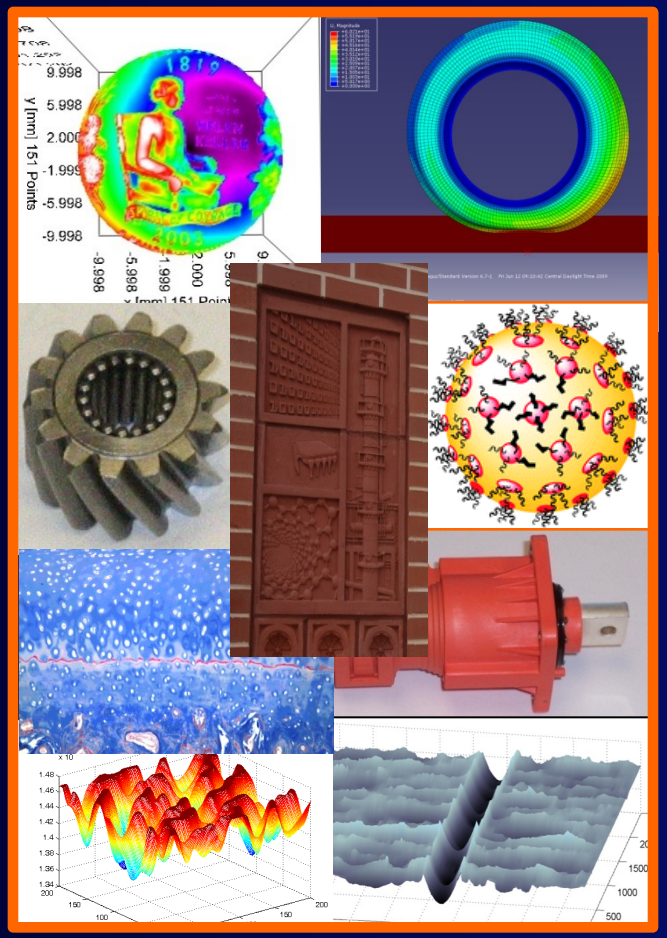


Education of the Next Workforce in Tribology

Robert L. Jackson

Director, Professor

Department of Mechanical Engineering

Auburn University

jackson@auburn.edu, 1-334-844-3340

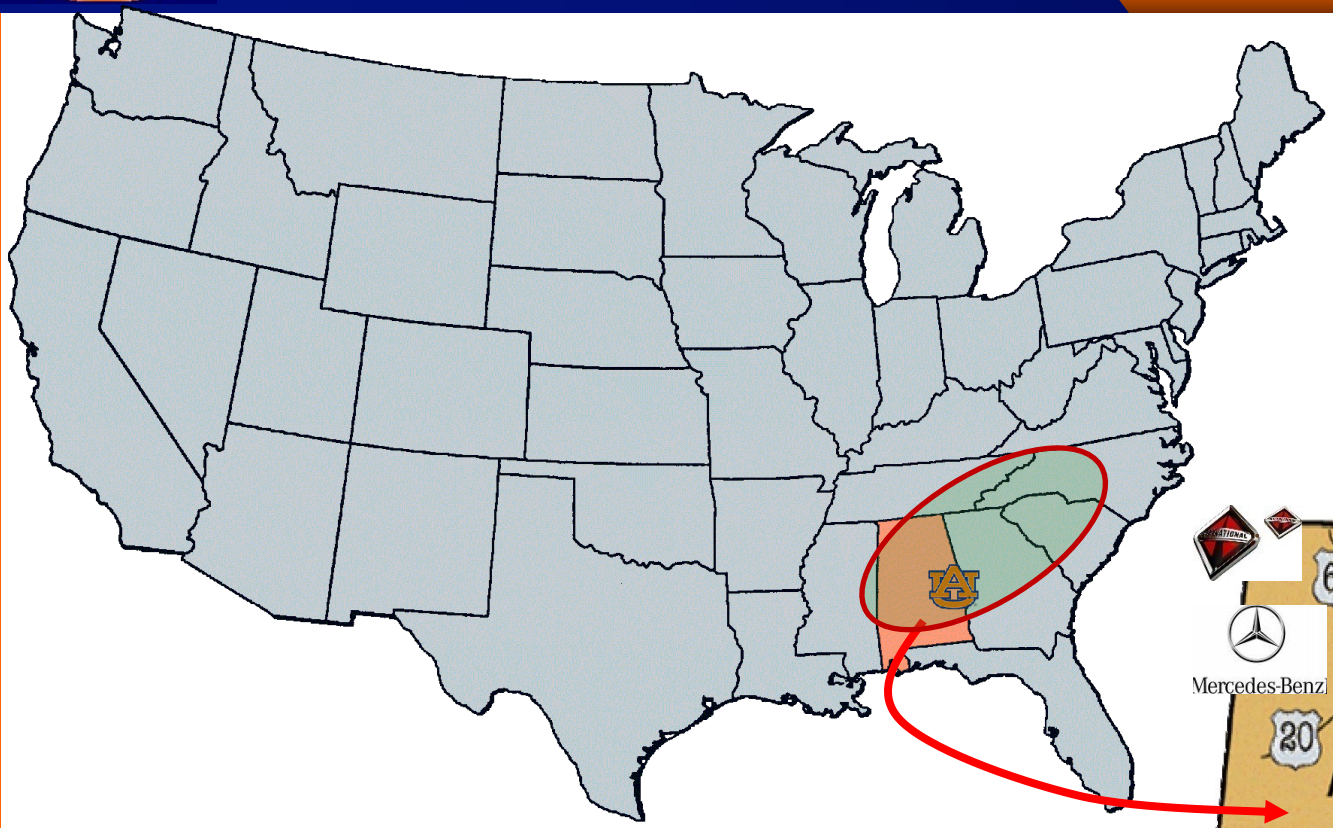
AUBURN UNIVERSITY

TRIBOLOGY AND LUBRICATION SCIENCE MINOR

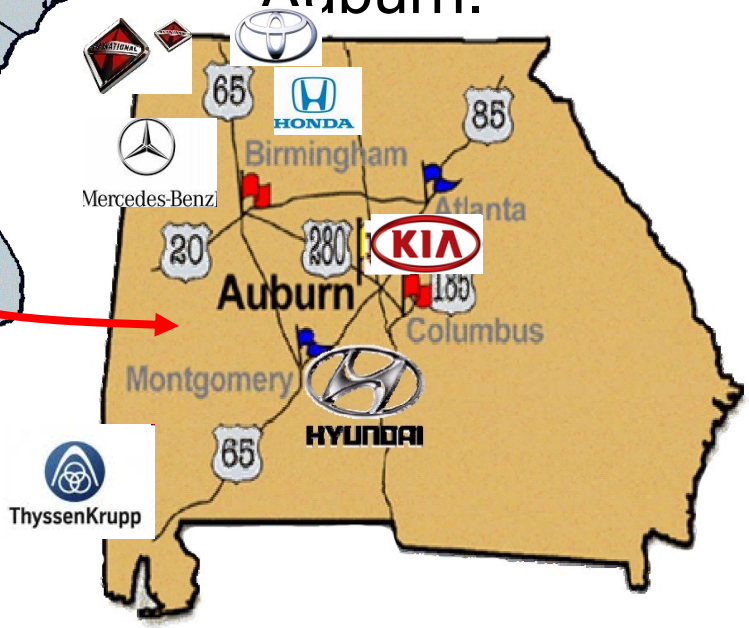
About Auburn University

- Auburn University was established in 1856 and remains one of the few universities to carry the torch as a land, sea and space grant university.
- Located in eastern Alabama, Auburn is the premier technical university in the state and one of the largest universities in the South.
- Originally Alabama Polytechnic University.

AUBURN UNIVERSITY
Location



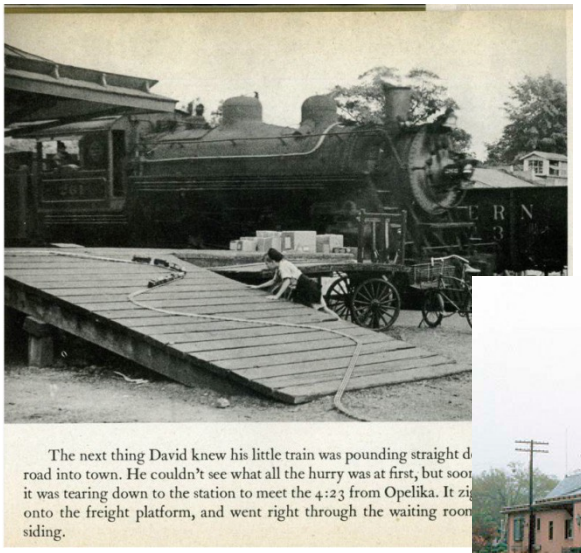
- Many manufacturers and suppliers are within driving distance of Auburn.



- "Southern Automotive Corridor"

Auburn's Tribology History

- Wreck Tech Pajama Parade originated in 1896.
- A group of mischievous Auburn students, snuck out of their dorms the night before the football game and greased the railroad tracks.
- According to the story, the train carrying the Georgia Tech team slid through town and didn't stop until it was halfway to the neighboring town of Loachapoka, Alabama.



The next thing David knew his little train was pounding straight d
road into town. He couldn't see what all the hurry was at first, but soo
it was tearing down to the station to meet the 4:23 from Opelika. It zi
onto the freight platform, and went right through the waiting roo
siding.

Finding Talent is a Major Concern

The ability of the field to attract talented and educated employees

Top areas of concern:

- The ability of the field to attract talented and educated employees
- The challenge of rec
  to the production / usage of products created by tribologists and lubrication engineers
- The availability of research funding from both government and for-profit sources compared to other scientific disciplines
- The cost of materials, chemicals and other resources

➢From the STLE report: Trends in Tribology and Lubrication Engineering, 2017.

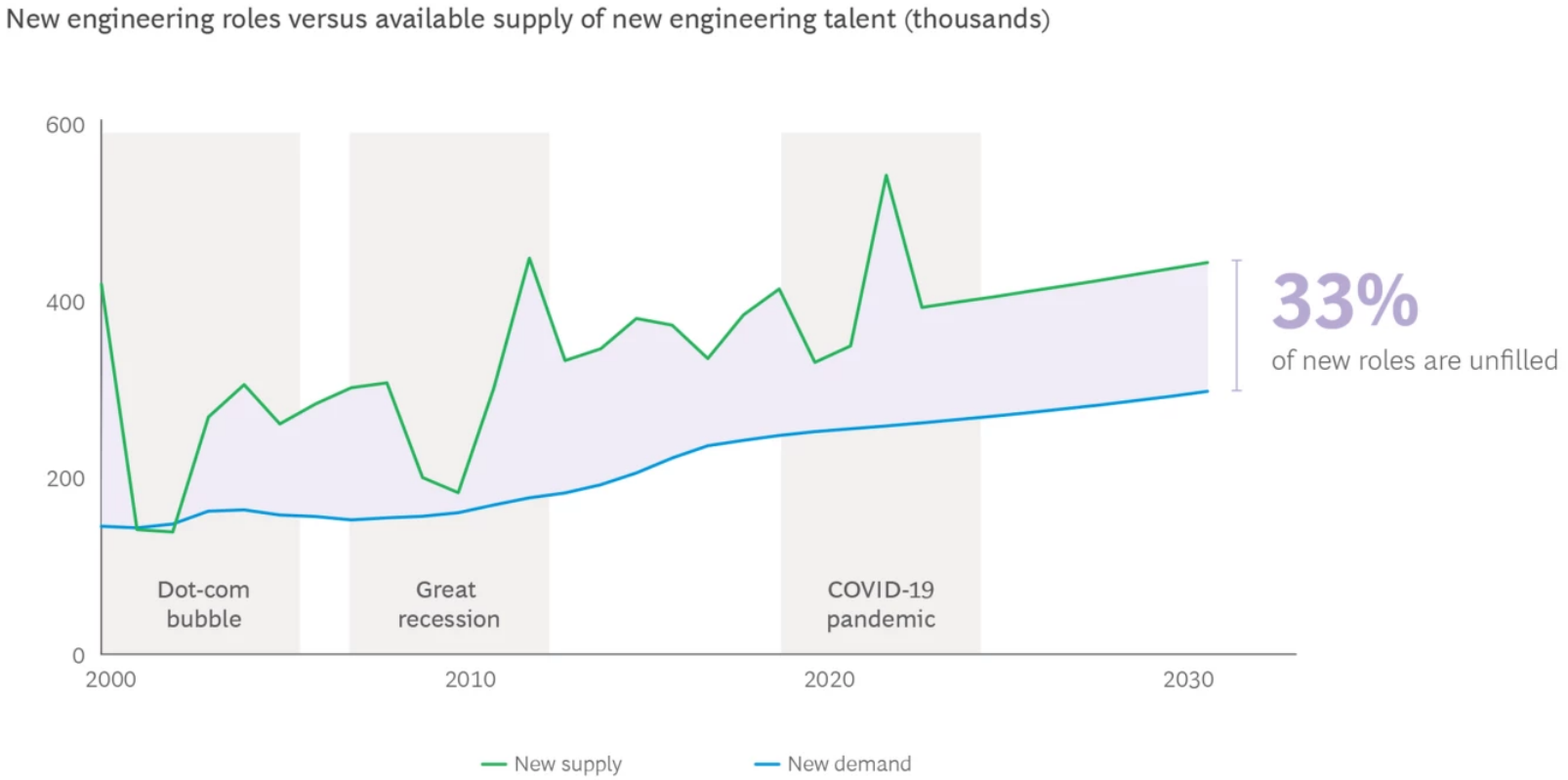
A Global Concern

	Africa/Arab States	Asia and Pacific	Europe/CIS	North America	South/Latin America
Sample	***34***	***99***	***97***	***441***	***47***
The ability of the field to attract talented and educated employees	75%	55%	62%	61%	71%
The challenge of reducing pollution related to the production/usage of products created by tribologists and lubrication engineers	50%	60%	67%	40%	79%

- From the STLE report: Trends in Tribology and Lubrication Engineering, 2017.

Engineer Deficit

Exhibit 1 - One in Three Engineering Roles Goes Unfilled Each Year, Hindering the US Economy

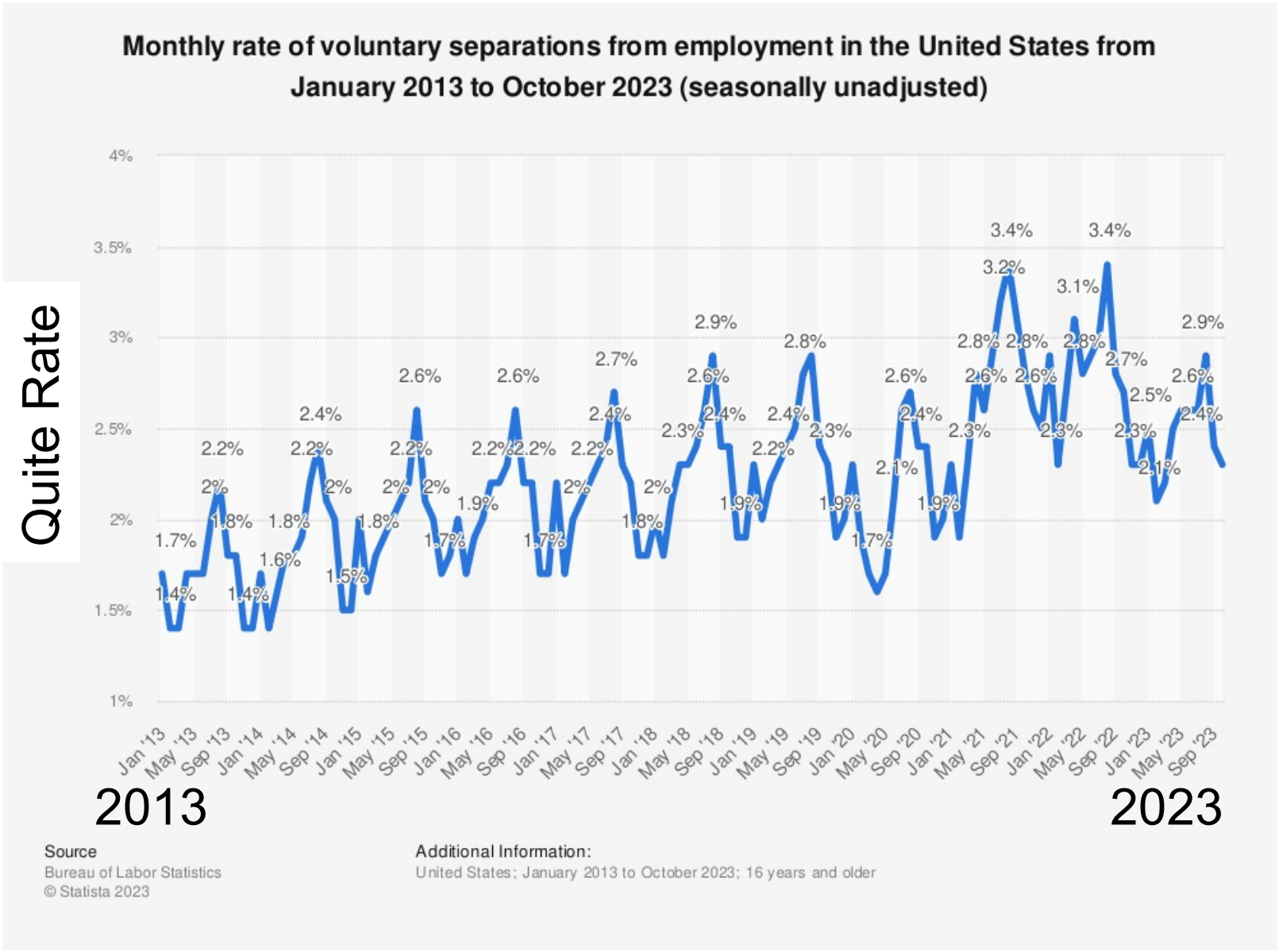


Sources: US Bureau of Labor Statistics; National Science Foundation; American Society of Engineering Education; US Citizen and Immigration Services; BCG analysis.

The US Needs More Engineers. What's the Solution? (bcg.com)

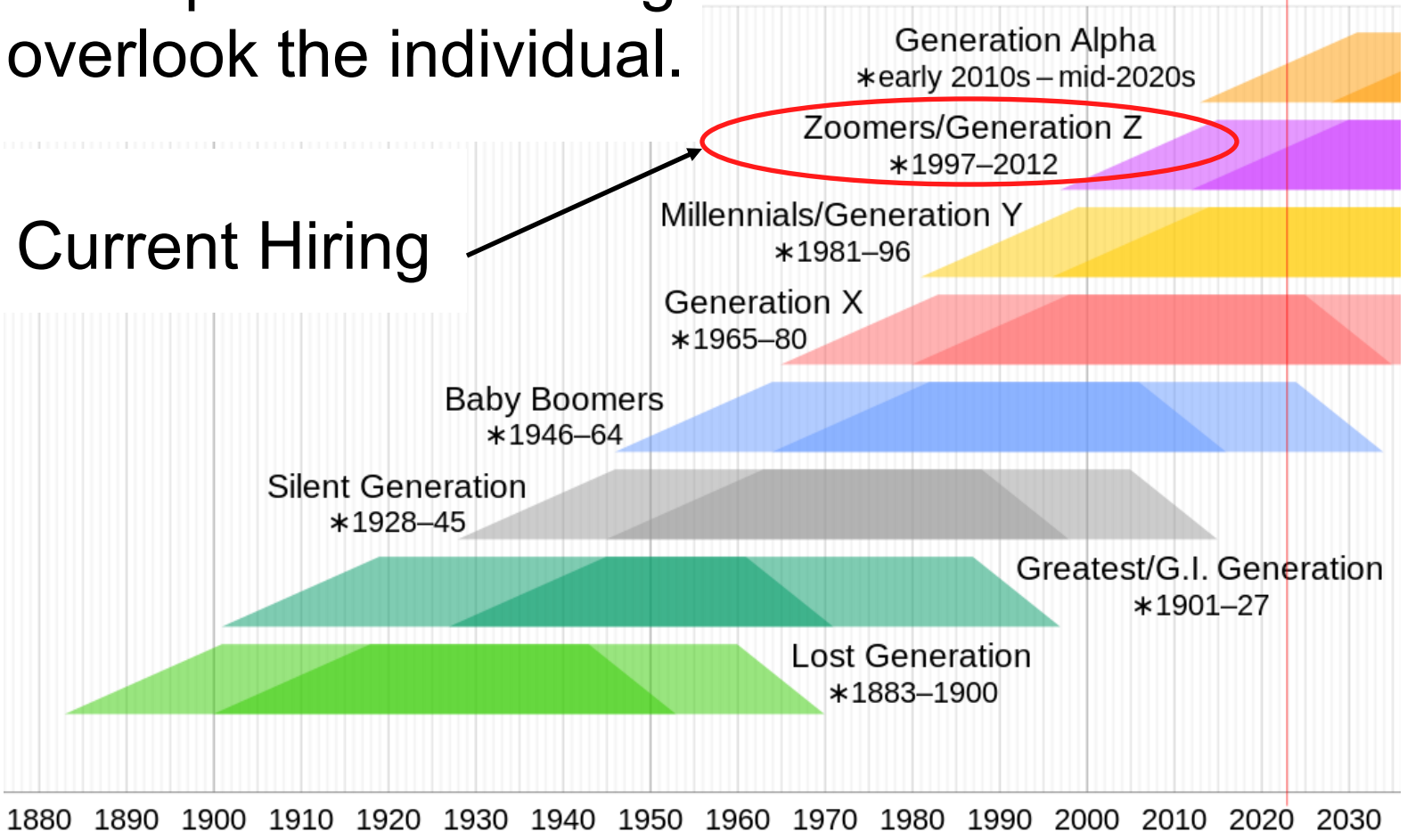
- Graduates in STEM are in high demand.
- They know their worth.
- Don’t need specializations, such as tribology to obtain employment.
- Social media allows for availability, benefits, pay to be communicated easily.
- Employees appear to more willing to leave a job for another.

Increased Career Mobility



Generations

- How do we define Generations of people?
- Perhaps it does over-generalize and tend to overlook the individual.



- Source: Wikepedia

The Concern

- “Just 19% of Gen Z professionals prefer working in a team environment”
- “31% of young workers claim that they work better alone”
- “53% of mangers feel Gen Z’s lack adequate communication skills”
- “Almost half of managers claim collaborative working has declined since Gen Z’s entered workplace”

Generation Driven or Disengaged? (robert-walters.ca)

Concerns with Manufacturing

- “A recent survey found most Gen Zs consider manufacturing to be a blue-collar job that would not allow them to use their college degree to their full advantage.”
- “53% of the population believe a mid-level manufacturing manager makes under $60,000 a year.”
- IW Staff, “Can Gen Z Save Manufacturing from the ‘Silver Tsunami’?,” *IndustryWeek*, Jul. 24, 2019. https://www.industryweek.com/talent/article/22027962/can-gen-z-save-manufacturing-from-thesilver-tsunami
- Bishop,Yarbrough, Harris, Understanding the Factors Influencing Gen Z and Millennial Career Choices: What it Means for Manufacturing, *Proceedings of the IISE Annual Conference & Expo 2022*

Sources of Data

- Online anonymous poll sent to students
  - 150 respondents.

- A literature review study performed by Industrial and Systems Engineering at Auburn:
  - Bishop, Yarbrough, Harris, Understanding the Factors Influencing Gen Z and Millennial Career Choices: What it Means for Manufacturing, *Proceedings of the IISE Annual Conference & Expo 2022*

ICAMS
Interdisciplinary Center for Advanced Manufacturing Systems

- *Other External Data*
- Personal Antidotes

Questions and Aims

- MWF are an integral part of manufacturing

How are Gen Zs and Millennials Different from Past Generations?

What Perception Do Gen Zs and Millennials Have of Manufacturing?

How Do We Change Their Perception/Eliminate Misconceptions?

How Are They Responding to Our Current Recruitment Strategies?

ICAMS
Interdisciplinary Center for
Advanced Manufacturing Systems

Valuable Traits and Skills

- From questionnaire to students.
- How important do you think these traits or skills are for your career?

- Tips for recruiting and retaining

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Communication

Hands-on Experience

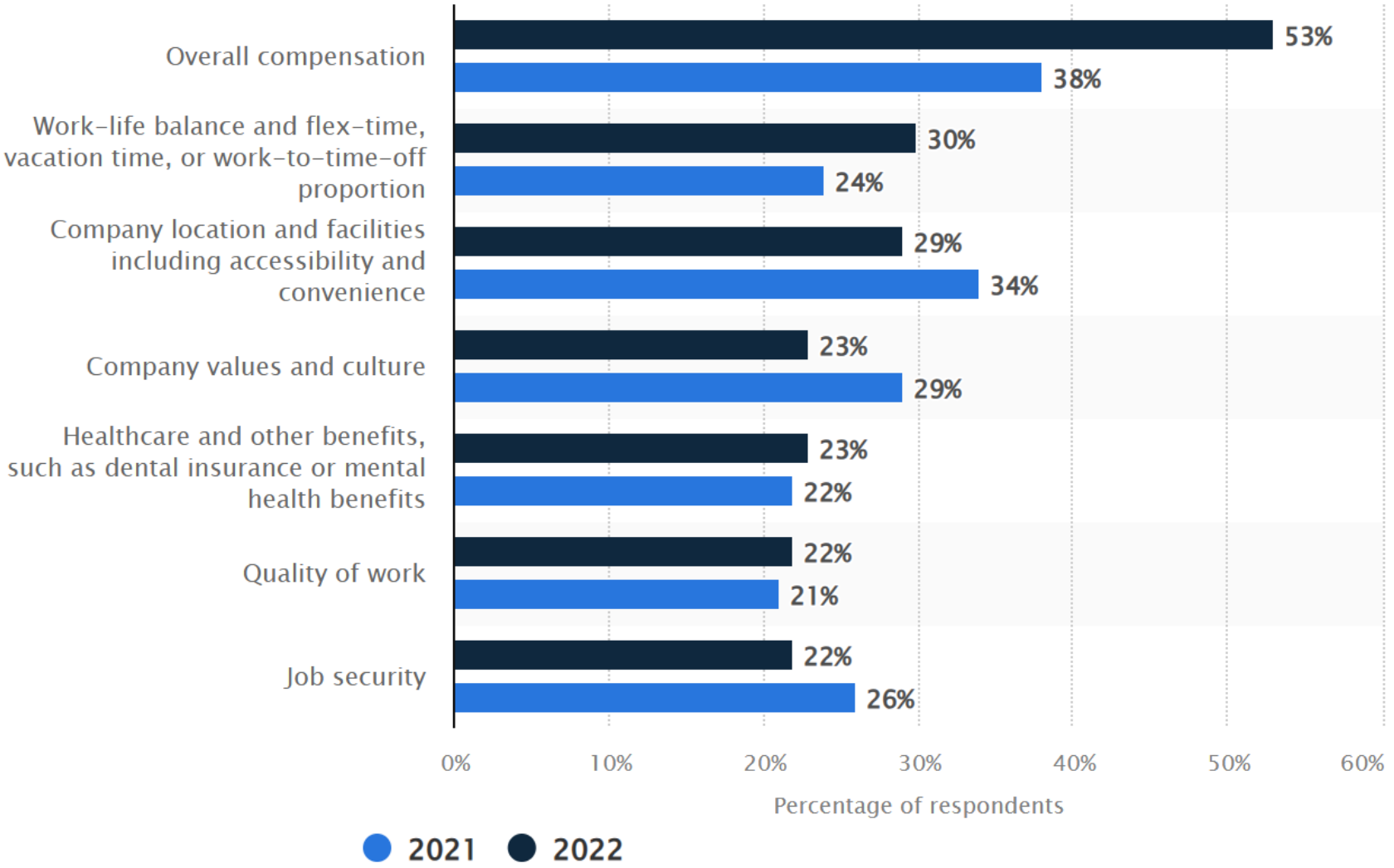
Immediate Feedback

Opportunity to Advance

Work Life Balance

- Rank these values in order of desirability in your career.

1. Pay
2. Type of Work
3. Location
4. Job Security
5. Professional Advancement Opportunities
6. Flexible Hours
7. Work Remotely
8. No Travel



[Main factors when accepting a job U.S. 2022 | Statista]

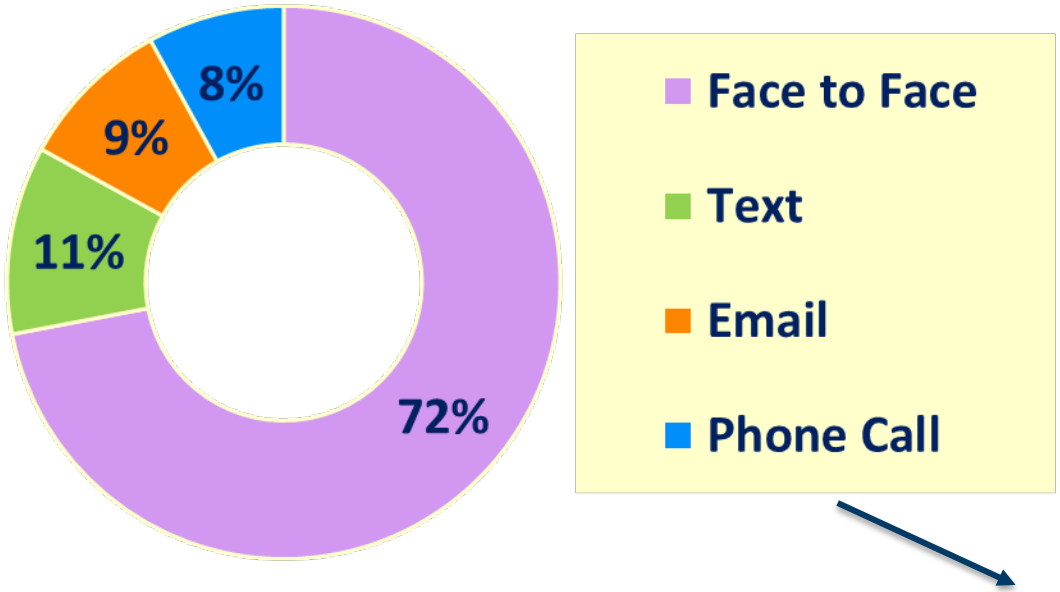
- Who is guiding Career Decision Factors?

1. Familial Influence
2. Social Media
3. Peer Perception
4. Personal Confidence
5. Future Status
6. Future Income
7. Personal Interest

Communication Preferences

Interdisciplinary Center for Advanced Manufacturing Systems

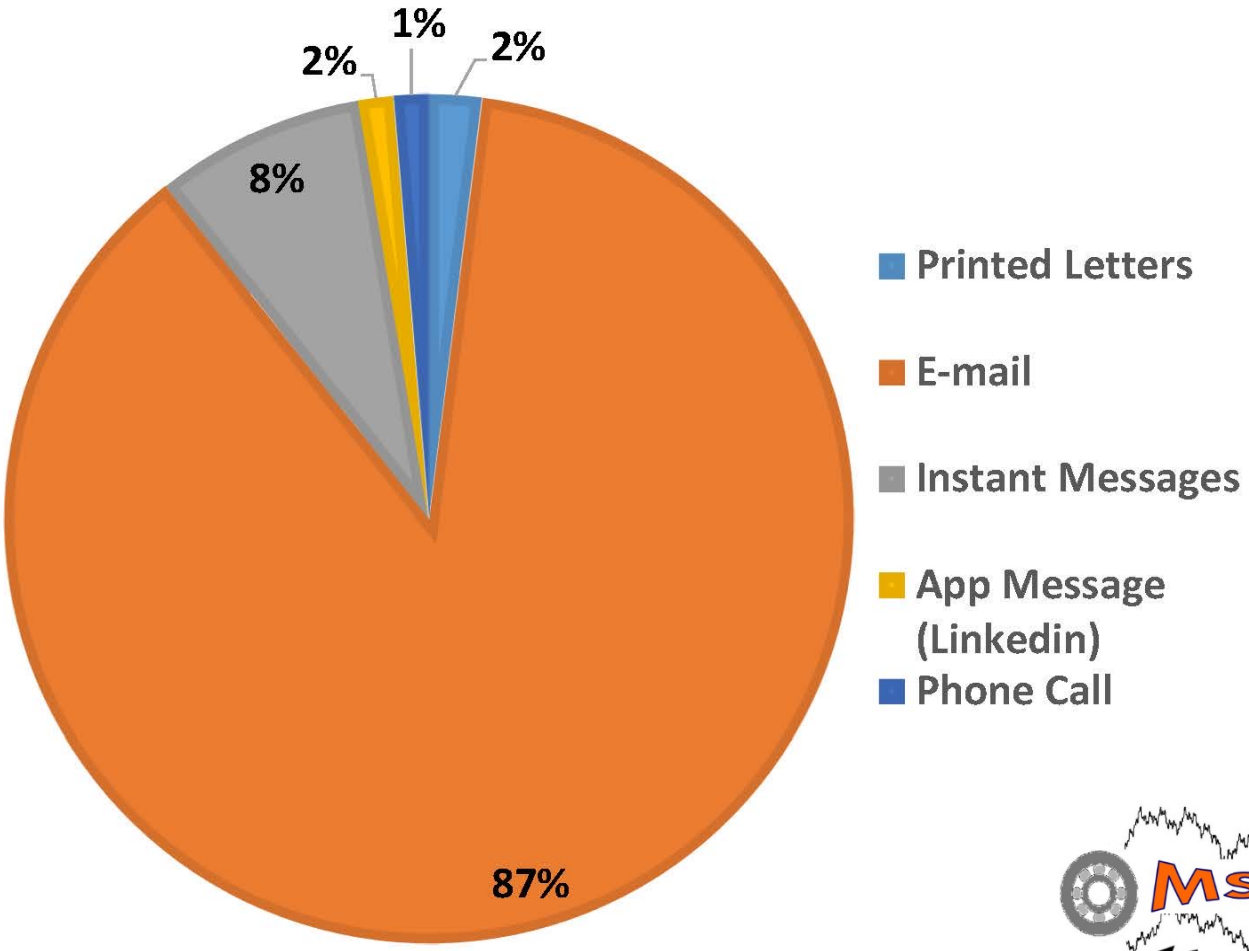
Gen Zs Preferred Method of Communication



75% of Gen Z's ranked phone calls as their least preferred method of communication.

Methods of Communication

- How do you prefer to communicate or receive notices about academic information?



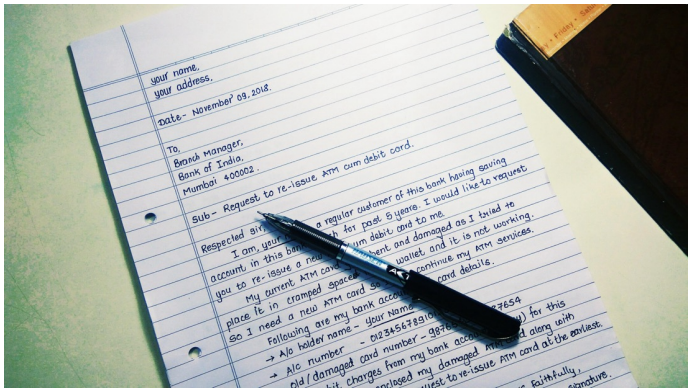
Communication Thoughts

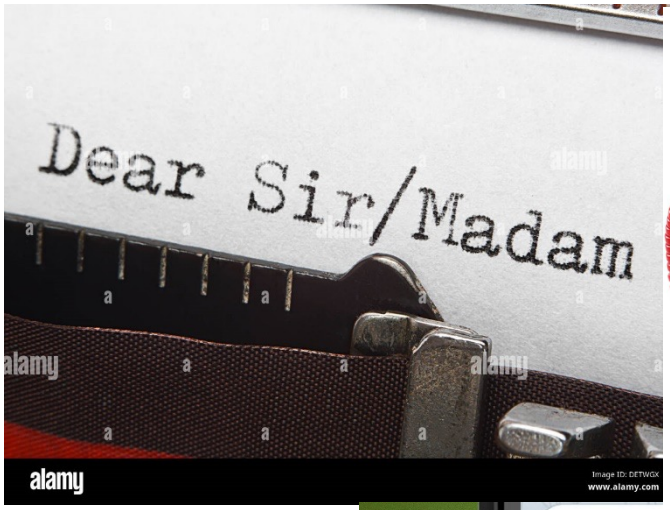
- Anecdotally, few emails from me about the tribology minor or class topics are responded to.
- Students do not appear to check emails frequently.

- Gen Z prefers short text.
- Images or videos instead of long letters.
- More personal and interactive (fast feedback).
- Zoom/Meetings?

https://www.deskbird.com/blog/generation-z-communication-preferences

Communcation Evolution





You've Got Mail

Big Ideas

Interdisciplinary Center for Advanced Manufacturing Systems

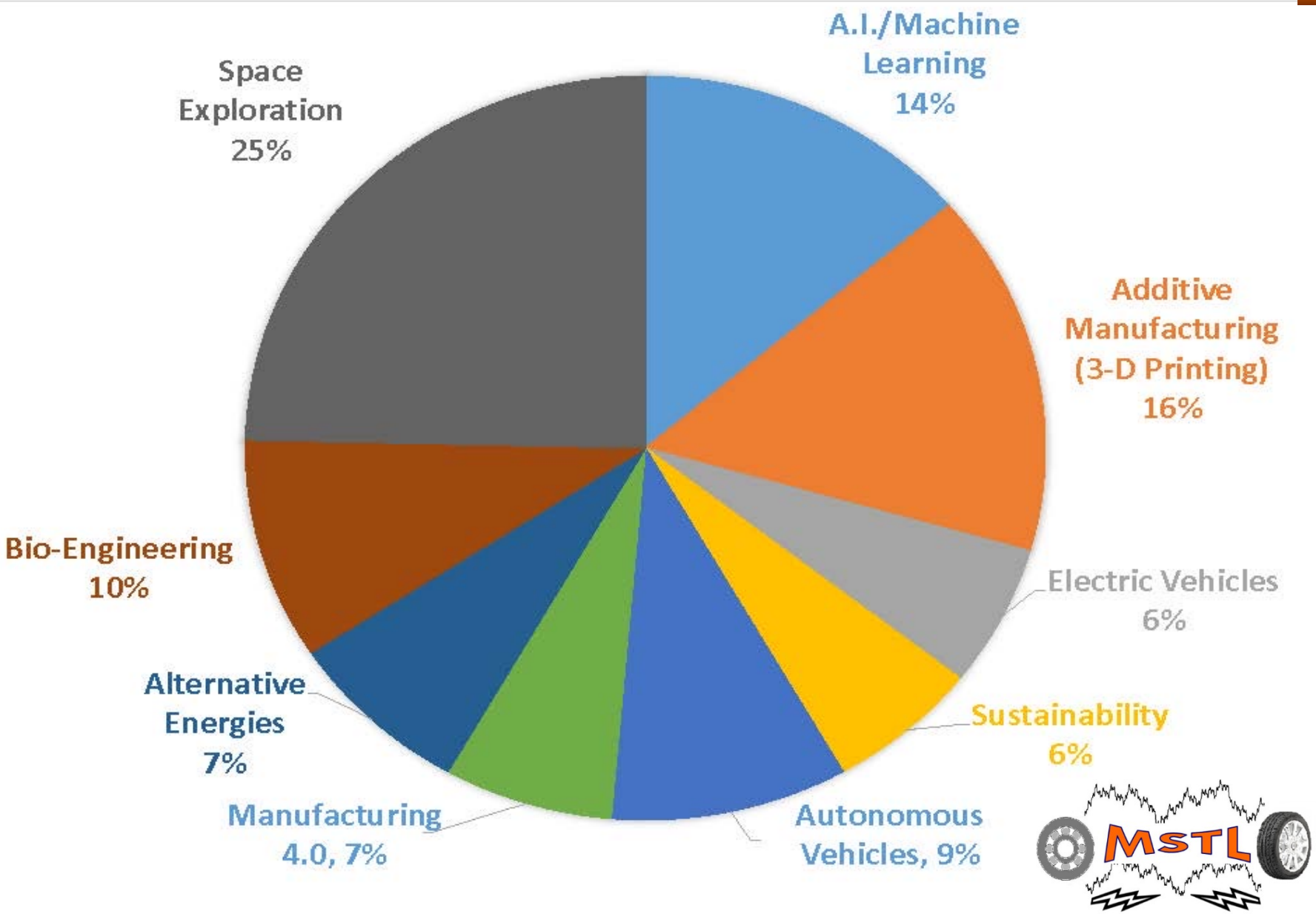
Gen Z has no exposure or experience with manufacturing.

Gen Zs want their contributions to mean something.

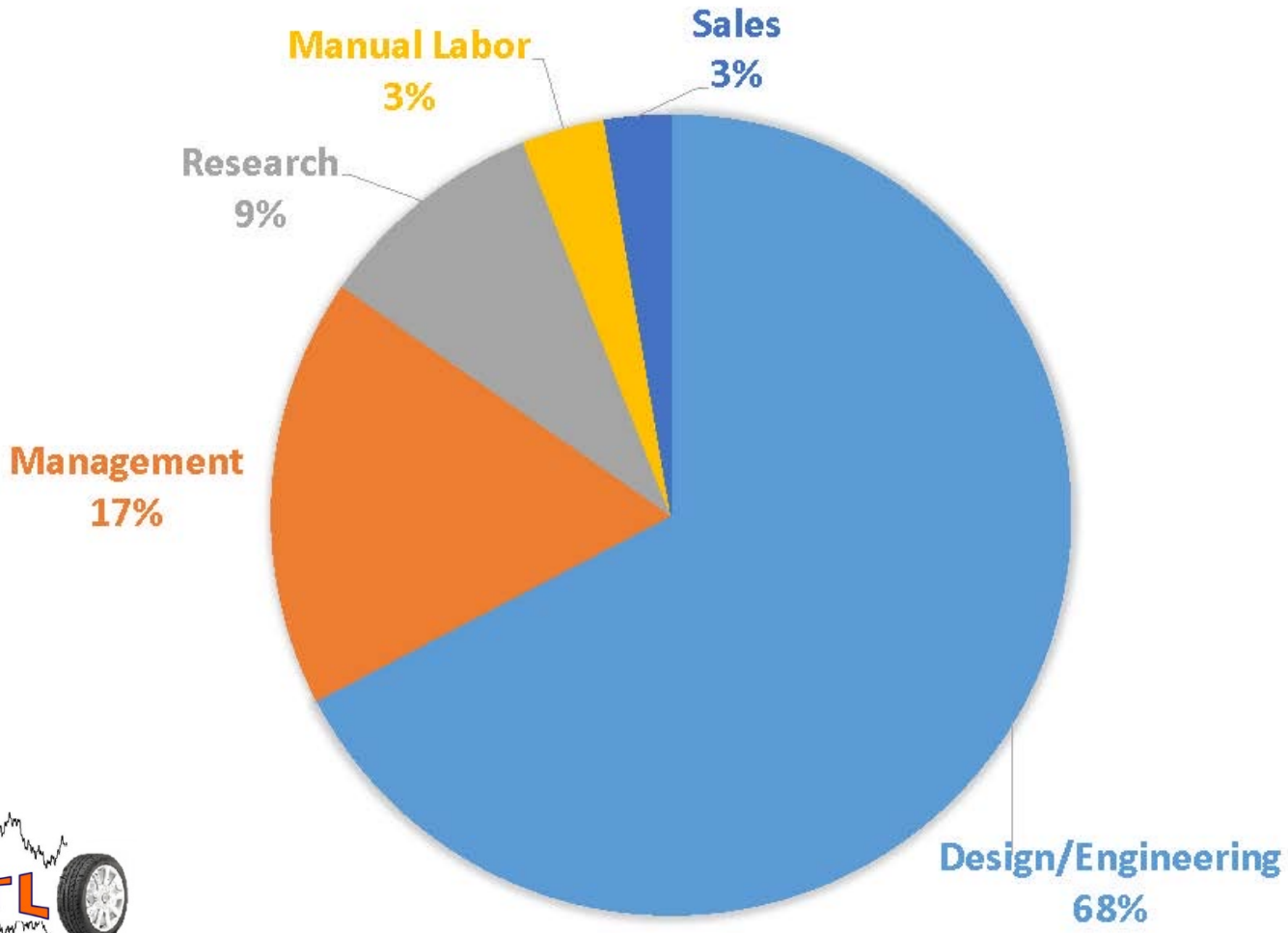
Current recruitment strategies do not align with what is appealing to Gen Zs.

Gen Zs want job to mean something.

Favorite Career Fields

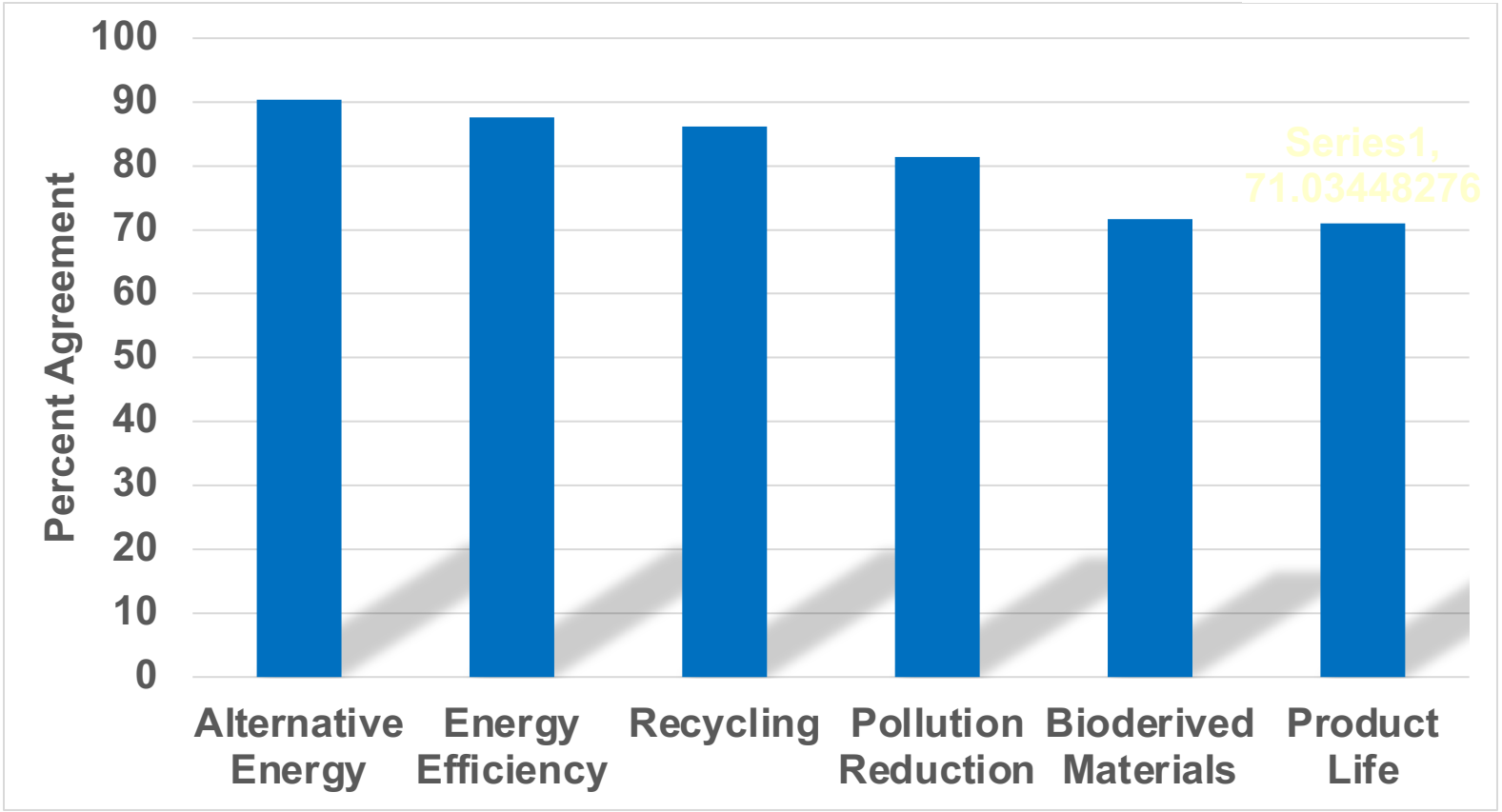


- What type of work do you want most of your future career to entail?



Tribology and Sustainibility

- Pick which of these areas you would categorize as part of sustainability:



Tribology plays a critical role in several of these, but alternative energy continues as the focus.

Higher Education

- How well do you believe your coursework at the university relates to your desired field of work? Rank 1-5, with 1 being the most related and 5 being the least related.
- Average response was 3.29.

- This suggests we can do more to adapt higher education to current career goals…
- …but students also often do not realize what is important for their careers.

Perception of Industry

- The technological world has a shiny façade.
- More and more people do noy see what's underneath the hood.

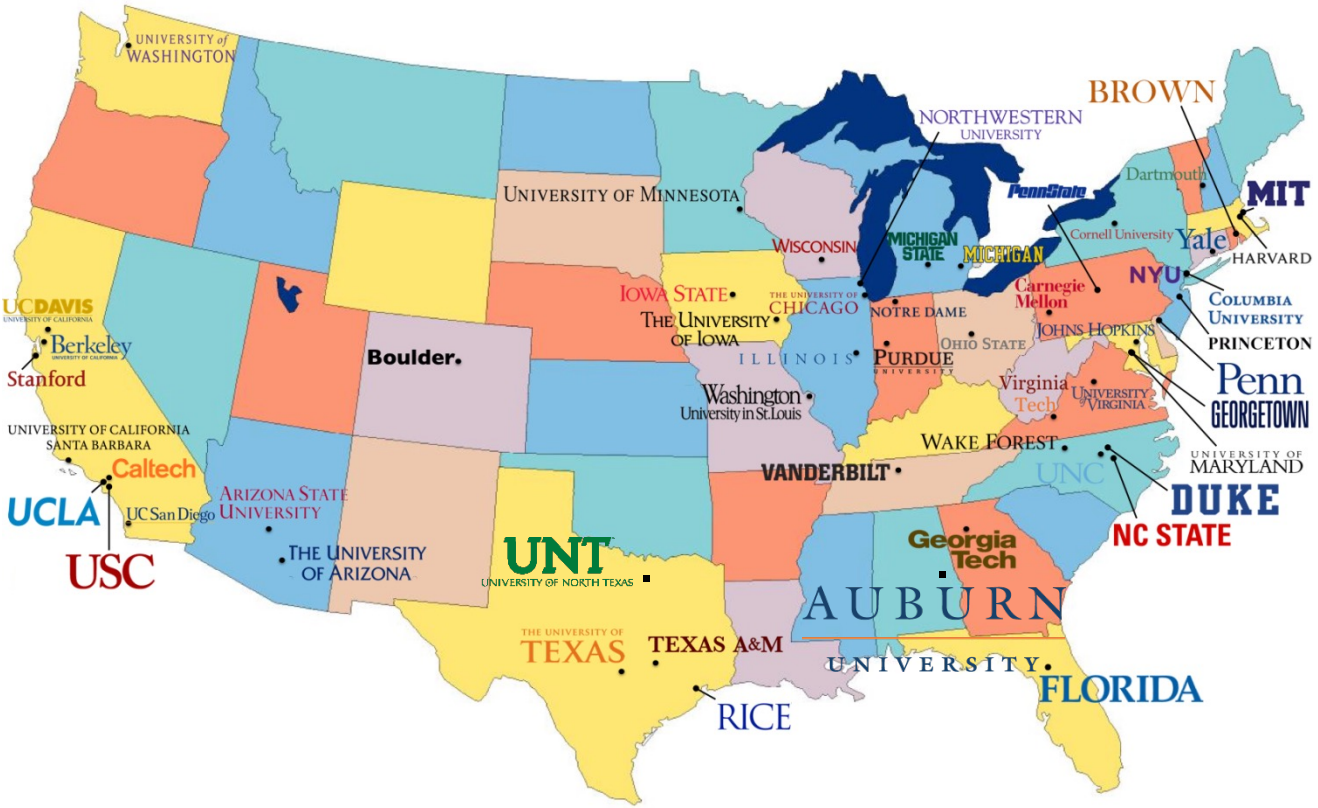
https://www.machinerylubrication.com/Read/30787/oil-change-signs

Other Poll Questions

- Are you involved in a professional organization (STLE, ASME, AICHE)?
  - 42% were members
- Do you find student organizations on campu valuable?

What currently exists at universities

Many engineering focused universities may have a professor or two who perform tribology graduate level research and teach an undergraduate elective course.



State of Tribology Education

- Few professors at universities teaching or researching traditional Tribology.
- Graduates receive very little exposure to Tribology via core courses (ME – Machine Design depending on who the instructor is. May be less in other majors.).
- A large demand from industry remains for graduates who have some background in Tribology.
- Tribology is an area that often goes unaddressed in industry and academia unless you have an appreciation for it.
- If we educate more people about it, many industries may benefit.
- The demand will increase as the current workforce retires.
- Auburn University has the only undergraduate Tribology Minor in the United States.

The Long Road Toward the Minor

- Met Parker Sizemore and Ralph Beard at the STLE Annual Meeting, May 2009, Orlando, FL.
- We noticed the lack of undergraduate education opportunities in tribology.
- Received helpful and positive feedback from many folks in industry for several years until the Tribology Minor concept was fully formed.
- Discussed again at IJTC 2009 and several other venues.
- Academic approval took about 2 years.
- The Minor was approved in the February, 2012 and started Fall 2012.

The Ralph Beard Fund for Excellence

- Ralph was integral in the creation of the minor and making contacts in industry.
- The Ralph Beard Fund for Excellence was established in 2017.

‘New’ Online Tribology Graduate Certificate

- Allows folks from industry to take our courses without need to apply as a full Undergraduate, Masters or PhD student.
- Courses are available online.

Number	Title
MECH 6230	Friction, Wear and Lubrication
MECH 6240	Boundary and Full-Film Lubrication
MECH 6250	Multiscale Contact Mechanics

- It is also possible to build a Masters of Engineering Degree with a specialization in Tribology.

Tribology Minor Curriculum

The minor is multi-disciplinary and open to all students.

The curriculum is evolving as new courses become available.

Courses required	
MECH 5240	Boundary and Full-Film Lubrication
or PFEN 5300	Rheology
or CHEN 5410	Macromolecular Science and Engineering
MECH 5230	Friction, Wear and Lubrication
CHEM 2080	Organic Chemistry II
or CHEM 2030	Survey of Organic Chemistry
or CHEM 4070	Physical Chemistry I

Tribology Minor Curriculum

Electives courses

CHEN 5430	Business Aspects of Chemical Engineering
MATL 5600	Corrosion
MECH 5830	Engines (This Course is newly added.)
MECH 5270	Metalworking and Manufacturing Tribology
CHEN 5660	Macroscale Assembly and Applications of Nanomaterials
MECH 5970	Intermediate Special Topics in Mechanical Engineering (Can be Advanced Manufacturing)
ENGR 3520	Integrating Business and Engineering Theory with Practice
MATL 5200	Crystallography
BSEN 5540	Biomass and Biofuels Engineering
CHEN 5120	Surface and Colloid Science
CHEM 4070	Physical Chemistry I
MECH 5250	Multiscale Contact Mechanics
ENGR 3510	Introduction to Business and Engineering
CHEN 5420	Polymer Chemical Engineering
BSEN 4250	Hydraulic Control Systems Design

Recruiting into Minor

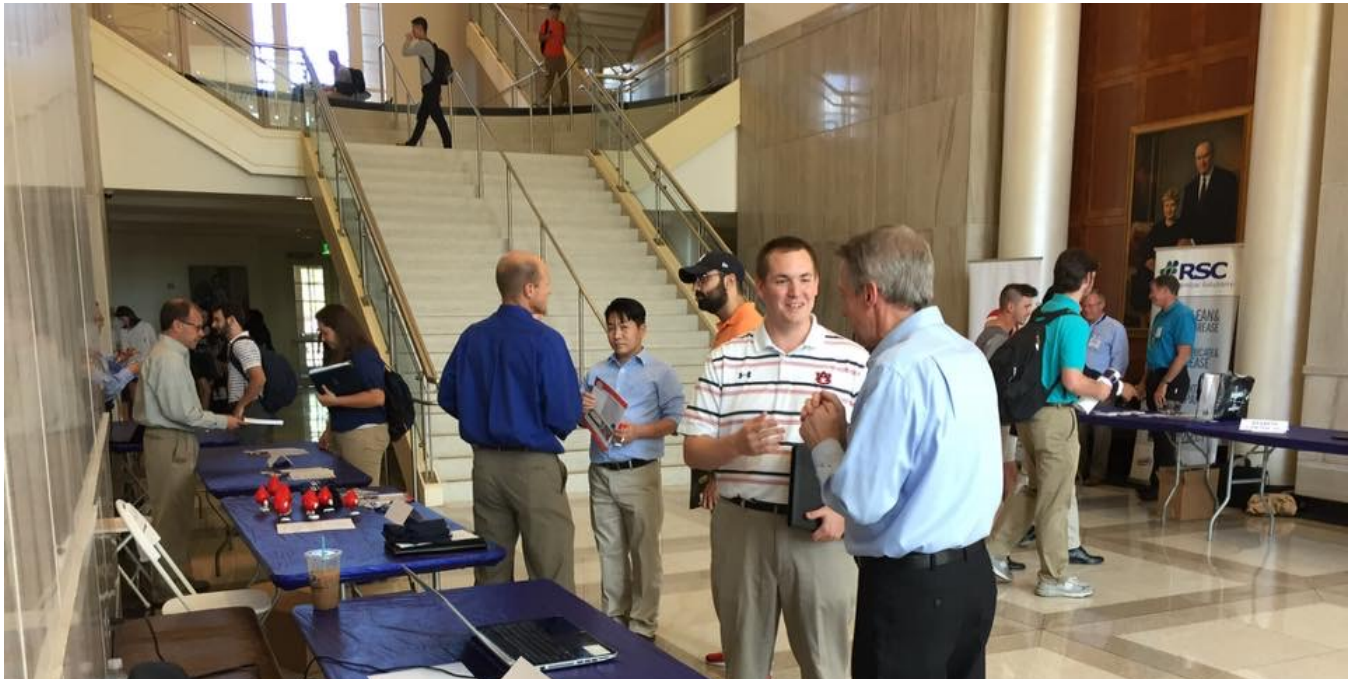
- What would be most likely to motivate you to pursue an academic minor?

1. Higher Salary
2. Internship/Job Placement
3. Scholarships
4. Expanded Expertise

- That said, rankings were very close.
- Courses on Tribology are full, but students reluctant to commit to full minor.

Career Fair

- Students from Tribology Minor, in Tribology Class, and others from Engineering and Science interested in the field.
- 2:15 pm-4:30 pm



How My Courses are Taught

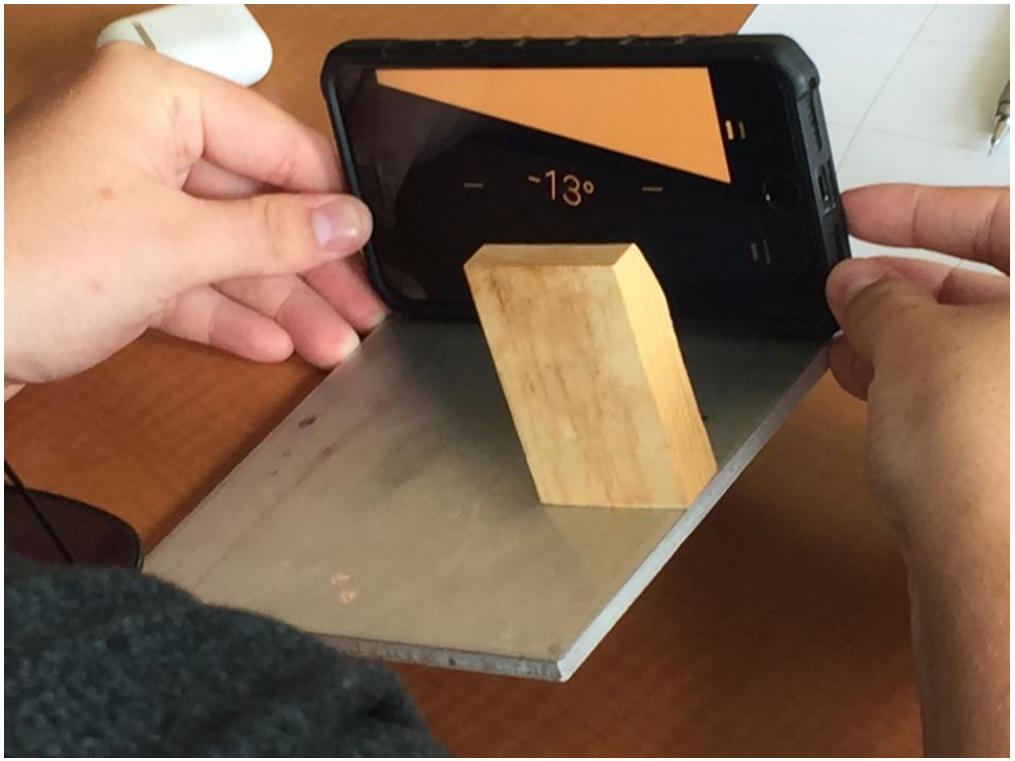
- The class will be taught using a relatively new method, called ‘flipping the classroom.’
- Watch lectures mostly at home.
  - Copy what I write and make notes.
  - Go back and review and read the book.
  - Ask questions in class.
- You must watch the videos before class, or you could fall behind.

Why use this method?

- Allows for class time to be used more constructively.
- Students always ask for more time for examples and review.
- People generally learn better by practice rather than watching. I can explain and help with real problems individually during class. Not everyone has the same issues.
- If I see a common issue between multiple students, I will announce it to the class.
- This method had been used for several years with positive results and feedback from students.

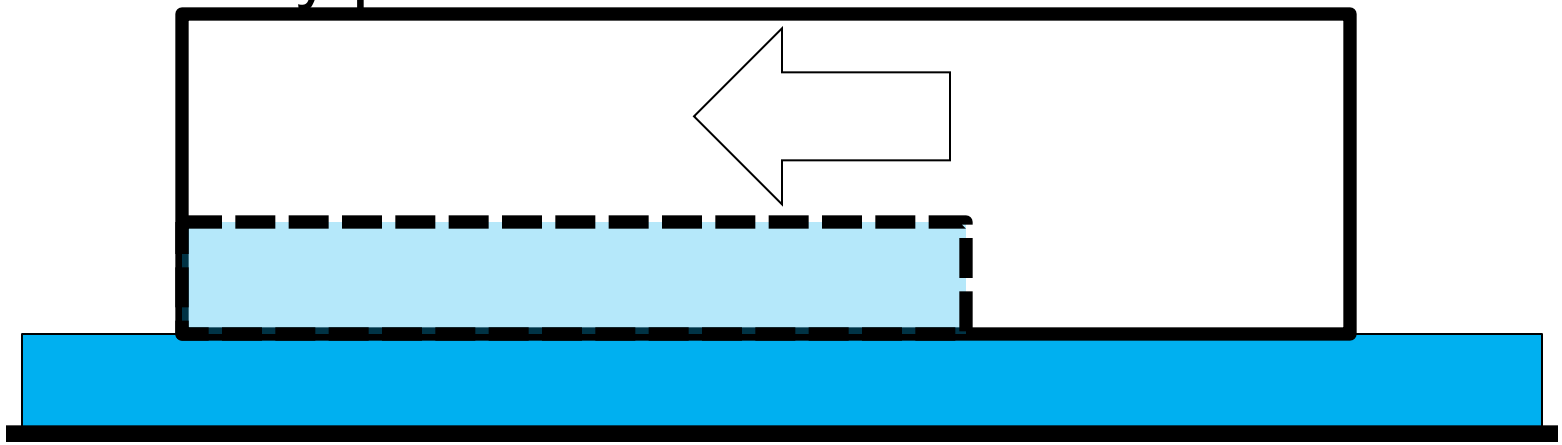
MECH 5230: Tribology Class

- Flipping the class has allowed me to bring more demonstrations into the class.
- Measuring static friction of a block on a tilted flat using smart phones to measure angle. We measured wood against glass, metal and plastic and on different sides of the block.



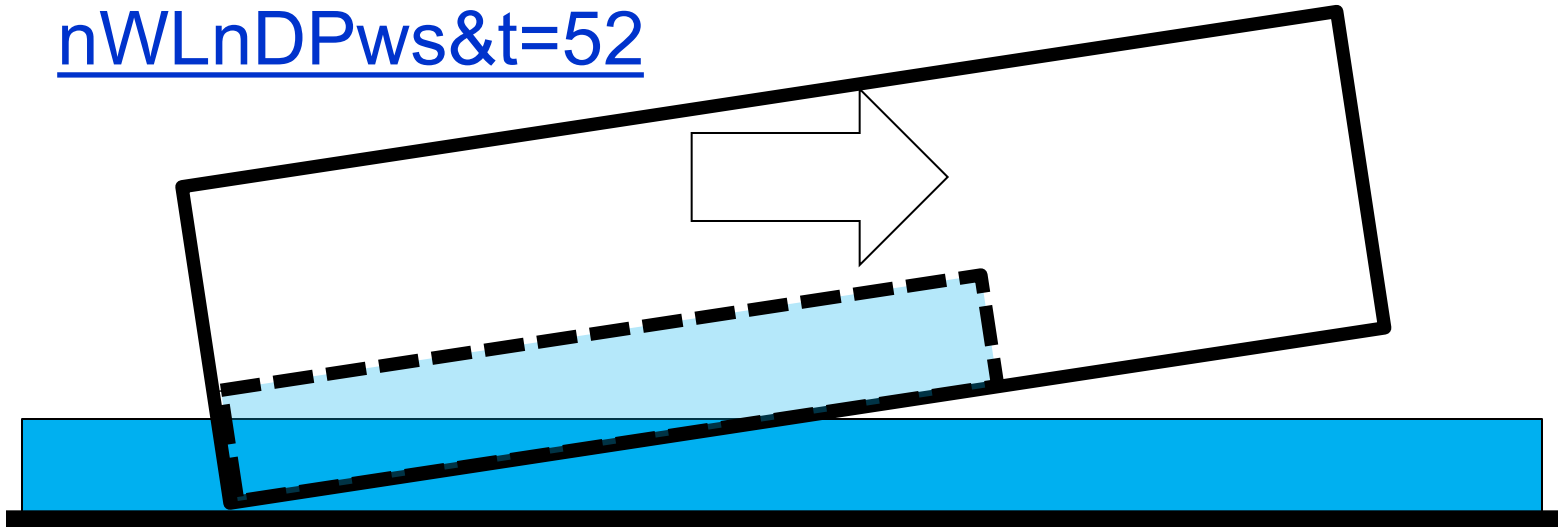
Magic Blocks

- Conclusion of tribology class includes a project.
- One option is to design and fabricate a slider bearing for a inclined 8ft ramp.
- Students often use a step bearing.
- See any problem here?



Magic Blocks

- Can demonstrate blocks in class with a little water to introduce hydrodynamic lubrication theory.
- This one works when flipped!
- https://youtu.be/vrgSZA2zPAc?si=E5fOEeM3nWLnDPws&t=52



Friction, Wear and Lubrication Labs and Project

- Example Lab Topics
  - Surface Profilometry and Characterization
  - Dry Friction/Wear Pin on Disk test- steel ball on several samples.
  - Viscosity Measurement
  - Lubricant Comparative Test - A base oil with additives and one without additives will be tested and compared.
  - A Stribeck-curve Generation – Show the transition between the full-film and boundary lubrication regimes.

Student Activities

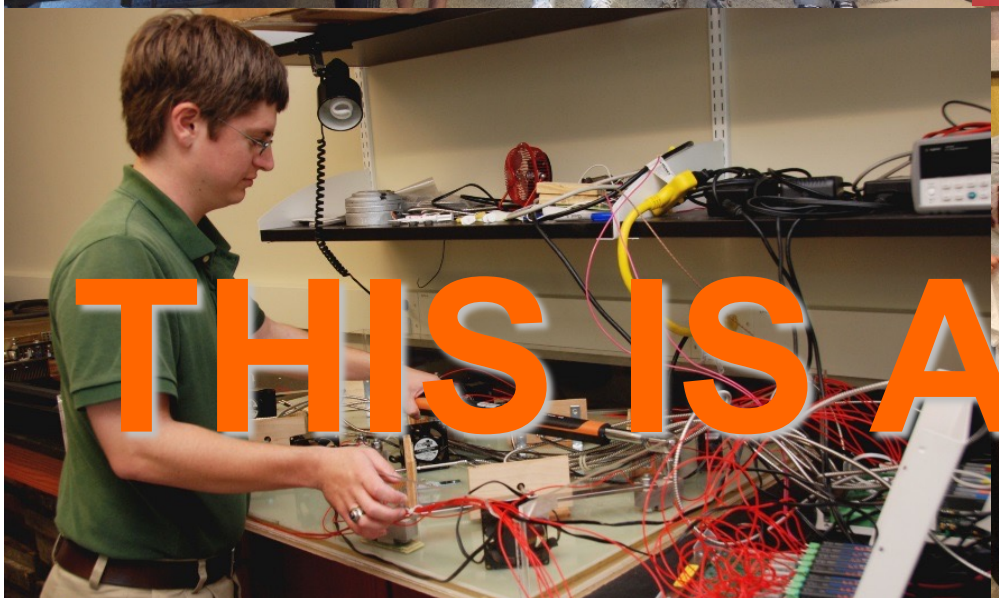
- Active student tribology and lubrication science society with ties to STLE, NLGI and ILMA.
- Participated in STLE STEM Camp with High School Students.
- Organize networking and seminar events on campus.

Conclusion

- Consider the individual over the generation.
- Current new hires may values different qualities about their careers.
- Communicate the importance of their job and individual tasks.
- Use frequent but more informal communication.
- Provide incentives and benefits to improve retention.
- Support educational and advancement opportunities.

Thank You!

A Commitment to Preparing Tomorrow's Tribology and Lubrication Engineers



Industry Support

- We would not be where we are today without support from organizations, individuals, and corporations like yourself.
- Ralph Beard, RSC Chem. Sol., Cummins, ExxonMobil, Bruker, Ducom, AMRRI, STLE, ILMA and NLGI have already put their support behind the program, but we need your help to bring the program to the level that is needed by industry.
- Here's how you can help:
  - Sponsor scholarships
  - Sponsor research projects
  - Speak as a seminar speaker at Auburn University
  - Hire our students as interns and permanent employees
  - Spread the word about the program