Introduction: Research Methodology

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Lecture 1

Today

- Meaning, objectives and motivation of research
- What is engineering research?
- Elements of engineering research
- Types of research,
- Methods and methodology
- Research Problem
- Criteria of good research
- Ethics

Meaning

Research in common parlance refers to a search for knowledge. Once can also define research as a scientific and systematic search for pertinent information on a specific topic.

In fact, research is an art of scientific investigation.

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Meaning

The Advanced Learner's Dictionary: research as "a careful investigation or inquiry specially through search for new facts in any branch of knowledge."

Redman and Mory: research as a "systematized effort to gain new knowledge."

Some people consider research as a movement, a movement from the known to the unknown. It is actually a voyage of discovery.

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Objective of Research

The purpose of research is to discover answers to questions through the application of scientific procedures. The main aim of research is to find out the truth which is hidden, and which has not been discovered yet. Though each research study has its own specific purpose, we may think of research objectives as falling into a number of following broad groupings:

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Objective of Research

1. To gain familiarity with a phenomenon or to achieve new insights into it (studies with this object in view are termed as exploratory or formulative research studies);
2. To portray accurately the characteristics of a particular individual, situation or a group (studies with this object in view are known as descriptive research studies);

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Objective of Research

3. To determine the frequency with which something occurs or with which it is associated with something else (studies with this object in view are known as diagnostic research studies);

4. To test a hypothesis of a causal relationship between variables (such studies are known as hypothesis-testing research studies).

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Motivation of Research

What makes people to undertake research? The possible motives for doing research may be either one or more of the following:

1. Desire to get a research degree along with its consequential benefits;
2. Desire to face the challenge in solving the unsolved problems, i.e., concern over practical problems initiates' research;
3. Desire to get intellectual joy of doing some creative work;
4. Desire to be of service to society;
5. Desire to get respectability

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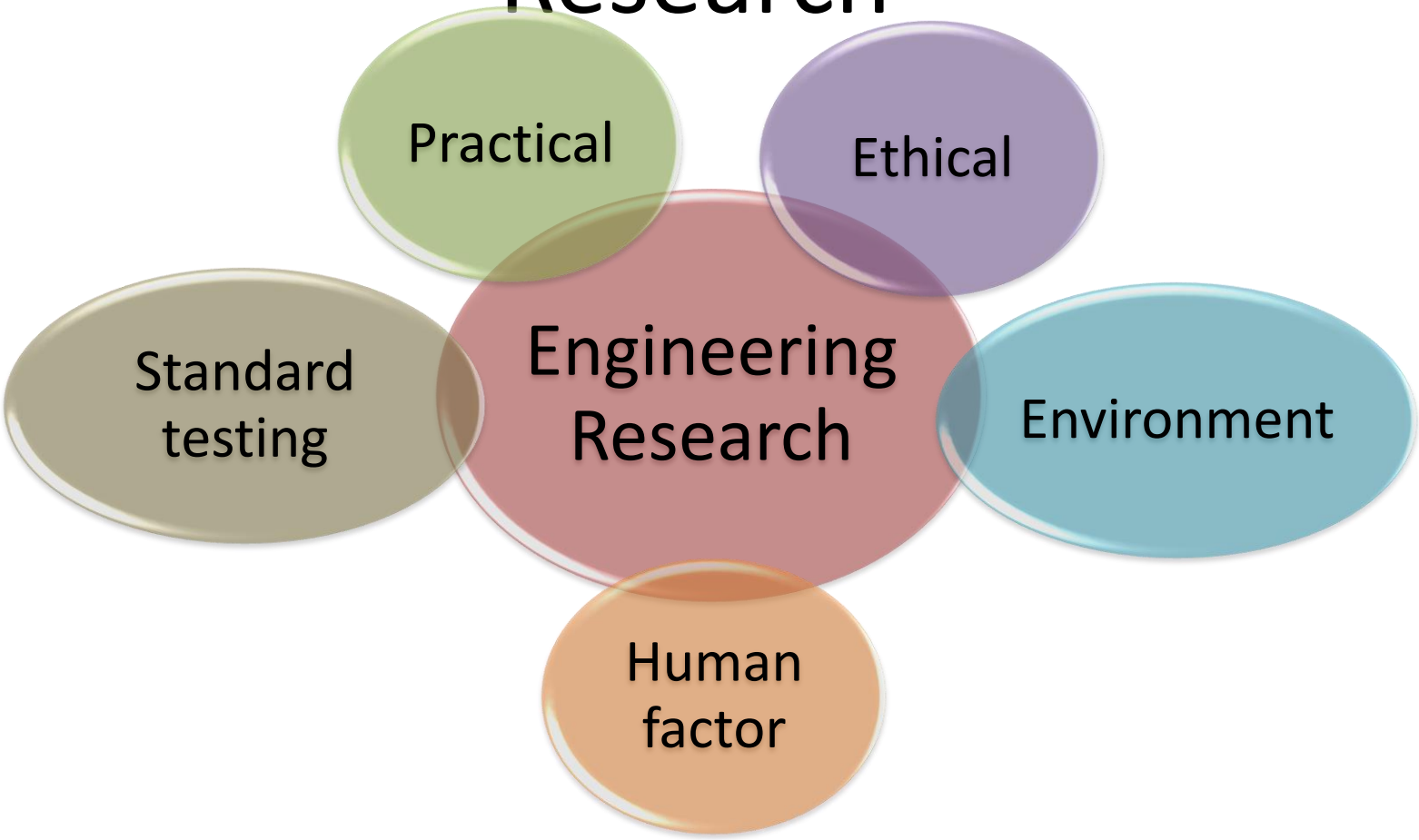
Engineering Research

- Practical applications of science concepts
- The problem statement is a ‘function’
  - New function with a set of specifications
  - Old function with improved specifications
- Result is a product/process to meet the specifications – Design is the key

Elements of Engineering Research



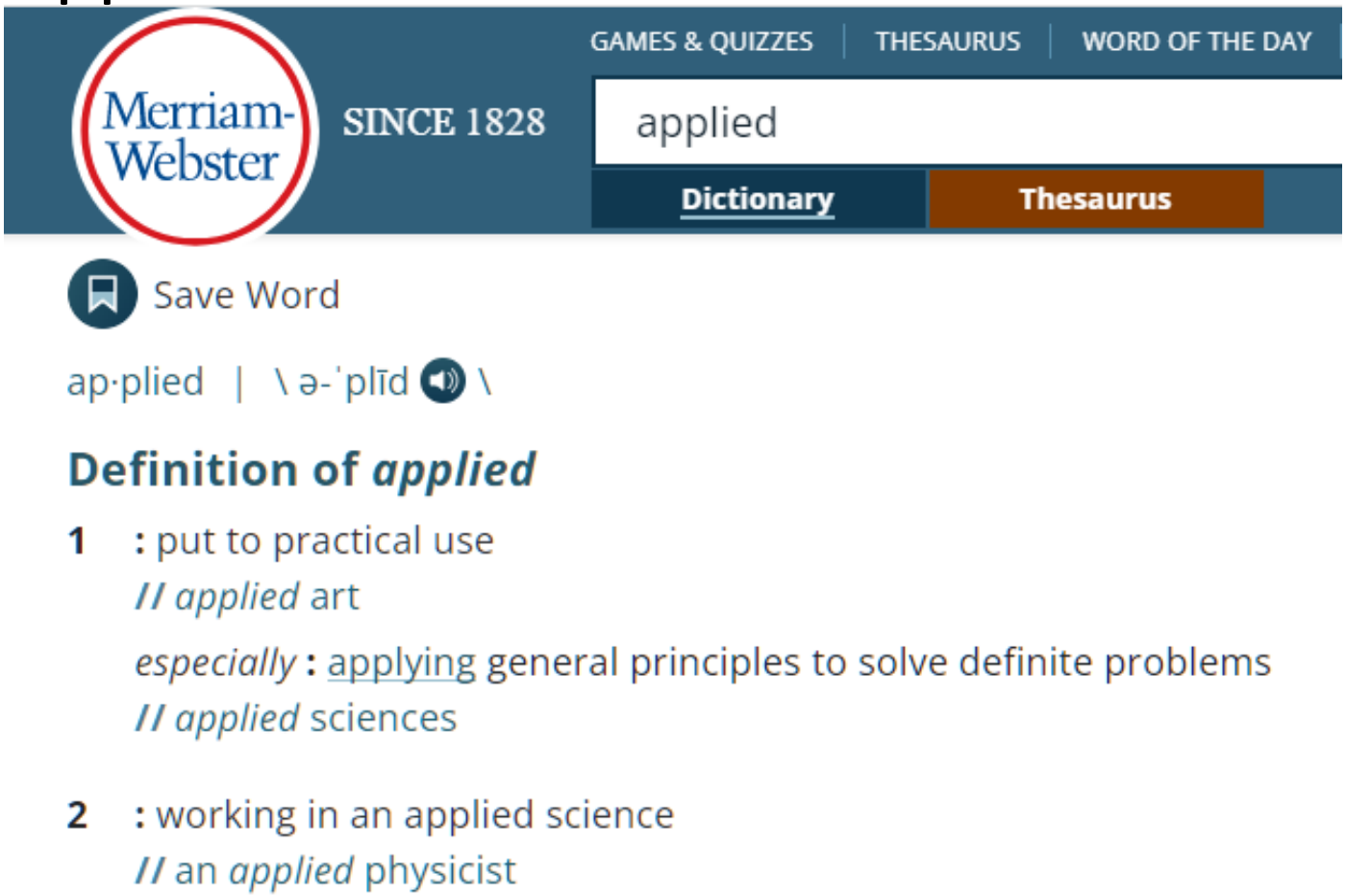
Research Methods for Engineers by David V. Thiel, ISBN-13:978-1-107-61019-4 Cambridge University Press, 2014

Types of Research

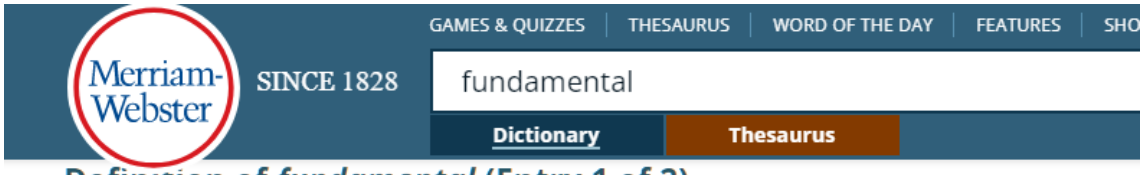
- Fundamental innovation – groundbreaking
  - Integrated circuits
  - Personal computer and graphical user interface
- Incremental research
  - Application of solutions from one field to another and address issues raised
  - Modification of existing solution for improvement

Types of Research

Applied vs Fundamental



Applied vs Fundamental



Definition of *fundamental* (Entry 1 of 2)

1 **a** : serving as a basis supporting existence or determining essential structure or function : BASIC

// Responsibility is *fundamental* to democracy.

// The Constitution ensures our *fundamental* rights.

b : serving as an original or generating source : PRIMARY

// a discovery *fundamental* to modern computers

2 **a** : of or relating to essential structure, function, or facts : RADICAL

// *fundamental* change

also : of or dealing with general principles rather than practical application

// *fundamental* science

b : adhering to fundamentalism

// a preacher who is evangelical, Bible-teaching, and *fundamental*

3 : of central importance : PRINCIPAL

// *fundamental* purpose

// such *fundamental* events as birth, marriage, and death

4 : belonging to one's innate or ingrained characteristics : DEEP-ROOTED

// her *fundamental* good humor

5 : of, relating to, or produced by the lowest component of a complex vibration (see VIBRATION sense 1)

Applied vs Fundamental

Findings of applied research can be applied to resolve problems, whereas fundamental studies are used simply to explore certain issues and elements

Source: Research-Methodology.net

Quantitative Vs Qualitative

Definition of quantitative
1: of, relating to, or expressible in terms of quantity
2: of, relating to, or involving the measurement of quantity or amount
3: based on quantity
specifically, of classical verse : based on temporal quantity or duration of sounds
Source: Merriam-Webster

Definition of qualitative
: of, relating to, or involving quality or kind

Quantitative Vs Qualitative

Quantitative data are measures of values or counts and are expressed as numbers. Quantitative data are data about numeric variables (e.g., how many; how much; or how often). Qualitative data are measures of 'types' and may be represented by a name, symbol, or a number code.

Research Approaches

The above description of the **types of research** brings to light the fact that there are two basic approaches to research, viz., **quantitative approach** and the **qualitative approach**. **The former involves the generation of data** in quantitative form which can be subjected to rigorous quantitative analysis in a formal and rigid fashion.

Qualitative approach to research is concerned with **subjective assessment of attitudes, opinions and behaviour**. Research in such a situation is a function of researcher's insights and impressions.

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Significance of Research

"All progress is born of inquiry. Doubt is often better than overconfidence, for it leads to inquiry, and inquiry leads to invention" is a famous Hudson Maxim in context of which the significance of research can well be understood.

1. Research inculcates scientific and inductive thinking, and it promotes the development of logical habits of thinking and organization.
2. Research provides the basis for nearly all government policies in our economic system.
3. Research has its special significance in solving various operational and planning problems of business and industry.
4. Research is equally important for social scientists in studying social relationships and in seeking answers to various social problems.

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Significance of Research

In addition to what has been stated above, the significance of research can also be understood keeping in view the following points:

(a) To those students who are to write a master's or Ph.D. thesis, research may mean a careerism or a way to attain a high position in the social structure;

(b) To professionals in research methodology, research may mean a source of livelihood;

(c) To philosophers and thinkers, research may mean the outlet for new ideas and insights;

(d) To literary men and women, research may mean the development of new styles and creative work;

(e) To analysts and intellectuals, research may mean the generalizations of new theories.

Thus, research is the fountain of knowledge for the sake of knowledge and an important source of providing guidelines for solving different business, governmental and social problems.

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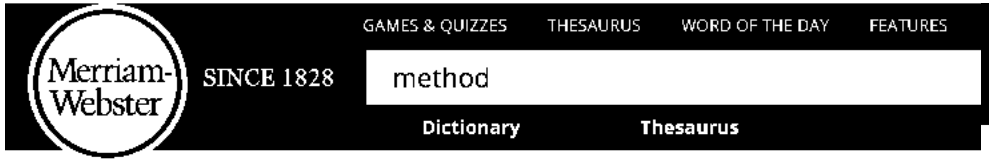
Method vs Methodology



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meth·od | \ ˈme-thəd \

Definition of *method*

1 : a procedure or process for attaining an object: such as

a **(1)** : a systematic procedure, technique, or mode of inquiry employed by or proper to a particular discipline or art

(2) : a systematic plan followed in presenting material for instruction
// the lecture *method*

b **(1)** : a way, technique, or process of or for doing something
// often slow in their business *methods*
— T. R. Ybarra

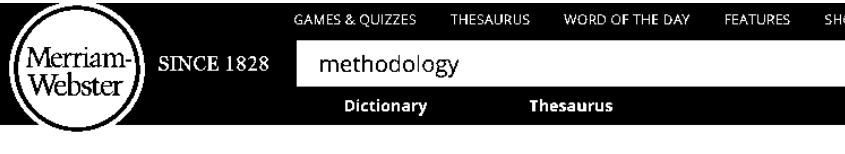
(2) : a body of skills or techniques
// in the art of the novel, heavily armed with *method*
— J. D. Scott

2 : a discipline that deals with the principles and techniques of scientific inquiry

3 **a** : orderly arrangement, development, or classification : PLAN
// The book is completely lacking in *method*.

b : the habitual practice of orderliness and regularity
// time enough to do everything if only you used *method*
— Angela Thirkell

4 *capitalized* : a dramatic technique by which an actor seeks to gain complete identification with the inner personality of the character being portrayed



methodology noun

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meth·od·ol·o·gy | \ ˌme-thə-ˈdä-lə-jē \
plural **methodologies**

Definition of *methodology*

1 : a body of methods, rules, and postulates employed by a discipline : a particular procedure or set of procedures
// demonstrating library research *methodology*
// the issue is massive revision of teaching *methodology*
— Bob Samples

2 : the analysis of the principles or procedures of inquiry in a particular field

Method vs Methodology

Research methods may be understood as all those methods/techniques that are used for conduction of research. Research methods or techniques*, thus, refer to the methods the researchers use in performing research operations.

Research methodology is a way to systematically solve the research problem. It may be understood as a science of studying how research is done scientifically. In it we study the various steps that are generally adopted by a researcher in studying his research problem along with the logic behind them. I

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Research Process

The following provides procedural guideline for research process:

(1) formulating the research problem;
(2) extensive literature survey;
(3) developing the hypothesis;
(4) preparing the research design;
(5) determining sample design;
(6) collecting the data;
(7) execution of the project;
(8) analysis of data;
(9) hypothesis testing;
(10) generalizations and interpretation, and
(11) preparation of the report or presentation of the results.

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Technique Involved in Defining Problem

The technique for the purpose involves the undertaking of the following steps generally one after the other:

(i) statement of the problem in a general way;

(ii) understanding the nature of the problem;

(iii) surveying the available literature

(iv) developing the ideas through discussions; and

(v) rephrasing the research problem into a working proposition

Research Process: Problem Statement

- One statement or question that describes the problem
- Most challenging phases of research process
- Clarity on this opens several routs to arrive at solution
- Several iterations is required before it is finalized

This will be discussed again in coming weeks in more detail

Research Process: Problem Statement

Professor W.A. Neiswanger correctly states that the statement of the objective is of basic importance because it determines the data which are to be collected, the characteristics of the data which are relevant, relations which are to be explored, the choice of techniques to be used in these explorations and the form of the final report.

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Research Process: Problem Statement

Before starting a project, ask “What is a research problem?”

Knowledge gap or a fundamental challenge in a field, and outcome of research investigations or systematic research study contributes to the solution of the problem.

Refers to some difficulty which a researcher experiences in the context of either a theoretical or practical situation.

Research Process: Sources of Research Problem

Interviews: Sessions with individuals can provide significant research problems.

Personal experiences: Everyday experiences can be a good source of research problems.

Deductions from theory: Inferences made from generalizations of life in a society.

Interdisciplinary perspective: Helps in understanding complex issues during research.

Relevant literature: Existing research and studies can inspire new research problems.

Source: https://www.helpforassessment.com/blog/sources-of-a-research-problem/

Selection of Good Research Problem

Criteria for selecting a good research problem:

Importance to the research area, original, feasible, funding requirement, team and management support, availability of topics, ethics, solvable or not, interesting, clear, verifiable, relevant, systematic and logical.

Overview of Research Design and Methods
By: Sue L. T. McGregor
In: Understanding and Evaluating Research: A Critical Guide
Chapter DOI: https://doi.org/10.4135/9781071802656.n8

Criteria of Good Research

One expects scientific research to satisfy the following criteria:

1. The purpose of the research should be clearly defined and common concepts be used.

2. The research procedure used should be described in sufficient detail to permit another researcher to repeat the research for further advancement, keeping the continuity of what has already been attained.

3. The procedural design of the research should be carefully planned to yield results that are as objective as possible.

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Criteria of Good Research

4. The researcher should report with complete frankness, flaws in procedural design and estimate their effects upon the findings.

5. The analysis of data should be sufficiently adequate to reveal its significance, and the methods of analysis used should be appropriate. The validity and reliability of the data should be checked carefully.

6. Conclusions should be confined to those justified by the data of the research and limited to those for which the data provide an adequate basis.

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Criteria of Good Research

7. Greater confidence in research is warranted if the researcher is experienced, has a good reputation in research and is a person of integrity

In other words, we can state the qualities of a good research as under:

1. Good research is systematic
2. Good research is logical
3. Good research is empirical
4. Good research is replicable

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Ethics in Engineering Research

- Extremely important as engineered products deal with humans
- Failure in engineering research outcome may lead to
  - Casualties, health hazards, pollution
  - Property loss, hit on economy
- Professional societies regulate the activities of practicing engineers and industry

Ethics in Engineering Research

- Practicing engineer should
  - Exchange of information freely with other practitioners
  - Adhering to code of ethics
  - Holistic view of the project
  - Maximize benefit of all stakeholders

Summary

- Meaning, objectives and motivation of research
- What is engineering research?
- Elements of engineering research
- Types of research,
- Methods and methodology
- Research Problem and its selection
- Criteria of good research
- Ethics

Lecture 1 completed