

ECEn 391 – Junior Seminar

Graduate School and Fellowships

Prof. Karl Warnick



INTERESTED IN RESEARCH?

UNDERGRADUATE RESEARCH ROTATIONS

Research opportunities, paid research positions, prestigious national graduate research fellowships, and exciting research projects in the ECEn department will be highlighted.

TUESDAY NOV. 28, 2023 | 5pm | EB Event Space
Pizza will be provided

BYU Electrical & Computer
Engineering

Should you go to graduate school?

- Is graduate school for everyone?
 - No, but it is for many
- Many high-end technical jobs require MS or PhD.
- If you have the opportunity, go!

President Gordon B. Hinkley

You must get all of the education that you possibly can. Life has become so complex and competitive. You will be expected to put forth great effort and to use your best talents to make your way to the most wonderful future of which you are capable. Sacrifice a car; sacrifice anything that is needed to be sacrificed to qualify yourself to do the work of the world. That world will in large measure pay you what it thinks you are worth, and your worth will increase as you gain education and proficiency in your chosen field.



BYU Graduates getting PhDs

- Undergraduates who go on to get PhDs
 - BYU is in the top 5 nationally
 1. UC-Berkeley
 2. Cornell
 3. University of Michigan
 4. University of Texas
 5. BYU
 - 2,442 in the last 10 years.

Myths about Graduate School

- Overqualifies you for some jobs
- Only reason to get PhD is to teach
- I'm not smart enough to do it
- It's too expensive

Benefits of a MS

- Increased technical understanding
- Opportunity for mentored research experience
- Greater opportunity for technical leadership over BS
- Many jobs require it
- Increased pay
- Elevates career trajectory
- Increased job satisfaction

Benefits of a PhD

- Greater opportunity for technical leadership
 - Lead technical teams
 - Determine direction for research and development
 - Some venture capitalist required a PhD leading technical team
- Opportunity to understand topic deeply
- Many jobs require it
- Increased pay
- Elevates career trajectory
- Work has a creative focus
- Increased job satisfaction

Differences between Degrees

- BS:
 - Understand the field broadly
- MS:
 - Understand scope and breadth of a sub-discipline
 - Create a new design or solution that extends prior work
- PhD:
 - Make unique contributions in sub-discipline
 - Completely understand one problem or a few related problems
 - Solve an open problem
 - Emphasis on writing, scholarship, and publishing ideas

Can you do it?

- Yes!
 - 10s of thousands earn MS degrees yearly
 - Thousands earn PhD degrees yearly
- GPA requirements:
 - Usually > 3.2 for MS acceptance
 - Usually > 3.4 for PhD acceptance
- Qualifications:
 - Hard work
 - Willingness to focus on one topic for 2-4 years

BYU vs Elsewhere

- Pros of staying at BYU:
 - Continuity, already know professors, programs
 - Will likely take less time
 - Attention/mentoring received from advisors
- Pros of going elsewhere:
 - Top schools have strong brand name
 - Different perspective on ECE
 - Increased network
 - Increased course offerings

BYU vs Elsewhere

- Quality of education mostly determined by
 - Self motivation
 - Faculty advisor
 - Fellow graduate students
- Quality of graduate education at one university can be as good as anywhere else

Funding

- Most graduate engineering students:
 - Have tuition paid for by advisor / institution
 - Receive a stipend on order of \$20-25k
- Many fellowships available
 - Usually requires strong GPA
 - NSF, NDSEG, SMART
 - Others

Time to Completion

- MS:
 - 1.5-2.5 years
- PhD
 - 3-6 years (post BS)

APPLICATION PROCESS

ece.byu.edu/prospective-student

APPLICATION DEADLINES

Fall semester: January 15

Winter semester: August 15

MORE INFORMATION

ece.byu.edu/ece-graduate-programs

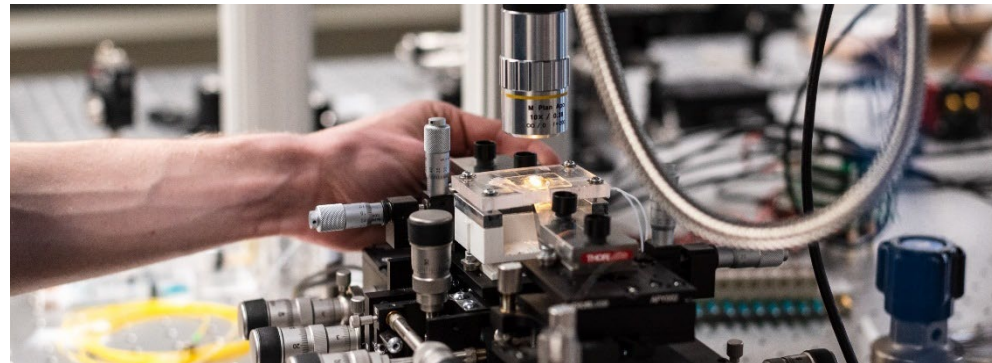
Research Areas



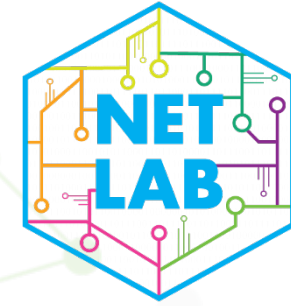
Using the quantum properties of light for computing, communications, and sensing.
camacholab.byu.edu

Students in our research group:

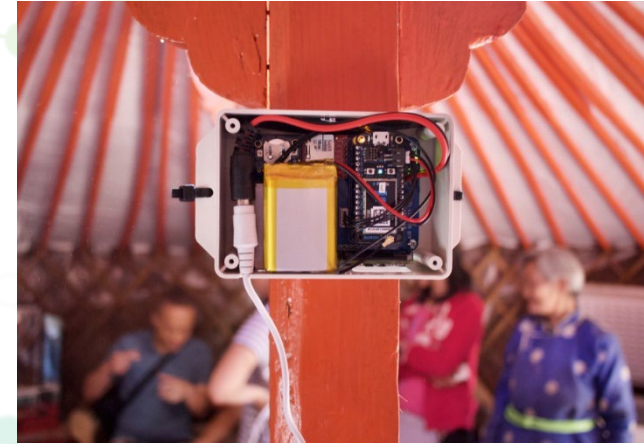
1. Use quantum entanglement in their everyday lives.
2. Design and build integrated photonic circuits.
3. Eat pizza at least once a month.
4. Work with amazing collaborators from Harvard, MIT, and other top schools.
5. Publish papers.



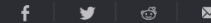
NET Lab



- Long-range low-power wireless networking
- Air quality monitoring in Utah and Mongolia
- Sensor data processing and machine learning
- Privacy and security of sensor networks
- Help make the Internet of Things a reality!



engadget

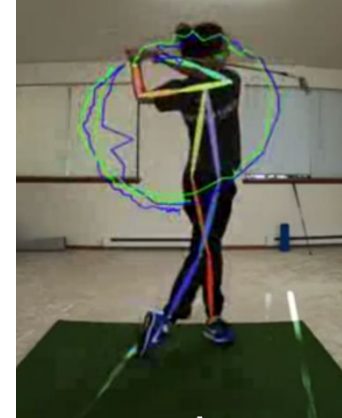
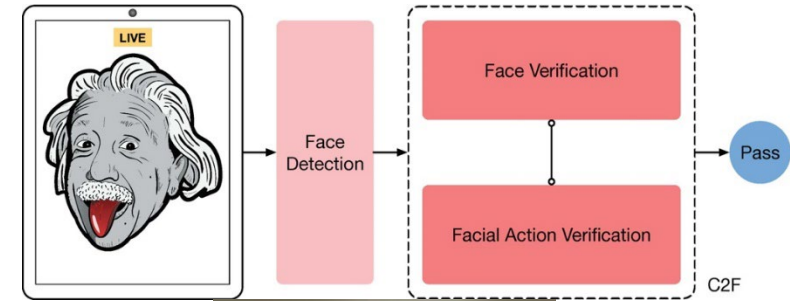


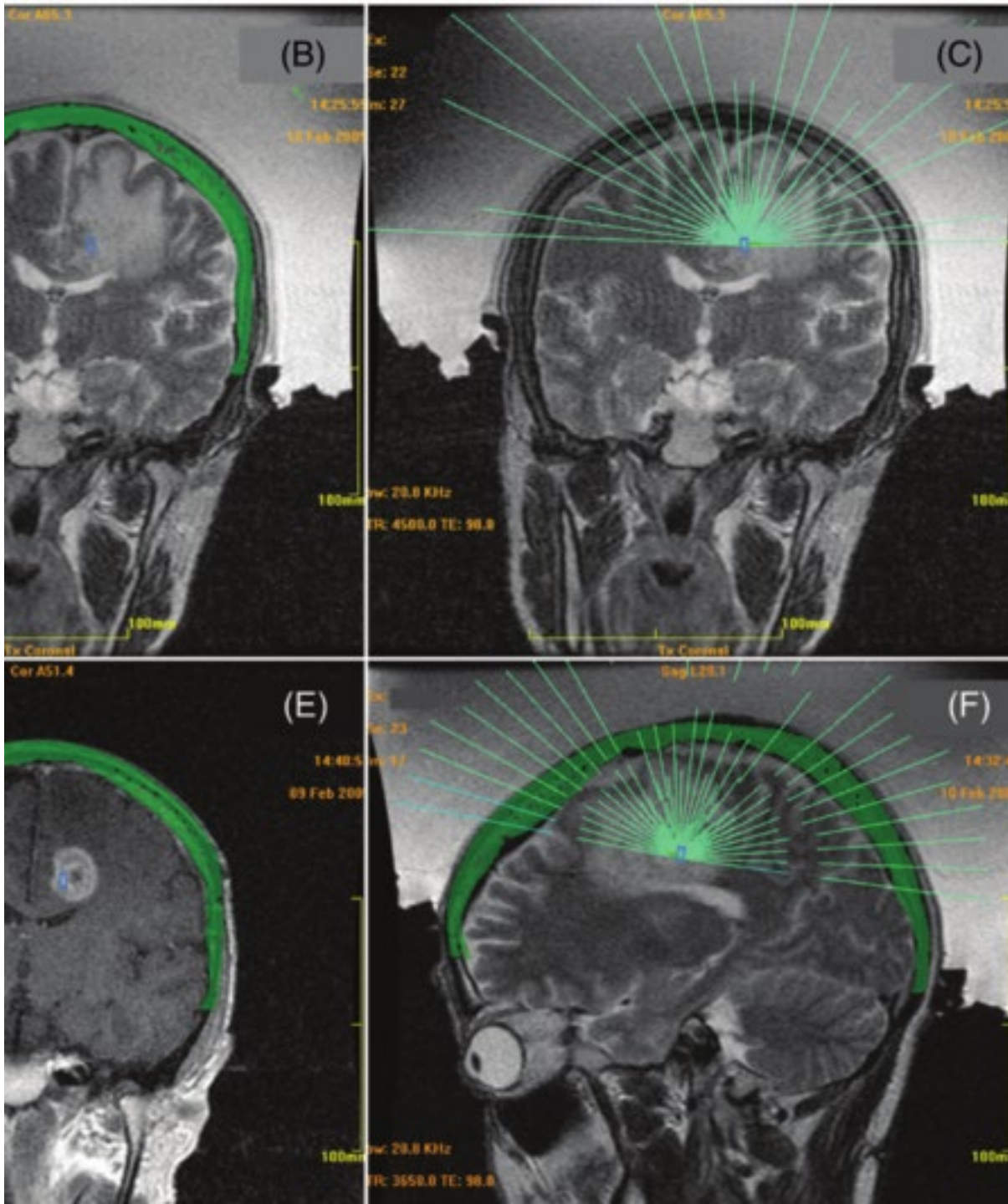
BYU researchers extend WiFi range by 200 feet with a software upgrade

Their protocol doesn't require hardware like mesh network routers.

Robotic Vision Lab – rvl.byu.edu - Lee

- Artificial Intelligence
 - Two-Factor Identity Verification
 - Performance Evaluation in Sports
 - AI Assistant Football Coach
- High-Performance Visual Computing
 - Deep Learning on FPGA
 - Low Latency Target Tracking
- Robotic Vision
 - Self-Driving Car
- Visual Inspection Automation
 - Food Quality Inspection
 - Foreign Material Detection
 - Fish Species Recognition





Non-Invasive Neurosurgeries

- Use ultrasound to kill tumors
- Use MRI to watch it happen

Steven Allen
Electrical and Computer
Engineering
spallen@byu.edu
Fridays, 3:00 PM

Field Robotic Systems Lab

We are interested in the development of perception, navigation, planning, and reasoning algorithms and tools that increase the reliability of autonomous field robotic systems, enabling them to consistently perform real-work in complex unstructured environments.

For more information contact Dr. Mangelson at: mangelson@byu.edu



Autonomous Underwater Navigation and Mapping



Autonomous Multi-Agent Underwater Inspection



Automated Fault-Diagnosis and Verification

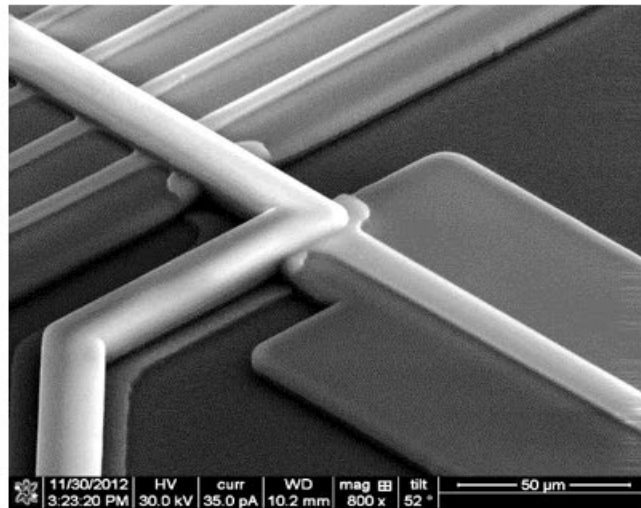


Hardware Accelerated Navigation/Planning



Autonomous Wheelchair Navigation

Microengineering Research Group



- Class 10 Cleanroom
- World leader in Optofluidics
- Lab-on-a-Chip and Bioengineering
- Integrated Optics
- Solid-state Devices
- Excellent placement in graduate programs or in semiconductor industry

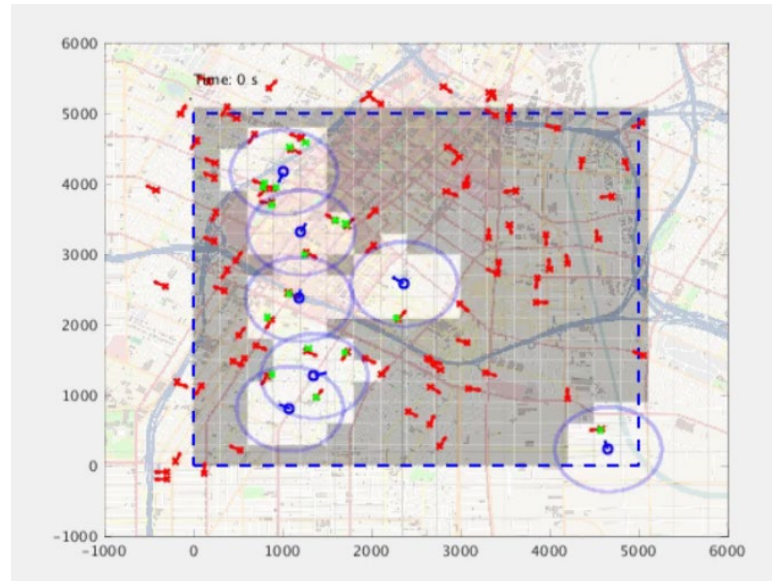
Professor Aaron Hawkins

<http://hawkinsweb.groups.et.byu.net//>

Cooperative Path Planning – Dr. Peterson, MAGICC Lab

Develop *optimal and efficient* methods for coordinating vehicle behavior of unmanned air vehicles.

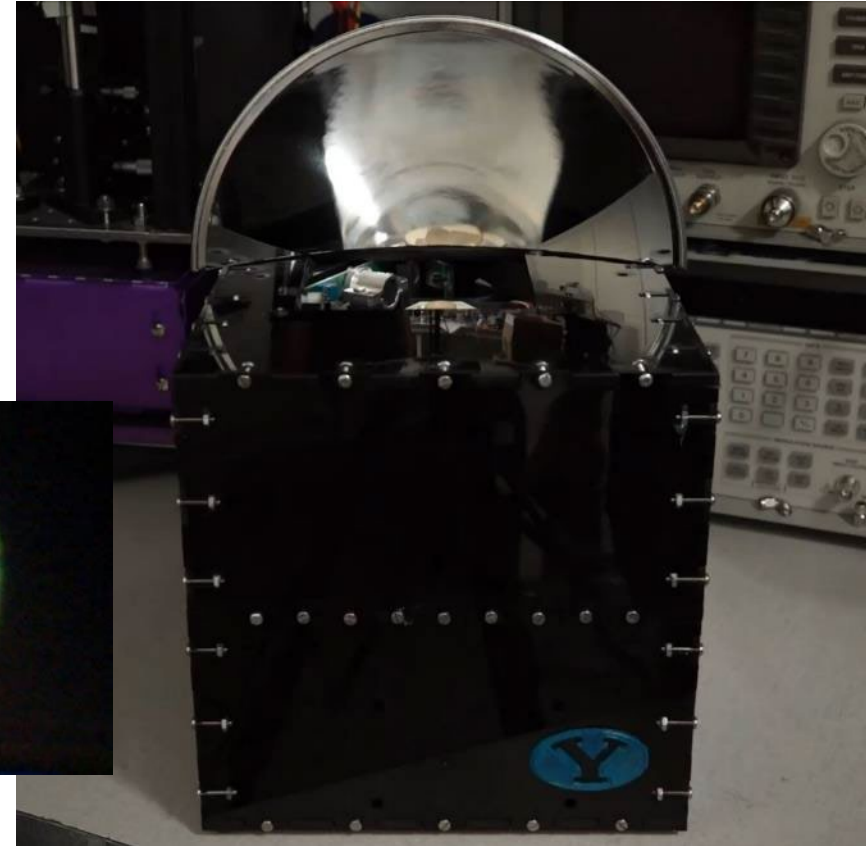
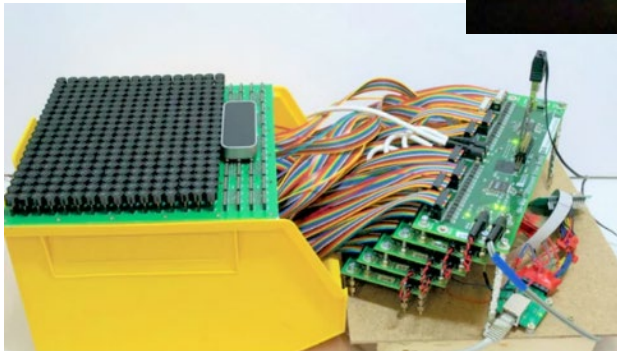
- Balancing competing, time-varying, objectives like searching and tracking targets
- Uses information based reward function
- Uses Kalman Filter techniques for tracking targets or estimating state variables
- Receding Horizon Control for cooperatively planning paths



Blue circles are UAV with their sensing radius
Red x's and arrows are targets
Green x's are targets being tracked
Dark squares haven't been searched for a long time

Smalley Lab

Creating a low-cost holographic video monitor



Looking for volunteers to use
ultrasound to make holograms you can
touch!



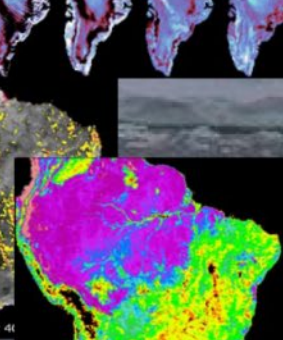
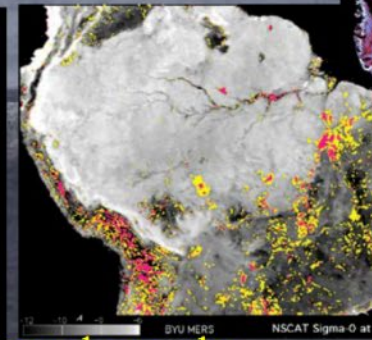
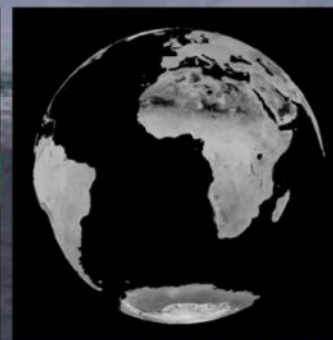
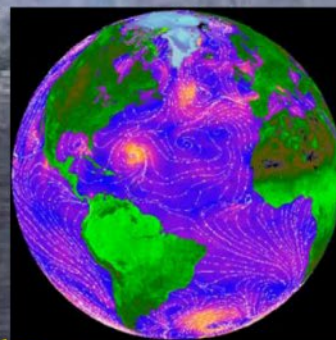
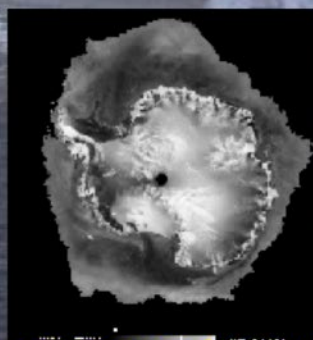
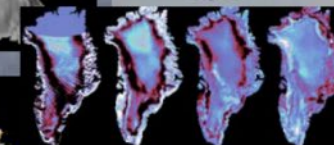
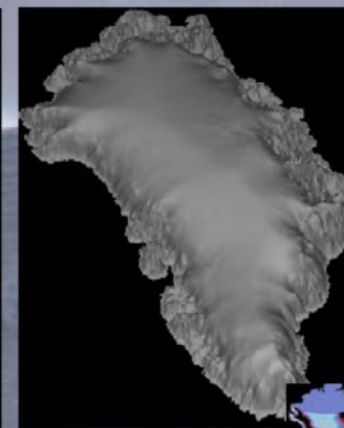
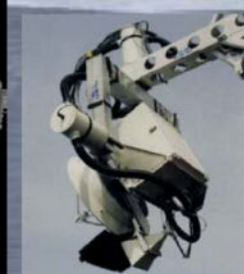
Microwave Earth Remote Sensing (MERS) Laboratory

Dr. David Long

Center for Remote Sensing

MERS conducts research in remote sensing of the Earth including:

- Remote sensing
- Development of advanced microwave sensors
- Satellite sensor system design
- Satellite data scientific data analysis and processing

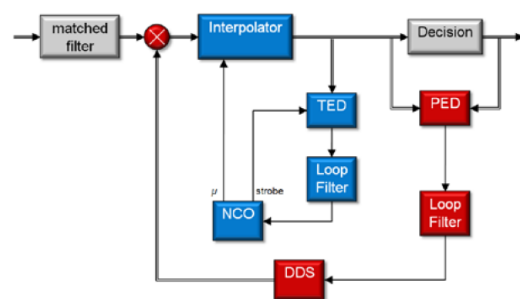


www.scp.byu.edu

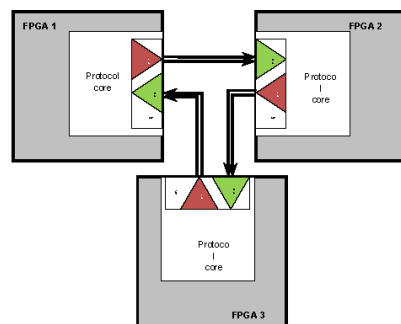
www.mers.byu.edu

Configurable Computing Laboratory (FPGA Lab)

Brent Nelson, Mike Wirthlin, and Brad Hutchings



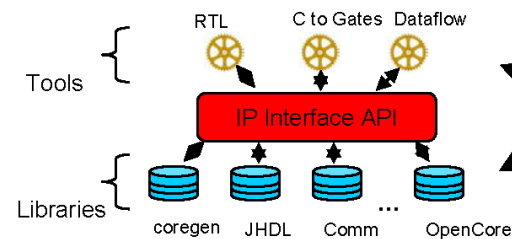
Digital Communication



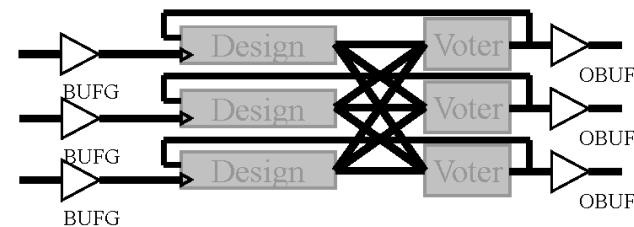
High Speed Serial Communication



Space-Based FPGA Computing



Circuit Reuse

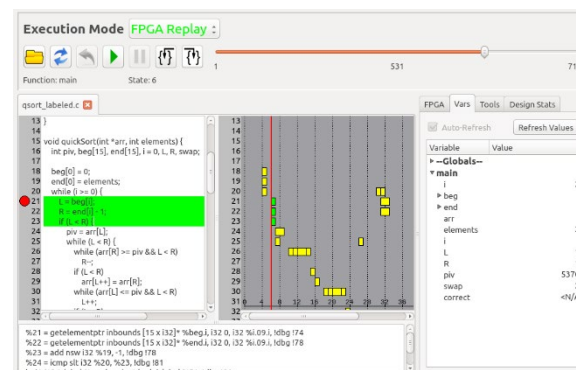
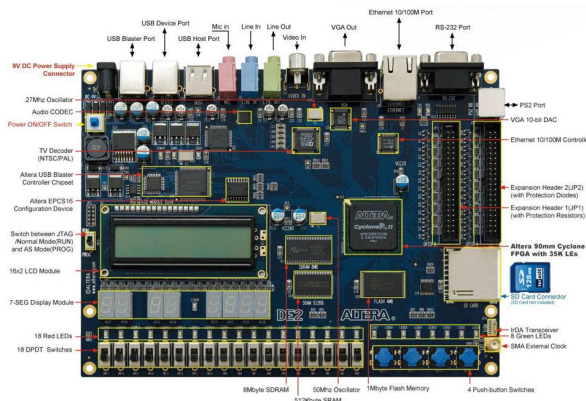
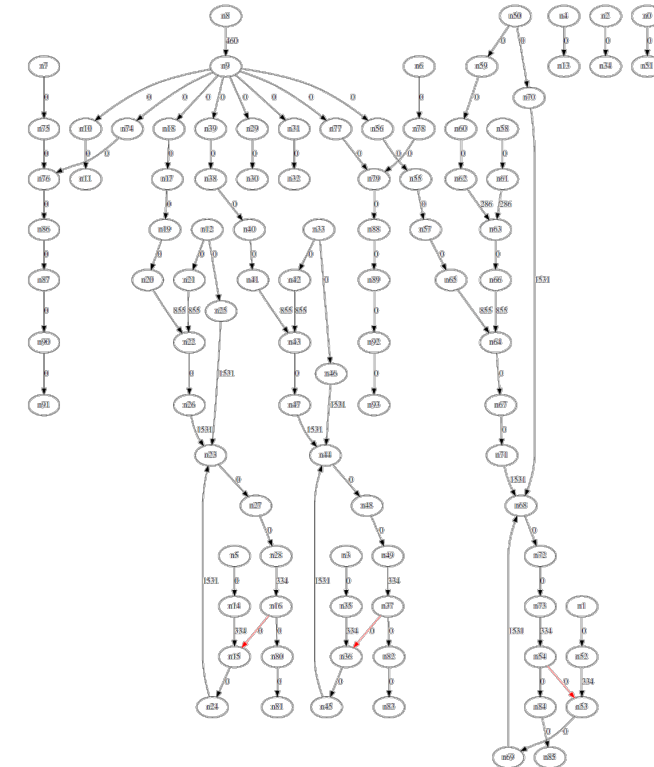


Fault Tolerant Computing

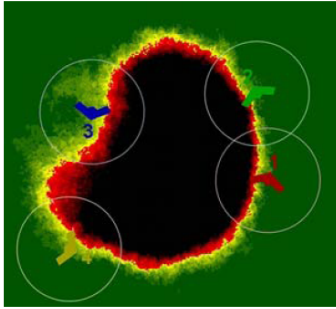
Jeffrey Goeders

Research: Better tools for creating digital logic circuits

- High-level synthesis:
 - Automatically creating digital circuits from software programs
- FPGAs:
 - How do we make FPGAs easier to program?
- Debugging tools:
 - Observing internals of hardware circuits while they run



MAV Research @ BYU (Beard)



Cooperative Control

- Cooperative timing problems
- Cooperative persistent imaging
- Cooperative fire monitoring
- Consensus seeking
- UAV / UGV

Path Planning Trajectory Generation



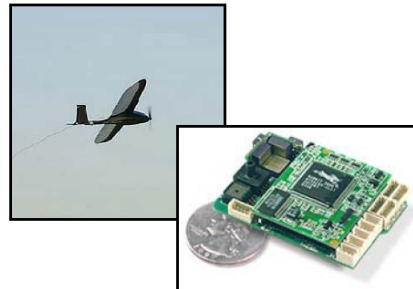
- 3D Waypoint path planning
- Wind compensation
- Collision avoidance
 - Optic flow sensor
 - Laser ranger



Image Directed Control

- Geo-location
- Target tracking
- Precision landing
- Collision avoidance

Autonomous Vehicles



- Autopilot design for small UAVs
- Attitude estimation
- Adaptive control
- Tailsitter, quadrotor GNC

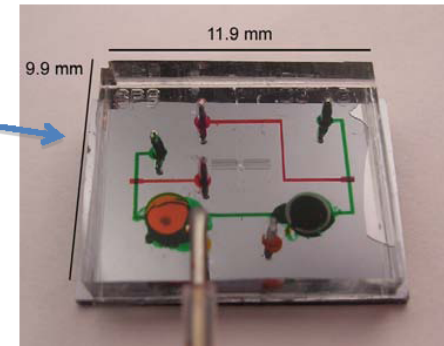
Nanomechanical Biosensors

Dr. Greg Nordin

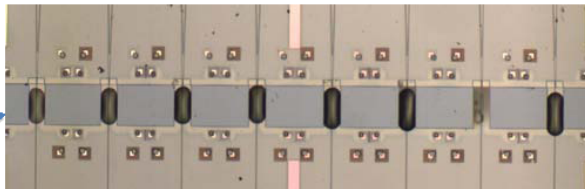
- Integration of:
 - MEMS (microelectromechanical systems)
 - Silicon photonics
 - Microfluidics (lab-on-a-chip)
- Applications:
 - Medical diagnostics (cancer, disease)
 - Biowarfare agent detection
 - Intelligence agency & homeland security
- Tools used:
 - Cleanroom
 - Scanning electron microscopy (SEM) & focused ion beam (FIB)
 - Photonic readout & control
 - Fluidic control
 - Experiment automation



Sensor chip

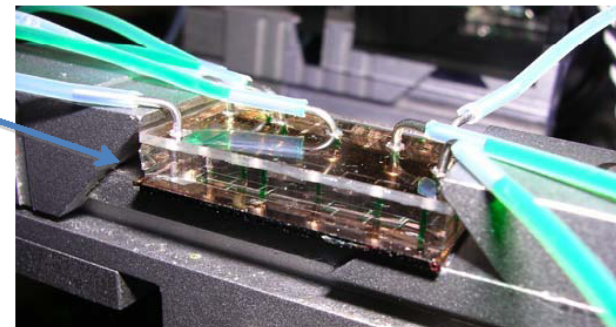


High speed
microfluidic
pump



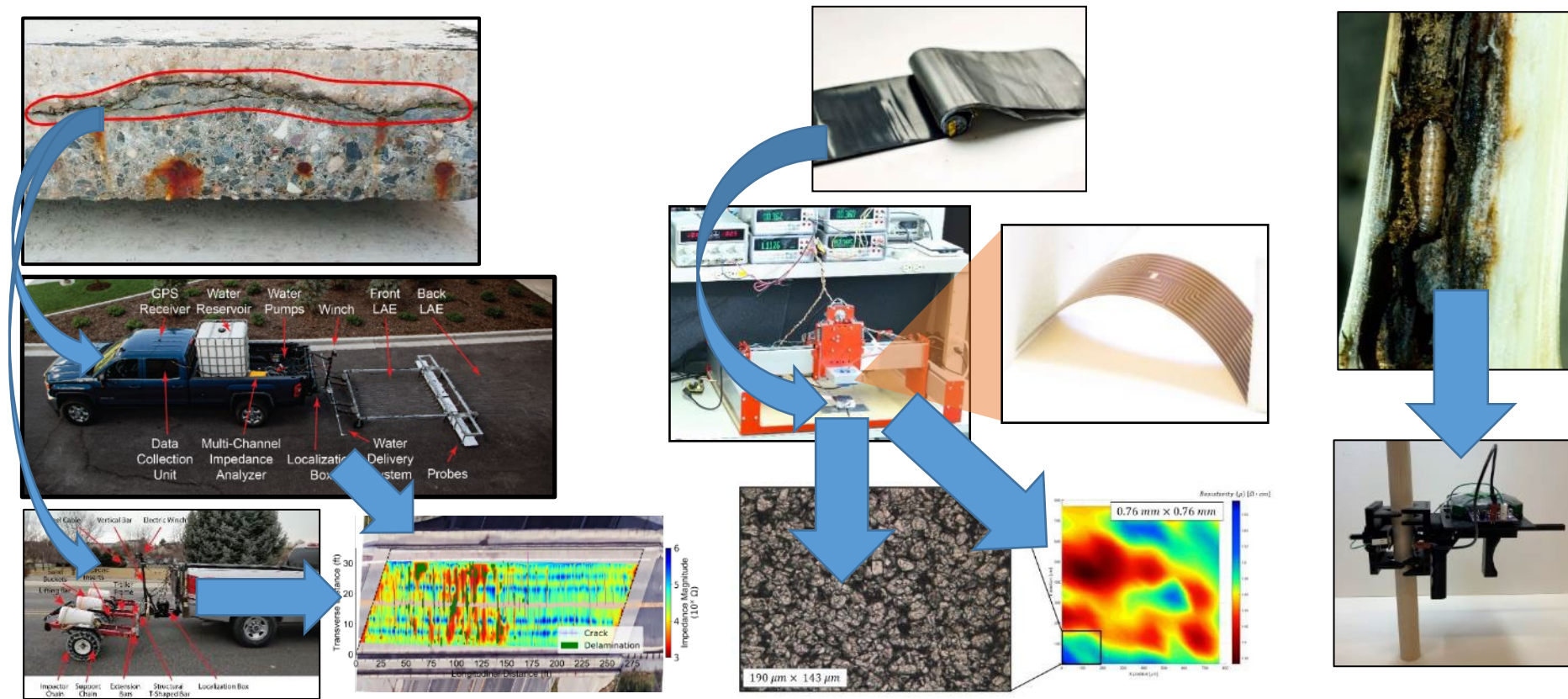
Linear sensor array

Integrated
sensor &
microfluidic
chips

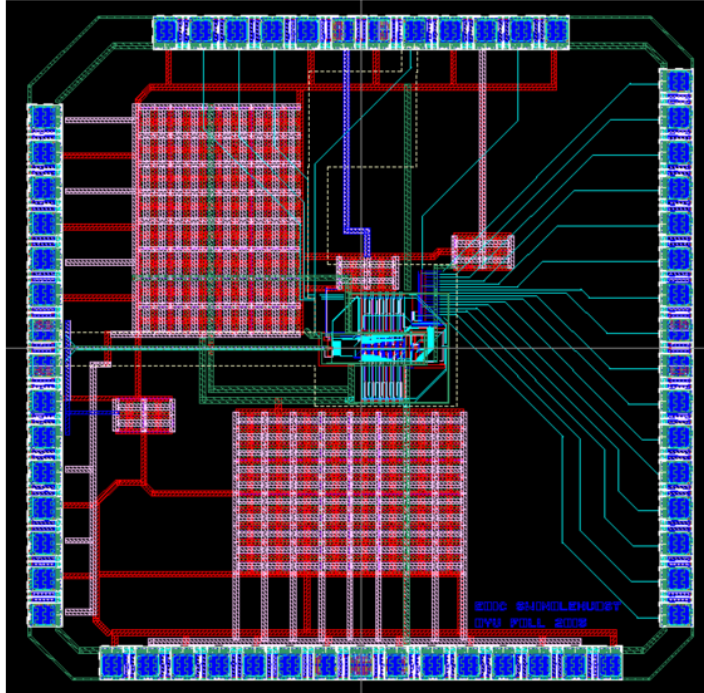


Mazzeo Research Group

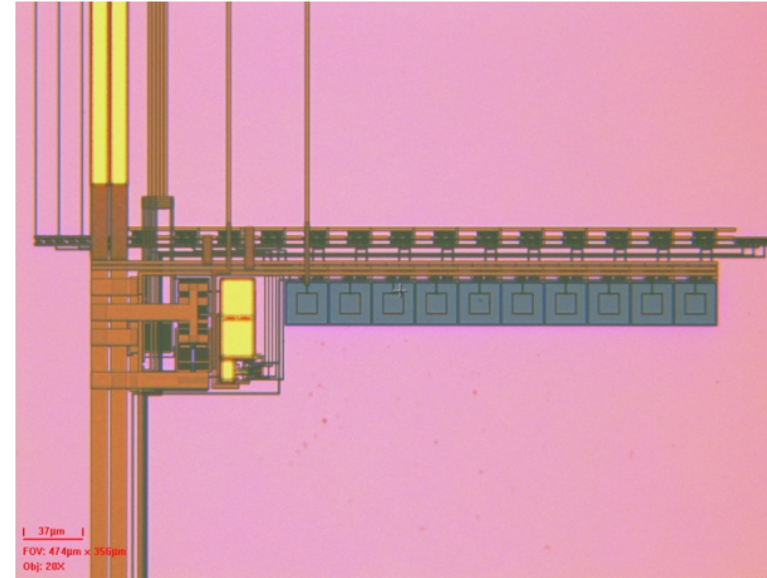
Topics: Bridges (nondestructive evaluation at high speed), Batteries (Li-ion electrode microstructure), Bugs (Agriculture IoT)



RF/Analog/Mixed-Signal Integrated Circuits, Dr. Shiuh-hua Wood Chiang



[120-MHz, 9-bit ADC]



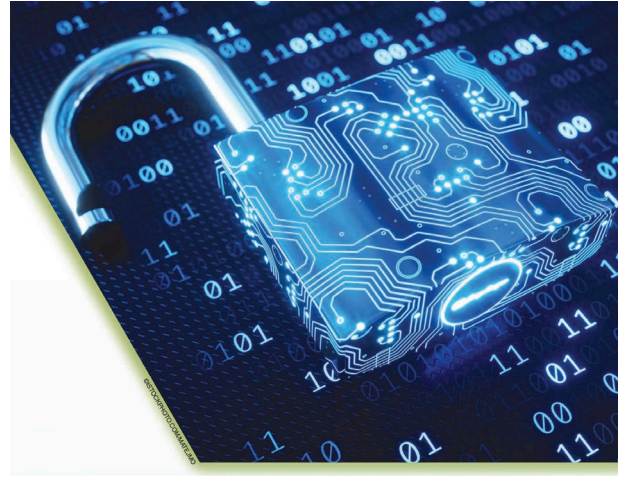
[CMOS image sensor]

- **Cutting-edge research on**
 - High-performance data converters
 - Low-noise instrumentation amplifiers
 - Biodetectors
 - Implantable sensors



Dr. Harrison – Partner in the Information Theory and Communications Engineering (ICE) Lab

- Physical-layer security: using noise in the communications channel for security.
- Secret codes: optimizing codes that keep secrets and correct errors.
- Cryptography
- Machine Learning
- Sports Analytics



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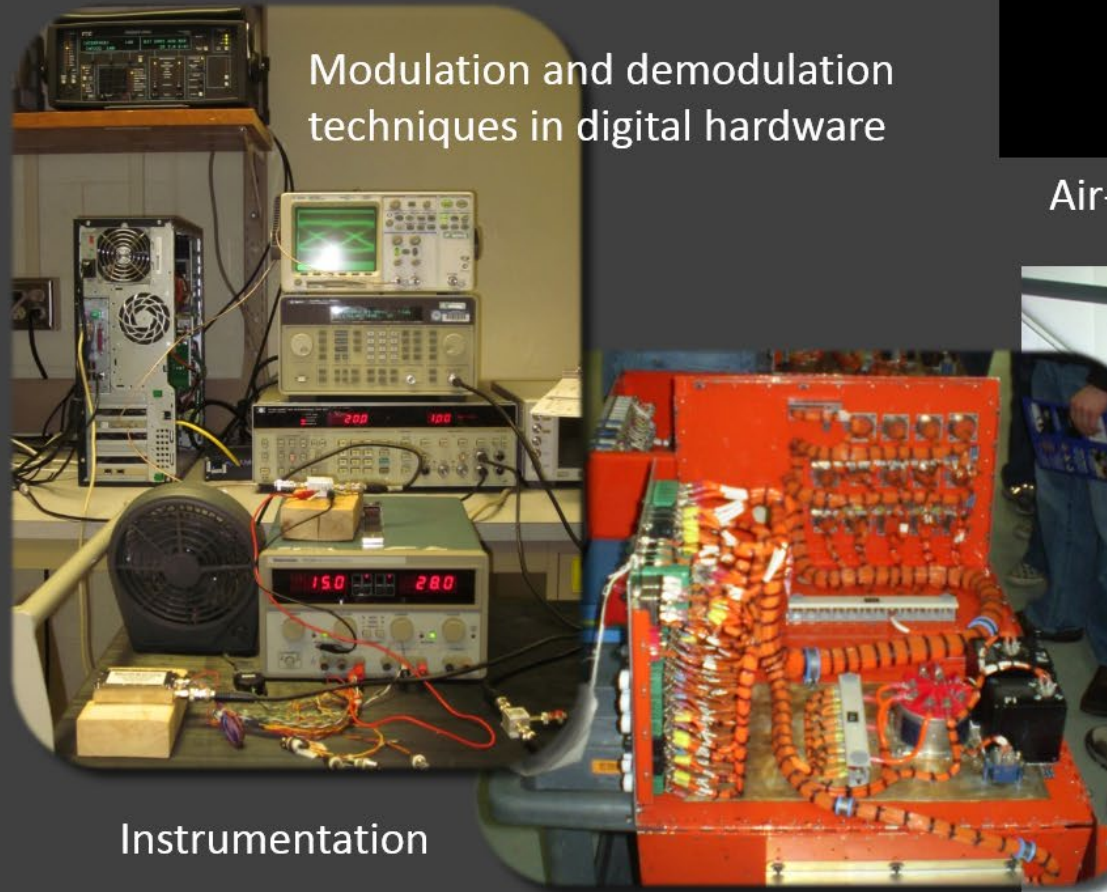
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Aeronautical Telemetry

Undergraduate Projects in
instrumentation, digital techniques for
modulation, wireless communication
channels



Modulation and demodulation
techniques in digital hardware

Instrumentation



Air-to-ground communications



BYU Smart Antenna Systems Lab & Radio Astronomy Systems

Karl F. Warnick & Brian Jeffs

Research Areas:

Radio Astronomy Systems, Advanced L band Camera for Astronomy (ALPACA), Focal L-band Array for GBT (FLAG), world's most sensitive astronomical imaging phased array, liquid helium cryogenics

Multichannel, broadband, real time digital signal processing for imaging arrays, FPGA algorithm implementations

Phased array antennas for satellite communications, electronically steered satellite communication ground terminals, highest efficiency planar arrays reported in the literature

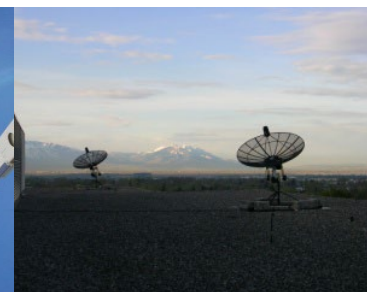
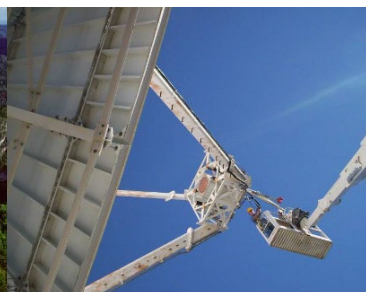
Communications antennas and sensors for unmanned air vehicles, collision avoidance radars for sense and avoid



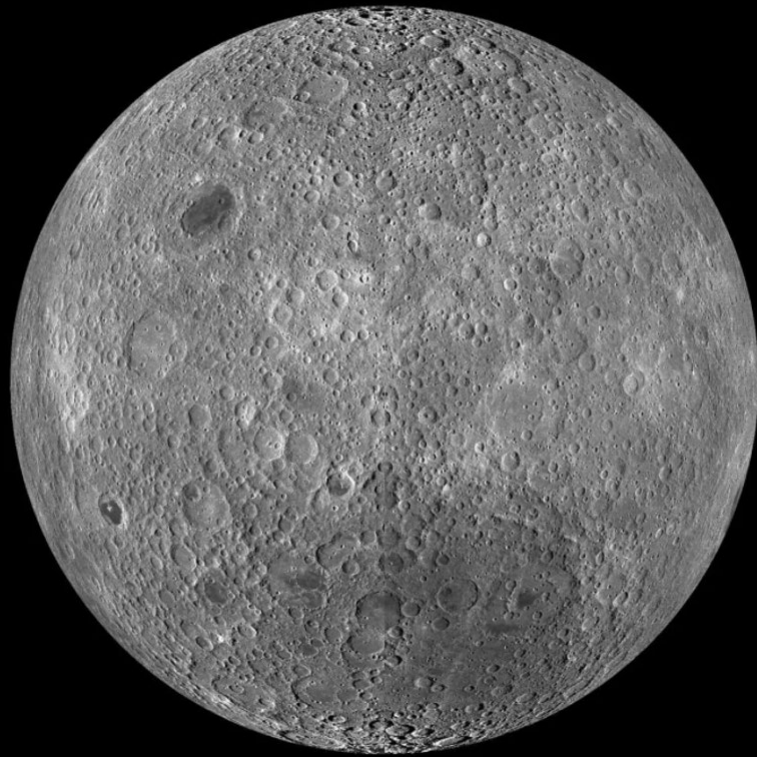
NavAir



AFOSR

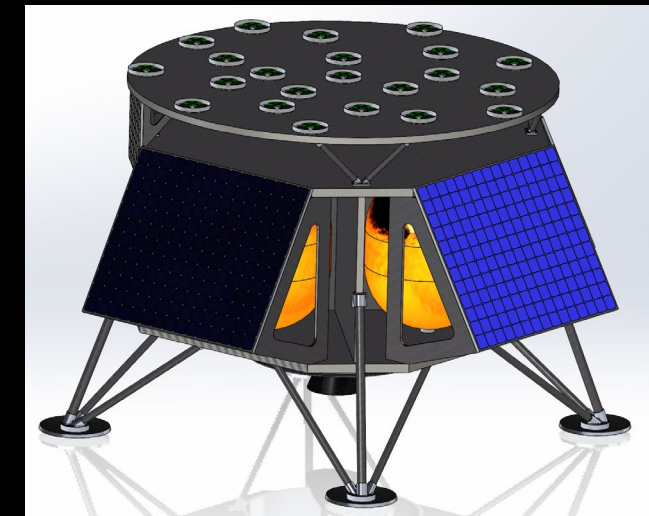
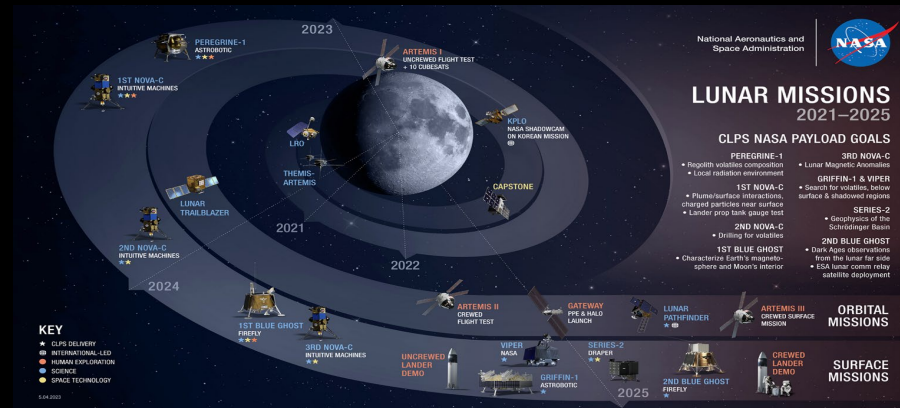


BREAKTHROUGH LISTEN



LUNAR FARSIDE TECHNOSIGNATURE AND TRANSIENTS TELESCOPE (LFT3)

CONTACT WARNICK@BYU.EDU



Graduate Research Fellowships

A TRAJECTORY TO OPPORTUNITIES

A graduate fellowship can be a key to your engineering success. Begin now to prepare for fellowship applications and place yourself on a trajectory to opportunity.



1 FRESHMAN

Participate in the
BYU Honors Program

2 SOPHOMORE

Find a faculty mentor
Apply for an ORCA Grant

3 JUNIOR

Participate in undergraduate research
Publish a research paper
or give a conference presentation

4 SENIOR

Apply for fellowships

5 GRAD SCHOOL

Pursue an MS or PhD—or both

OPPORTUNITIES

Breakthrough research
Leadership
Strategy
Innovation
Policy
Grand challenges
Entrepreneurship

PRESTIGIOUS NATIONAL FELLOWSHIPS IN ENGINEERING

GRADUATE RESEARCH FELLOWSHIPS

Winners typically go to top U.S. graduate schools

Worth \$30,000–60,000 per year

Aim for 3.8 GPA or higher

Participate in undergraduate research

Apply in the fall of your senior year

Generally reserved for U.S. citizens or U.S. persons

BYU's engineering program has a good track record of successful candidates



National Science Foundation



Department of Defense



Department of Energy



NASA



SMART



Hertz

GRADUATE STUDY ABROAD FELLOWSHIPS

Winners go to graduate school in the United Kingdom or elsewhere

Various dollar values

Aim for 3.9 GPA

Seek broadening experiences

Apply at the end of your junior year

Generally reserved for U.S. citizens or U.S. persons

Can be very competitive



Fulbright



Gates



Marshall



Mitchell



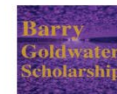
Rhodes

UNDERGRADUATE SCHOLARSHIPS

Good practice for graduate fellowships

Can be worth several thousand dollars

Apply as a sophomore or junior



Goldwater



Tau Beta Pi



Phi Kappa Phi



Many other options

For more information, contact your department fellowship expert (listed below) or visit www.et.byu.edu.

CHEMICAL ENGINEERING: John Harb, 801-422-4393, john_harb@byu.edu

CIVIL ENGINEERING: Michael Scott, 801-422-6324, michael.scott@byu.edu

ELECTRICAL AND COMPUTER ENGINEERING: Karl Warnick, 801-422-1732, warnick@ee.byu.edu

MECHANICAL ENGINEERING: David Fullwood, 801-422-6316, dfullwood@byu.edu

SCHOOL OF TECHNOLOGY: Richard Helps, 801-422-6305, richard_helps@byu.edu

Trajectory to Opportunities

- Freshman
 - Scholarships
 - Honors Program
- Sophomore
 - Find a faculty mentor
 - Apply for an ORCA grant
- Junior
 - Participate in undergraduate research
 - Write a paper or present at a conference
- Senior
 - **Apply for fellowships**
- Graduate school
 - MS and/or PhD degrees
 - Breakthrough research, public policy, grand challenges, innovation, entrepreneurship

BYU has a Prestigious Scholarships Office

- They are not BYU's Scholarship Office or BYU's Financial Aid Office
- What they do:
 - Promote national & international scholarships & fellowships
 - Help students apply for external scholarships
 - Make scholarship resources easily accessible
 - Focus: Rhodes, Marshall, Gates Cambridge, Truman, and Fullbright
- Where they are:
 - Maeser Building -> Library
- Contact info:
 - national.scholarships@byu.edu
 - (801) 422-0590
 - ugrad.byu.edu/scholarships



Graduate Fellowships

General and Humanities Fellowships:

- Marshall
- Mitchell
- Rhodes
- Gates
- Fulbright
- Institute for Humane Studies (IHS)
- Intercollegiate Studies Institute (ISI)
- National Security Education Program (Boren)
- Woodrow Wilson (Pickering)
- Samuel Huntington Public Service Award
- James Madison Memorial Fellowship

Science, Engineering & Technology:

- Hertz Foundation
- Department of Energy Computational Science Graduate Fellowship
- National Defense Science and Engineering Graduate Research Fellowship
- National Science Foundation Graduate Research Fellowship Program
- NASA Space Technology Graduate Research Opportunities
- National Institutes of Health-Graduate Partnerships Program
- Rocky Mountain NASA Space Grant
- Tau Beta Pi (Engineering)
- U.S. Department of Energy
- U.S. Department of Homeland Security
- Science, Mathematics And Research for Transformation (SMART) Scholarship (DOD)



Why a Fellowship?

- Most graduate students in engineering fields are supported by stipends from external research grants
- Why is a fellowship better than a regular research assistantship?
 - Winning a prestigious national fellowship is an indicator of future success in research
 - More money
 - Extra funds for tuition, books, supplies, and research expenses
 - Helps in the admissions process for top ranked graduate programs

National Science Foundation Graduate Research Fellowship

- *Support students who have demonstrated their potential for significant achievements in science and engineering research*
- College seniors or 1st year graduate students
- Fields of science, mathematics, or engineering
- Stipend of \$37,000, \$16,000 education allowance (\$159k total value)
- 3 years
- Good GPA (3.8+), research products – journal paper and/or conference paper

Deadline: October to Mid-November
(deadlines vary by discipline)



NSF GRFP Application

- Submit at www.fastlane.gov/grfp
- U.S. citizens, nationals, and permanent residents
- Academic transcripts
- Three letters of reference (online)
- Personal statement
 - How will grad school prepare you to expand scientific understanding and broadly benefit society?
- Research statement
 - Intellectual merit and broader impact on society
 - Creative and transformative
 - Well-reasoned research plan
- GRE scores optional
- About 2,000 awards out of 12,000 applications (~20%)
- See nsf.gov/grfp for more info

Students Preparing for Prestigious Scholarships Should

- Participate in undergraduate research
- Develop meaningful relationships with people who can open doors for you – faculty mentor
- Know scholarship eligibility requirements and deadlines.
- Apply
- Keep trying!

Advisor and Recommenders

- Scholarship Advisor
 - An advisor is a critical contact; he or she will help you develop a competitive application, give you meaningful revision advice, and provide answers to questions you have along the way
- Recommenders
 - Choosing the right recommenders can give your application the competitive edge

Letters of Recommendation

- Carefully select your recommenders
 - Letters must be specific and include details
 - Choose professionals and academics, but remember that the *quality* of the letter is generally better than the prestige of the recommender's title.
 - Recommendations need to be positive and well written (we can help faculty with this)
- Be helpful
 - Provide recommenders with specific information about the scholarship and yourself. A brief listing of your accomplishments or a draft letter will make writing a glowing letter about you much easier for them.
- Respect your recommenders' time
 - Give recommenders 2-4 weeks to write the letter.
 - Let them know the deadline
- Follow up
 - Drop in a week before it is due to offer any additional help and remind them of the approaching deadline.

Application

- Make sure to follow directions:
 - Deadline.
 - Be complete and correct.
 - Appearance is important.
- Start early and revise!
 - Write your essays early and seek feedback from qualified editors! Revision is not optional. Only those who revise, revise, revise will be successful.
 - Aim to submit your application early; last minute crises often occur.

Typical Essays

- Personal statement
 - NOT a resume! - Curriculum Vitae (CV): “personal/intellectual biography in narrative form
 - Discuss personal motivations, experiences, education, and activities
 - Show how this ties in to future goals for graduate education and career
 - Reveal your personality and make it memorable (i.e. entertaining) but not frivolous or canned
 - Find a balance between interesting and personal and a mature tone
- Research Plan
 - Relevant and exciting problem
 - Well thought out plan with clear goals and logical steps
 - Research must have high impact on the technical field and society
 - Rewrite so your passion comes through and writing is clear
 - NSF: Thoroughly address both “Intellectual Merit” and “Broader Impacts.”

Takeaways

1. Consider graduate school at BYU or elsewhere
2. Find a faculty mentor and get involved in undergraduate research
3. Learn more about fellowships:

Graduate program, application links, details: ece.byu.edu

College fellowships page: engineering.byu.edu/scholarships

Department fellowships page: honors.ee.byu.edu

4. Get involved:

Fall 2023 Grad Info Session – Nov. 16 at 7pm in EB Event Space

Undergraduate Research Rotations - Tues. Nov. 28 at 5pm in EB Event Space

January – **IMMERSE application deadline** - immerse.byu.edu