

An Introduction To Research Methods

Prof. N. Sundararajan

**EEE/NTU
Singapore**

Email: ensundara@ntu.edu.sg

**Presented to VTU Research Scholars
May 25-26 & May 28 -29, 2009.**

Organization

Day I

- **Lecture I --- Introduction To Research Methods
(1 ½ hrs)**
- **Lecture II ---- Literature Survey/Database Search
(1 ½ hrs)**
- **Lecture II A --- Advice to Ph D students I
(1 hr)**

Day II

- **Lecture III Technical/Research Writing, Oral Presentation. (1 ½ hrs)**
- **Lecture IV ---- Research Ethics (1 ½ hrs)**
- **Lecture III B ----- Advice To Ph D students II (1 hr)**

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Objectives:

- To learn the basic skills that are essential to becoming a successful researcher.
- Topics include research methodology, experimental design, professional ethics and academic integrity, and oral and written presentation techniques.
- You will be required to perform a literature survey (on a topic in your own research area), analyze the papers, summarize and write your own survey paper in the style of a formal scientific paper.

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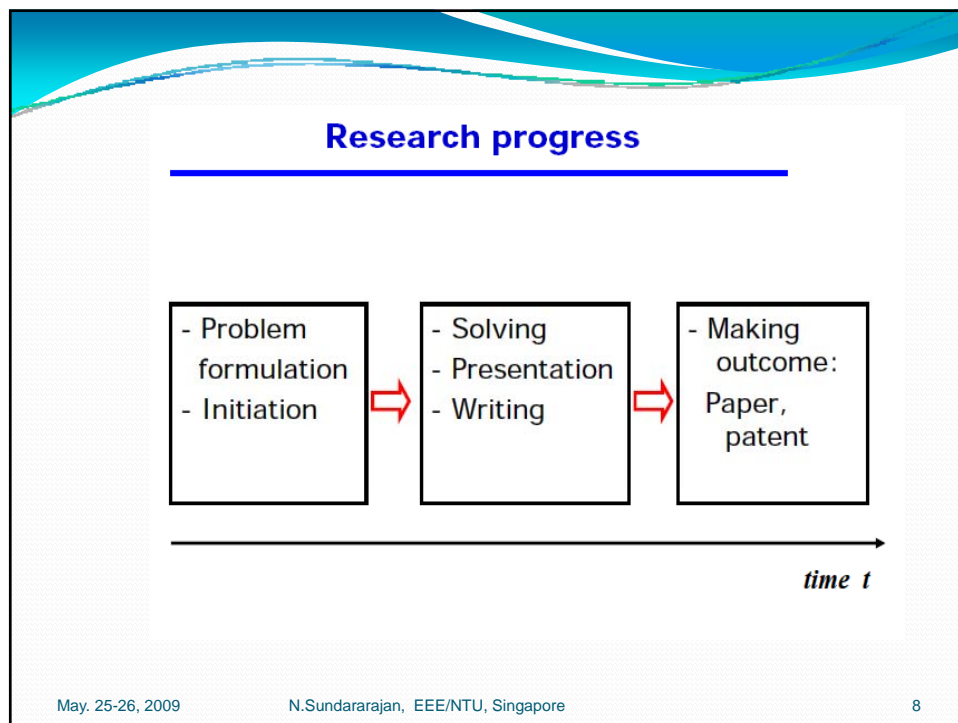
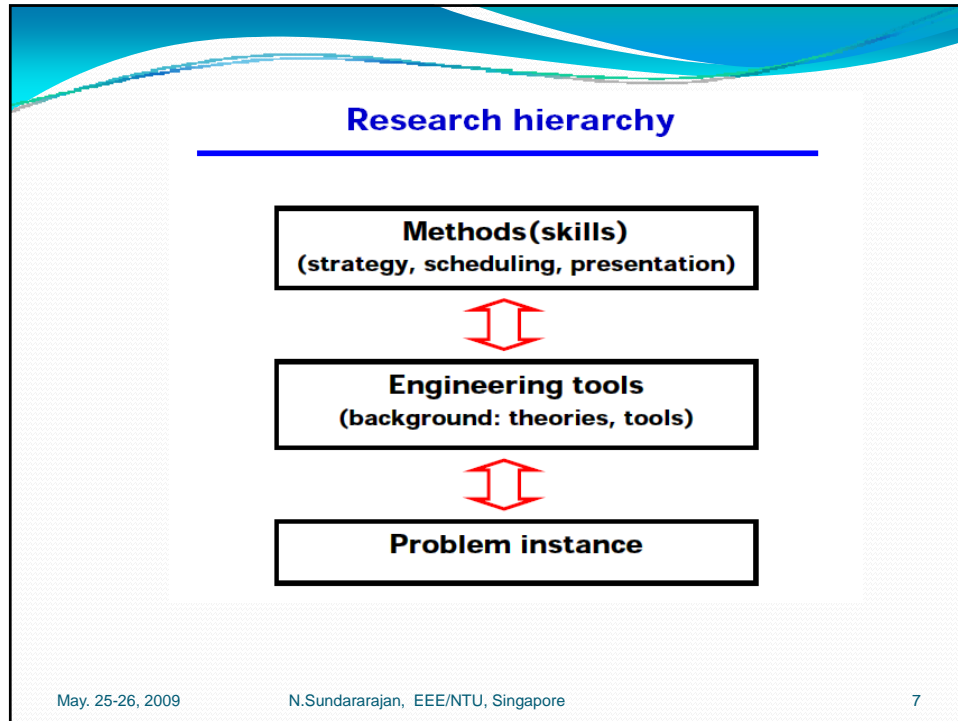
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Reference Books

1. **P.D. Leedy and J.E.Ormrod . Practical Research Planning and Design : 8th edition, Pearson / Merrill / Prentice Hall Publishers, 2005**
2. **Bordens K.S. and Abbott, B.b., Research Design and Methods, Mc Graw Hill, 2008.**
3. **Graziano, A., M., and Raulin, M.,L., Research Methods - A Process of Inquiry, Sixth Edition, Pearson , 2007.**

Today's definition of research

- To answer scientific questions
- To solve problems
- To make something new



What is necessary for research

For example, control engineering

- Background
 - Mathematics, and system and control theories
 - Engineering tools: software(C++, matlab...) and hardware(cpu, arm, rom...)
- Methods(skills)
 - How to think logically
 - How to start to do research
 - How to find qualitative references
 - How to make research plan
 - How to manage the research progress
 - How to present the result: oral presentation and writing
 - How to deal with research result(e.g., legal aspect: patent)

Main purpose of the course

- Main purpose

To develop and practice methods for research in Eng.
- Tasks you will be asked to do
 - Select your own research topic
 - Find qualified stuffs for your own research topic
 - Make a schedule for your research(Management skill)
 - Make oral presentation(communication skill)
 - Write reports(technical writing)
 - (Make outcome(Patent and publication))

Positive participation

I hear and I forget

I see and I remember

I do and I understand

Confucius 5th century B.C.

Possible research topics

- Discrete-time linear MPC
- Continuous-time nonlinear MPC
- Input-constrained control(non-MPC approaches)
- Switching adaptive control(supervisory control)
- Adaptive control
- Nonlinear control theory
- Linear parameter and state estimation
- Systems biology
- Linear output regulation problem
- Nonlinear observer theory

Research Methods – A broad outline

Outline

- Definition of scientific research
- Types of research
- Research procedure
- Case study

Definition of research I

Research: a detailed study of a subject, especially in order to discover (new) information or reach a (new) understanding

*Cambridge Dictionaries Online,
© Cambridge University Press 2003.*

Research: the detailed study of something in order to discover new facts, especially in a university or scientific institution

Macmillan Publishers Ltd. 2002

Definition of Research II

- Making a rigorous and relevant contribution to knowledge.
- Understanding of a cause and effect relationship of a given phenomenon or uncovering a new phenomenon
- Organized inquiry to provide information for the solution to a problem (Emery&Cooper`91)
- A careful and systematic investigation in some field of knowledge, undertaken to establish facts or principles (Kumar `96)
- Scientific or scholarly inquiry or investigation and the proper communication of the findings (McCuen `96)

Definition of Research III

- It uses blend of assorted resources, such as classical or modern theories, state-of-the-art technology, statistical technology, and engineering techniques, to uncover previously unknown facts and principles
- Process of searching for (general) answers in any field of study, or the solution of just one particular problem
- Systematic, controlled, empirical, rigorous, and precise methods are used to obtain solutions or to discover and interpret new information

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Ingredients to define research

- **Logical and systematic**
it should be reasonable and understood by others
- **Creative**
it leads to new solution, theory, or technology
- **Generalizable**
it investigates a small sample which can be generalized to a larger population
- **Replicable**
others can test the findings by repeating it
- **Presentation**
it includes presentation to others(oral or writing)

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Type of research

- Explanatory or descriptive research
- Theoretic research
- Applied research

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Explanatory or descriptive research

- To give a description of phenomena or a situation
- To present a picture of the topic
- Survey, interview, and observation

- To ask the questions about what and how
- May address a new topic or phenomenon
- Define the problem rigorously
- Allows for formulation of more precise questions from which can do further research (Neuman, 1994)

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Goals of E/D research

- Uncover basic facts, people, and issues involved
- Provide information to promote new explanation
- Develop a good picture of the area of investigation

- Generate ideas and establish tentative theories and propositions.
- Determine feasibility of continuing research.
- Formulate questions for more systematic work.

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Theoretic(or Pure) research

- Advances fundamental knowledge
- Concerned with knowledge that is "irrefutable"
- Contributes largely to theory formation
- The stuff that applied research is built upon

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Applied research

- Concerned with the application of knowledge
- Solving particular problems
- Applied research has direct applicability to the real world

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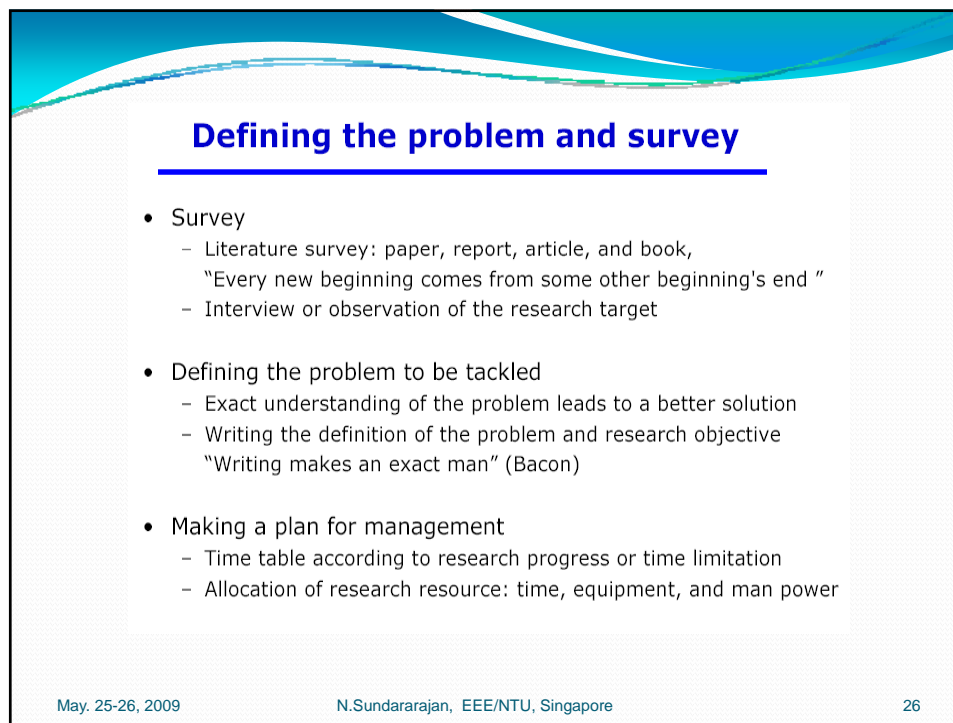
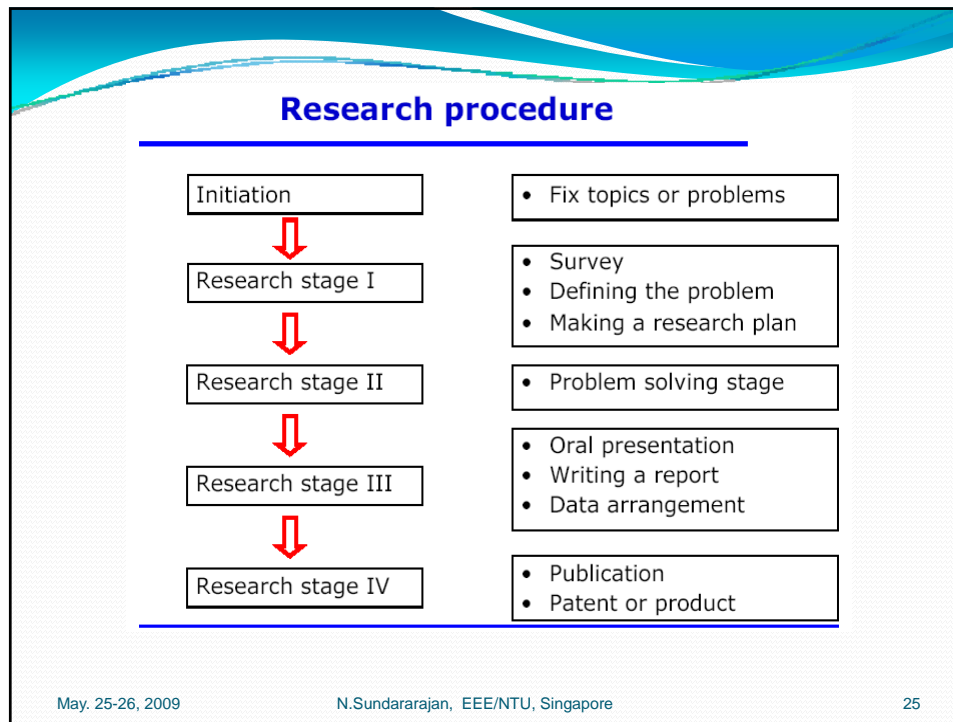
Theoretic vs Applied (Cooper & Emery '91)

- Applied research has a practical problem-solving emphasis. It is conducted to reveal answers to specific questions related to action, performance, or policy needs.
- Theoretic research is also problem solving but in a different sense. It aims to solve perplexing questions (that is, problems) of a theoretical nature that have little direct impact on action, performance, or policy decision.

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Solving problem

- Getting to the bottom of the problem
- Redefining the problem (if necessary)
- Brainstorming
- Creative and logical thinking
- Discussing with others
- Background needed to solve the problem
 - What I knew
 - What I should learn

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Presentation

- Oral presentation(meeting, conference, and invitation)
 - Time limitation
 - Face-to-face
- Writing a report
 - Writing down with full detail for the purpose of backup
 - Data arrangement
 - Experiment data and setting
 - Program code for simulation
 - Proof detail

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Handling the research result

- Publication
 - Selection of journal: quality decision
 - Writing skill
- Patent
 - Legal right of the result
 - Topic of a coming lecture (21.06.2006)
- Product
 - Some applied research results in a product

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Summary and announcement

- Elements of research
 - Survey, studying background
 - Solving problem, presentation of the result to others
 - Handling the result
- Summary
 - Definition and types of research
 - Research procedure
- Next lecture
 - “How to find the qualitative references”

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Research Methods

Summary of Contents

- **Research as a Creative and Strategic Thinking Process.**
- **Managing the Process.**
- **Developing Your Research Question.**
- **Exploring Power and Ethics in Research.**
- **Indicators of Good Research**
- **Working with Literature**

- **Methodological Design**
- **Exploring Populations**
- **Investigating Complexities of the Social Changes**
- **Facilitating Change through Research**
- **Data Collection**
- **Data Management and Analysis**
- **The challenge of Writing-up**

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Research as a Creative and Strategic Thinking Process

- What is a research ?

The definition - "Research" as "the systematic study of materials and sources in order to establish facts and research new conclusions"

[Oxford English Dictionary (2002)]

- In practice research is often an open-ended process that is likely to generate as many questions as it does answers.
- Good research is a thinking person's game, it is a creative and strategic process that involves constantly assessing, reassessing, and making decisions about the best possible means for obtaining trustworthy information, carrying out appropriate analysis, and drawing Conclusions.

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Research as a Creative and Strategic Thinking Process

- As a budding researcher, it is important to remember that particular research strategies are good or bad to the exact degree that they fit with the questions at hand.
- The perspectives you will adopt and the methods you will use need to be as fluid, flexible, and eclectic as is necessary to answer the questions posed.

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The Best researchers are those who manage to be creative in thinking. They manage to:

- Be original, innovative, and imaginative,... yet know where they want to go
- Think outside the square ... yet stay squarely on target
- Use their intuition ... but are able to share the logic of that intuition
- Be fluid and flexible... yet deliberate and methodical
- Be inspired, imaginative, and ingenious ... in the development of methods that are realistic, partial, and doable.

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Research as a Creative and Strategic Thinking Process

- The construct of Research
 - Researching was simply a scientific enterprise that followed the rules of scientific method . Research was united by common objectives, logic, presuppositions, and general methodological approaches.
- Working through the complexity
 - It is a challenge for any research student to be able to make some sense of working through the complexity
 - In order to make your way through the tangle of “methods” you need a framework for organizing the various aspects of research

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Research as a Creative and Strategic Thinking Process

- One way to construct such a framework is to consider the diverse range of methods listed above as “answers” to particular research questions.
- Once you know the question, the methods simply fall into place
- Understanding the relationship between these questions and various aspects of method can help you make sense of a highly complex field
- **Putting it all together**
 - There must be recognition that there is no “best type” of research
 - There are only good questions matched with appropriate procedures of inquiry and this is always driven by the researcher.

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Research as a Creative and Strategic Thinking

- Laying the groundwork
- Defining your question
- Researching reflexively
- Exploring the literature
- Exploring design, methodologies, and methods
- Communicating through research

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Managing the Process

- The research Journey
- Navigating the process
- Staying on course

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The Research Journey

- Researching is a process that demands planning, forethought, commitment, and persistence.
- It needs to be managed, navigated, and negotiated from early conception to final destination.
- It is important for a student researcher to keep in mind that your journey to produce knowledge will also be a learning journey about both research itself and your ability to manage intricacies and complexity.

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The Research Journey

- Exploring your own approach to knowledge
- VAK learning style
 - ❖ Visual learning
 - ❖ Auditory learning
 - ❖ Kinesthetic learning
- Kolb learning (1984) styles

Kolb saw learning as a cycle of concrete experiences, reflective observations, abstract conceptualization, and active experimentation.
- Surface, deep, and strategic learning
 - ❖ Surface learners: interested in “facts”, they rely on memory and do not enjoy conceptualization.

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The Research Journey/Navigating the process

- ❖ Deep learners: Enjoy the search for meaning
- ❖ Strategic learners: Pursue learning in order to achieve defined goals.
- Research is a process that simultaneously demands imagination, creativity, discipline, and structure, and needs to be navigated strategically from start to finish.
- It is well worth considering a number of practicalities related to the process.
- In order for student researchers to navigate a path through the research process, they need to:
 - Familiarize themselves with their institution/programmer's resources and requirements.

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Navigating the process

- Get appropriately set-up
- Negotiate the advisory process
- Manage their workload

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Staying on course

- For most, the student research project is likely to be the biggest academic project ever undertaken.
- Knowing a field, being responsible for the production of “new knowledge”, designing method, collecting and analyzing data, and writing it all up can be an intimidating challenge, particularly for those whose roles and responsibilities in the real world extend beyond those of student.
- Finding a balance
 - At work: try taking the time to discuss the demands of study with your managers
 - At home: confirm your achievements and questions

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Staying on course

- At university: being open and honest with your supervisor is crucial to your ability to set realistic and most importantly, achievable goals.
- Dealing with crisis
 - Crisis of motivation
 - Crisis of confidence
 - Lacking direction
 - Feeling disorganized
 - Personal crisis

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Methodological Design

- Methodology, methods, and tools
- From questions to answers
- Three key prerequisites for methodological design
- Getting down to the nitty gritty
- Thoughts on the qualitative/quantitative divide

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Methodology, methods, and tools

- Methodology: the framework associated with a particular set of paradigmatic assumptions that you will use to conduct your research, i.e. scientific method, ethnography, action research.
- Methods: the techniques you will use to collect data, i.e. interviewing, surveying, participative observation.
- Tools: the devices you will use to help you collect data, i.e. questionnaires, observation checklists, interview schedules
- Methodological design: the plan for conducting your study that includes all of the above.

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From questions to answers

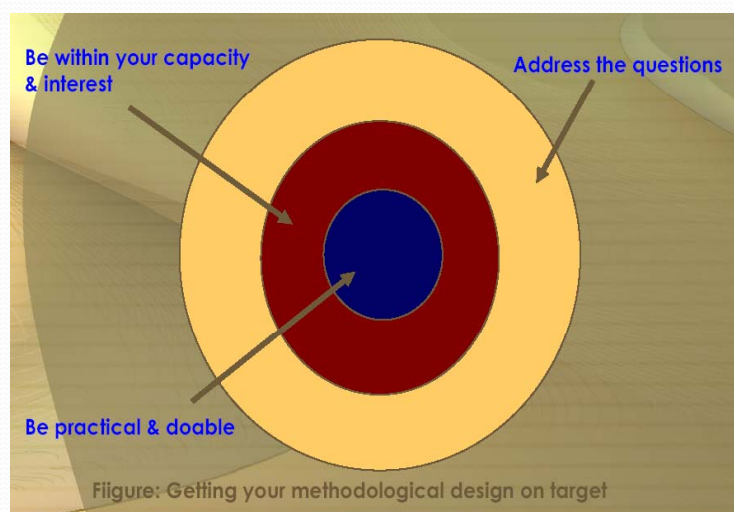
- **Finding a path**
 - If you are happy with your research questions, the next step is figuring out how to best go about getting the answers.
 - As you move from finding the path, to choosing from a range of potential paths, the need to consider issues that can affect credibility increases.
- **Designing creative and strategic methods**
 - **Methodological design is about informed decision-making that involves weighting up pros and cons, and deciding what is best given your specific context.**

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Three key prerequisites for methodological design



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Three key prerequisites for methodological design

- Addressing the question
- Making it right for the researcher
- Making it doable

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Address the question

- The development of clear and unambiguous research questions is an essential part of the research process
- It is difficult to plan for a journey with destination unknown.
- Knowing what you want to know does not mean your questions must be set in stone from their first articulation.
- A research is an ongoing and iterative process of development and redevelopment that may see questions shift and change before taking on their final form.

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Address the question

- Exploring methodologies
- Letting the question drive the methods

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Making it right for the researcher

- **Roles**
 - Consider what roles might be uncomfortable or inappropriate for you and your methodological design
- **There is no need for these rules to be mutually exclusive.**
- **Skills and interests**
 - You are not only will you take on roles, you will need to have, and/or develop, particular interests and specific skills.

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Making it doable

Ethics approval

- An ethical study is one that takes responsibility for integrity in the production of knowledge
- Acknowledges responsibility for the researched; and ensure that the mental, emotional, and physical welfare of respondents is protected.
- If your study is “unethical” or does not have ethics approval, it should not be considered doable

• Resources

- It is important to develop a realistic budget for your study.

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Making it doable

- A practical methodological design from the start is much better than one that comes to a premature halt when funds run dry.

• Times

- Ensuring that your design will fit within your timelines will help you avoid:
 - ❖ Applying for extension
 - ❖ Compromising your study by changing your methodology mid-stream
 - ❖ Doing a shoddy, half-assed job with your original methods

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Making it doable

- ❖ Compromising the time that should be dedicated to self, and work.

- **Assess**

- A major challenge for researchers is gaining access to data

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Getting Down to the Nitty Gritty

- **Who, where, when, how, what**

- who**

- Who do you want to be able to speak about?
 - Who do you plan to speak to/observe?

- where**

- Are setting relevant to the credibility of your method?
 - What is the physical domain of your Sample

- when**

- How do your methods fit into your time frame?
 - Is timing relevant to the credibility of your methods?

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Getting Down to the Nitty Gritty

how

- How will I collect my data?
- How will I conduct my methods?

what

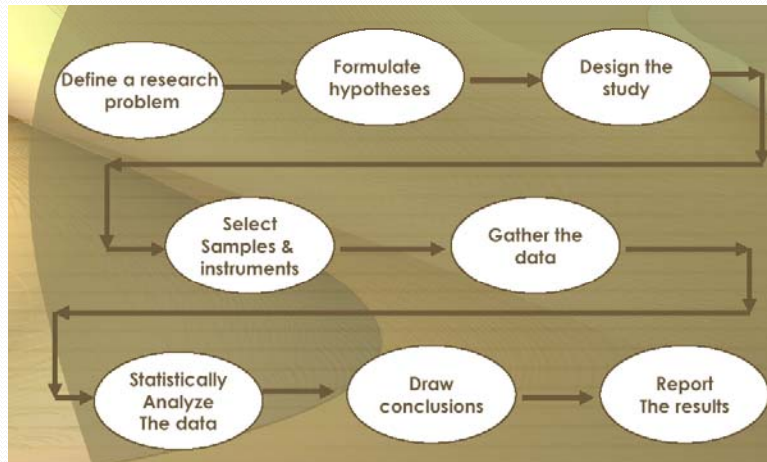
- What will you look for/what will you ask?

- **Emergent methodological design**
- **Grounded theory**

Thoughts on the Qualitative/Quantitative Divide

- Quantitative and qualitative have come to represent a whole set of assumptions that dichotomize the world of methods and limits the potential of researchers to build their methodological designs from their questions.
- Research in the Quantitative methods follows a linear sequence, as shown in the figure next page

Thoughts on the Qualitative/Quantitative Divide



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Thoughts on the Qualitative/Quantitative Divide

• Social reality

- Qualitative researchers believe that since humans are conscious of their own behaviours, the thoughts, feelings and perceptions of their information are vital.
- How people attach meaning and what meanings they attach are the bases of their behavior.
- The qualitative researcher is not concerned with objective truth, but rather with the truth as the informant perceives it.
- Social reality is the product of meaningful

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Thoughts on the Qualitative/Quantitative Divide

Social interaction as perceived from the perspectives of those involved, and not from the perspectives of the observer.

- Therefore, the central data-gathering techniques of a qualitative approach are participant observation and unstructured interviewing.

• Analytic induction

- Analytic induction and theoretical sampling are essential features of qualitative studies.
- These two processes enable the investigator to construct, elaborate and test propositions and hypotheses while the study is ongoing

• Sampling

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Thoughts on the Qualitative/Quantitative Divide

- Whereas quantitative research uses probability sampling, qualitative research employs non-probability sampling, especially snowball sampling and theoretical sampling.
- The purpose of theoretical sampling is the discovery and development of categories.
- This approach is linked to analytic Induction in which a search for falsifying evidence is made which leads to modification of the theory until no further disconfirming evidence is found.

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Thoughts on the Qualitative/Quantitative Divide

- **Reliability and validity**

- How do we know what is reliable and valid in qualitative research where the responses of individuals to interviews and general conversation noted in participant observation?
- The best way is triangulation, in which we can argue that if different methods of assessment or investigation produce the same results.

- **Literature review**

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Thoughts on the Qualitative/Quantitative Divide

- Qualitative researchers do not search for data that will support or disprove their hypothesis.
- They develop theories and propositions from the data they collect as the research develops.
- The literature review is a stimulus for your thinking and not a way of summarizing in your own mind the previous work in the area that can blind you to only considering existing concepts and conceptual schemes, as in quantitative method.

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