Chapter 1

Introduction

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OUTLINE

Module 1: Introduction

Module 2: Define Research Problem

Module 3: Research Design

Module 4 : Data Collection

Module 5 : Processing ,Analysis and Interpretation of data

Module 6 : Report Writing

Module 7 : Proposal Writing

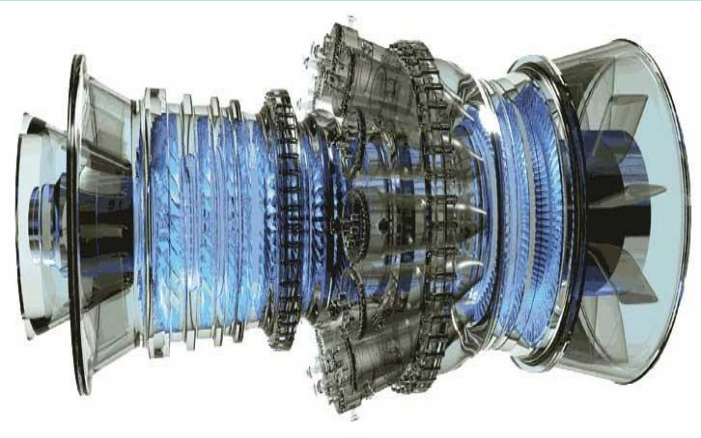
Module 8 : Scientific Paper Writing

1. INTRODUCTION

1.1. Meaning of Research

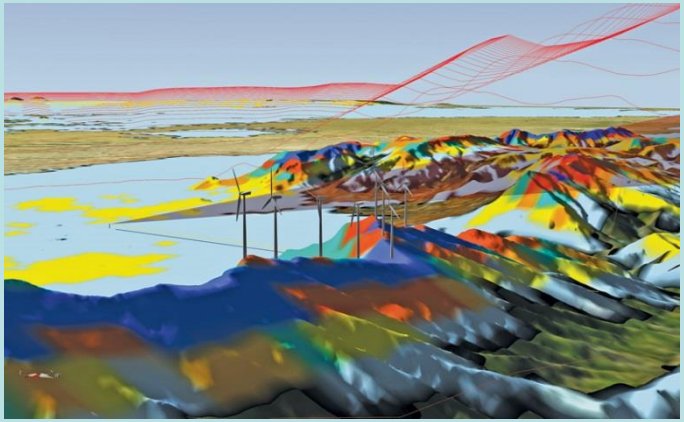
- Research can be defined as an art of investigation
  - Process of arriving at dependable solutions to problems through systematic data collection, analysis and interpretation of data
- A systematized effort to gain new knowledge; a movement from the known to unknown
- Research deals with discovering, interpreting and developing of methods and systems for the advancement of human knowledge

Examples



How to increase the efficiency of gas turbine ?

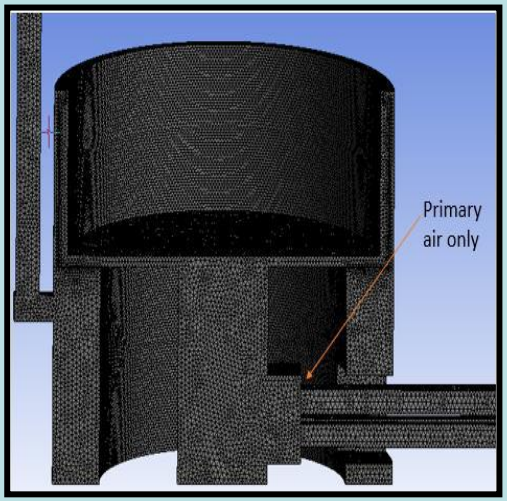
How to avoid corrosion problems of Superheater tube bundles ?

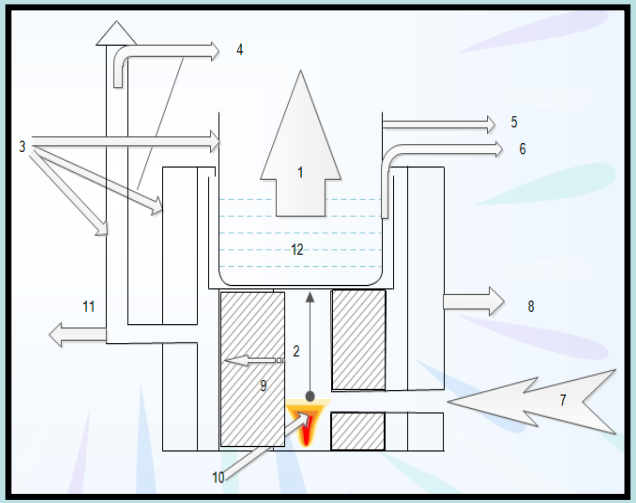


How can we capture the real wind flow pattern in complex terrain ?

How to improve Biomass cooking systems in Ethiopia ?

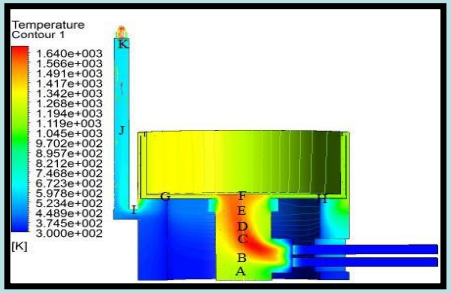
Examples





$$\rho c_p \frac{DT}{Dt} = \frac{\partial}{\partial x_i}\left(\lambda \frac{\partial T}{\partial x_i}\right) + \frac{DP}{Dt} + \tau_{ij}\frac{\partial u_i}{\partial x_j} - \frac{\partial T}{\partial x_i}\rho \sum_{k=1}^{n} v_k y_k c_p + \dot{w}'_T$$

Heat	pressure	power of	comes from	heat
Diffusion	increase	viscous stress	diffusion velocity	released

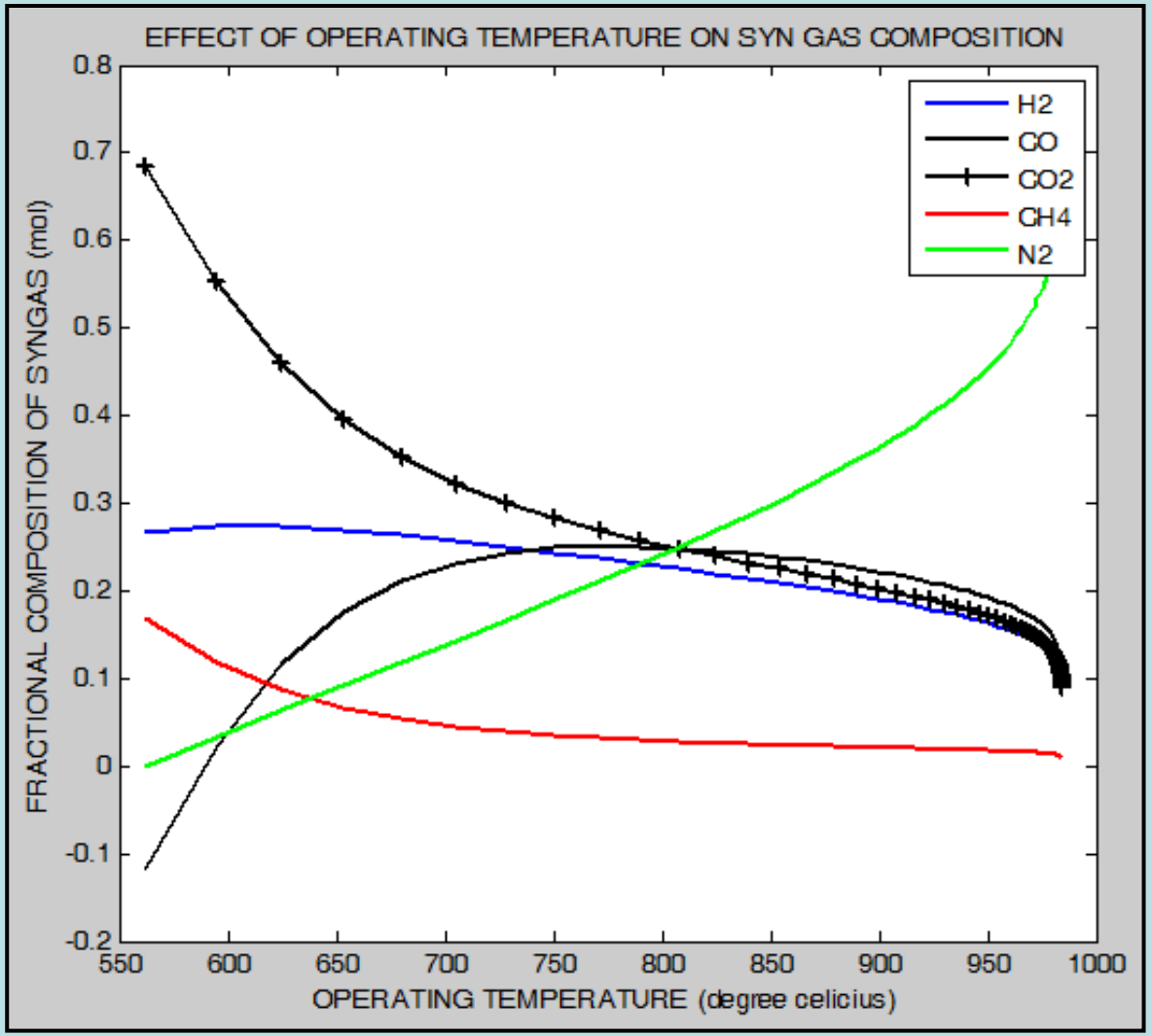


CFD

Description	A	B	C	D	E	F
Tem.(k)	986	1171	1563	1538	1352	1334

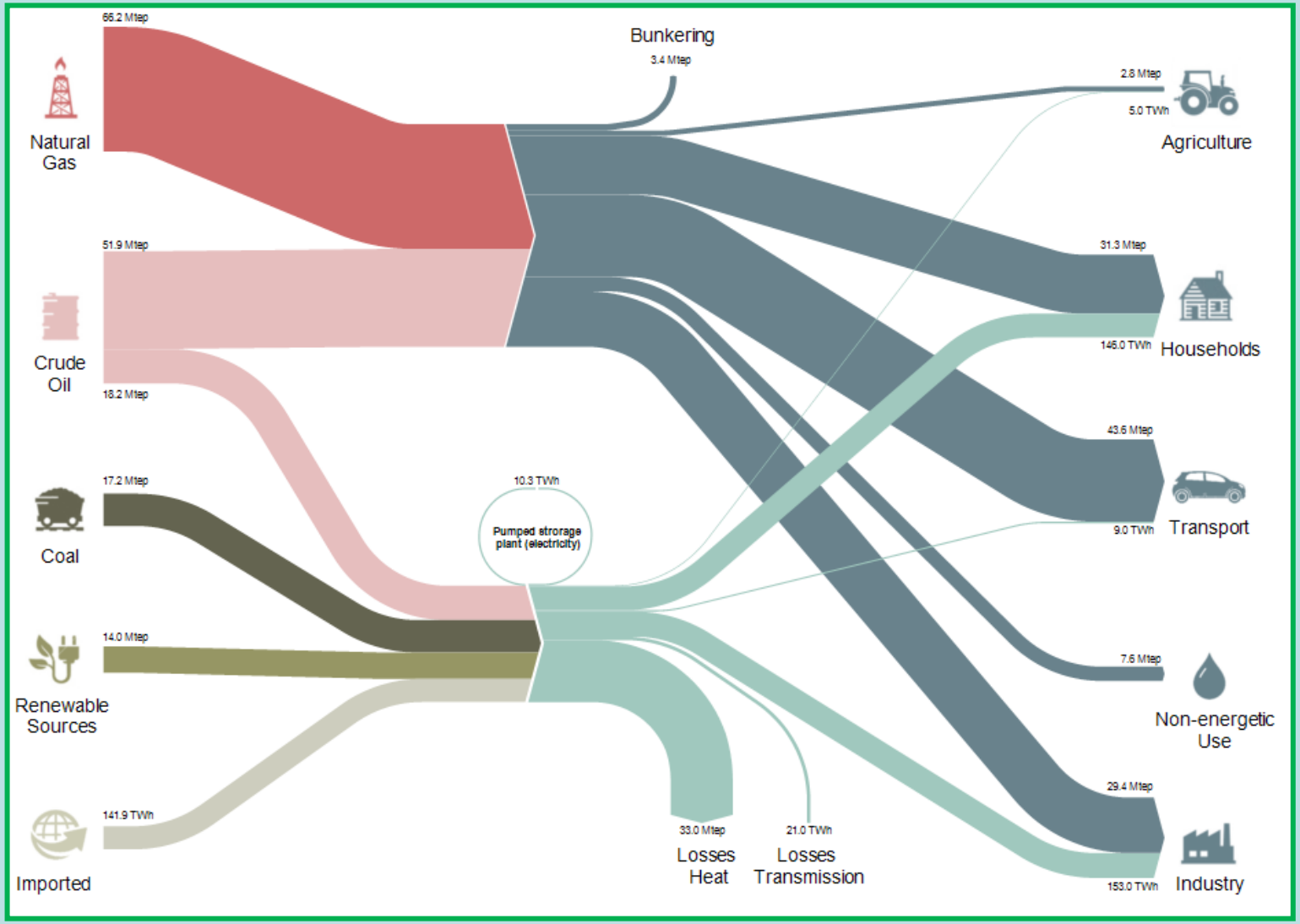
Experimental result

Examples



Gasification model

Examples

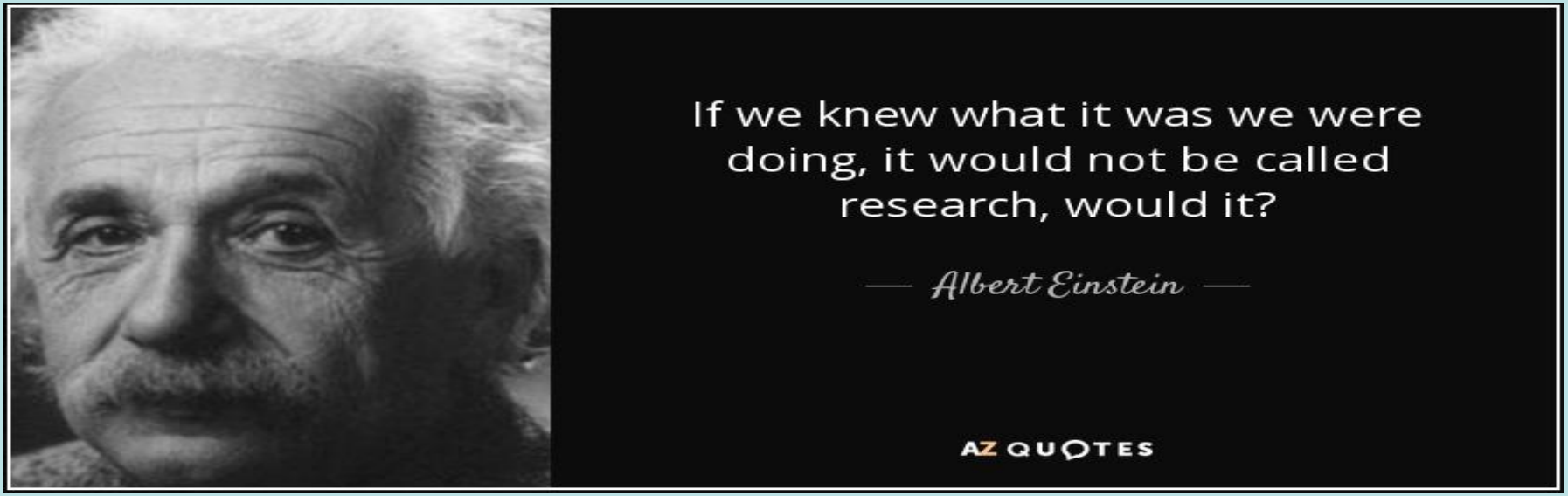


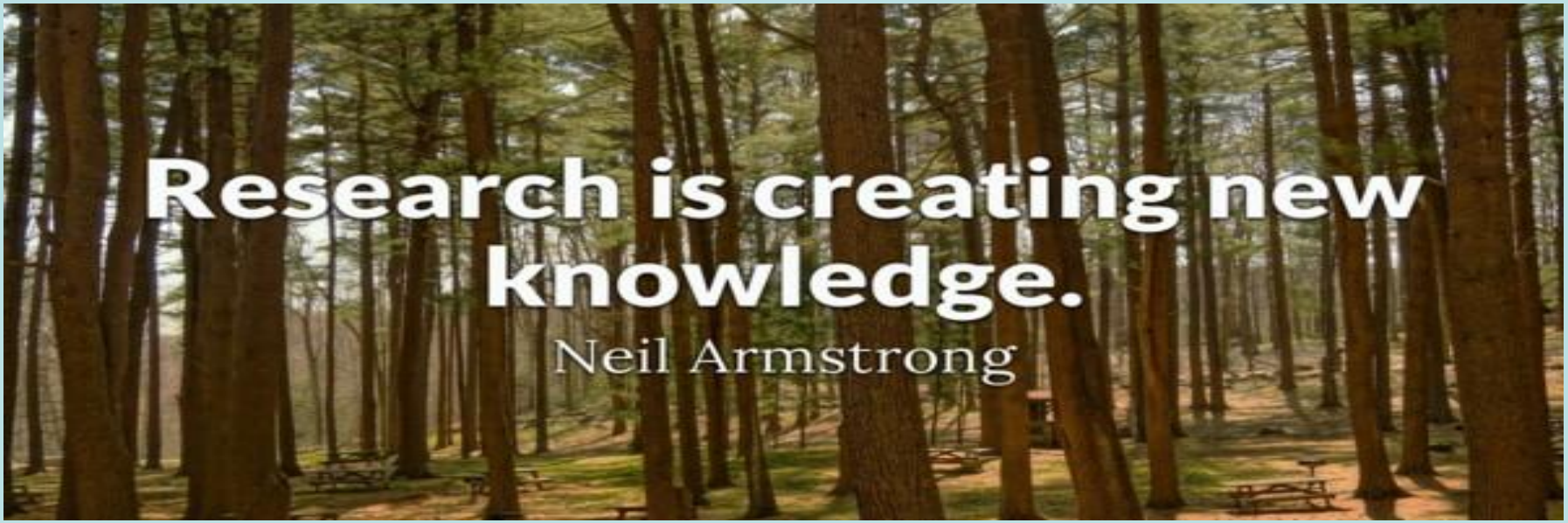
Energy Balance for a Country

It doesn't matter how beautiful your theory is, it doesn't matter how smart you are. If it doesn't agree with experiment, it's wrong.

(Richard Feynman)

izquotes.com


If we knew what it was we were doing, it would not be called research, would it?
— Albert Einstein —
AZ QUOTES

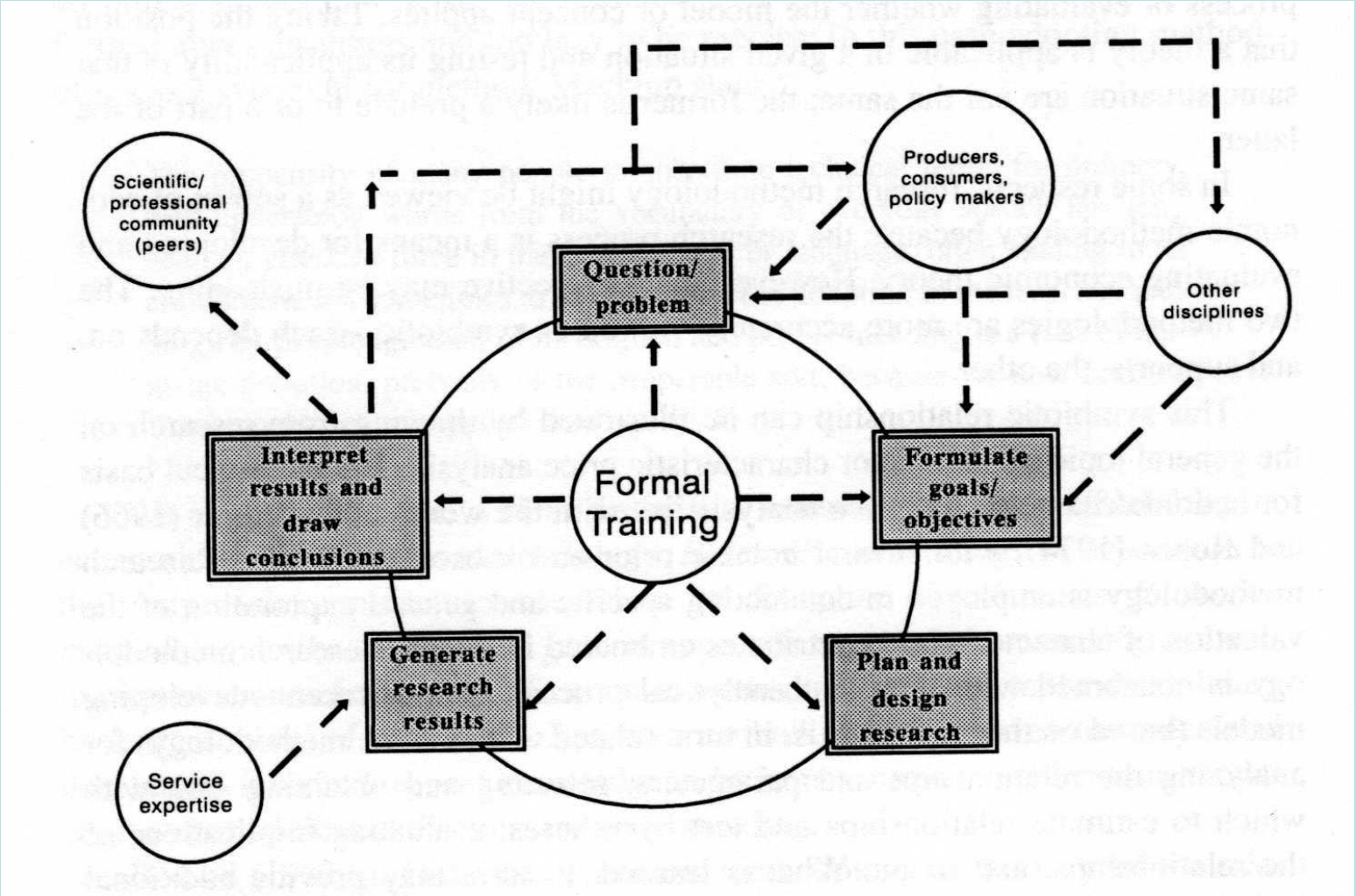

Research is creating new knowledge.
Neil Armstrong

1. INTRODUCTION

The research process :

- The process is initiated with a question or problem (Step 1)
- Next, goals and objectives are formulated to deal with the question or problem (Step 2)
- Then the research design is developed to achieve the objectives (Step 3)
- Results are generated by conducting the research (Step 4)
- Interpretation and analysis of results follow (Step 5)

1. INTRODUCTION



1.2. 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

- To gain familiarity with a phenomenon
- To know accurately the characteristics a problem
- To test a hypothesis of a causal relationship between variables

1.3. MOTIVATION FOR RESEARCH

What makes people to undertake research? This is a question of fundamental importance.

The possible motives for doing research may be either one or more of the following :

- Desire to get a research degree
- Desire to face the challenge in solving the unsolved problems
- Desire to get intellectual joy of doing some creative work
- Desire to be of service to society
- Desire to get respectability

1.4. TYPES OF RESEARCH

The basic types of research are as follows :

1. **Descriptive vs. Analytical**
2. **Applied vs. Fundamental**
3. **Quantitative vs. Qualitative**
4. **Conceptual vs. Empirical**
5. **Some Other Types of Research**: All other types of research are variations of one or more of the above stated approaches, based on either the purpose of research, or the time required to accomplish research, on the environment in which research is done, or on the basis of some other similar factor.

1.4.1. DESCRIPTIVE VS. ANALYTICAL

- In descriptive research, the researcher has to **only report what is happening or what has happened**
- The main characteristic of this method is the researcher has **no control over the variables, he can only report what has happened or what is happening**
- In analytical research, the researcher has **to use the already available facts or information, and analyze them to make a critical evaluation of the subject**

1.4.1. DESCRIPTIVE VS. ANALYTICAL

- Analytical research attempts to explain why and how. It usually concerns itself with cause – effect relations among variables
- The distinction between **descriptive** and **analytical** research is based on the question it asks. **Descriptive research** attempts to determine, describe, or identify **what is**, while analytical research attempts to establish **why it is that way**
- Example : Explaining why and how the Ethiopian trade balance move in a particular way.

1.4.1. DESCRIPTIVE VS. ANALYTICAL

Descriptive Research	Analytical Research
Describe characteristics of a group	Explains characteristics of a group
Is more exploratory	It is more explanatory
Answer the question "What?" **<>**	Answer the question "Why?"
Hypothesis needed	No hypothesis needed?
The researcher only reports what is happening or what has happened.	Uses the available facts or information, and analyze them to make a critical evaluation of the subject.
Example : Examining the fluctuation of Ethiopian trade balance in 2019	Example: Explaining why and how the Ethiopian trade balance move in a particular way.

1.4.2. APPLIED VS. BASIC

- An attempt to find solution to an immediate problem encountered by a firm, an Industry, a business organization, or the Society is known as Applied Research.
- Gathering knowledge for knowledge's sake is 'Pure' or 'Basic' or 'Fundamental' Research.
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1.4.2. APPLIED VS. BASIC

- Basic research - Theoretical understanding
  - Advancement of knowledge
- Applied research - Practical application of science
  - Solve practical problems

1.4.2. APPLIED VS. BASIC

Basic Research	Applied Research
Expands existing knowledge	Solves practical problem
Theoretical in nature	Practical in Nature
Less associated with technologies	Associated with advancement of Technology
Predicts future problems	Creates solutions for future problems
Usually does not have direct commercial objectives	Has direct commercial objectives
Curiosity driven	Clint or demand driven
Wider scope	Specific in scope

1.4.3. QUANTITATIVE VS. QUALITATIVE

- **Quantitative research** is a more logical and data-led approach which provides a measure of what people think from a statistical and numerical point of view. For example, if you wanted to know how many of your customers support a proposed change in your products or service and how strongly (on a scale) they support it.
- **Quantitative research** largely uses methods such as questionnaires and surveys with set questions and answers that respondents tick from a predefined selection. Answers can be measured in strengths of feeling such as ‘strongly agree’ ‘disagree’ or numbers.

1.4.3. QUANTITATIVE VS. QUALITATIVE

- **Unlike quantitative research** which relies **on numbers and data**, qualitative research is **more focused on how people feel, what they think and why they make certain choices**. For example, if you are thinking of changing your branding you would carry out qualitative research to see what emotional reactions people have to the new identity and what they associate it with.
- **Qualitative research** is largely led with discussion around certain concepts or ideas with open questioning. Attendees are encouraged to explain or describe their reasons for having certain responses which can reveal underlying motivations, associations and behavioral triggers.

1.4.3. QUANTITATIVE VS. QUALITATIVE

- **Quantitative research** aim to measure the quantity or amount and compares it with past records and tries to project for future period
- If you want to get inside your customers' minds you need to do qualitative research. Face-to-face interviews and focus groups can provide valuable insights into your products, your market and your customers.

1.4.3. CONCEPTUAL VS. EMPIRICAL

- **Conceptual research** is that related to some abstract idea(s) or theory. It is generally used by philosophers and thinkers to develop new concepts.
- **Conceptual research** focuses on the concept or theory that explains or describes the phenomenon being studied. What causes disease? How can we describe the motions of the planets? The conceptual researcher sits at his desk with pen in hand and tries to solve these problems by thinking about them.

1.4.3. CONCEPTUAL VS. EMPIRICAL

- On the other hand, **empirical research** relies on **experience or observation alone**, often without due regard for system and theory.
- It is **data-based research, coming up with conclusions which are capable of being verified by observation or experiment.**

1.5. EXPERIMENTAL VS. SIMULATION

- **Experimental research** helps to see the effects of dependent variable & to explore a particular event.
- The researcher manipulates one or more variables and controls and measures any change in other variables using experimental approach.
- Before doing the experiment, it is good to know what variables are to be tested and how they can be controlled and measured.
- Laboratory based experiment is very helpful procedure before developing or scale up the given technology.

1.5. EXPERIMENTAL VS. SIMULATION

- ***Simulation*** involves devising a representation in a small and simplified form (model) of a system, which can be manipulated to gauge effects.
- It is similar to experimental design in the respect of this manipulation, but it provides a more artificial environment in that it does work with original materials at the same scale. Models can be mathematical or physical
- The performance of the model must be checked and calibrated against the real system to check that the results are reliable. Simulation enables theoretical situations to be tested – what if ?

1.5. EXPERIMENTAL VS. SIMULATION

- ***Efficiency Improvement of Power Plant:*** Suppose we want to improve the efficiency of large power plant. However, it may need a huge investment to improve the efficiency experimentally. Therefore, before going to the decision, we have to perform simulation and optimization so as the result from the simulation will help us to decide.
- ***Automotive related research:*** Before manufacturing a car, the design will be checked from different perspective using simulation: Strength, aerodynamics of the shape, Fuel Economy and Environmental impact. The simulation will also be validated using experimental result. Thus, it will help us to better understand the system before going to manufacturing.

1.5. EXPERIMENTAL VS. SIMULATION

- ***Human Body heat Transfer***: Suppose we want to study in detail the heat transfer phenomena of our body, it is very difficult to study this heat transfer phenomena experimentally, thus simulation can be done.
- ***Manufacturing Plant layout design:*** *Layout of a company, material flow, Operational requirement, process flow, sequence of operation, cost of operation using virtually. What is the best operational cost, less time and convenience?*
- ***Transportation network:*** Considering transportation load, number of vehicles, routes, number of passengers, how to serve the users can be simulated without actually engaging in the transportation. In doing that we can increase service quality, cost optimization, travel distance optimization.

1.5. EXPERIMENTAL VS. SIMULATION

- ***Electrical Transmission losses:*** The electrical distribution loss in Addis Ababa is assumed to be 20 % to 22.7%. Thus, doing research in reducing these losses and giving recommendation for the government has a huge benefits. This can don using simulation.
- ***Improving construction quality:*** Improving the quality of road, building and other infrastructure related constriction must be improved.
- ***Ergonomic Design (Workstation Design):*** Considering the work situation, the input to the work and the human body measurement in a given community , it is possible to simulate virtually the workstation that can give a productive environment.

1.5. EXPERIMENTAL VS. SIMULATION

- Experimental research needs high investment compared to simulation. However, we can have more confidence to use the experimental research output directly to the intended purpose. The researcher may choose either simulation or experimental approach or both of them to solve a given problem. However, it is very important to understand the basic science. Without knowing the science in detail using simulation or experimental result, will lead to confusion.

1.6. RESEARCH APPROACHES

- According to types of research discussed, there can be two approaches to research:
  - Quantitative approach
  - Qualitative approach
- Quantitative approach can be further divided into 3 groups:
- **Inferential approach** – infer characteristics of a phenomenon through collection of data – example CO_2 emission.

1.6. RESEARCH APPROACHES

- **Experimental approach** – Researcher deliberately changes some variables to know the causal effect- example – effect of temperature rise on plant growth under open sky.
- **Simulation approach** – Researcher artificially construct an environment and data can be generated. This permits an observation of the dynamic behavior of a system under controlled conditions.

1.6. SIGNIFICANCE OF RESEARCH

- Research has its special significance in solving various problems : Energy, Water, Technology, Food….
- Research inculcates scientific and inductive thinking and it promotes the development of logical habits of thinking and organization.
- Research provides the basis for nearly all government policies in our economic system.

1.6. SIGNIFICANCE OF RESEARCH

- The role of research in several fields of applied economics, whether related to business or to the economy as a whole, has greatly increased in modern times.
- Research is equally important for social scientists in studying social relationships and in seeking answers to various social problems

1.7. RESEARCH METHODS VERSUS METHODOLOGY

RESEARCH METHODS	RESEARCH METHODOLOGY
◉ Research methods are the methods by which you conduct research into a subject or a topic ◉ Research methods involve conduct of experiments, tests, surveys and the like. ◉ Research methods aim at finding solutions to research problems	◉ Research methodology explains the methods by which you may proceed with your research ◉ Research methodology involves the learning of the various techniques that can be used in the conduct of research and in the conduct of tests, experiments, surveys and critical ◉ Research methodology aims at the employment of the correct procedures to find out solutions

1.8. IMPORTANCE OF KNOWING HOW RESEARCH IS DONE

- The study of research methodology gives the student the necessary **training in gathering material** and **arranging or card-indexing them**, **participation in the field work when required**, and also **training in techniques for the collection of data appropriate to particular problems**, in the use of statistics, questionnaires and controlled experimentation and in recording evidence, sorting it out and interpreting it.

1.8. IMPORTANCE OF KNOWING HOW RESEARCH IS DONE

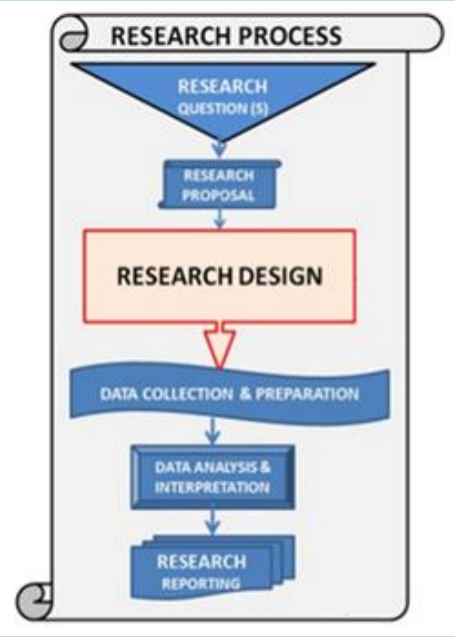
- In fact, **importance of knowing the methodology** of research or how research is done stems from the following considerations :
  - The knowledge of methodology provides good training specially to new researcher and enables him **to do better research**. It helps him to develop disciplined thinking **to observe the field objectively**.
  - Knowledge of how to do research will inculcate the ability to evaluate and use research results with reasonable confidence.

1.8. IMPORTANCE OF KNOWING HOW RESEARCH IS DONE

- When one knows how research is done, then one may have **the satisfaction of acquiring a new intellectual tool which can become a way of looking at the world and of judging everyday experience**. Accordingly, **it enables use to make intelligent decisions concerning problems** facing us in practical life at different points of time. Thus, the knowledge of research methodology provides **tools to took at things in life objectively.**
- The knowledge of methodology **helps the consumer of research results to evaluate them and enables him** to take rational decisions.

1.9. RESEARCH PROCESSES

- Research process consists of series of actions or steps necessary to effectively carry out research and the desired sequencing of these steps.



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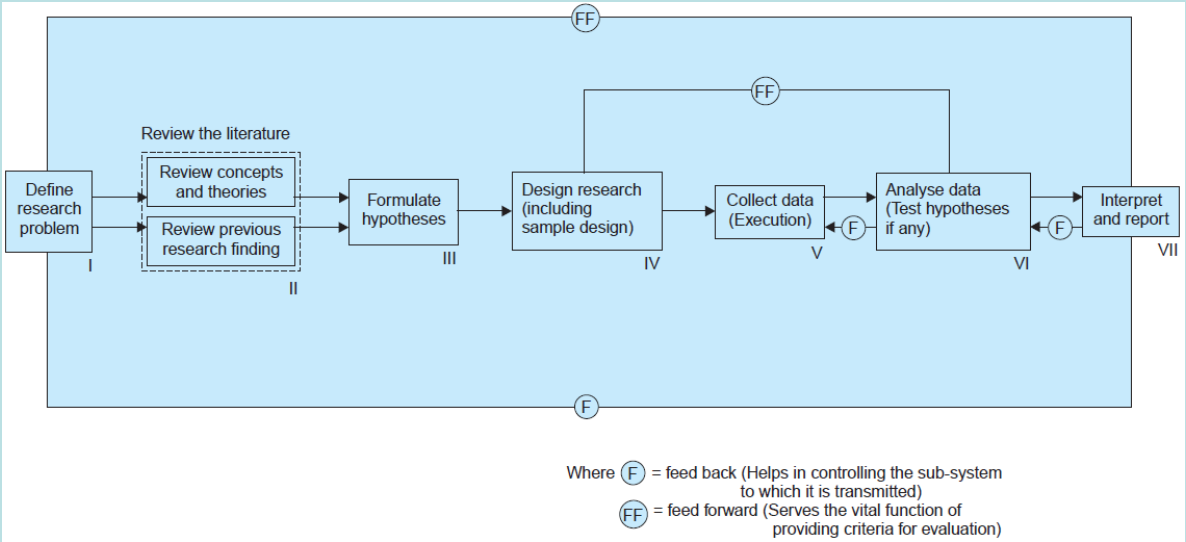
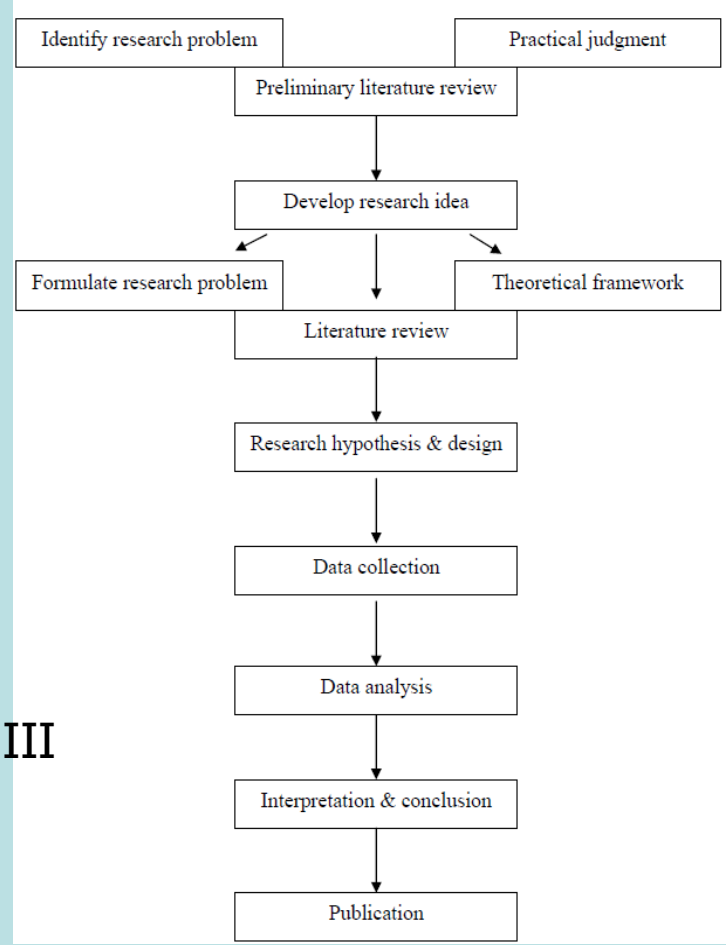


II

1.9. RESEARCH PROCESSES

III



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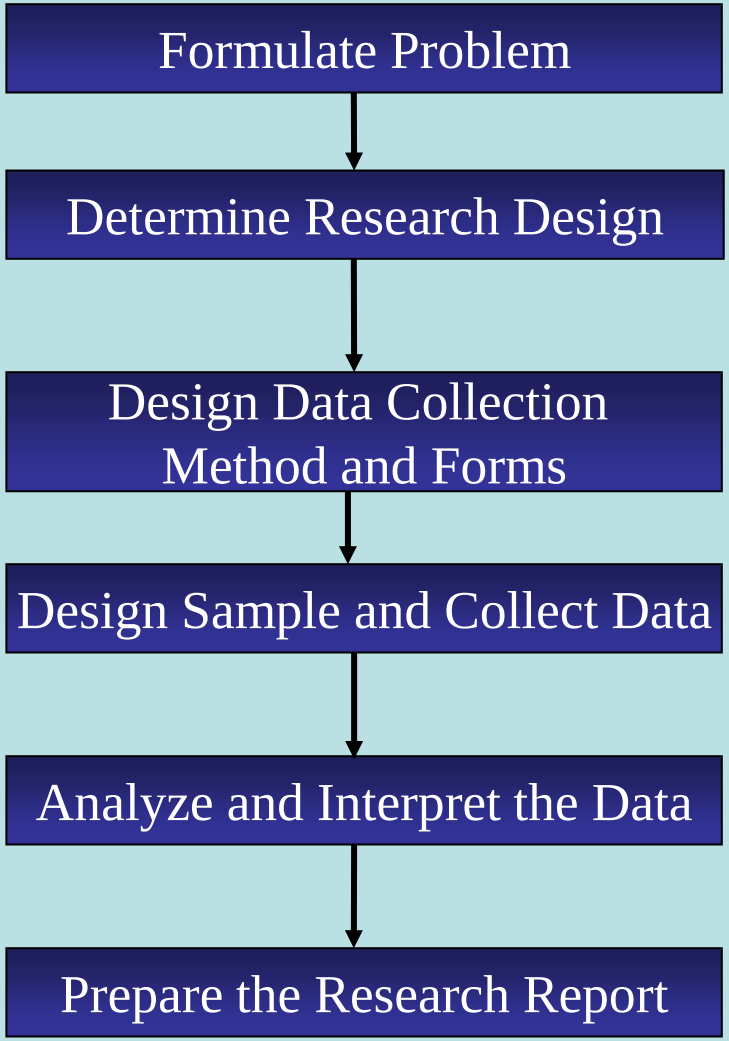
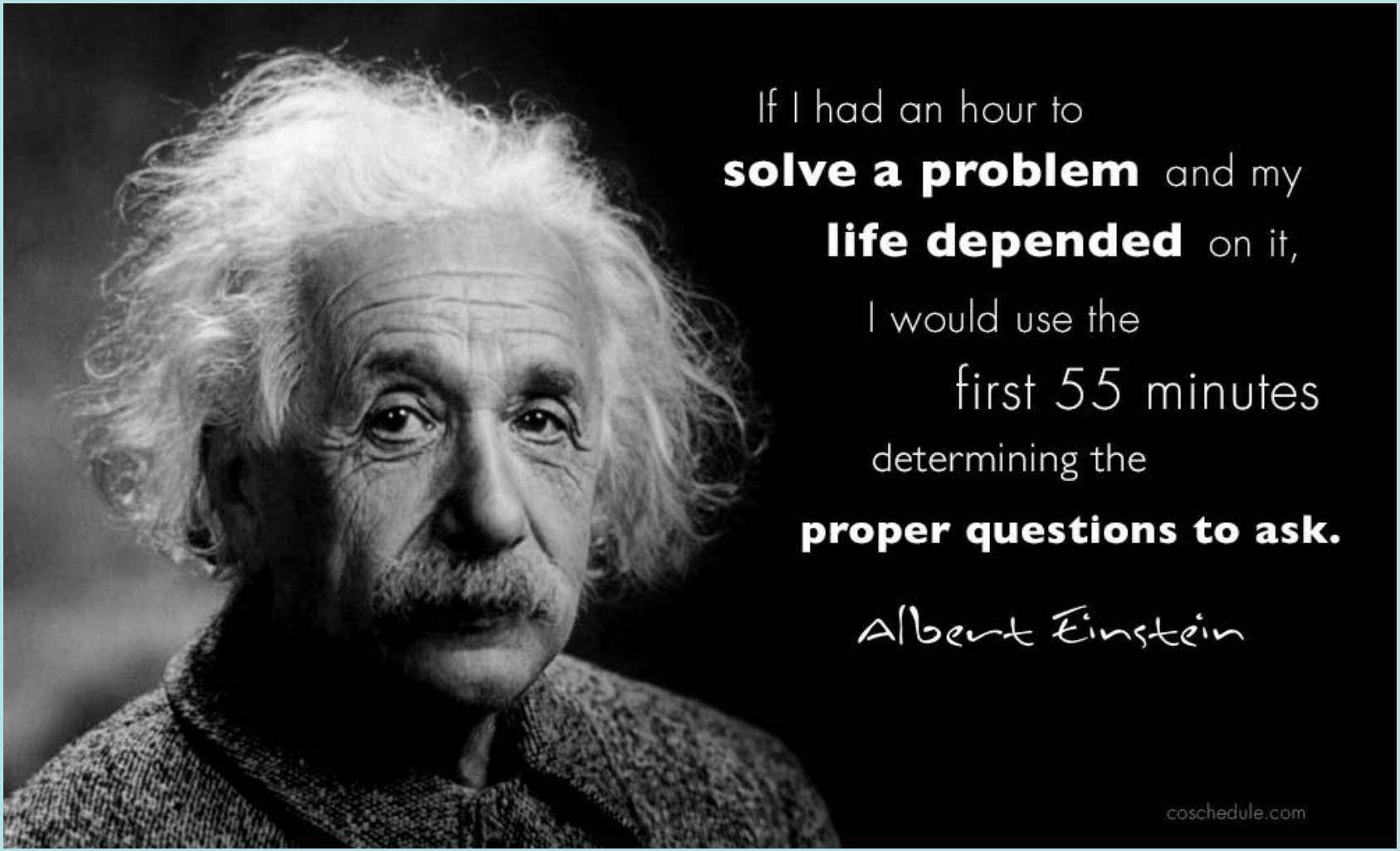


1.9.1. PROCESS OF FORMULATING RESEARCH QUESTION [S]



1.10. CRITERIA OF GOOD RESEARCH

- The objective of the research clearly defined
- The research methodology used should be described in sufficient detail to permit another researcher to repeat the research for further advancement
- The writing should be done with complete frankness – nothing which has bearing on the result should be hidden
- The validity and reliability of data as a well as calculations should be re-checked to avoid mistakes
- Conclusions should be confined to those justified by data and analysis
- Researcher should be a person of integrity

1.10. CRITERIA OF GOOD RESEARCH

- Clarity and relevance of the problem
- Researchability of the problem
- Adequacy and relevance of the literature review
- Match between the purpose, design and method
- Suitability of the sampling procedure and the sample
- Correctness of the analytical procedure
- Clarity of findings

1.11. PROBLEMS ENCOUNTERED BY RESEARCHERS IN ETHIOPIA

- Insufficient interaction between academics and practitioners
- Lack of training on the part of researchers
- Fear that information provided to researchers may be used against them
- Secondary sources of data are not timely available

Way forward to overcome research problems in Ethiopia

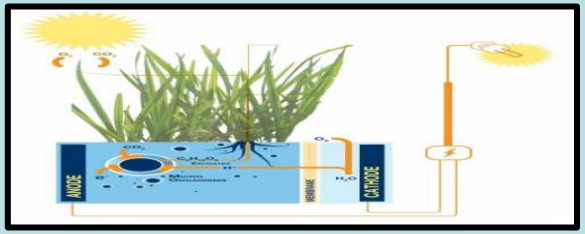
- Greater interaction between academic institutions and practicing organizations/ government/ NGOs etc.
- More education and training on research methodology
- National Policy on Research mentioning that research data can not be used against the person
- Timely publication of secondary data and enforcement of act on “Right to Information”

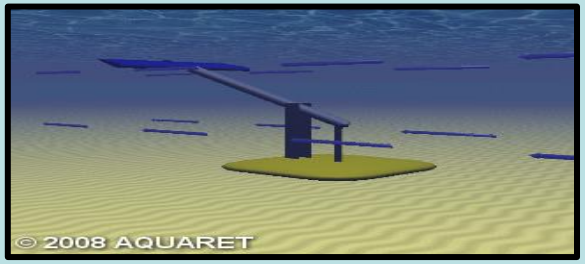
Research activities

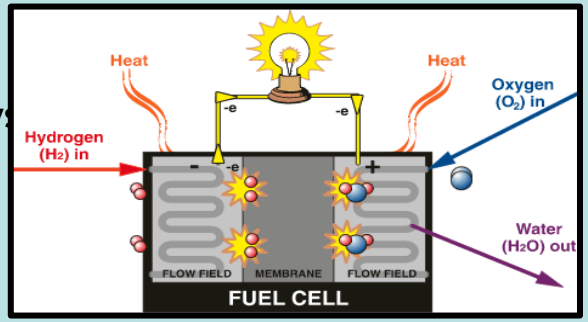
The following are some of the research activities in the area of Renewable energy technologies :

- Solar Energy
  - Photovoltaic
    - Low cost Photovoltaic
    - Producing PV cells in Ethiopia
  - Solar heating
    - Low cost solar water heating systems
    - Maximizing efficiency of solar water heating systems
    - Low cost solar cooker
    - Solar thermal power plant ?
- Biomass energy
  - Improved Biomass cooking stove (η_{th} = 40 %)

    --- > Finding ways to further increase the efficiency ?
  - Biomass for electricity generation in Ethiopia?
  - Biomass gasification technology ?
  - Biomass pyrolysis technology ?
  - Biochar from agricultural wastes ?
- Biogas upgrading and Electricity Generation from biogas ?
- Energy recovery from Waste (Combustion, Gasification and pyroly
- Maximizing the energy potential of geothermal power plant
- Small scale hydropower plant
- Wind energy assessment in complex terrain with high resolution







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