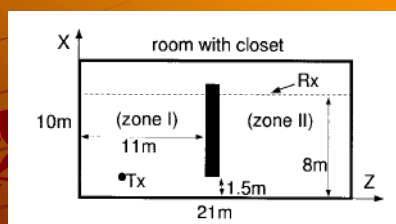
33

Version 0.6: Diffraction



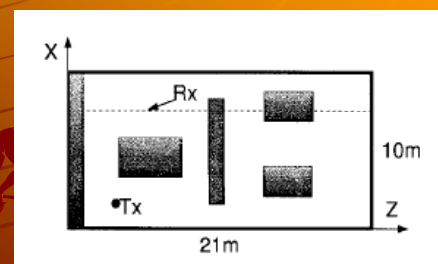
34

Version 0.7: Room with Single Closet



35

Version 1.0: Room with Multiple Closets



36

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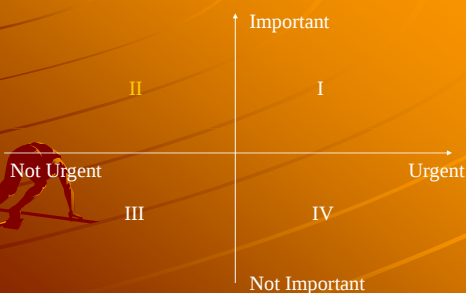
37

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



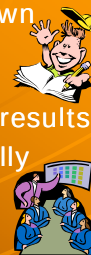
Quadrant II Time Management



39

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



40

Example of Research Notes

Optimal control systems (Problem 1) (2nd)	
Optimal Regulation Boundary Condition: 1st order SISO	(1)
Control: Measurement / State FB	
Optimal Regulation Boundary Condition: 1st order SISO (continuous)	(2)
Control: G_c	
Optimal Regulation Boundary Condition: 2nd order SISO	(3)
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41

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42

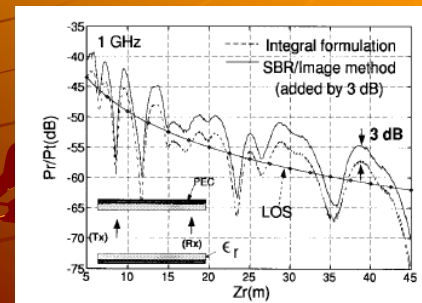
Verification, Comparison, Explanation

- Verification
 - Power of evidence
 - Reliability of your contribution
- Comparison
 - Value of your contribution
- Knowledge comes from comparison and explanation



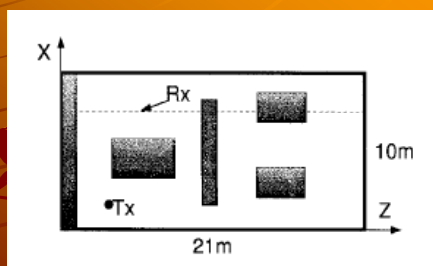
43

Version 0.4: Multiple Reflection between Coated PEC Planes



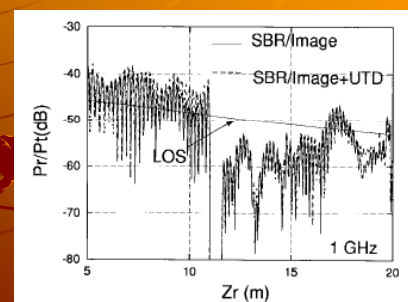
44

Version 1.0: Room with Multiple Closets



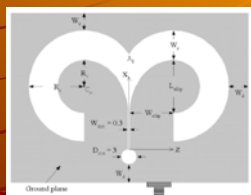
45

Room with Multiple Closets



46

Example of Parametric Study: Ma and Jeng, 2005



Antenna	W_x (mm)	$L_{x,y}$ (mm)	W_y (mm)	W_z (mm)	f_0 (GHz) predicted from (1)	Measured operating band f_0 (GHz)	f_c (GHz)
Design I (Reference ant.)	8	15	12.5	5	3.16	3.09	10.09
Design II (Miniature ant.)	6	10	5	4	5.09	4.84	10.23
Design III	10	15	12.5	5	3.08	3.06	10.47
Design IV	12	15	12.5	5	3.00	3.02	11.02
Design V	8	12	12.5	5	3.62	3.41	9.85
Design VI	8	18	12.5	5	2.79	2.95	11.00
Design VII	8	15	7.5	5	3.44	3.61	11.68
Design VIII	8	15	10	5	3.33	3.31	10.83

47

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?



48

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



49

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50

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



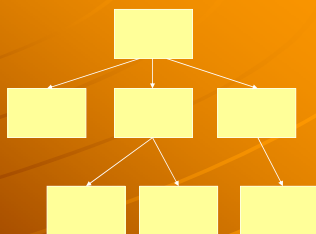
Preparing a Presentation

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

52

Preparing a Presentation

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



53

Writing a Paper/Thesis

- ✦ Running title
- ✦ Brainstorming
- ✦ Identify key ideas
- ✦ Outline
- ✦ Start writing
- ✦ Allow 3-4 weeks for me to revise your paper/thesis



54

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55

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.

56