
Designing a Great
Research Poster!

Today's Learning Objectives:

Students will be able to:

1. Apply organizational features to create an effective poster
    a. Create logical headers and supporting text/visuals
    b. Develop argumentative structures
2. Demonstrate effective use of language, contextualized within the genre
    a. Maintain professional and appropriate tone
    b. Use content-specific persuasive style
3. Illustrate data effectively
    a. Create large, clear, readable visuals that support arguments
    b. Link visual evidence to tell a complete data story

Many skills are needed to create an effective poster

1. Summarizing your data is a key skill (especially visually)
2. Communicating to non-expert audiences is essential
3. Collaborating and presenting as a team is a learned skill
4. Editing your work to suit the requirements is important

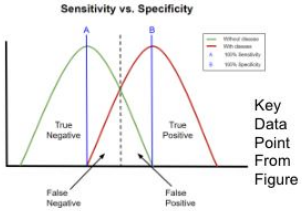
How many of you have created/presented a research poster?

90 A title that alludes to the method, STATES a CONCLUSION, and gestures toward the application (& uses the client/product name)

70 Names of authors go here in a smaller font

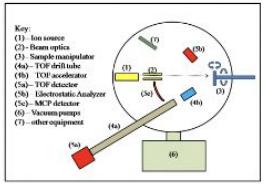
Introduction 75

- Research question
- Background, context,
- Motivation
- Bullet points
- Keep it brief 50

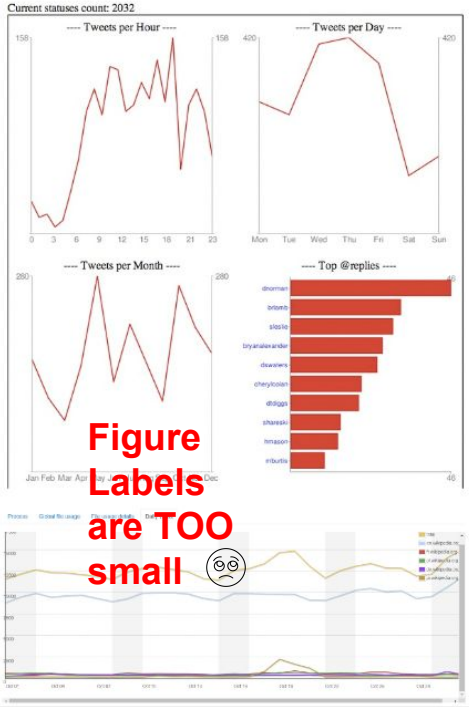


Key Data Point From Figure 40

Methods



Content-specific title



Text that explains this graph, the key data that you want your audience to see

Text that explains this graph, the key data that you want your audience to see

Text that explains this graph, the key data that you want your audience to see

Figure Labels are TOO small

Content-specific title

- Key point
- Another point
- Data

Text that explains this graph, the key data that you want your audience to see

Conclusions

- The most important things
- Key figures
- Numbers

References

- Just what is needed
- Seriously, just a couple

Margins are not equal

Arrange elements to maintain symmetry & cohesion

Margin size is up to you, but white space is GREAT

Each design choice should be repeated once to maintain unity

> Example: vertical margins are the same size, a header that begins half-way down on the left side aligns with another element on the right

Maintain symmetry: visually balance your poster

Columns do not need to be equal size

MSEC

MSEC NAMRC Conference, Hosted by Purdue University
June 27th , 2022 – July 1st , 2022

Company, Univ and lab logos

Add NSF or other funding agency logo (to the right) →

TITLE OF POSTER ARIAL 88 PT CENTERED ON POSTER SMALL CAPS

Author box centered on poster
Author Arial 44 pt bold centered
Affiliations Arial 40 pt italics centered
Upper and lower case
email address

Text Box 1 16 inches wide ½ inch from left edge

HEADERS IN BOLD ARIAL 32 PT FONT SMALL CAPS

possible header sections (but author will select based on research)

- **INTRODUCTION (OR BACKGROUND)**
- **RESULTS**
- **DISCUSSION**
- **CONCLUSIONS**
- **REFERENCES**
- **ACKNOWLEDGMENTS**

Body text in Arial 28 point font, upper and lower

All text fully justified

Figures, tables and other graphics should be inserted within the confines of the text box areas shown

Abstract box centered on poster

ABSTRACT: IN BOLD ARIAL 32 PT FONT SMALL CAPS

200 words max

Body text in Arial 28 point font

All text fully justified

Adjust the box size to fit around the text

Text box 2 centered on poster

HEADERS IN BOLD ARIAL 32 PT FONT SMALL CAPS

Body text in Arial 28 point font, upper and lower

All text fully justified

Figures, tables and other graphics should be inserted within the confines of the text box areas shown

Text box 3 16 inches wide ½ inch from right edge

HEADERS IN BOLD ARIAL 32 PT FONT SMALL CAPS

Body text in Arial 28 point font, upper and lower

All text fully justified

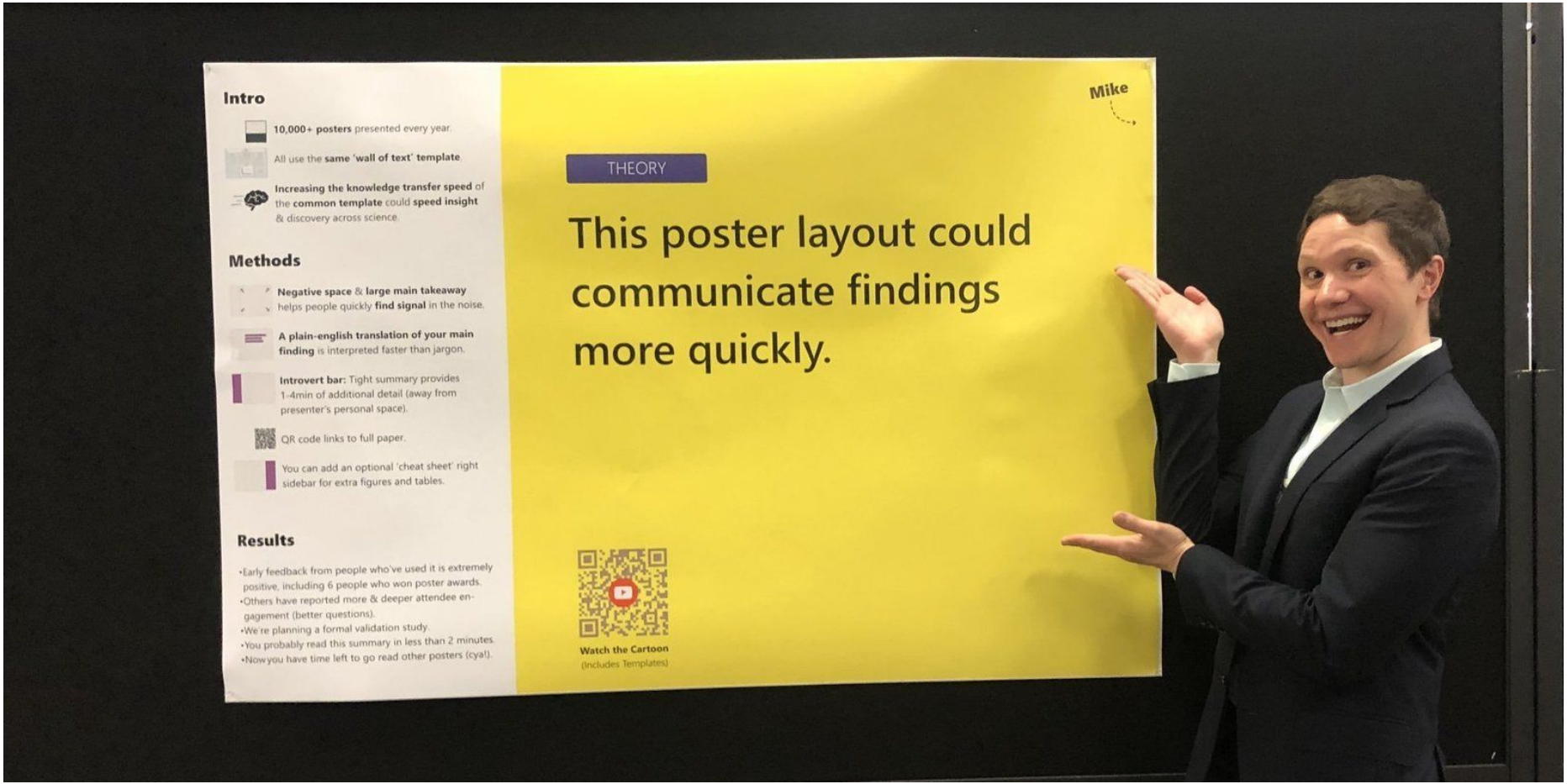
Figures, tables and other graphics should be inserted within the confines of the text box areas shown

POSTER SUBMISSION for REVIEW:

1. Save as a PDF
2. Make sure that the PDF file size does not exceed 15 MB
3. **Submit the posters through the ASME conference webtool (and not via email to organizers or ASME staff)**
4. E-mail Prof. Binil Starly, NC State (bstarly@ncsu.edu) or Prof. Yong Chen, University of Southern California (yongchen@usc.edu) with any questions about the poster layout or content.
5. Email toolboxhelp@asme.org with any questions about the submissions process.
6. **Posters must be submitted by March 1st, 2022**
7. Authors will be notified by **March 15, 2022**
8. You may submit a poster for review even if you did not submit a poster abstract in November 2021.
9. The Copyright Transfer Form must be completed by March 26, 2022.
10. If poster is accepted, presenter should be registered by April 15, 2022, to prevent the poster (and abstract) from being withdrawn from the conference.

ACKNOWLEDGE source(s) of funding

Do not forget to include the grant number(s) if the work was funded by a national funding agency.


Intro
10,000+ posters presented every year.
All use the same 'wall of text' template.
Increasing the knowledge transfer speed of the common template could speed insight & discovery across science.
Methods
Negative space & large main takeaway helps people quickly find signal in the noise.
A plain-english translation of your main finding is interpreted faster than jargon.
Introvert bar: Tight summary provides 1-4min of additional detail (away from presenter's personal space).
QR code links to full paper.
You can add an optional 'cheat sheet' right sidebar for extra figures and tables.
Results
•Early feedback from people who've used it is extremely positive, including 6 people who won poster awards.
•Others have reported more & deeper attendee engagement (better questions).
•We're planning a formal validation study.
•You probably read this summary in less than 2 minutes.
•Now you have time left to go read other posters (cya!).
Mike
THEORY
This poster layout could communicate findings more quickly.
Watch the Cartoon
(Includes Templates)

How would you adapt the poster for these scenarios?

1. Poster displayed in a lab during a sponsor visit (no one presents it)
2. Poster emailed to an executive as a summary of work completed
3. Poster presented at an ASME conference
4. Poster presented at a University-wide, interdisciplinary graduate student symposium
5. Poster presented to engineers and marketing experts in a workplace situation

Outline your poster before you begin creating it

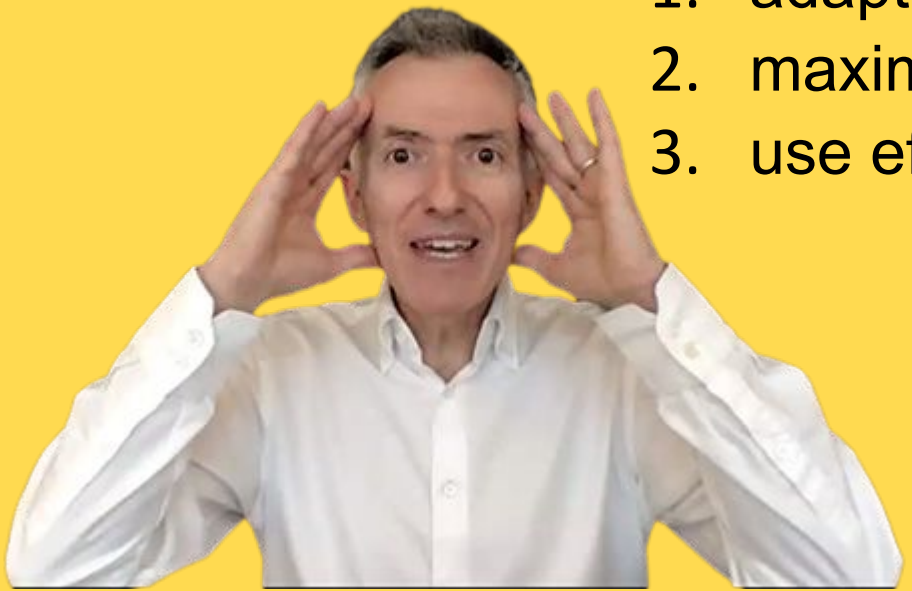
1. Consider ‘backward design’ to sketch out your presentation
    a. Tell your data story (beginning, middle, end)
    b. Curate a set of visual evidence

2. Plan your oral delivery WITH your visual aid

Your Poster Should Convey the Following:

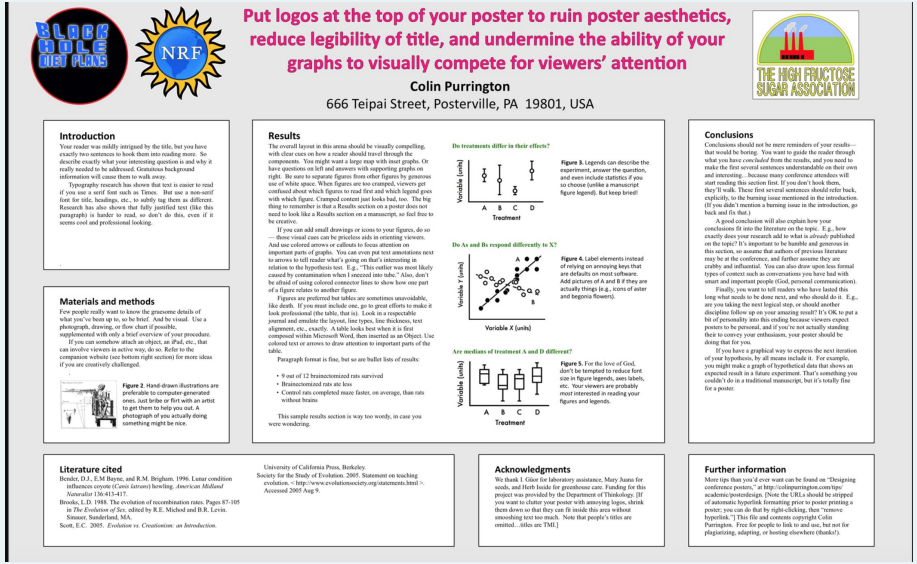
1. What technical problem you are addressing
2. What approaches you used (experimental, analysis, design)
3. What key findings you discovered
4. What impact your solution provides

Doumont's 3 rules of effective communication are universal



1. adapt to your audience
2. maximize the signal-to-noise ratio
3. use effective redundancy

Perceived cognitive load stands between your message and your audience



Put logos at the top of your poster to ruin poster aesthetics, reduce legibility of title, and undermine the ability of your graphs to visually compete for viewers' attention

Colin Purrington
666 Teipai Street, Posterville, PA 19801, USA

Introduction

Your reader was mildly intrigued by the title, but you have exactly two sentences to hook them into reading more. So describe exactly what your interesting question is and why it really needed to be addressed. Gratuitous background information will cause them to walk away.

Typography research has shown that text is easier to read if you use a serif font such as Times. But use a non-serif font for title, headings, etc., to subtly tag them as different. Research has also shown that fully justified text (like this paragraph) is harder to read, so don't do this, even if it seems cool and professional looking.

Materials and methods

Few people really want to know the gruesome details of what you've been up to, so be brief. And be visual. Use a photograph, drawing, or flow chart if possible, supplemented with only a brief overview of your procedure.

If you can somehow attach an object, an iPad, etc., that can involve viewers in active way, do so. Refer to the companion website (see bottom right section) for more ideas if you are creatively challenged.

Figure 2. Hand-drawn illustrations are preferable to computer-generated ones. Just bribe or flirt with an artist to get them to help you out. A photograph of you actually doing something might be nice.

Results

The overall layout in this arena should be visually compelling, with clear cues on how a reader should travel through the components. You might want a large map with inset graphs. Or have questions on left and answers with supporting graphs on right. Be sure to separate figures from other figures by generous use of white space. When figures are too cramped, viewers get confused about which figures to read first and which legend goes with which figure. Cramped content just looks bad, too. The big thing to remember is that a Results section on a poster does not need to look like a Results section on a manuscript, so feel free to be creative.

If you can add small drawings or icons to your figures, do so — those visual cues can be priceless aids in orienting viewers. And use colored arrows or callouts to focus attention on important parts of graphs. You can even put text annotations next to arrows to tell reader what's going on that's interesting in relation to the hypothesis test. E.g., "This outlier was most likely caused by contamination when I sneezed into tube." Also, don't be afraid of using colored connector lines to show how one part of a figure relates to another figure.

Figures are preferred but tables are sometimes unavoidable, like death. If you must include one, go to great efforts to make it look professional (the table, that is). Look in a respectable journal and emulate the layout, line types, line thickness, text alignment, etc., exactly. A table looks best when it is first composed within Microsoft Word, then inserted as an Object. Use colored text or arrows to draw attention to important parts of the table.

Paragraph format is fine, but so are bullet lists of results:

- 9 out of 12 brainectomized rats survived
- Brainectomized rats ate less
- Control rats completed maze faster, on average, than rats without brains

This sample results section is way too wordy, in case you were wondering.

Do treatments differ in their effects?

Figure 3. Legends can describe the experiment, answer the question, and even include statistics if you so choose (unlike a manuscript figure legend). But keep brief!

Do As and Bs respond differently to X?

Figure 4. Label elements instead of relying on annoying keys that are defaults on most software. Add pictures of A and B if they are actually things (e.g., icons of aster and begonia flowers).

Are medians of treatment A and D different?

Figure 5. For the love of God, don't be tempted to reduce font size in figure legends, axes labels, etc. Your viewers are probably most interested in reading your figures and legends.

Conclusions

Conclusions should not be mere reminders of your results—that would be boring. You want to guide the reader through what you have *concluded* from the results, and you need to make the first several sentences understandable on their own and interesting... because many conference attendees will start reading this section first. If you don't hook them, they'll walk. These first several sentences should refer back, explicitly, to the burning issue mentioned in the introduction. (If you didn't mention a burning issue in the introduction, go back and fix that.)

A good conclusion will also explain how your conclusions fit into the literature on the topic. E.g., how exactly does your research add to what is *already* published on the topic? It's important to be humble and generous in this section, so assume that authors of previous literature may be at the conference, and further assume they are crabby and influential. You can also draw upon less formal types of context such as conversations you have had with smart and important people (God, personal communication).

Finally, you want to tell readers who have lasted this long what needs to be done next, and who should do it. E.g., are you taking the next logical step, or should another discipline follow up on your amazing result? It's OK to put a bit of personality into this ending because viewers expect posters to be personal, and if you're not actually standing their to convey your enthusiasm, your poster should be doing that for you.

If you have a graphical way to express the next iteration of your hypothesis, by all means include it. For example, you might make a graph of hypothetical data that shows an expected result in a future experiment. That's something you couldn't do in a traditional manuscript, but it's totally fine for a poster.

Literature cited

Bender, D.J., E.M Bayne, and R.M. Brigham. 1996. Lunar condition influences coyote (*Canis latrans*) howling. *American Midland Naturalist* 136:413-417.

Brooks, L.D. 1988. The evolution of recombination rates. Pages 87-105 in *The Evolution of Sex*, edited by R.E. Michod and B.R. Levin. Sinauer, Sunderland, MA.

Scott, E.C. 2005. *Evolution vs. Creationism: an Introduction.* University of California Press, Berkeley.

Society for the Study of Evolution. 2005. Statement on teaching evolution. < http://www.evolutionsociety.org/statements.html >. Accessed 2005 Aug 9.

Acknowledgments

We thank J. Glue for laboratory assistance, Mary Juana for seeds, and Herb Inside for greenhouse care. Funding for this project was provided by the Department of Thinkology. [If you want to clutter your poster with annoying logos, shrink them down so that they can fit inside this area without smoothing text too much. Note that people's titles are omitted…titles are TMI.]

Further information

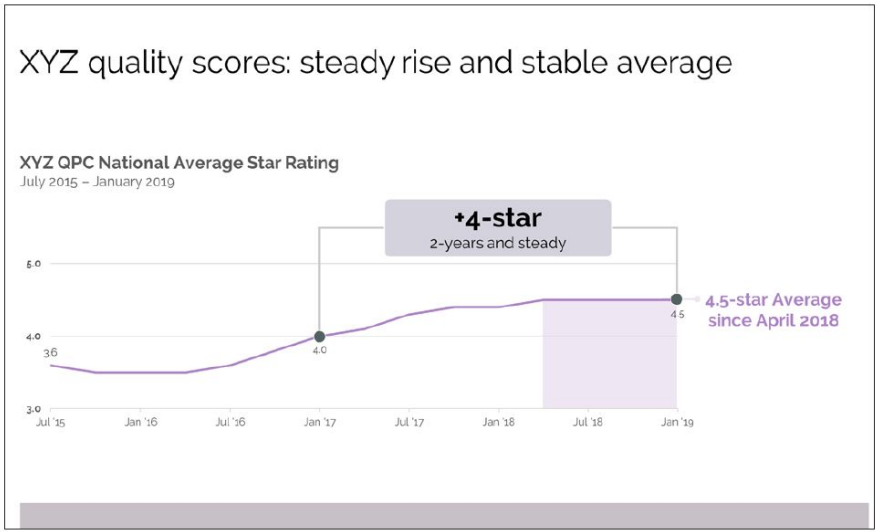
More tips than you'd ever want can be found on "Designing conference posters," at http://colinpurrington.com/tips/academic/posterdesign. [Note the URLs should be stripped of automatic hyperlink formatting prior to poster printing a poster; you can do that by right-clicking, then "remove hyperlink."] This file and contents copyright Colin Purrington. Free for people to link to and use, but not for plagiarizing, adapting, or hosting elsewhere (thanks!).

Mental effort = disengagement

1. Guide your viewer’s eye by overlaying visual annotations

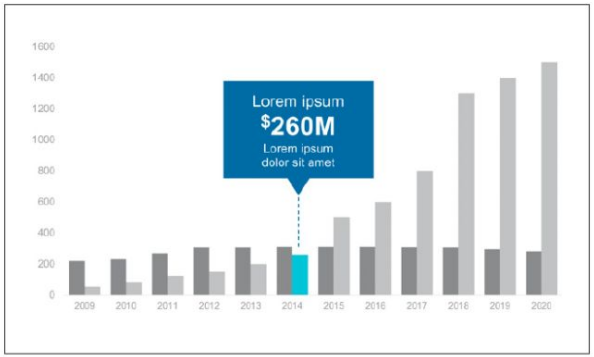
2. Do the work for your audience

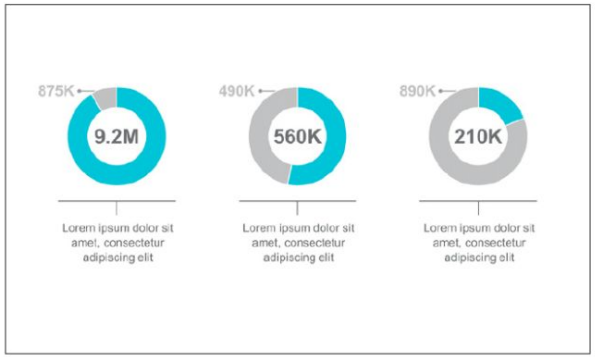
Visual Annotations are Effective



ADD LABELSTO CHARTSTO COMMUNICATE WHAT'S IMPORTANT

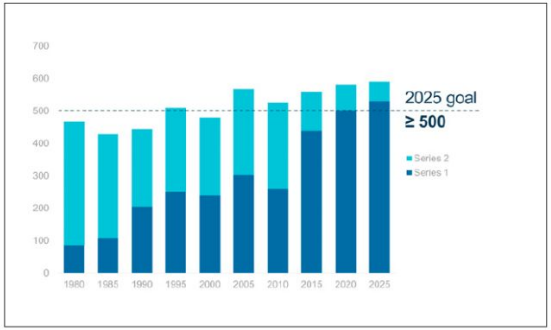
Charts often include a lot of numbers and data, and it can be hard for a viewer to know where to look. To draw attention to the most important points, call out statistics with labels or large type in addition to using a contrasting color.

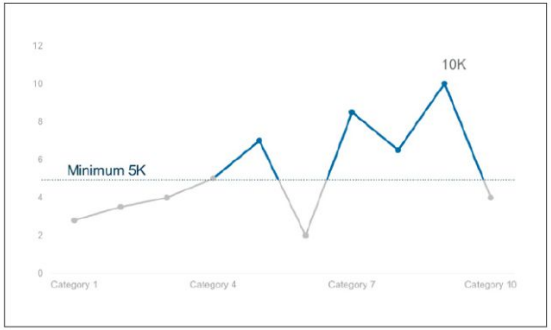


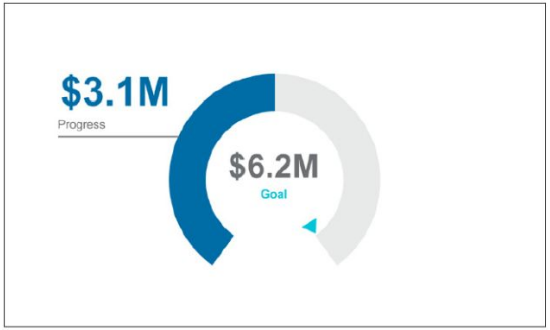


DELINEATING DATA SHOWS SHORTFALLS AND SURPLUSES

Adding a simple horizontal line to indicate a baseline turns a simple chart into a clear visualization of where benchmarks are being met and where they are not.

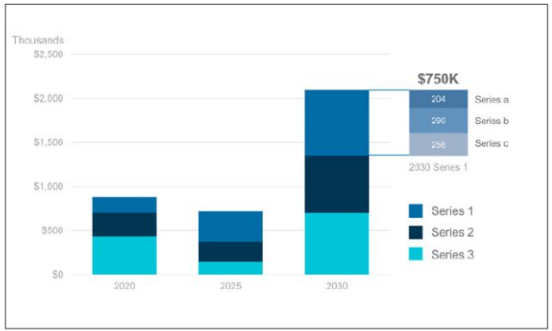


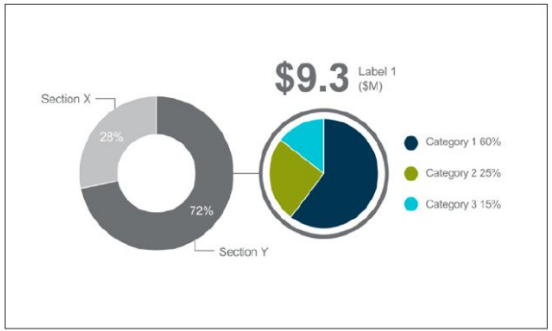




DISSECT DATA BY EXPLODING IT OUT

To provide additional information on one data set, create a secondary element on the chart where you highlight subcategories with colors and graphics.





Tell us the recommendation at the beginning, refer to it throughout, repeat it at the end:
do this orally, visually, and/or textually.

Let’s look at poster elements top to bottom

Which title is most effective?

1. IOE 591 Progress Report on Cycle Time
2. Optimizing Ford's Manufacturing Process: IOE 591
3. Six Sigma Application to Ford Manufacturing: Improving Cycle Time
4. Progress Update on Optimizing Cycle Time
5. Ford Progress Update: Six Sigma Optimization has Improved Cycle Time

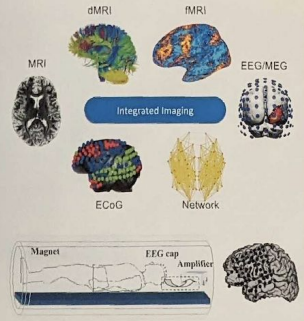
Laboratory of Integrated Brain Imaging

Principal Investigator: Zhongming Liu
Biomedical Engineering, Electrical and Computer Engineering,
University of Michigan, Ann Arbor

Biomedical Engineering
University of Michigan

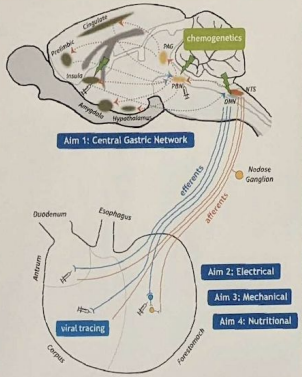
Electrical & Computer Engineering
University of Michigan

Multimodal Neuroimaging



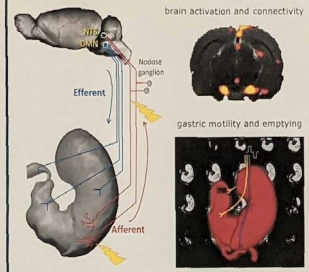
Funding: NIH R01MH104402

Gut-Brain Neuroaxis



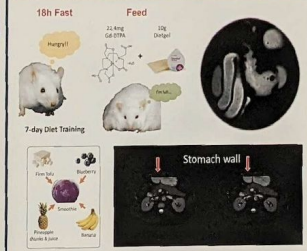
Funding: NIH R01AT011665

Bioelectric Medicine



Funding: NIH OT2OD023847

Gastrointestinal MRI



Funding: NIH R01AT011665

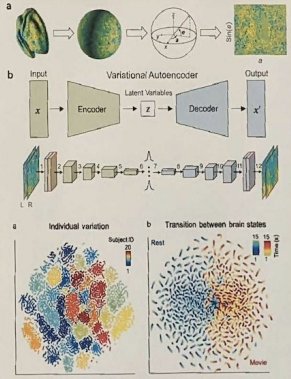
Virtual Stomach

Funding: NIH OT2OD030538

Brain Decoding

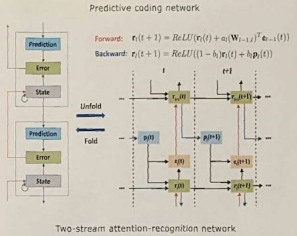
Funding: NIH R01MH104402

Machine Learning for fMRI

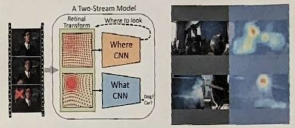


Funding: Michigan Precision Health

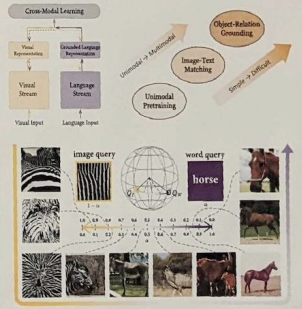
Brain-Inspired AI



Two-stream attention-recognition network



Grounding language to vision



Funding: NSF IIS 2112773

Medical School
University of Michigan

Michigan Engineering
University of Michigan

SORT 'N MERGE: A DETERMINISTIC MICROFLUIDIC PLATFORM FOR CO-ENCAPSULATING DISTINCT PARTICLES IN MICRODROPLETS

Meng Ting Chung [1], Daniel Nunez [2], Dawen Cai [2, 3], and Katsuo Kurabayashi [1, 4]

[1]Department of Mechanical Engineering, [2]Department of Cell & Developmental Biology, [3]Department of Biophysics, [4]Department of Electrical Engineering and Computer Sci.
University of Michigan, Ann Arbor, MI USA

Abstract

Single-cell study reveals cellular heterogeneity. **The key to successful sing-cell research is accuracy and throughput.** Although droplet-based microfluidics has a highest throughput among all the other tools, its efficiency significantly suffers from stochastic encapsulation process which prevents us from many applications. We presents a microfluidic platform for deterministic **co-encapsulation of two and three different particles at a yield as high as 87.0% and 80.1%**, respectively, by integration of active droplet sorting and downstream merging processes. This eliminates stochastic pairing processes for which severely limits the yield to < 10%.

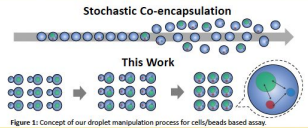


Figure 1: Concept of our droplet manipulation process for cells/beads based assay.

Background – Droplets based single-cell study

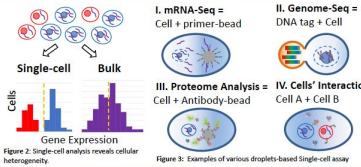


Figure 2: Single-cell analysis reveals cellular heterogeneity.

Figure 3: Examples of various droplets-based Single-cell assay

Challenge

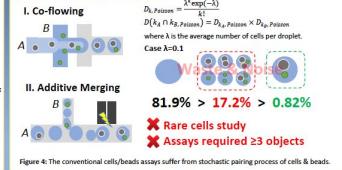
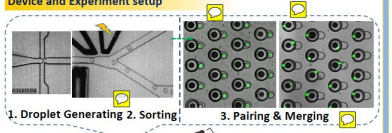


Figure 4: The conventional cells/beads assays suffer from stochastic pairing process of cells & beads.

Device and Experiment setup



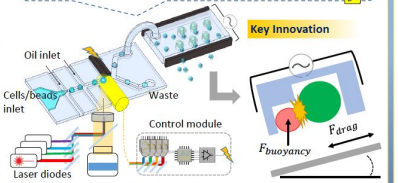


Figure 5: 3-D schematics of our microfluidic system composed of droplet generating/sorting and droplet merging devices. Scale bar:100μm.

Key Innovation

Figure 6: Operation principle of our droplet pairing & merging device. (Side view)

Spec:

Generating : 40/80 μm Droplets
Sorting : Up to **6,000 droplets / sec** (40μm)
Pairing: 500-3,000 Droplets pairs / Device
Merging : Up to **4** rounds of merging process

- Buoyance-based Capturing
- Size-based 1-1 Pairing
- Scalable & No back-Pressure
- Electrical Coalescence
- Multi-round merging

Result

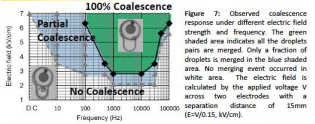


Figure 7: Observed coalescence response under different electric field strength and frequency. The green shaded area indicates all the droplets pairs are merged. Only a fraction of droplets is merged in the blue shaded area. No merging event occurred in white area. The electric field is calculated by the applied voltage V across two electrodes with a separation distance of 15mm (E=V/0.15, kV/cm).

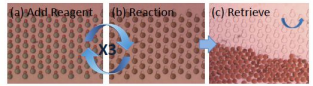


Figure 8: The capability of merging multiple droplets and retriving them for down-stream analysis.

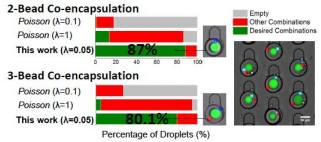
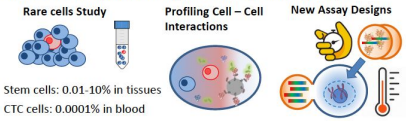


Figure 9: The histogram shows the success rate of droplets that contain the correct numbers of blue, red, and green fluorescent beads. The data was collected from a total 1176 host droplets in a merging device with 3 repeats.

Broader Impact

In additional to improve accuracy and efficiency of existing assays...



Stem cells: 0.01-10% in tissues
CTC cells: 0.0001% in blood

Acknowledgement

We acknowledge financial support from National Science Foundation (CBET-1263889), the Rackham Graduate Research Funds, M-Cubed interdisciplinary collaboration initiative of the University of Michigan, and Transducer Research Foundation. The Lurie Nanofabrication Facility at the University of Michigan, a member of the National Nanotechnology Infrastructure Network (NNIN) funded by the National Science Foundation, is acknowledged for support in microfabrication.

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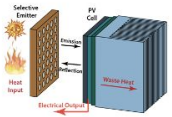
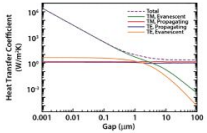
1. Department of Mechanical Engineering, University of Michigan; 2. Departamento de Física Teórica de la Materia Condensada and Condensed Matter Physics Center, Universidad Autónoma de Madrid; 3. Department of Materials Science and Engineering, University of Michigan.

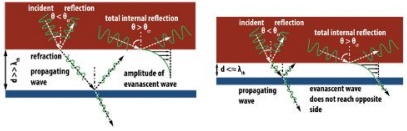
Motivation

- Thermal management of micro devices
- Thermal microscopy
- Energy conversion, e.g. nano-scale gap thermo-photovoltaics



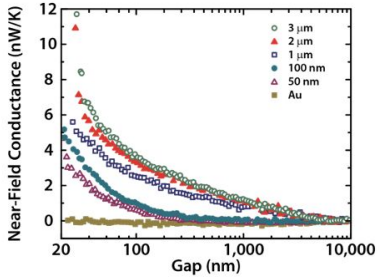


❖ How much can a thin dielectric coating contribute to radiative heat transfer?

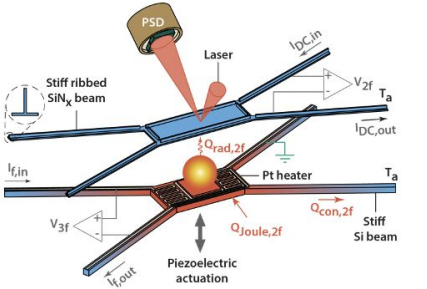


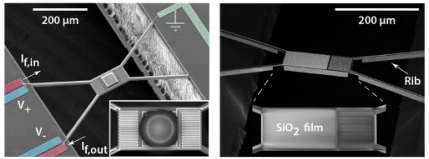
Intuition based on far-field behavior

Nanoscale Dielectric Coatings Enhance Near-field Radiative Transport

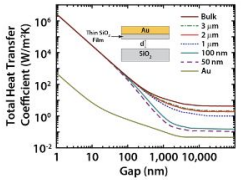


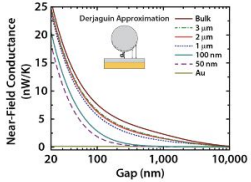
Experimental Setup



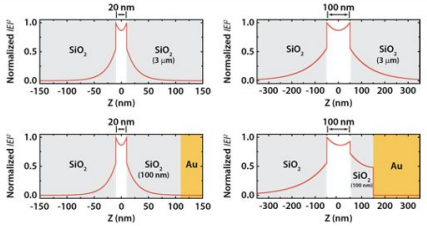


Fluctuational Electrodynamics Theory Predicts the Experimental Results





Penetration Depth Scales with Gap-Size



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M-TRAC - Transportation, University of Michigan

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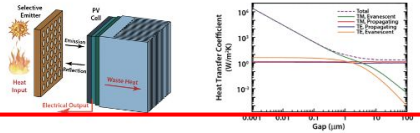

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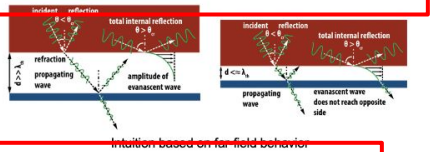

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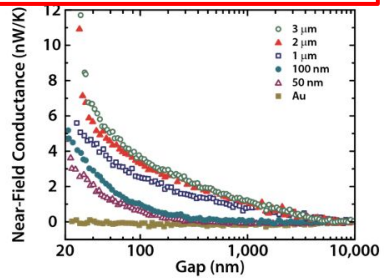

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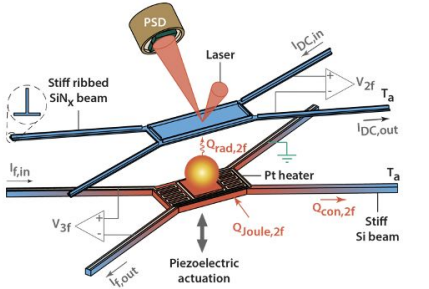

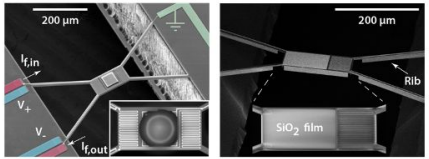

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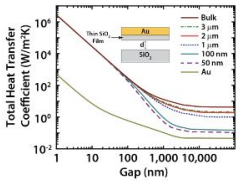

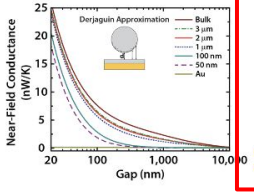

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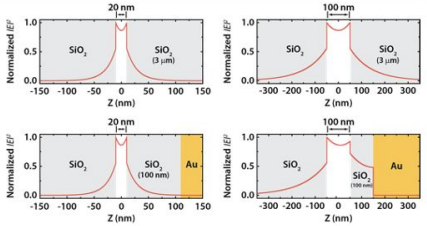

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College of Engineering, Center for Entrepreneurship, University of Michigan
M-TRAC - Transportation, University of Michigan

Design Element	Poster Detail	Best Practice Design Elements	I
Text Content	Title	Concise Describes Outcome	
	Author Info	Included	
	Introduction	Brief Clear; often broken into two paragraphs Includes essential background, research aims & hypothesis References used	
	Methods	Clear and concise Flowchart used	
	Results	Concise with bullet points Graphical summary of main findings References	
	Figure Legend	Included next to graph or not needed	
	Table Legend	Brief	
	Conclusion	Brief, restates major finding Describes limitations & future directions	
	References	Essential only	
	Acknowledgments	Brief	
	Headings	Describes content in section All caps, numbered	
Graphic Content	Diagrams	Used to graphically present methods Used to summarize major finding	
	Table	Methods-clear	
	Graphs	Large Chart junk removed No key Axis labeled Title describes what graph depicts No legend No background color	
	Images/Logos	Logo small and at bottom Images large and high contrast	
Aesthetics	Font Type	Sans serif for headings, serif for text Left justified	
	Font Size	Minimum 24-point, font 'hierarchy' consistent	
	Color Scheme	Cool tones that relate to the content	
	Poster Background	White, all elements clear and stand out	
	Layout (flow)	All elements aligned Ample white space Flow is clear from headings Results is largest section	
	Overall Assessment	Mainly visual with clear graphics and good flow; little text used, high signal to noise ration	

An Effective Research Poster Should Carry a Low Cognitive Load

Context

Expos, Conferences. Bait to hook passersby.

Title

Tell us your claim: one or two lines.
No noun strings: *Automotive Driveshaft Vibration Reduction Solution*

Format

Typography

Sans-serifed font (Arial, Helvetica)

Headings — clear separation among levels
Subheading

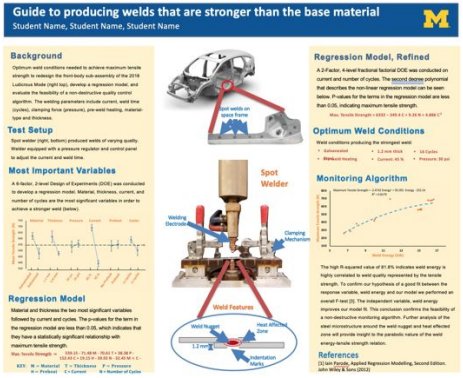
Font/point —avoid changes in typefaces.

Generous line spacing

Bullets/formatting

•Your text starts right next to the bullet, and when your text wraps it lines up under the bullet. (Avoid)

- Your text starts near the bullet, and when your text wraps it lines up under the text **(hanging bullets)** (Yes)



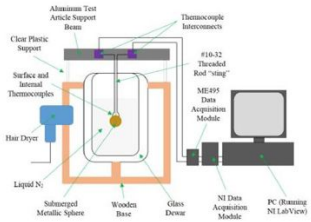
Prominent main visual—a wise choice for design

Visuals — must send a visual message

Low ratio of ink-to-data; cut non-data ink.

"Clutter and confusion are failures of design, not attributes of information"
Edward Tufte, *Envisioning Information*

Clutter: High ratio of ink-to-data, redundant closure with the box, unnecessary legend (direct label).



Good design, clear labels, low ratio of ink-to data. Line drawings sometimes better than a photo, show detail, cut non-data ink.

Common mistakes

Too much text, text too small, bad tracking

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nulla tempus lectus quis nulla sodales, non dapibus nisl cursus. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos himenaeos. Integer non tempus libero. Donec id consequat risus. Integer efficitur turpis a laoreet fringilla. Aliquam finibus mauris ante, sed dignissim metus sagittis in. Etiam et quam vel tortor lectus quis nulla sodales, non dapibus nisl cursus. Class aptent taciti

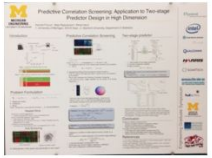
Container v. Content

Content should trump container (unlike above). Content should be primary.

Data Dumping

Facts not self interpretive. Focus on highlights, outcomes.

Local good posters



EECS 3333

- Content primary
- Visually heavy
- Quantitative depth

Lay Auto Lab

- Portrait orientation
- Main visual
- Descriptive Title

Jean-luc Doumont: *Effective Conference Posters*. Edward Tufte: *The Visual Display of Quantitative Information. Envisioning Information.*

Preparing a Poster

Context

A common way to present ideas in engineering is to make a poster to display in a venue such as a design expo or conference. This poser shows how to make one

Title

Descriptive title: one or two lines
No noun strings: *Automotive Driveshaft Vibration Reduction Solution*

Formats

Typography

Sans-serifed font (Arial, Helvetica)

Headings	clear separation
Subheading	among levels

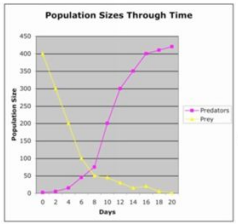
Font/point Discipline—avoid **cha**nges in typefaces. Point size clear 4' away
Generous line spacing, in other words, you want to have plenty of line spacing so the text doesn't look dense, which is a bad thing to have in posters.
Bullets/formatting

- Your text starts right next to the bullet, and when your text wraps it lines up under the bullet. (Avoid)
- Your text starts near the bullet, and when your text wraps it lines up under the bullet. (Avoid)
- Your text starts near the bullet, and when your text wraps it lines up under the text **(hanging bullets)** (Yes)

The poster illustrated below show a good example of a poster that relies almost exclusively on visuals to tell the story of the senior design project. The most prominent visual is of the drone, and specific features of the drone are shown in close up photos. Another thing to consider is to have sections that show the progression of your work, which means to have a context, then methods, results , discussion, and conclusion

Visuals—most important

Low ratio of ink-to data (1:1 best); cut non-data ink
"Clutter and confusion are failures of design, not attributes of information" Edward Tufte, *Envisioning Information*



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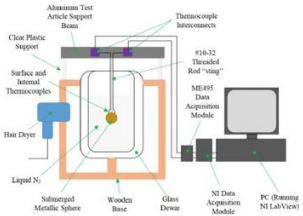


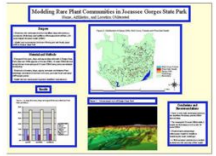
Good design, clear labels, low ratio of Ink-to data. Line drawings sometimes better than a photo, show detail, cut non-data ink

Common Mistakes

Too much text, awkward word spacing

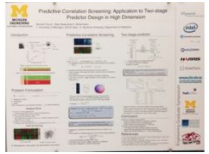
Lorem ipsum dolor sit amet, consectetur adipiscing elit. Nulla tempus lectus quis nulla sodales, non dapibus nisl cursus. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos himenaeos. Integer non tempus libero. Donec id consequat risus. Integer efficitur turpis a laoreet fringilla. Aliquam finibus mauris ante, sed dignissim metus sagittis in. Etiam et quam vel tortor lectus quis nulla sodales, non dapibus nisl cursus. Class aptent taciti

Container v. Content



Container trumps content. Content should be primary; a self-effacing design.

Local Good Posters



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Preparing an engineering poster: Guidelines for an effective design

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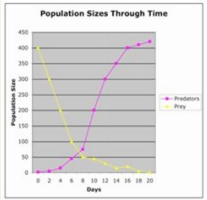

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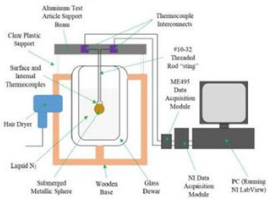

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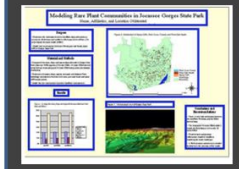

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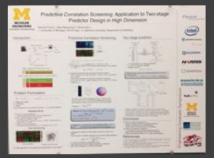

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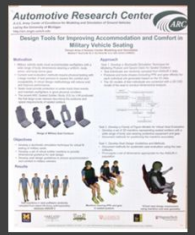


Lay Auto Lab

- Portrait orientation
- Main visual
- Descriptive Title

E-DINING OPTIMIZATION RESEARCH

Ima Graduate
University of Michigan
Facility and Operations Research Institute

INTRODUCTION

Mr. Reed Sharp, President of E-Dining, is interested in improving the efficiency of his company's packaging and shipping operations to meet the steady increase of online sales. E-Dining's operations are currently housed in an 1800 square foot facility; however, the increase in sales has caused the packaging and shipping operations to become inefficient and crowded. Mr. Sharp is also interested in expanding his customer base to include nearby university students. Mr. Sharp has decided to rent an adjacent rental space to expand E-Dining's facilities with the intent to meet the following objectives:

- **Decrease kit assembly and packaging times**
- **Eliminate box clutter**
- **Optimize Personnel and Shipping Records**
- **Implement new automated technology**
- **Create an efficient and clean walk-in store.**

Mr. Sharp contracted the University of Michigan Facility and Operations Research Institute to evaluate his company's current state and develop operational and design modifications to meet his goal and objectives.

CURRENT STATE

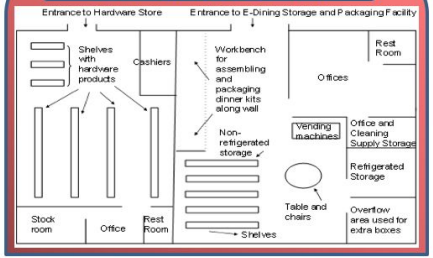
Kits:
- 21 different kinds of dinner kits offered
- 4x6 ingredient card and enough ingredients for four individuals included
- 215 to 290 orders per day, seven days a week

Assembly:
- Multiple trips for ingredient collection
- Wait times for available assembly space

Packaging:
- Boxes stacked in hallway create trip hazard
- No particular box storage organization
- Shipping Labels handwritten

Total Process Time: **12-16 minutes!**

CURRENT LAYOUT DESIGN



METHODS

EVALUATE EMPLOYEE CONCERNS & MORAL

Employee Interviews and Surveys:
- 14 Employees
- 15 min interviews
- Analysis of August 2010 Surveys

QUANTIFY PROCESS PERFORMANCE AND EMPLOYEE EFFORT

Time and Distance Studies:
- Ingredient Collection
- Available Workspace Acquisition
- Kit Assembly
- Packaging Selection and Retrieval
- Final Packaging and Shipping Preparation
- Pedometer Analysis

ANALYZE HISTORICAL DATA

Scheduling Studies:
- Time Card Analysis
- Peak and Non-Peak Shift Performance
- Employee Distributions
- Past Shipping Records

SIMULATE CURRENT AND POTENTIAL PROCEDURES AND DESIGNS

Computation and Simulation:
- Microsoft Excel Solver
- AMPL
- MiniTab
- Promodel Professional Simulations

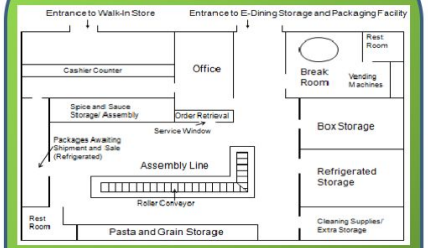
FINDINGS

Layout Design	Current	Proposed
Output (Kits/ Day)	270	1280
Walking Distance	1020 feet	50 feet
Assembly Time	16 min	3.75 min
Service Time	N/A	4.5 min

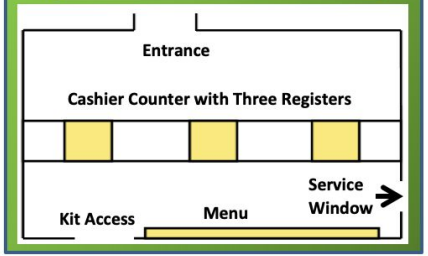
CONCLUSIONS

- Employees unhappy with current layout and processes
- New Layout provides extra storage and larger assembly area
- Specified box storage would eliminate clutter
- Baskets would eliminate multiple trips to collect ingredients
- Decreased packaging times with label printer and conveyor system
- Walk-in store would efficiently serve projected customer base

PROPOSED LAYOUT DESIGN



WALK-IN STORE DESIGN



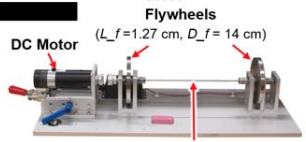
Patricia Frans-Ego
Rodney Navarro
Shula Napper
Harvey Singh
Section 8, Team 1

A Title that Tells us the Outcome of Your Research

Wolverine System Dynamics

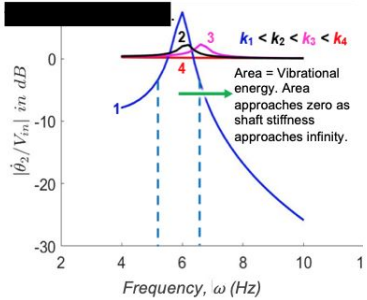
Background

Mesa Hybrid Vehicles Inc. [redacted]



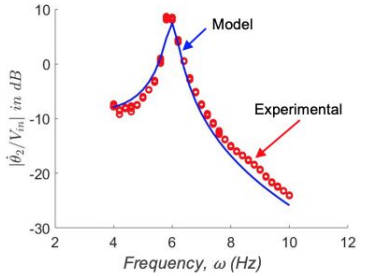
Validation of Shaft Vibration

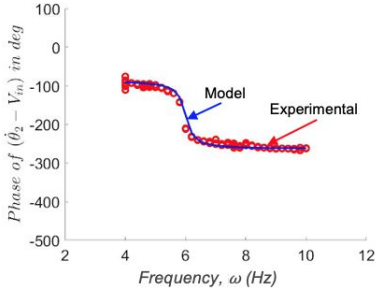
Driveshaft [redacted]



Validation of Model

The mathematical model has been validated [redacted]





Model Validation	Resonant Freq. [rad/s]	Magnitude [dB]
Experimental	5.8	8.7
Model	6.0	7.4
Difference [%]	3.4	14.9

Sensitivity Analysis

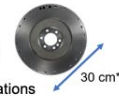
The sensitivity analysis [redacted]

Parameter	Sensitivity [%]
Flywheel Diameter, D_f	1.020
Motor Resistance, R_m	0.759
Motor Constant, K_m	0.518
Shaft Diameter, D_s	0.503
Flywheel Length, L_f	0.492
Flywheel Density, ρ_f	0.492
Shaft Damping, B_s	0.490
Shaft Length, L_s	0.490
Shaft Shear Modulus, G_s	0.487
Motor Damping, B_m	0.250
Bearing Damping, B_b	0.007
Motor Inertia, J_m	0.004
Winding Inductance, L_m	0.001

Reducing the Vibration Magnitude by ≥ 70%

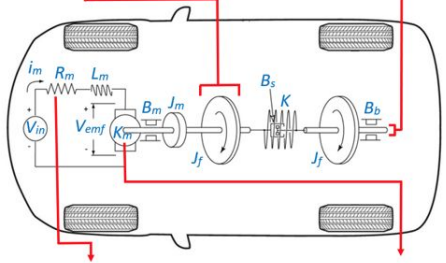
Increase Flywheel Diameter by **≥ 41.47%**

- Bigger [redacted] and reduce vibrations



Increase [redacted] by **≥ 36.62%**

- To reduce driveshaft elasticity



Increase [redacted] by **≥ 29.47%**

- Increase coil length
- Decrease coil diameter
- Use material with higher resistivity

Decrease [redacted] by **≥ 23.89%**

- Consider a different motor with lower motor constant

*Google Images

"Lab 2: Flexible Shaft." *Canvas*. University of Michigan, 22 Oct. 2018.]

Four Solutions to Reduce Drive Shaft Vibrations in the Gulo 3000

David Ludlow, Erika Hinu, Mason Momrik, Dennis Smarch

Wolverine System Dynamics

Context/Intro/Goals (you pick)

MESA Hybrid Vehicles Inc., identified excessive and undesirable drive shaft vibration in its prototype vehicle, the Gulo 3000. The following tasks were requested:

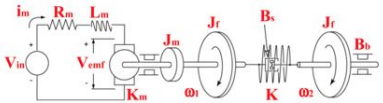
(1) Determine the root cause of the thing.

(2) Develop a mathematical model that does that thing.

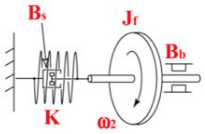
(3) Use the model to identify four solutions that will reduce that thing by 50%.

System Parameters (more specific)

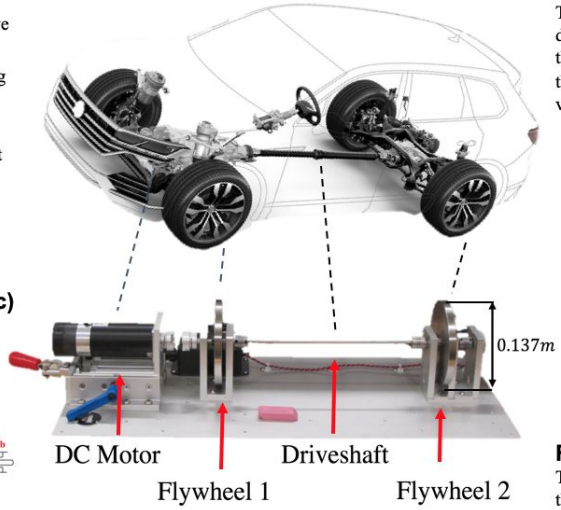
To develop an accurate mathematical model, certain system parameters were determined via experimental testing.



Several things were determined by conducting constant test A, test B, and test C. And we did a bunch of other important stuff that we discuss here.

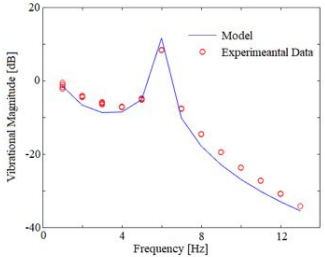


The thing and thing damping were found by doing a cool test with one thing and the other part and then we put them together.



System Model

With the parameters of the system determined from experimentation, a model of the system was derived.

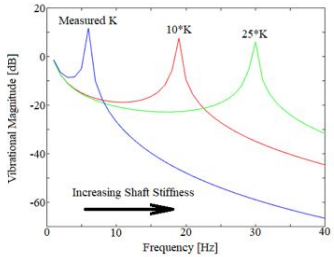


The model is excellent; I will prove that here.

Let me tell you more about that thing here, because it's really great and valid. Here's data to prove it.

Root Cause of Vibration

The thing was manipulated in the model to determine thing that you told us to find. By using the model with this parameter, it can be shown that the thing A is responsible for the undesirable vibrations.



Four Most Effective Solutions

The four solutions were derived from that thing again. Each reduces vibration by at least 50%

- Increase the diameter of that thing by 40%
- Increase the width of that other thing 38%
- Change the thing of the thing to 75% higher density

- Increase the thing by 85%, which will require a thing with a 12% lower thing A

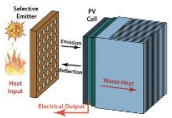
Harnessing Nanoscale Dielectric Coatings to Enhance Near-field Radiative Heat Transfer for Thermo-photovoltaic Applications

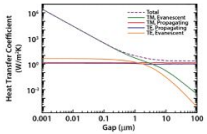
Yashar Ganjeh[1†], Bai Song[1†], Seid Sadat[1†], Dakotah Thompson[1], Anthony Fiorino[1], Víctor Fernández-Hurtado[2], Johannes Feist[2], Francisco J. Garcia-Vidal[2], Juan Carlos Cuevas[2]

1. Department of Mechanical Engineering, University of Michigan; 2. Departamento de Física Teórica de la Materia Condensada and Condensed Matter Physics Center, Universidad Autónoma de Madrid; 3. Department of Materials Science and Engineering, University of Michigan.

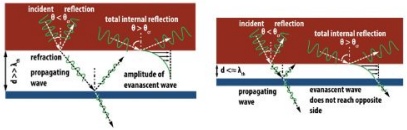
Motivation

- Thermal management of micro devices
- Thermal microscopy
- Energy conversion, e.g. nano-scale gap thermo-photovoltaics



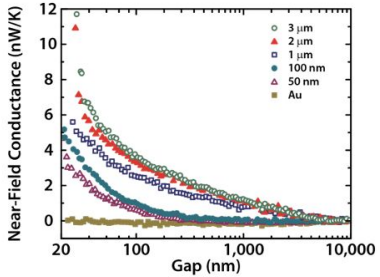


❖ **How much can a thin dielectric coating contribute to radiative heat transfer?**

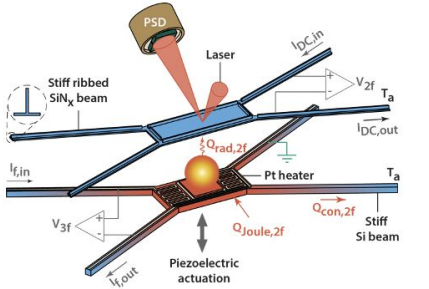


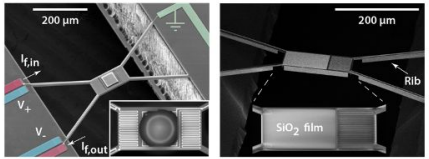
Intuition based on far-field behavior

Nanoscale Dielectric Coatings Enhance Near-field Radiative Transport

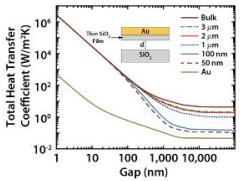


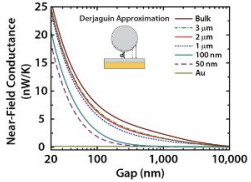
Experimental Setup



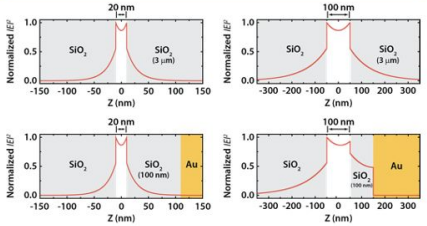


Fluctuational Electrodynamics Theory Predicts the Experimental Results





Penetration Depth Scales with Gap-Size



✓ **For small gaps:**
- Mode shapes are identical for different film thicknesses
- Penetration depth is the same order as the gap-size
- The modes decay rapidly into the film

✓ **For larger gaps (greater than film thickness):**
- Penetration depth becomes larger
- The modes decay slowly into the dielectric coating
- There is a sudden drop in intensity at Au-SiO_2 interface resulting in a diminished heat transfer at the interface

Acknowledgements

We acknowledge support from the Army Research Office (W911NF-12-1-0612) and the National Science Foundation (CBET 1235691). J.C.C. acknowledges financial support from the Spanish MICINN (Contract No. FIS2011-28851-C02-01). F.J.G.-V. and J.F. acknowledge support from European Research Council (ERC-2011-AdG Proposal No. 290981).

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No Strings Attached: A Sensor-Based Pedal Steel Guitar

EECS 452: Digital Signal Processing Design Lab
Student Name, Student Name, Student Name, and Student Name

INTRODUCTION

Our project is an electronic pedal steel guitar, a low-cost, sensor-based alternative to a traditional pedal steel guitar. To play a traditional pedal steel, a performer plucks the guitar strings, moves a metal slide up and down the strings to control their pitches, and "bends" the pitches of certain strings with foot pedals. Using sensors to electronically emulate these functionalities, our instrument is novel, easy to play, and is significantly less expensive than a traditional pedal steel guitar. Our demonstration showcases our instrument's capabilities with a fun musical experience.

Figure 1. Major hardware components of the electronic pedal steel guitar.

SYSTEM REQUIREMENTS

- Inexpensive (~$300) in comparison to the price of traditional pedal steel guitars ($1000 -$4000 and up)
- Work in real-time without noticeable delay
- Sensitive to subtle changes in sensor input
- Sound similar to a traditional pedal steel guitar
- Robust to potential rough handling

DESIGN CHALLENGES

To keep prices low, we used a combination of low-cost sensors and wires to collect user input as well as 3D-printed custom parts.

To speed up our algorithms, we used several optimization techniques, including pre-calculating and storing parameters and multithreading code.

OVERALL SYSTEM ARCHITECTURE

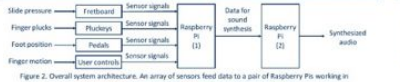


Figure 2. Overall system architecture. An array of sensors feed data to a pair of Raspberry Pis working in synchrony to synthesize a guitar-like sound in response to user inputs.

HARDWARE ARCHITECTURE

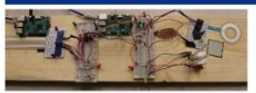


Figure 3. Test setup. Five major groups of sensors are used in our system: ribbon sensors for the fretboard (left), vibration sensors for pluck detection (bottom right), a pressure sensor for muting (middle right), a circular position sensor for volume control (top right), and two pedals for bending pitches (not shown). The sensors interface to the first Raspberry Pi (middle) through a pair of analog-to-digital converters (ADCs). The first Pi communicates with the second Pi (top left) via an Ethernet connection, and the second Pi outputs the generated audio.

Figure 4. *Pluckey. Top:* pluckey with piezo sensor. *Bottom:* pluckey in case. Pluckeys are low-cost 3D-printed parts used to simulate plucking a string. A piezo sensor inside the pluckey detects vibrations when the prong is plucked. The length and shape were iteratively adjusted to improve performance.

SOFTWARE ARCHITECTURE

Fretboard: sensor readings are calibrated to fix non-linearities then converted to frequencies to emulate a guitar fretboard (Figure 5).

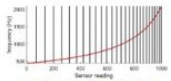


Figure 5. Conversion from sensor readings to frequencies on our 27-fret fretboard.

Pluck detection: a modified smoothed Z-score algorithm [2] detects spikes in the voltage output corresponding to plucks, ignoring spikes that are too small or too close together.

Volume control: audio gain is scaled exponentially by a smoothed derivative of the circular ribbon sensor output. To cancel the effects of noise, derivatives that are too high or too low are ignored.

Sound generation: The Karplus-Strong algorithm (Figure 6) mimics the sound of plucked strings, using low-pass filters to attenuate the high frequency sound components in a feedback loop [1].

Figure 6. Karplus-Strong sound generation algorithm. Emulates the sound of a plucked instrument.

RESULTS

Our system synthesizes the clean, sustained sounds of a steel guitar in real-time, producing smooth variations in pitch that match the fretboard position with the slide.
The system detects plucks with virtually **no false positives or false negatives** (Figure 7).

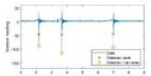


Figure 7. Results of pluck detection algorithm.

Our system requires 10 µs to synthesize one audio sample, twice as fast as required for our sample rate of 48 kHz. The volume control algorithm varying gain that plateaus at a set minimum and maximum gain (Figure 8).

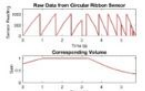


Figure 8. Results of volume control algorithm.

ACKNOWLEDGEMENTS

Our team gratefully acknowledges the help and funding that we received from the Harris Corporation, the ECE Undergraduate Program, the U-M 3D Printing Studio Staff, Professor Gregory Wakefield, Professor Kurt Metzger, and Siddharth Venkatesan.

CITATIONS

[1] Sullivan, Charles R. "Extending the Karplus-Strong Algorithm to Synthesize Electric Guitar Timbres with Distortion and Feedback." Computer Music Journal, vol. 14, no. 3, 1990, p. 26., doi:10.2307/3679957.
[2] Jean Brakel, Jean Aval. "Peak Signal Detection in Real-time Timeseries Data." Stack Overflow, 26 Mar. 2016, stackoverflow.com/questions/22185935/peak-signal-detection-in-realtime-timeseries-data.

R.A.P.T.O.R.

Robot thAt Pursues and Tracks via Object Recognition

Jerry Dault, Keith Dawkins, Arturo Holt, Robert Roscoe
EECS 452 Winter 2015

Objective

To implement a tracking algorithm that allows a robot to track and follow an object of a specific shape and color. The robot should keep a set distance from the object and react quickly to sudden movements of the object. To minimize performance sensitivity to object color at the sensor from variations in illumination, the object to be tracked should be a colored light source. Control theory will be used to implement a PD controller in the robot guidance system, which will make tracking and following the object more accurate and responsive once it has been

Hardware

Raspberry Pi 2 Model B

- Features a 4 core 900 MHz system on a chip
- Handles majority of computation, such as image processing and control algorithms.
- Communicates with Arduino over Serial UART

Raspberry Pi Camera

- Features a five megapixel fixed-focus camera
- Captures images in front of robot at 60 FPS

Arduino Uno R3

- Microcontroller based on the ATmega328
- Formats commands for the motor controller
- Communicates with Raspberry Pi over Serial UART

Arduino Motor Shield R3

- Features a motor controller based on the L298
- Handles amplification and current control of PWM signals to two D.C. motors

Electrical Power System Solution

- Powers entire system by one 7.2 V Battery
- Features a 5 V voltage regulator to step down for Raspberry Pi

System Architecture

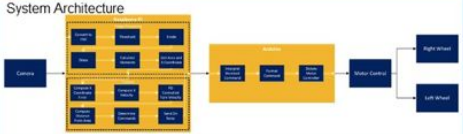
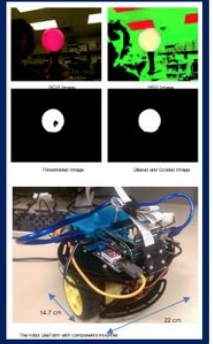
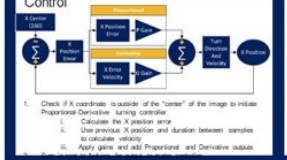


Image Processing

1. Capture BGR color space image and scale to 320 x 240 pixels
2. Convert BGR image to HSV (Hue, Saturation, Value) color space to separate chroma (color) and luma (light) elements
3. Threshold each pixel of the image: if the pixel is between a range specified to identify the correct object, set the pixel to white. Otherwise the pixel is set to black
4. Morphological Opening (Dilation of the image): Convolute the image with the kernel structuring element, in our case a 6 x 6 pixel rectangle, to expand the white areas of the image by computing the local minima over the area of the kernel
5. Morphological Closing (Erosion of the image): Compute the local maxima over the area of the kernel structuring element. Causes white areas to become thinner
6. Calculate the moments of the largest mass of white pixels in the image. This gives us the X coordinate, Y coordinate, and area of the largest white object



Control



1. Check if X coordinate is outside of the "center" of the image to initiate Proportional-Derivative turning controller
   i. Calculate the X position error
   ii. Use previous X position and duration between samples to calculate velocity
   iii. Apply gains and add Proportional and Derivative outputs

Acknowledgements

Our group would like to thank Professor Gregory Wakefield, Dr. Kurt Metzger, Jonathan Kurzer, and Dominic Calabrese for their help and insight.
Libraries from: OpenCV, Raspicam_CV, WiringPi

R. A. P. T. O. R.

Robot thAt Pursues and Tracks via Object Recognition

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Objective

To implement a tracking algorithm that allows a robot to track and follow an object of a specific shape and color. The robot should keep a set distance from the object and react quickly to sudden movements of the object. To minimize performance sensitivity to object color at the sensor from variations in illumination, the object to be tracked should be a colored light source. Control theory will be used to implement a PD controller in the robot guidance system, which will make tracking and following the object more accurate and responsive once it has been identified.

Hardware

Raspberry Pi 2 Model B

- Features a 4 core 900 MHz system on a chip
- Handles majority of computation, such as image processing and control algorithms.
- Communicates with Arduino over Serial UART

Raspberry Pi Camera

- Features a five megapixel fixed-focus camera
- Captures images in front of robot at 60 FPS

Arduino Uno R3

- Microcontroller based on the ATmega328
- Formats commands for the motor controller
- Communicates with Raspberry Pi over Serial UART

Arduino Motor Shield R3

- Features a motor controller based on the L298
- Handles amplification and current control of PWM signals to two D.C. motors

Electrical Power System Solution

- Powers entire system by one 7.2 V Battery
- Features a 5 V voltage regulator to step down for Raspberry Pi

System Architecture

Image Processing

1. Capture BGR color space image and scale to 320 x 240 pixels
2. Convert BGR image to HSV (Hue, Saturation, Value) color space to separate chroma (color) and luma (light) elements
3. Threshold each pixel of the image: if the pixel is between a range specified to identify the correct object, set the pixel to white. Otherwise the pixel is set to black
4. Morphological Opening (Dilation of the image): Convolute the image with the kernel structuring element, in our case a 6 x 6 pixel rectangle, to expand the white areas of the image by computing the local minima over the area of the kernel
5. Morphological Closing (Erosion of the image): Compute the local maxima over the area of the kernel structuring element. Causes white areas to become thinner
6. Calculate the moments of the largest mass of white pixels in the image. This gives us the X coordinate, Y coordinate, and area of the largest white object

Control

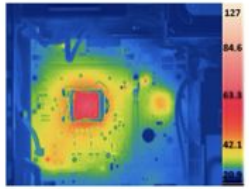
1. Check if X coordinate is outside of the "center" of the image to initiate Proportional-Derivative turning controller
   i. Calculate the X position error
   ii. Use previous X position and duration between samples to calculate velocity
   iii. Apply gains and add Proportional and Derivative outputs
2. Sum is sent to Arduino for output to motor controller

Acknowledgements

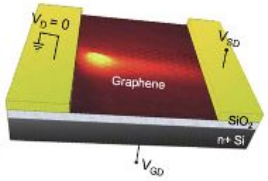
Our group would like to thank Professor Gregory Wakefield, Dr. Kurt Metzger, Jonathan Kurzer, and Dominic Calabrese for their help and insight.
Libraries from: OpenCV, Raspicam_CV, WiringPi

Introduction

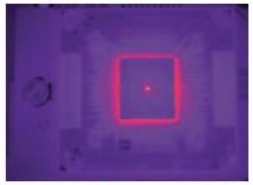
- Continued miniaturization of electronic devices poses serious challenges for nanoscale heat management.
- Classical heat transfer laws break down at the nanoscale.
- Understanding energy transport and conversion is crucial for realizing novel technologies in the near future.



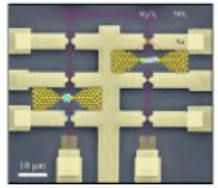
Hotspot of CPU



Hotspot in graphene



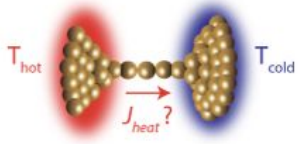
On-chip thermoelectric (Peltier) cooling



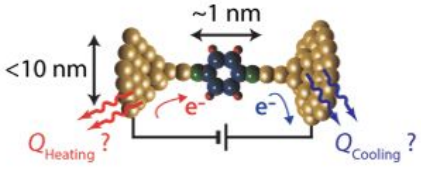
Molecule transistor

Objectives

- **What is the fundamental (quantum) limit of heat transfer at the atomic-/nano-scale?**
- **Is it possible to realize molecular-scale thermoelectric cooling?**



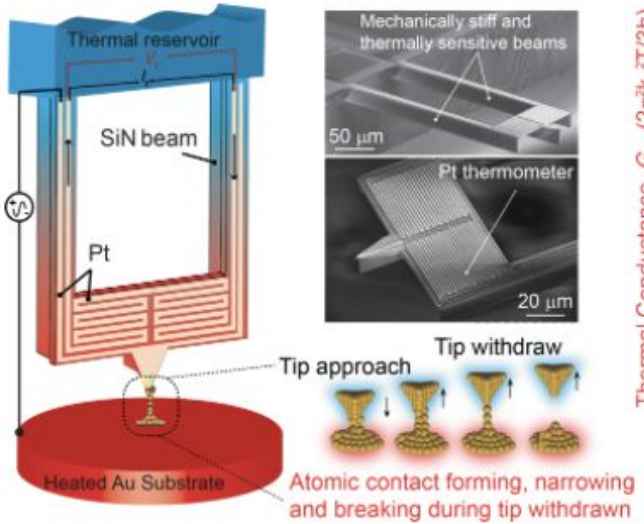
Single-atom contact

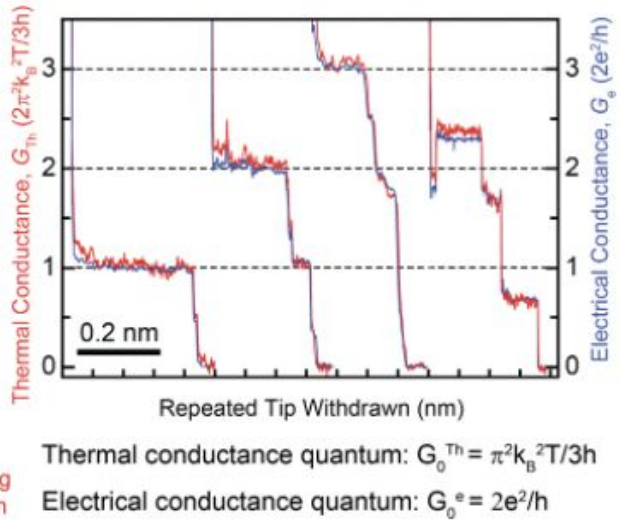


Molecular junction

Quantized Thermal Transport in Single-Atom Contacts

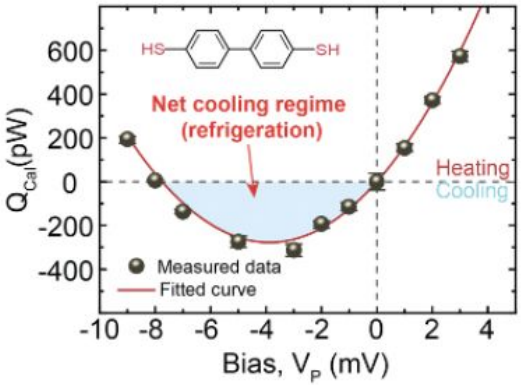
➢ **Calorimetric scanning thermal microscope probe enables heat transfer measurement at the atomic scale**

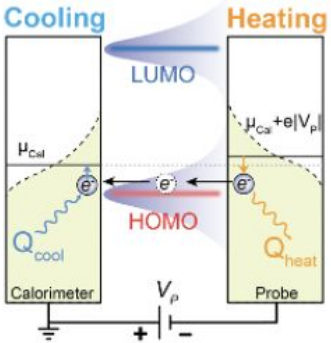




- Custom-developed scanning probes can precisely track minute electrical and heat current flowing across atomic contacts.
- Observed plateaus showing at integer multiples of the electric and thermal conductance quantum reveal the quantum limit to charge and heat transport.

➢ **Refrigeration at high density (~3 kW/cm²) observed in Biphenlydithol and explained in Landauer quantum transport picture**





Landauer theory:

$$Q(V_P) = \frac{2}{h}\int_{-\infty}^{\infty}(\mu_{Cal} - E)\tau(E, V_P)[f_{Cal} - f_P]dE$$

$$= GTSV_P + \frac{1}{2}GV_P^2 + O(V_P^3)$$

Q : Heating/cooling power V_P: Bias across molecules

μ : Chemical potential E : Energy level

f : Fermi-Dirac function G : Electrical conductance

S : Seebeck coefficient T : Absolute temperature

- Net cooling (thermoelectric refrigeration) is accomplished when Peltier cooling is larger in magnitude than Joule heating effect.
- Cooling density sensitively depends on the electron transmission characteristics.

characteristics.

Key Conclusions

1. Developed picoWatt-resolution calorimetric scanning probes to quantify atomic/nanoscale energy transport and conversion
2. Determined the quantum-limited heat conduction in single-atom junctions
3. Wiedemann-Franz law is found valid to the atomic limit
4. Refrigeration at the molecular-scale far exceeds the cooling densities of existing Peltier technology (<1 kW/cm^2)
5. Enabled future work on quantum energy transport and conversion in other mesoscopic systems, low-dimension materials, and nanostructures.

Acknowledgements

This research is supported by DOE, AFSOR and NSF. We thank W. Jeong, S. Hur and D. Thompson for device fabrication.

References

1. L. Cui et al., ***Science***, 355, 1192 (2017).
2. L. Cui et al., ***Nature Nanotechnology***, in final revision (2017).
3. L. Cui et al., ***Journal of Chemical Physics***, 146, 092201 (2017).
4. L. Cui et al., ***Nature Communications***, 8, 14479 (2017).

Poster Checklist

1. Visual Message
2. Title makes a claim and/or tells us the result
3. Text = 30/40% (text/labels are large enough, use margins & white space)
4. Supporting visuals = 60/70%
5. Limited branding
6. Descriptive headings, logical flow and order (guide the eye)
7. Avoid non-data ink
8. Visuals: resolution & clarity
9. Design so good you don’t know it’s there

Poster Delivery

Posters require that you prepare pitches

Quick conference pitch–to the random audience member who may wish to move on

Tech-heavy pitch–to content-experts that are familiar with the jargon, acronyms, etc.

Non-tech pitch–to an educated audience with NO tech background

Practice Your Delivery…Yes, Actually Do This

Replicate the presentation scenario as much as possible (in the lab)

Practice saying it out loud…a lot

Plan Your Introduction Carefully

- Practice your opening line WORD-FOR-WORD
- Introduce yourself
- Tell us why we are here
- Gesture toward the recommendation

Be Intentional When Explaining Technical Material

- Make use of your visual aid–actually point to it, use gestures, etc.
- Use tangible examples or analogies
- Speak slowly
- Define terms, speak out acronyms

Be Aware of Your Presentation Voice

- Speak slowly and intentionally
  - You speak faster when nervous
  - You know the material–we do not
- Pause
  - Give us time to process your material
  - Break at intentional moments
- Use emphasis for main points: *sound excited*!
  - Speak louder or pause
  - Use gestures

Use Transitions to Your Advantage

Use transitions effectively, “And now, Hector is going to discuss…”
“Thanks, Farah, I’m going to be speaking about…”

Use effective redundancy through transitions

- Helps structure your talk (serves as an agenda)
- Helps argue your point (tells us the argument in the transition)

“Now, Hector is going to explain why our proposed solution is the most effective…”

Conquer the Poster Q+A

- Recognize that folks *want to learn* from you
- Repeat the question, answer it in a sentence, expand with evidence, then repeat the sentence-length answer
- If you don’t understand the question, ask them to repeat it, or explain it
  - Be okay with admitting you don’t know–but TRY
  - Divert to something you DO know

Battle Your Nerves Effectively

- Know your material
- Practice, practice, practice
- Look for a sympathetic/friendly face
- Defer to your visuals

Common Pitfalls

- There is no oral introduction: why are we all in this room?
- The solution is not indicated until the very end of the presentation
- There is a lack of flow or connection between parts of the presentation (too many assumptions)
- There is not a clear solution/conclusion presented

Content and Speech

Audience targeted?

Purpose achieved?

Needed information conveyed?

Terms defined; background given?

Emphasis appropriate?

Structure

Context?

Background and credibility?

Memorable mapping?

Depth satisfies?

Assertions emphasized?

Assertions supported?

Main assertions summarized?

Closure achieved?

Repetition used effectively?

Placement used effectively?

Visuals

Each section conveys a message?

Each section serves the audience?

Visual evidence supports?

Level of detail appropriate?

Visual evidence explained?

Extraneous details excluded?

Type easy to read?

White space used effectively?

Delivery

Speaker shows passion?

Speaker exudes confidence?

Voice clear and engaging?

Speed is appropriate?

Filler phrased (“uh”) avoided?

Effective eye contact made?

Movements contribute?

Questions handled convincingly?

Time is appropriate?

Resources

https://www.craftofscientificposters.com/
(poster templates, examples, advice)

Anything by Nancy Duarte (not just posters, but visuals and any presentation--she contributes to a lot of blogs, writes short articles, easily digestible and USEFUL tips you can use today)
https://www.duarte.com/

Jean-Luc Doumont https://www.principiae.be/book/X0100.php

Edward Tufte (perhaps best known for his criticism of PowerPoint)https://www.edwardtufte.com/tufte/

Sources

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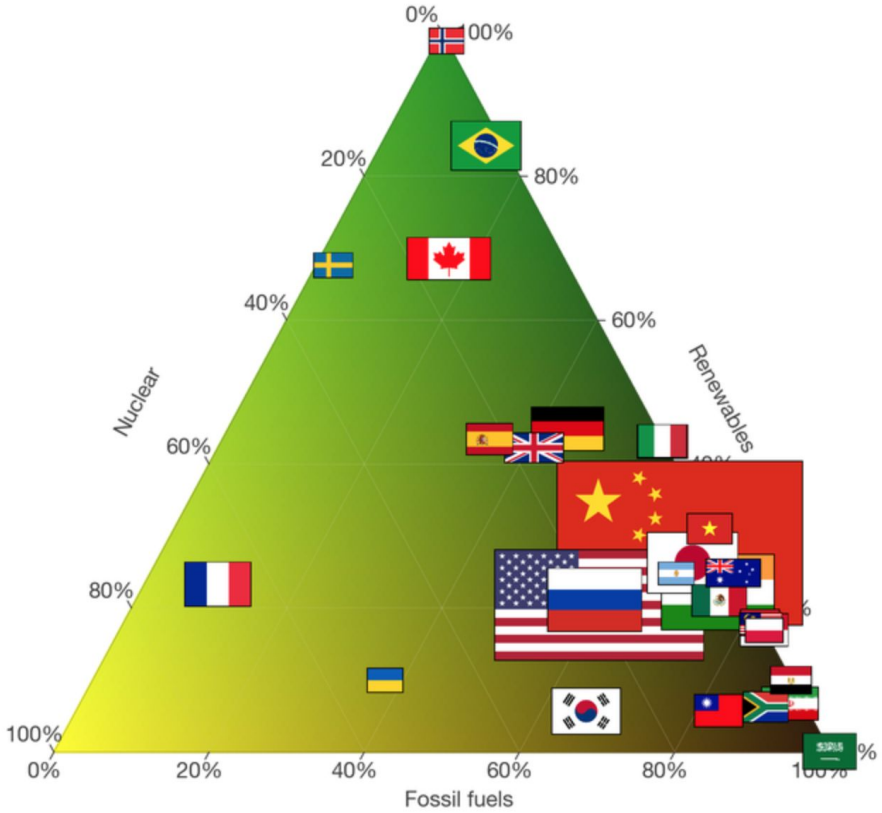
Electricity Generation by Source



The top 30 electricity-producing countries are shown.
Flag size is proportional to each country's total electricity generation.
Latest available data from 2019/2020 is used.

Source: Our World in Data based on BP Statistical Review of World Energy & Ember
OurWorldInData.org/electricity-mix

Premier League table

Final rankings at the end of the 2011/2012 season

		WON	DRAWN	LOST	GOALS FOR	GOALS AGAINST	GOAL DIFFERENCE	POINTS
1	Manchester City	28	5	5	93	29	64	89
2	Manchester United	28	5	5	89	33	56	89
3	Arsenal	21	7	10	74	49	25	70
4	Tottenham Hotspur	20	9	9	66	41	25	69
5	Newcastle United	19	8	11	56	51	5	65
6	Chelsea	18	10	10	65	46	19	64
7	Everton	15	11	12	50	40	10	56
8	Liverpool	14	10	14	47	40	7	52
9	Fulham	14	10	14	48	51	-3	52
10	West Bromwich Albion	13	8	17	45	52	-7	47
11	Swansea City	12	11	15	44	51	-7	47
12	Norwich City	12	11	15	52	66	-14	47
13	Sunderland	11	12	15	45	46	-1	45
14	Stoke City	11	12	15	36	53	-17	45
15	Wigan Athletic	11	10	17	42	62	-20	43
16	Aston Villa	7	17	14	37	53	-16	38
17	Queens Park Rangers	10	7	21	43	66	-23	37
18	Bolton Wanderers	10	6	22	46	77	-31	36
19	Blackburn Rovers	8	7	23	48	78	-30	31
20	Wolverhampton Wanderers	5	10	23	40	82	-42	25

Sun 13th

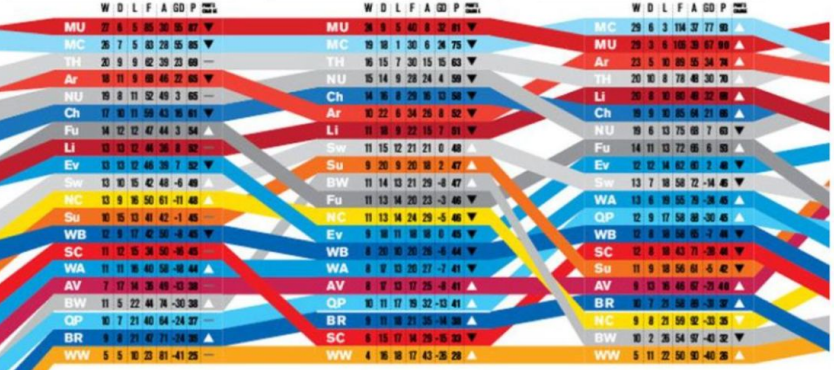
Turning the table

On 13th May Manchester City won the English Premier League with two goals in extra time, proving that even over a ten-month, 380-match season, the smallest detail can make all the difference. Here we see how the table would have looked if different factors came into play

Data courtesy of Opta, www.optasports.com

No extra time

If goals in the 90th minute or later were excluded



A game of one half

If only goals scored in the first half counted

No woodwork

If all woodwork hits were goals

No top scorers

If goals from each team's top scorer were excluded*

No goal-keepers

If all shots on target were goals

No set-pieces

If only goals scored in open play counted

*Lampard and Sturridge were Chelsea's joint-top scorers – this table excludes Lampard's goals