

# Research, Publications, and Modern Academic Tools

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# Outline

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- Introduction
- What is Research?
- What is Engineering Research?
- Why Research
- Research Process
- Academic Papers
- Annotated Bibliography
- Literature Review
- Reproducibility Aids
- Mendeley
- Overleaf

# Introduction

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- We have all heard of research or even do research, but:
  - Can we define it?
  - Is there a difference between basic research and engineering research?
- How are academic papers, the main output of research, structured?
- What is the difference between a literature review and an annotated bibliography?
- What modern software helps with data reproducibility?
- What are modern softwares that help with citations and paper writing?

# Research

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# What is Research?

## UTA Internal Review Board Training

The federal regulations define research as “a **systematic investigation** including research development, testing, and evaluation, **designed to develop or contribute to generalizable knowledge.**” A key aspect of research is that there is a **systematic design in advance**, generally utilizing a scientific approach or protocol, for the definite **purpose of contributing to generalizable knowledge**. Research can include a wide variety of activities including: experiments, observational studies, surveys, tests, and recordings designed to contribute to generalizable knowledge.

Research generally DOES NOT INCLUDE operation activities such as: Routine medical care, quality assurance, quality improvement, certain aspects of public health practice, journalism, history, philosophy, fact finding inquiry, simple data collection. However some of these activities MAY INCLUDE OR CONSTITUTE RESEARCH in the specific circumstance where there is clear advance intent to contribute to generalizable knowledge with a formal systematic design to collect information

## Hampshire College

Research is a **process of systematic inquiry** that entails collection of data; documentation of critical information; and analysis and interpretation of that data/information, in accordance with suitable methodologies set by specific professional fields and academic disciplines. **Research is conducted to:**

- Evaluate the validity of a hypothesis or an interpretive framework.
- To assemble a body of substantive knowledge and findings for sharing them in appropriate manners.
- To help generate questions for further inquiries.

# What is Research Continued

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## SOAS University of London

We can define research as an activity of **systematic enquiry** that seeks **answers to a problem**.

## National Library of Medicine: Arab Journal of Urology

Research is a general term that covers all processes aiming to find responses to worthwhile scientific questions by means of a **systematic and scientific approach**. In fact, research is the **search for scientific knowledge**, a **systematically** formal process to **increase the fund of knowledge** and use it properly for the development of novel applications.

## University System of Georgia

Research is a **process of investigation**. An examination of a subject from different points of view. It's not just a trip to the library to pick up a stack of materials, or picking the first five hits from a computer search. Research is a hunt for the truth. It is getting to know a subject by reading up on it, reflecting, playing with the ideas, choosing the areas that interest you and following up on them. Research is the way you educate yourself.

# What is Engineering Research?

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## NSF

NSF-funded engineering researchers **create new knowledge, concepts and designs** that become **technological breakthroughs** and **solve real-world problems**. They innovate for clean water, the electric grid, agriculture and other national challenges. They launch economic opportunities in areas such as 3D printing, artificial intelligence and secure, high-speed computer and communication technologies. Engineers improve people's lives with smart transportation, prosthetic devices, faster computers and everything in between.

# What is Engineering Research? Continued

## National Academies of Sciences, Engineering and Medicine

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In many ways, the methods of academic engineering research and the resulting insights into the nature of the physical world are indistinguishable from those of basic scientific research. However, there are crucial differences between the two endeavors. **Basic scientific research is concerned with the discovery of new phenomena and their integration into coherent conceptual models of major physical or biological systems.** By definition, the focus of greatest interest tends to be at the outer edges of present knowledge. Most scientific knowledge will, in a highly variable and unpredictable fashion, find technical applications of economic and social value, but in most cases the nature of such applications will not be apparent to the those who perform the original scientific research.

**Basic research in engineering is by definition concerned with the discovery and systematic conceptual structuring of knowledge.** Engineers develop, design, produce or construct, and operate devices, structures, machines, and systems of economic and societal value. **Virtually all engineering research is driven by the anticipated value of an application.** However, not all potential applications can be anticipated, and occasionally the hoped-for application may not be nearly as important as one that turns up by serendipity. The time from research to production may be a few years, as in the development and application of the laser or in the progression from the integrated circuit to microprocessor, or it may be decades, as in the development of television.

Engineering, unlike science, is concerned not only with knowledge of natural phenomena, but also with how knowledge can serve humankind's needs and wants. Such variables as cost, user compatibility, producibility, safety, and adaptability to various external operating conditions and environments must be taken into account in the design, development, operational support, and maintenance of the products and services that engineers create. **Thus, engineering involves the integration of knowledge, techniques, methods, and experiences from many fields.**

# Why Research?

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- **National Library of Medicine: Arab Journal of Urology**
- Research is the fuel for future progress and it has significantly shaped perspectives in medicine. In urology there are numerous examples showing that current practice has rapidly changed as a result of several key research findings. For example, from the research of Huggins and Hodges (who won the Nobel Prize in 1966), hormone therapy has become the standard treatment for patients with advanced/metastatic prostate cancer.
- **SOAS University of London**
- Research begins when we want to know something. Research is concerned with increasing our **understanding**. Research provides us with the **information** and **knowledge** needed for **problem solving** and **making decisions**.
- Research is sometimes divided into **pure** (or basic) and **applied** research in order to make a distinction between research that is carried out to further our knowledge and that which seeks to apply pre-existing knowledge to real world problems. Our focus here is applied research for decision-making for public policy. In this context the purpose of research is 'problem solving' which can serve the following functions:
  - **Description** - to provide baseline data or simply a picture of how things are.
  - **Explanation (analytical)** - to understand why things are the way they are, what factors explain the way things are.
  - **Prediction** - to predict how systems will change under alternative scenarios (modelling).
  - **Prescription and planning (decision-making)** - prescription and planning relating to changes in existing systems.
  - **Monitoring and evaluation** - monitoring and evaluation of the effects of changes during and after they have been made. Investigations may be made to compare results in practice with predictions, or to monitor the effects of a policy, management technique or treatment.

# Common Themes

## Research:

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- Systematic Investigation
- Systematic Design
- Conceptual Structuring or Modeling
- Increase Generalizable Knowledge
- Addresses a Research Question

## Engineering Research:

- Solves a real-world problem
- Has a value component
- Applies knowledge to address human needs and wants

# Research Process

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# Research Process

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## UTA

- Develop a Topic
- Locate Information
- Evaluate Information
- **Write**
  - Take Notes
  - **Utilize Writing and Grammar Resources**
  - **Annotated Bibliography**
  - **Literature Review**
- **Cite Sources**
- Legal / Ethical Use

## University of Nebraska at Lincoln

- Identify a Research Problem
- **Review the Literature**
- Determine Research Question
- Develop Research Methods
- Collect and Analyze Data
- **Document the Work**
- **Communicate Your Research**
- Refine/Expand, Pioneer

# Academic Paper Structure

- Usually follow the IMRAD Format: Introduction Methods Results and Discussion
- However the actual elements of an academic paper include:

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- **Abstract**

- A summary of the research, its methods, and findings.
- The study's hypothesis or research questions.
- The main points of a study can be found here.

- **Introduction**

- Background information on the study's topic of focus.

- **Literature Review**

- A summary of the current state of knowledge on the topic when it was studied.
- Problems or gaps in the research may be introduced, which the study attempts to address.

- **Methods**

- The paradigm or study design, and rationale for use.
- Description of the population, people, or samples used in the study.
- Instrumentation and measurements used.
- (For systematic reviews or meta-analyses) Pre-established criteria defined.

- **Results**

- A summation of the information or data collected.
- A statistical analysis of the study and its findings, including types of statistics used.
- May include many charts or tables of the analysis.

- **Discussion**

- Shortcomings of the study.
- Conclusions of the findings.
- Gaps in knowledge identified or recommendations for further study

- **Acknowledgements**

- Important if Funded By Grants

- **References**

- Cite All Sources

# Annotated Bibliography

## What is an annotated bibliography?

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An **annotated bibliography** is a list of citations to books, articles, and documents that follows the appropriate style format for the discipline (MLA, APA, Chicago, etc). Each citation is followed by a brief (usually about 150 word) descriptive and evaluative paragraph - the annotation. Unlike abstracts, which are purely descriptive summaries often found at the beginning of scholarly journal articles or in periodical indexes, annotations are descriptive and critical.

The purpose of the annotation is to **inform the reader of the relevance, accuracy, and quality of the sources cited**. The annotation exposes the author's point of view, clarity and appropriateness of expression, and authority.

- <https://libguides.uta.edu/researchprocess/bib>
  - Example here
  - From UTA's Research Process Step By Step
- <https://guides.lib.berkeley.edu/polisci1/bibliography>

# Annotated Bibliography: How to Read Engineering Paper

An Excellent Outline from [William G. Griswold](#) UC San Diego. He even has a 2 page print out for it.

- 1. What are the *motivations* for this work?** For a research paper, there is an expectation that a problem has been solved that no one else has published in the literature. This problem intrinsically has two parts. The first is the **people problem**: the benefits that are desired in the world at large; for example some issue of quality of life, such as saved time or increased safety. The second part is the **technical problem**, which is: *why doesn't the people problem have a trivial solution?*
- 2. What is the proposed solution?** This is also called the **hypothesis** or **idea**. This is the proposed answer to the research question. There should also be an answer to the question *why is it believed that this solution will work, and be better than previous solutions?* There should also be a discussion about *how the solution is achieved*.
- 3. What is the work's evaluation of the proposed solution?** An idea alone is usually not adequate for publication of a research paper. This is the concrete engagement of the research question. What argument, implementation, and/or experiment makes the case for the value of the ideas? What benefits or problems are identified?
- 1. What is your analysis of the identified problem, idea and evaluation?** Is this a good idea? What flaws do you perceive in the work? What are the most interesting points made? What are the most controversial ideas or points made? For work that has practical implications, you also want to ask: *Is this really going to work, who would want it, what it will take to give it to them, and when might it become a reality?*
- 1. What are the contributions?** The contributions in a paper may be many and varied. Beyond the insights on the research question, a few additional possibilities include: ideas, software, experimental techniques, or an area survey.
- 1. What are future directions for this research?** Not only what future directions do the authors identify, but what ideas did you come up with while reading the paper? Sometimes these may be identified as shortcomings.
- 1. What questions are you left with?** What questions would you like to raise in an open discussion of the work? What do you find confusing or difficult to understand? By taking the time to list several, you will be forced to think more deeply about the work.
- 1. What is your take-away message from this paper?** Sum up the main implication of the paper from your perspective. This is useful for very quick review and refreshing your memory. It also forces you to try to identify the essence of the work.

# Literature Review

A literature review is a summary of the published work in a field of study. This can be a section of a larger paper or article, or can be the focus of an entire paper. Literature reviews show that you have examined the breadth of knowledge and can justify your thesis or research questions. They are also valuable tools for other researchers who need to find a summary of that field of knowledge.

Unlike an annotated bibliography, which is a list of sources with short descriptions, a literature review synthesizes sources into a summary that has a thesis or statement of purpose—stated or implied—at its core.

Step 1: Define Research Scope

Step 2: Identify the Literature

Step 3: Critically Analyze the Literature

Step 4: Categorize Your Resources

- <https://new.library.arizona.edu/research/write-cite/lit-review>
- <https://guides.lib.berkeley.edu/c.php?g=866367&p=6216460>
  - Example Here

# Reproducibility

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# Reproducibility Aids

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## Reproducibility Includes:

- Data Management
- Data Best Practices
- **Software Best Practices**
  - Github Layouts
- Project Management

## Resources

- Data Repositories
- Documentation Tools
  - **R Studio**
  - Jupyter Notebooks
    - **Google Collab**
- Writing your Paper
  - **LaTeX**
  - **Overleaf**
- Citation Software
  - **Mendeley**
  - Zotero

# Reproducibility Standards and Code Notebooks

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- Reproducibility Standard for Code
- Rstudio Cloud
  - The online version of R Studio
  - Limited in RAM
- Google Collab
  - Google's Version of Jupyter Notebooks

# Demonstration: GitHub Project Folder Template

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# Demonstration: Google Collab

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# Demonstration: R Studio

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# Reference Managers

**Citation management tools** help you manage your research, collect and cite sources, and create bibliographies in a variety of citation styles. Each one has its strengths and weaknesses, but any are easier than doing it by hand!

1. Zotero: A **free** and open source tool by academics, for academics. It works as a standalone version or as a plug in with the Firefox browser. Zotero lets you keep copies of what you find on the web, permits tagging, notation, full text searching of your library of resources, works with Word and/or OpenOffice. It also lets you create a shared group of resources if you are working with others on a project.
2. Mendeley, from Elsevier, is a freely available reference manager and academic social network with web-based, desktop, and mobile versions; You can sync your library of papers between these different versions and across different computers. The Library has created this guide to using Mendeley.

It's always good to **double check the formatting** -- none of the software is always perfect!

Import references from word to Mendeley: <https://libguides.eku.edu/c.php?g=122788&p=4810281>

# Demonstration: Mendeley

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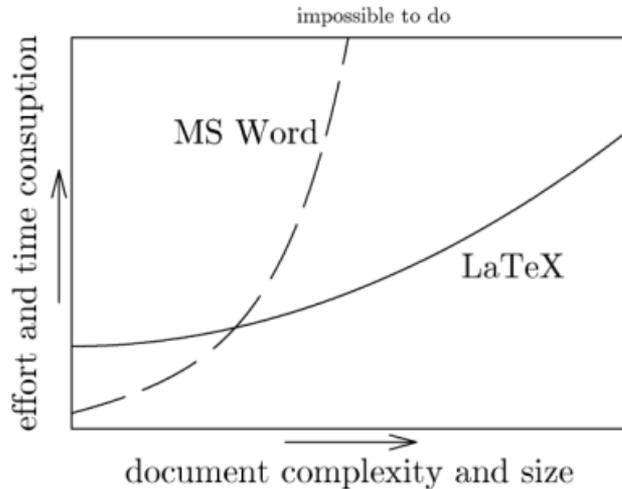
# Adding Articles to Shared Mendeley Folder

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1. Get Mendeley Extension for Chrome
2. Lookup an Academic Article (Google Scholar can help)
3. Add It to the Shared Mendeley Folder Using the Extension
4. Check Details of Journal to Make sure They Are Right
5. Highlight All References in the Shared Folder
6. Export as a .bib file

# LaTeX and Overleaf

LaTeX, which is pronounced «Lah-tech» or «Lay-tech» (to rhyme with «blech» or «Bertolt Brecht»), is a document preparation system for high-quality typesetting. It is most often used for medium-to-large technical or scientific documents but it can be used for almost any form of publishing. LaTeX is not a word processor! Instead, LaTeX encourages authors not to worry too much about the appearance of their documents but to concentrate on getting the right content.



## When you MUST use LaTeX?

- **You are in academia, particularly in any STEM discipline.** In this scenario manuscripts are everything. Content is really important and requires a tremendous amount of work. In the case of Ph.D. manuscripts, you MUST consider spending some time learning LaTeX to make the difference in your final outcome. I have seen Ph.D. manuscripts written in MS Word and I have to say that somehow (for me) it diminishes the value of the manuscript.
- **You work with abundant bibliography.** Professional works may manage hundreds of citations. Citations must have a consistent format, otherwise your bibliography section will be a mess. To save time, you must go with LaTeX + BibTeX. Fill your BibTeX file with your citation entries, tag them, and use the tag in your latex document as a reference. The compiler will do the rest of the work. I know there are plugins and solutions for MS Word and other text processors. But remember, for thirty years, this problem has been solved with plain text. And from my experience, these plugins result cumbersome.
- **You are using formulas.** Plugins can easily manage formulas like:

$$y = \frac{1}{x}$$

Other formulas like

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

can be impossible to write. Every decent solution around to manage math formulas is based on LaTeX. Why not use it directly?

# Overleaf

Overleaf is an online collaborative writing and publishing tool that makes the whole process of writing, editing and publishing scientific documents much quicker and easier.

Overleaf provides the convenience of an easy-to-use LaTeX editor with real-time collaboration and the fully compiled output produced automatically in the background as you type.

## What's the Appeal of Overleaf

**Ease of Use.** Overleaf is a ready-made tool. “It just works”, not excluding less tech-savvy users. It's a lot more user-friendly than maintaining a LaTeX installation yourself, which drastically lowers the entry barrier. You can get collaborators to use LaTeX far more easy if you say “You just need to register there and then click this link”, compared to giving them a whole page of installation instructions. The fact that it only works with LaTeX (and not plain TeX oder ConTeXt, e.g.) out of the box does not matter to its target group.

**Mobility & LaTeX as a hosted service.** It works on the Internet. This means you can use it from anywhere in the world, really, without a local setup: a friend's computer, the terminals in the library or some lab where you might not be able to use USB drives; even your tablet or cell phone in a pinch.

**Sharing & Collaboration.** It works a lot like “Google Docs for LaTeX”. Several users can edit the same document at the same time, there is a chat feature and you can add comments and track changes with ease. You can leave notes anywhere, you can see where the cursor of the other person is. You can sit in a teleconference with another author and discuss the paper and make changes in a very natural and organic way. It's also easy to share a document, without having to explicitly compile and send it (via email, say.) Proper version control is still possible (Overleaf allows for syncing projects with Dropbox or GitHub, e.g.) but you don't have to persuade and teach other users to use git properly.

**Document Organization & Templates.** Overleaf allows you to create an organized library of your previous work to which you can refer to in the future. It also provides a collection of useful templates for various use cases that you can simply open in a new project, or download to use offline.

<https://tex.stackexchange.com/questions/573627/whats-the-appeal-of-overleaf>

# Demonstration: Overleaf

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# Adding a .bib file & Citations to an Overleaf Template

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1. Go to Templates
2. Search Elsevier
3. Click Elsevier's CAS LaTeX Single-Column Template
4. Open as Template
5. Fill in some Areas (e.g. Author and Introduction)
6. Add your .bib file to the folder
7. Type the .bib file name in the bibliography section
8. Compile the Paper