What you need to know about finding and using quality information
Faculty workshop series

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What I’ll be talking about

- Overview of quality sources
- Where to get background info
- Process for searching effectively for detailed info
- Organizing and referencing what you find
- Literature reviews
Research in undergrad courses

Type some words into Google Scholar, and **presto**!

- Some papers on your topic
- Good enough
Laser assisted bioprinting of engineered tissue with high cell density and microscale organization

B Guillotin, A Souquet, S Catros, M Duchastel... - Biomaterials, 2010 - Elsevier
Over this decade, cell printing strategy has emerged as one of the promising approaches to organize cells in two and three dimensional engineered tissues. High resolution and high speed organization of cells are some of the key requirements for the successful fabrication of...

Tissue engineered skin substitutes created by laser-assisted bioprinting form skin-like structures in the dorsal skin fold chamber in mice

S Michael, H Sorg, CT Peck, L Koch, A Dewick... - PloS one, 2013 - journals.plos.org
Tissue engineering plays an important role in the production of skin equivalents for the therapy of chronic and especially burn wounds. Actually, there exists no (cellularized) skin equivalent which might be able to satisfactorily mimic native skin. Here, we utilized a laser...

Laser-assisted bioprinting for creating on-demand patterns of human osteoprogenitor cells and nano-hydroxyapatite

S Catros, JC Friscain, B Guillotin, B Pippenger... - IOP, 2011 - iopscience.iop.org
Developing tools to reproduce and manipulate the cell micro-environment, including the location and shape of cell patterns, is essential for tissue engineering. Parallel to inkjet printing and pressure-operated mechanical extruders, laser-assisted bioprinting (LAB) has...

Dispensing pico to nanolitre of a natural hydrogel by laser-assisted bioprinting

M Grune, C Ungher, L Koch... - Biomedical... - Biomedical-engineering-online...
But...

- In grad school and in engineering practise, you are expected to be able to quickly find and summarize the **quality** scientific literature on very specific topics
But…

- When you are working in industry, you will not usually be asked to ‘do a literature review’
- But you will be asked to evaluate different options/methods/etc, prepare reports
- You will need to do research! With little guidance
The process of researching and writing a paper

1. **CHOOSING A TOPIC**
   Do some preliminary searching to help think of ideas

2. **SEARCHING**
   While searching, you may decide you need to refine your topic

3. **REVIEWING WHAT YOU FIND**
   It’s important to organize as you go

4. **WRITING & CITING**
   You may need to do more searching at this point

5. **CHOOSING WHERE TO SEARCH**
   Look to a research guide or librarian for advice
Types of sources in engineering

- Broader (context)
- Textbooks, reliable news sources
  - Scholarly books, handbooks, industry publications/sites
    - More detailed
      - Research articles, conference papers, patents
What does it mean to be a quality source in science and engineering?

- There are so many types of sources and information that it’s impossible for me to give you specific guidance about every type
What does it mean to be a quality source in science and engineering?

Characteristics of a good source:

▸ **Authoritative** – written/created by someone knowledgeable in the topic

▸ **Balanced** – acknowledges the strengths and limitations of the research discussed, without a clear conflict of interest

▸ **Supported** – references other quality sources to support their claims

▸ **Timely** – The conclusions are still valid and have not been made outdated by newer work
Example situation

- You’re writing a report reviewing the most accurate AI image analysis methods to help detect cancerous skin growths like moles
Example

- Searching on Google for ‘skin cancer AI’, some of the results include
  - An article from ‘Healthcare IT News’ about a new product
  - An article in the Guardian describing the results of a scientific paper
  - A press release from the American Academy of Dermatology
Example

- Many of these pages are talking about and summarizing scientific/engineering research
- But the accuracy of the summary varies
  - It is hard to tell if you don’t read the original research too
Example

Questions to ask:
1. Is this source detailed?
2. Is it balanced – does it provide pros and cons of the proposed topic?
3. How much expertise does the author have on the topic?
4. Not in a biased position?
5. Does it reference its own sources of info?
What distinguishes journal articles from most other sources?

- Describe research done by the authors themselves (except for review articles)
- Peer-reviewed (checked) by other independent researchers
- Each article references many other articles and documents
- They can be advanced and quite difficult to read!
What distinguishes journal articles from other sources?

- Special type of article called a review article
- Summarizes developments in a topic of research
- Find them in the databases I’ll show later
Research Databases – what are they?

▸ Research databases are designed to help users find relevant info for academic or research purposes
▸ They are not journals – they don’t host the articles on their own sites
▸ Most research databases focus on journal articles and books
▸ Unlike a search engine, the contents are partly manually screened to ensure a minimum level of quality
## Comparison

<table>
<thead>
<tr>
<th>Google or Google Scholar</th>
<th>Research database</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOTS of results for a typical search</td>
<td>Many fewer results</td>
</tr>
<tr>
<td>Includes papers, theses, reports, course pages, corporate publications, etc.</td>
<td>Focused on scholarly articles and papers. Has specific criteria for which journals/conferences are included.</td>
</tr>
<tr>
<td>Uses lots of AI to try to guess what you are looking for</td>
<td>Only uses a little AI, is quite literal</td>
</tr>
<tr>
<td>Has only a couple filtering options to help you sort through</td>
<td>Has many filtering options</td>
</tr>
</tbody>
</table>
Start searching with introductory sources
Start with introductory sources

- If you are researching a topic you’re not already knowledgeable about, start with broader info sources
- E-books on the topic from the library
- Trade/industry publications on a topic (you can google trade publication *topic X”*)
- See [our research guides for each subject](#) for specific recommendations
Start with introductory sources

- AccessEngineering textbooks – cover typical course subjects in all areas of engineering
- LinkedIn Learning – online courses and videos on software and business topics
- Synthesis Lectures – short books on topics in computer, electrical and applied math
- Access all of them using Databases list
Advanced searching for detailed info
Research Databases

- When you know how to use, you can find much more relevant articles for specific searches
  - But you need to prepare your search
Preparing your search strategy

Steps in preparing a detailed search query:

1. **Identify the key concepts in your research question** - focus on scientific terms only

2. **Find synonyms, variations, and/or alternate spellings for each concept**

3. **Connect your concepts together into a machine-readable query with Boolean search operators** AND, OR, ()

4. **Run your search and evaluate how useful the results are**
1. Identify the key concepts in your topic

- Review of the most accurate AI image recognition methods to help detect cancerous skin growths like moles

- A focused question will usually have 3-4 concepts
- Don’t include general terms like ‘accurate’, methods, etc
2. Generate alternate terms for your concepts

<table>
<thead>
<tr>
<th>Concept 1</th>
<th>Concept 2</th>
<th>Concept 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>skin cancer</td>
<td>AI</td>
<td>image, imagery</td>
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</tbody>
</table>


2. Generate alternate terms for your concepts

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<td>AI</td>
<td>image, imagery</td>
</tr>
<tr>
<td>melanoma</td>
<td>artificial intelligence</td>
<td>photo, photograph</td>
</tr>
<tr>
<td>moles</td>
<td>neural network</td>
<td></td>
</tr>
<tr>
<td></td>
<td>deep learning</td>
<td></td>
</tr>
</tbody>
</table>
3. Build your Boolean search query

- Goal of a Boolean search string: tell the search engine that you want documents that:
  - Contain each of your concepts at least once
  - But for each concept, they can use any of the alternate terms
3. Build your Boolean search query

(Concept 1 OR alt term OR alt term…)

AND

(Concept 2 OR alt term OR alt term…)

30
### Other commands

<table>
<thead>
<tr>
<th>Asterisk * (wildcard)</th>
<th>electric* finds electric, electrical, electricity, etc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quotes “”</td>
<td>“anaerobic digestion” finds exact phrase</td>
</tr>
<tr>
<td>(parentheses)</td>
<td>Specifies the order of operations for search engine</td>
</tr>
</tbody>
</table>
3. Build your Boolean search query

(“skin cancer” OR melanoma OR moles) AND (AI OR “artificial intelligence” OR “neural network” OR “deep learning”) AND (photo* OR image*)
4. Run your search and look at the results

- Demo: library search
- Demo: Scopus
- Sort your results by relevance

- Even if you’re an expert, it’s normal to take 5-10 tries to arrive at a great search for your topic!!
Choose your topic or question

Choose the databases/sites to search

Turn your question into a structured Boolean search (concepts, synonyms)

Run your search

Look over the results – how relevant are they?

Filter or modify search

Repeat with next database

Review and save the documents you want
Comparison of Google Scholar and Scopus results

- Top Google Scholar results included some influential papers on the topic.
- But Scopus results were more on-topic overall.
- If you use one tool you’ll miss out!
Citations

- What is the ‘citation count’ of an article?
- Articles with lots of citations are usually influential or highly-regarded in their field
- But newer articles, or articles on very niche topics, will naturally have fewer
- Don’t just look at highly-cited articles
How do you know what search tool to use?

- Usually for a thorough paper you’ll want to use tool
  - Scopus
  - PubMed
  - Web of Science
  - Google / Google Scholar
  - Library catalogue (e-books)
  - IEEE Xplore

These are linked from my research guide
How do you know what search tool to use?

▸ There are other specific publisher databases that you may hear about (ScienceDirect, Springer, ASME, etc)

▸ It is rarely useful to search them because the other databases I’ve mentioned are more effective and will include the articles in these databases anyway
Finding free articles

- Scopus, Web of Science, IEEE Xplore are all subscription databases that uOttawa pays for you to have access to.
- So after you graduate, you probably won’t be able to use them.
- Google Scholar and PubMed are still free, but some of the articles they find are not freely available (‘open-access’).
- 1findr is a free tool that lets you search 30M open-access articles.
How do you know what search tool to use?

<table>
<thead>
<tr>
<th>Tool</th>
<th>Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scopus or Web of Science</td>
<td>Finding advanced information on a specific topic</td>
</tr>
<tr>
<td>Google Scholar</td>
<td>Easy to use, and good for finding non-peer reviewed info (e.g. reports, pre-prints, patents)</td>
</tr>
<tr>
<td>PubMed</td>
<td>Questions with an application to medical research/care</td>
</tr>
<tr>
<td>1findr</td>
<td>Finding free (open-access) articles</td>
</tr>
</tbody>
</table>
Practice Exercise

▸ Do a library search for
“autonomous vehicle” AND (safe OR safety) AND (test OR testing OR verif*)

▸ Do a Google search for
Autonomous vehicle safety testing

Which results looks best for an overview of the testing requirements AVs need to pass?
Which results look best for a paper on designing an automated validation test system?
Reading, using and citing your sources
Reading articles

- Seriously reading an article can be difficult! But it is possible

- https://www.sciencemag.org/careers/2016/03/how-seriously-read-scientific-paper
The structure of an engineering paper

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abstract</strong></td>
<td>A short summary of the article – read this first to see if you want to read the rest</td>
</tr>
<tr>
<td><strong>Introduction</strong></td>
<td>The reason for doing the study – <strong>the problem with the existing situation</strong> The previous literature that was used</td>
</tr>
<tr>
<td><strong>Methods (or procedure, design, setup, …)</strong></td>
<td>How the researchers did their study (Materials, fabrication of prototype, type of software used, …)</td>
</tr>
<tr>
<td><strong>Results and Discussion (analysis, …)</strong></td>
<td>What happened – how successful was the research compared to its goals?</td>
</tr>
<tr>
<td><strong>References</strong></td>
<td>The list of articles cited in the paper</td>
</tr>
</tbody>
</table>
Using your sources in a report

- When you are writing an engineering report, your goal is to **summarise** the info you have found, in a way that highlights what is most important for your particular report (and for your client)

- This can be difficult if you don’t understand the material – so some students copy and paste a sentence and just change a couple words
When deicing salts are applied on the surface of concrete to melt ice/snow, salt solutions are usually absorbed into the concrete joints, cracks, or pores, and thus saturate the concrete. As water evaporates during times of low precipitation/humidity, the concentration of salt in the pore solution increases.

Original text from article

Slightly modified

When deicing salts are used on concrete to melt snow, salt solution saturates the concrete through absorption in joints and cracks. When the water evaporates later during times of low precipitation/humidity, the salt concentration in the pores increases.

Using your sources in the report

- If you are only changing a few words, it is considered bad practice even if you cite the article.
- If you aren’t sure how to summarize a paragraph, read some more info so you understand the topic better.
- Another option is using a direct-quote.
Using your sources in the report

▸ Better example

When concrete encounters de-icing salts, the salt solutions are often absorbed into the cavities such as joints, cracks, or pores, which can create a chemical reaction with the cement paste, and change its chemical properties, resulting in damage to the concrete (Althoey, 2018). Physical damage may also occur in the form of cracking (due to high crystallization), freeze-thaw damage, corrosion of reinforcement, and scaling of the concrete surface. As the concrete slab becomes more exposed to de-icing salts, the concentration of salts penetrating the concrete slab increases, resulting in osmotic pressures in the pores (Althoey, 2018). The use of proper air entrainment, high-quality cementitious materials and aggregates, and admixtures are effective methods to mitigate the impact of de-icing salts on Portland cement concrete (Shi et al., 2010).

From a real student report in CVG
Common mistakes in using sources

▸ Making very broad conclusions based on one paper, because it helps your hypothesis
  ▸ If the result is from one experiment with four samples, don’t assume that the result is generally valid

▸ False precision when you describe data – e.g. ‘The price to build 1m2 of the designed slab is 130 $/ m2 in the Ottawa region’

▸ Using only one type of source – e.g. only industry news, or only academic articles
Referencing your sources to avoid plagiarism

- When you write a term paper in your M.Eng. degree, you do not have to pretend that you are already a master expert on the entire topic – this is unrealistic
- This thinking can lead to plagiarism
Referencing your sources to avoid plagiarism

- Reminder: You need to cite everything that you learn in your research that contributes to your report – not just statistics and direct quotes
- This applies to any type of source you use
  - an assignment you find on the internet
  - an image you found on social media
  - A YouTube video
- Citing gives credit where it is due, and is required to avoid plagiarism
What do I need and not need to cite?

▸ You don’t need to reference facts that are well-known by everyone in your field

▸ This normally includes the basic definitions of popular technical terms

▸ For example, in a class on machine learning, you would not normally be expected to cite something for a short definition of supervised learning in your paper
What do I need and not need to cite?

- But you need to cite everything else
- If you are writing several paragraphs explaining the steps in a supervised learning process, you need to cite your sources for that, even if it’s your course textbook
What do I need and not need to cite?

- But you need to cite everything else.
- If you are describing something included in multiple papers equally, you may cite multiple papers at once.

Macromixing in single and multiphase continuous reactors of all scales is measured using residence time distribution (RTD) (Trambouze and Euzen, 2004, Kalaga et al., 2012, Kalaga et al., 2017). Knowing the RTD can help predict yield and diagnose problems in reactor operations (Fogler, 2006a). Furthermore, Kuan et al.’s (2014) work with secondary flow in twisted pipes in the laminar regime indicates that heat transfer, mass transfer, and RTD are linked and can be optimized simultaneously. RTD is therefore useful to determine the appropriateness of a particular micro-reactor for a specific application when examined in conjunction with other characteristics.
Citation example

In text of a paper:

“Tayo, Caparanga, Doma and Liao (2018) reviewed six current oxidation treatment methods and found that....“

In the bibliography at the end of the paper

More help on citations

- This [page from MacMaster University](#) has more guidance on what needs to be cited in science and engineering.
- For examples of creating a citation, see the ‘How to Cite’ page in each program’s [research guide](#).
Organizing your sources with a citation manager

- Because of the importance of referencing, it’s very important to be organized when doing research
- Never copy text into your draft essay without including the source with it
- Take notes (paper or electronic) describing the key points of an article
- Save journal articles and book chapters as PDFs with proper file names
Organizing your sources with a citation manager

- A citation manager like Zotero or Mendeley will save you a lot of time and will help you avoid plagiarism by keeping organized!
- Both are free to download
- Make sure the citation info created by the program is correct!
- Check that there are links to all electronic documents in your bibliography (including books, articles, etc.)
Citation workflow

Searching

Organizing papers

Zotero / Mendeley

Writing

Google Docs
<table>
<thead>
<tr>
<th>Title</th>
<th>Creator</th>
<th>Item Type</th>
</tr>
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<tbody>
<tr>
<td>Building an Internet of Things Risk Model in the Wake of Mirai</td>
<td>Gib Sorebo</td>
<td>Blog Post</td>
</tr>
<tr>
<td>IoT Security: What's Plan B?</td>
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<tr>
<td>Your WiFi-connected thermostat can take down the whole Internet. We need new regulations.</td>
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<tr>
<td>IoT Cybersecurity Considerations</td>
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<tr>
<td>Smart grid standards for home and building automation</td>
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<tr>
<td>Resilience and Cyber Security of Technology in the Built Environment</td>
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<td>Major requirements for building Smart Homes in Smart Cities based on Internet of Things technology</td>
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<td>Security and Liability in the Internet of Things</td>
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<td>Advancing the Internet of Things in Europe</td>
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<tr>
<td>Protecting Buildings Operational Technology (OT) from Evolving Cyber Threats &amp; Vulnerabilities</td>
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<tr>
<td>SECURING THE INTERNET OF THINGS: RISKS, REGULATIONS, AND SUGGESTIONS FOR CLIENTS</td>
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<td>Smart Buildings - People and Performance</td>
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<td>Information Technologies Engineering</td>
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<td>Cybersecurity in Smart Buildings: Preventing Vulnerability While Increasing Connectivity</td>
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<tr>
<td>2016 federal support - IoT pdf</td>
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<tr>
<td>IoT Considerations, Requirements, and Architectures for Smart Buildings</td>
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<td>#x2014; Energy Optimization</td>
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<td>Minoli et al.</td>
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Writing resources

▸ **Guides for STEM (available online):**

Reviewing the literature

- For term papers or directed readings, your professors want you to **synthesize the state-of-the-art literature** on a topic
  - What does this mean?
  - The overall goal is to communicate a summary of what you
Reviewing the literature

- For term papers or directed readings, your professors want you to **synthesize the literature** on a topic
  - What does this mean?
  - They don’t want you to just re-write the abstracts of some papers (for example,

  Paper A conducted experiments in...
  Paper B did an analysis of another thing...
  Paper C did something different....
Reviewing the literature

- For term papers or directed readings, your professors want you to synthesize the literature on a topic
  
  - It’s better if you can do the following: Traditional Method A for this problem (papers X, Y, Z)

  Alternative Method B (papers W, U, V) has these strengths and weaknesses in comparison
Reviewing the literature

- For term papers or directed readings, your professors want you to synthesis the literature on a topic
  - It’s very important to pick a good, specific topic so that you are able to do this well
  - Don’t be afraid to adjust your topic partway through (with permission of your instructor)
Reviewing the literature


At work

- You won’t have access to most of the research databases and articles you have now (even working for a large engineering company)
  - Use Google Scholar or 1findr to search and find technical info
- The same expectations re: what you cite apply to reports, documents, and emails you produce in professional practice
At work

- The expectations re: the particular citation style you use are often not as formalized, depending on the type of document
- But you cannot pass off someone else’s words as your own
- This includes even text you find on a webpage without an author identified
Intellectual property

- Innovations and work you create professionally may be your own “intellectual property” (IP), or the property of your employer

- Categories include
  - Copyrighted material
  - Patentable innovations/inventions
  - Industrial designs and circuit designs
  - Trade secrets

- Canadian Intellectual Property Office
Intellectual property

- Drawings, models, plans and documents created in engineering and design work are protected automatically by copyright in Canada.
- This means you cannot re-use someone else’s engineering work without their permission, unless they have published it.
- This would be a violation of the Code of Ethics of the Professional Engineers Act of Ontario.
Intellectual property

- By default, IP may belong to either you or your employer - depending on the category of IP, the type of employment you have, and who created the IP
  - Is often governed by an employee or contractor agreement
  - If you work as a contractor, you must be aware of this area
  - If you are bringing IP that you have created or found into a job, you must also be careful
More help

See Research Guides for each subject on the library website
Contact info for us is there

**Evan Sterling**
- Civil and Enviro Eng
- Mechanical and Biomedical
- Engineering and Business/Management

**Jolene Hurtubise**
- ECE and CompSci

**Amanda Hodgson**
- Chem and Biological Engineering