

PHYSICS@SOUTHERN

Physics and Engineering Department



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Changes

Change. Heraclitus of Ephesus, the ancient Greek philosopher and early proponent of careful, logical reasoning who lived some 500 years before Christ, was well-known for his pithy, paradoxical, and obscure sayings. (He also believed that fire was the ultimate building block of all reality, but let's not go there today.)

Consider this progression of thoughts:

- We've been through a lot of changes recently.
- Change means that things are different than they used to be.
- Things have always changed!
- Change itself is the only thing that hasn't changed.
- Everything changes but change itself.

You have surely experienced many changes in the past couple years—some painful and difficult, some that you may eventually come to see as challenges that led to growth and improvement.

Here are a few of the changes that we've had recently in the Physics and Engineering Department at Southern Adventist University:

June 1, 2019: Ken Caviness replaced Chris Hansen as departmental chair.

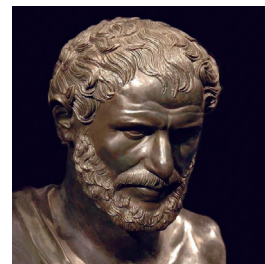
June 1, 2020: Vola Andrianarijaona joined the department.

October 29, 2021: Held first hybrid departmental open house during Homecoming Weekend.

February 2022: *Physics@Southern* published for the first time in the past seven years!

On June 1, 2019, Ken Caviness resumed his former role as department chair and professor, which he'd held for 11 years following Ray Hefferlin's

*Everything changes
but change itself.
Everything flows and
nothing remains the
same... You cannot
step twice into the same river, for
other waters and yet others go
flowing ever on. - Heraclitus*



retirement. During the intervening 12 years as a full-time professor, Caviness inaugurated a productive research track that involved 18 students. This "SESSIE" research (sequential substitution systems and their causal networks) looks at features that appear in complex "toy universes" generated by extremely simple "substitution rules." Of particular interest are features that parallel those found in the real universe, which physicists think is also fundamentally explainable by simple rules or "natural laws." Caviness reports a high degree of satisfaction with following in Ray Hefferlin's footsteps by involving students in research.

On June 1, 2020, Vola Andrianarijaona joined Southern as a professor, bringing a strong mix of theoretical and experimental expertise to the Physics and Engineering Department. He had taught for 14 years at Pacific Union College, where he involved students in experimental projects as a result of his connections at Oak Ridge National Laboratory.

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Department News

Physics and Engineering Club 2021-2022

Hello, everyone! I want to share what the club has already done this school year and the plans we've discussed for second semester.

During the fall semester, we held the following events:

- Liquid nitrogen and dry ice demonstration
- Weekly Tea Time (resumed)
- Work on the ion beam line with Professor Andrianarijaona
- Fall outing (a joint event with the Chemistry Club and the Math Club). Faculty and staff as well as students (and even some of their family members) from all three departments participated!
- Annual bridge-building competition
- Christmas party with Rubens' tube and piano
- Community service

As a special Christmas surprise, Office Manager Dennisse Blood and club member Andrea Stevens, senior biochemistry major, decorated the office and the study area. To adorn the tree, Blood used pictures

of physics and engineering majors to create a unique ornament for each student in the department! Many of us smiled big as we walked into the study area and noticed our faces on the tree!

Our winter semester plans include:

- Ballistics testing outing
- Tours of Volkswagen and TVA
- Stronger focus on community service and forming a club relationship with an organization to visit annually
- Remodeling the department Blue Room (including stenciling equations)
- Egg-drop competition
- At least two demonstration events (perhaps one on electricity and magnetism)
- Taking advantage of fundraising opportunities

Moving forward, we would like to hold monthly events and make them yearly traditions. "Upgrades" that are part of the Blue Room remodel will help to make our weekly Tea Time tradition more appealing. We would also like to host some "religion and science" events with guest speakers.

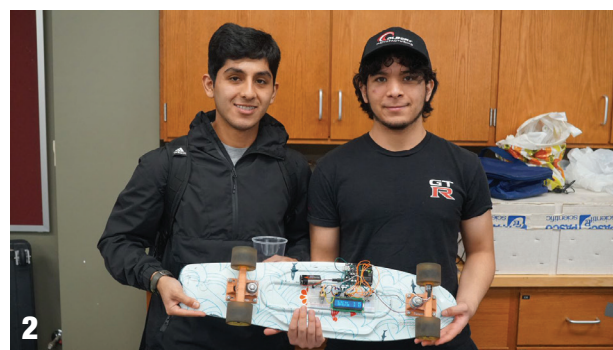
By Arian Dovald

Club & Department Events

1: Jeffrey Meadows, junior math major, and Professor Ken Caviness, PhD, conserve angular momentum.

2: Sophomore physics majors Ben Juarez and Oscar Tass Coral show off their skateboard project. **3:** The department welcomes new students for the Fall 2021 semester. **4-5:** Custom ornaments featuring each student adorn the departmental Christmas tree.

6: Tim Suzuki, junior physics major, pours liquid nitrogen onto dry ice during a demonstration. **7:** Tim Suzuki and Arian Dovald (senior physics major) use the prototype lightboard. **8-11:** Current students, faculty, and staff eat lunch with department visitors on the porch of Hickman Science Center.



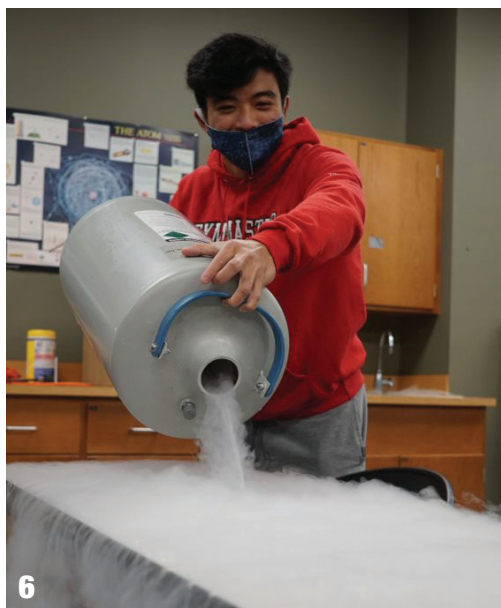
Ken's Korner

Physics@Southern has a long and venerable history, although it has been published only “every so often,” as longtime recipients will remember. The point of the newsletter is to keep in touch with you, alumni and friends of the Physics and Engineering Department, whether our majors or not. Some who received our newsletter over the years took just one class from Ray (“Doc”) Hefferlin or Henry Kuhlman, but that contact made a difference.

We’ve all been busy, but we’re going to make staying in touch a priority. The first semester of this school year has flown, but we decided that getting an issue out was important. We didn’t want to let another semester, or another year, slip by. So, starting with this issue, we commit again to sharing with you regularly—twice a year—news of what’s happening in our department.

We hope that you will get in touch with us, too, and share some of what has been happening in your lives. If it seems appropriate to do so (and if you don’t ask us not to), we’ll reprint excerpts to share in the newsletter. Relationships, contacts, and connections are all so important and impossible without communication. Please let us hear from you!

You’ll notice that this newsletter is still called *Physics@Southern*, as it has been for decades. That name is also, in fact, an email address! Feel free to send messages to physics@southern.edu or to my email address: caviness@southern.edu.



Changes: continued on from page 1



Professor Andrianarijaona, PhD, with SmartStart students.

Originally from Madagascar, where he completed his undergraduate studies, Andrianarijaona completed three postgraduate degrees in Paris, France, before transferring to the Université Catholique de Louvain in Belgium, where he had an appointment as assistant professor while completing his PhD. He then held postdoctoral research assistantships/fellowships at Max Planck Institute for Nuclear Physics, Heidelberg, Germany, and at University of Nebraska. (Yes, he is fluent in Malagasy, French, German, and English!) “Dr. Vola,” as the students call him, has a big heart for Adventist education.

By department staff

A Legacy Lives On

Ray “Doc” Hefferlin, the former editor of this newsletter, retired from active duty as department chair and professor on June 1, 1996. He then began unpaid duty as a research professor of physics, and later an emeritus professor—a qualification only a select few professors at Southern receive.

During his nearly 19 years of “retirement,” Doc remained an active member of the department and a mentor for us as well as for many others on this campus and around the world. He continued his work on periodic systems of molecules, maintaining an exacting research and publication schedule, with student and alumni co-authors on nearly every paper published.

Hefferlin passed away on March 7, 2015, following hospitalization due to severe pneumonia. He is still sorely missed, but his legacy lives on.



Professor Hefferlin, PhD, and then-student Joshua Barrow review research together in 2014.

We are happy to report that 100% of our full-time department faculty conduct research projects involving students! That, in our humble opinion, is a worthy legacy for Doc Hefferlin.

Alumni Spotlight

Chris Hansen, PhD



What years did you attend Southern Adventist University?

I attended from 1984-1989.

What attracted you to Southern?

I grew up in the Midwest and drove with a friend to visit Southern the summer after graduating from high school. I liked the rural setting and beautiful campus, and I liked the idea of trying out a new place.

Why did you choose to study physics?

I had always enjoyed mathematical word problems, and physics seemed like it would be more of that. I liked applying mathematics to real-life situations and enjoyed pure mathematics, as well. Perhaps the real deciding point came with the choice of summer research experience.

After submitting applications for both physics and mathematics research projects at universities, I received notice that I had been accepted into

the math research opportunity the day after I had accepted the physics opportunity. That really started me down the path of an advanced degree in physics instead of mathematics.

How would you describe your experience as a student at Southern? What is your favorite memory of that time?

I had a very, very good experience. I loved the exposure to new ideas and becoming friends with the faculty, who were such great mentors. I made lifelong friends from different parts of the country and world.

One of my favorite memories is of heading to the lake on Friday afternoons to sail with a friend who was taking the sailing class.

Where was your favorite place to study?

Probably in the Daniells Hall study room. (Daniells Hall housed the Computing, Mathematics, and Physics departments at the time.)

What was your favorite class?

I really liked most of my classes; however, Real Analysis with mathematics professor Art Richert was a true stand-out. Besides sharing mind-blowing concepts, he was a masterful teacher, generally lecturing with no notes but making everything seem like a story. I remember that at one point in the course, he took two full class periods just to go through a relatively complex proof, all without bringing notes to class. It was so organized that I can still recall the skeleton of the proof.

What did you do after graduating from Southern?

I spent a summer working with ADRA in Bolivia. That opportunity was arranged by the faculty mentor who had the most impact on my experience at Southern: Ray "Doc" Hefferlin.

I then enrolled in graduate school at Colorado State in the fall of 1989. I joined an atom and molecular physics research group and enjoyed it so much that I didn't mind that it took more than

six years to complete my PhD. Our research group collaborated on a project with a team at Los Alamos National Lab, and the timing worked out so that I spent the last three years of my program working in New Mexico.

After graduating in 1995, I was hired as a postdoc at Argonne National Lab, just out of Chicago, to work in a surface analysis group to help with laser-based detection of atoms. I met and worked with scientists who came from around the world to use the one-of-a-kind instrument for their research.

A teaching position in Southern's Physics Department came open shortly after I moved to Chicago, and I jumped at the chance to return and teach alongside my mentors.

What are some challenges you've faced?

A career in physics, as with most any discipline, whether teaching or not, entails hard work and failures that can be discouraging if not looked at as opportunities. Additionally, in a technical field such as physics, it is sometimes hard to explain to friends and family exactly what you do and how it is relevant. Physics educators have the additional challenge of helping students find relevance in physics concepts and problem-solving techniques—and perhaps even having them catch the excitement that comes with truly understanding a physics principle.

What are some rewards of a career in physics?

A profound intellectual reward comes from deeply studying how the stuff in the universe is “put together.” It gives a sense of confidence in one's ability to be successful when faced with complex problems in life. I simply treat each challenge like another physics problem by figuring which are the important aspects of the problem, breaking it into manageable pieces, finding ways to check that the “solution” makes sense at each stage, and being humble and honest enough to examine the limitations of the solution.

For me, the biggest reward has been the chance to work with incredible people at each stage of my career. People with inquisitive minds, interpersonal skills, and a sense of purpose have truly been an

inspiration. Many of those people were students I encountered in the classrooms and hallways at Southern, who have challenged and stretched my understanding and who I am happy to count as my friends.

What are you doing today?

Currently, I am the executive director of Institutional Research and Planning at Southern.

This means I help promote the effective use of data in the various decision-making activities on campus, from coordinating the administration and analysis of many campus surveys, to mining institutional data to build predictive models of student retention and success, to helping campus departments increasingly use a data-informed approach to improving their efficiency and effectiveness.

This transition came after teaching in the Physics and Engineering Department for more than 23 years. I had a growing interest in data science, so when I learned of an opening in the Office of Institutional Research and Planning that would grow its data analytics capabilities, I applied for the job. I feel fortunate that I have still been able to continue teaching at least one class per year while developing data science skills in my new position. I also feel that the timing of my transition was providential, because the Physics and Engineering Department was able to hire Vola Andrianarijaona, an experimental physicist with an active research program. He brings an enthusiasm for physics along with additional, very exciting possibilities for student research.

What advice do you have for current students who want to make the most of their time at Southern?

Here are two good pieces of advice that I have found to be practical and important: (1) Get to know faculty and fellow students, both inside and outside of your primary academic and friend circles. Listen carefully to their perspectives; (2) Intentionally look for connections between all of the things you are learning. It is very likely that what you learn in one setting will help you better understand something in another.

By Dennisse Blood

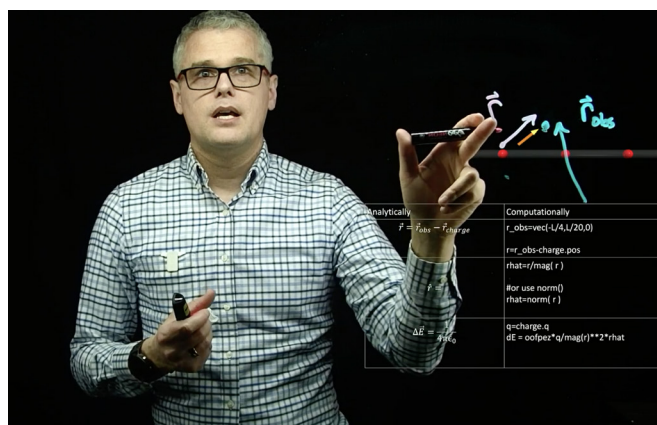
Pandemic Inspires New Methods

Even under ideal circumstances, students who are juggling multiple classes and responsibilities often find it difficult to fully engage in the logical progressions taught in physics courses. In the spring of 2020, a sudden transition to online learning presented circumstances that were even further from ideal for students worldwide. Thankfully, Professor Blake Laing at Southern identified two teaching strategies that would translate well to virtual instruction: (1) giving students decision-making agency in the laboratory sections of General Physics, and (2) developing a lightboard he could use to teach on Zoom.

Laing was in the process of improving his General Physics lab course to bring the curriculum in closer alignment with revolutionary advances in educational research, so he didn't want to invest effort in adding video assets to a traditional lab paradigm. After reading a paper suggesting that giving students decision-making agency—not just on how to carry out prescribed experiments but in developing the research question itself—could improve student outcomes in an inquiry-based lab setting. Through the AAPT Labs-L discussion forum, Laing was able to access pandemic-adapted labs.

Laing was already using an inquiry-based lab adapted from the University of Maryland's "Scientific Community Labs," which consisted simply of the question: "What is the relationship between force and distance for two magnets?" Independent groups designed their own experiments to answer this question, and the innovation at Southern was that the answer could only be revealed by combining data from multiple groups spanning a greater range of distances in an online spreadsheet. Students reported this experience as being their favorite lab course.

The new problem posed during the pandemic was that using PowerPoint presentations via Zoom can be boring for students and teachers alike. In this awkward situation, professors are staring into a grid of turned-off cameras. The solution Laing found was to teach his online courses using a lightboard: a plane of glass on which the teacher writes, letting students watch the teacher's face and hand movements. (The image is reversed during processing so students can easily



Professor Blake Laing, PhD, demonstrates the lightboard.

read what is written.) This creates a more engaging experience as close to "face-to-face" as possible. In contrast to a "shared screen" on Zoom, students do not have to choose which screen to focus on: a disembodied talking head or magically appearing "writing on the wall." It's clear where to focus, and lightboard presentations are inherently designed for small screens.

The lightboard studio developed at Southern features the option to add graphics, and it is as simple for the professor as giving each PowerPoint slide a black background, since black becomes transparent when the professor presents these slides with an HDMI input. The enabling technology is Blackmagic ATEM Mini Pro and an innovative use of the Elgato Streamdeck controlled by the open-source software Bitfocus Companion. This technical combination requires only a single Raspberry Pi computer.

The prototype lightboard remained in use in Hickman Science Center until Plant Services completed the construction of two nice working models: a desktop model, which remains in the Physics and Engineering Department, and a stand-alone model, now located in Summerour Hall and available to all instructors.

To see the lightboard in operation on Professor Laing's online Digital Engagement Science Lab, scan the QR code at right.



By department staff

Students Conduct Ion Beam Research at Oak Ridge National Laboratory

Timothy Suzuki and Arian Dovald, both physics majors at Southern, assisted with research last summer at Oak Ridge National Laboratory (ORNL). Located in Eastern Tennessee, the facility is the largest science and energy national laboratory in the Department of Energy system.

Such opportunities are rare for undergraduate students, since short-term internships are usually set aside for graduate students or for those working at the doctoral level.

Vola Andrianarijaona, PhD, a physics and engineering professor at Southern, invited the students to help with two of his research projects. The first involved building a specific square wave using a multi-pulse generator to ensure that the ion beam would send a specific number of pulses. The second involved achieving an ultra-high vacuum environment within the merged ion beamline, checking for leaks in the system to reach desired vacuum pressure.

"The work is very engaging, requiring critical thinking and good problem solving," Dovald said. "This is an important step toward entering the world of physics research, and it inches me closer to the graduate school of my choice."

Suzuki, who had dreamed of the opportunity to work at ORNL, agreed. "This opportunity granted me valuable experience in experimental physics with many practical applications that can apply to nuclear physics," he said. "The most important lesson that I learned from working at the lab was that in real life, problems do not have simple solutions, and that to overcome these challenges, a flexible mind is absolutely necessary."

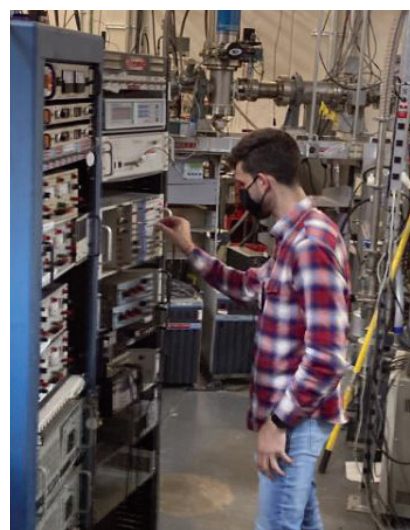
Before their two-week internship began, Suzuki and Dovald completed ORNL site access training, a cybersecurity awareness program, and electrical worker training. Once onsite, they worked under ORNL research scientist Charles Havener, PhD, who conducted and supervised the research experience with Professor Andrianarijaona.

The students began with a guided tour of

the facility and familiarization with the main components of the experimental apparatus. They had to learn how to recognize different elements and their roles in the setting, including ion source, vacuum pump, vacuum gauge, Einzel lens, Faraday cup, and slits. As part of their hands-on research, they performed assigned tasks such as chasing leaks using a residual gas analyzer, assembling vacuum chambers that involved special skills, and building high-frequency embedded square waves for data acquisition. The tasks were very engaging and required deep critical thinking as well as good problem-solving techniques.

Suzuki and Dovald submitted two poster abstracts for the upcoming American Physical Society meeting in March. Imagine the excitement of undergraduate students getting to present the research results from their own work, instead of someone else's work. Ownership of the experience has generated enthusiasm, and the enthusiasm is contagious! Two other physics majors at Southern have also submitted poster abstracts to the organizing committee. The whole department is impatiently waiting to hear whether their posters will be approved for presentation. Regardless of the results, it is obvious their summer internship had a positive and broader impact on their education.

The participation of Southern students in research at ORNL marked the beginning of the university's collaboration with the laboratory's physics division.



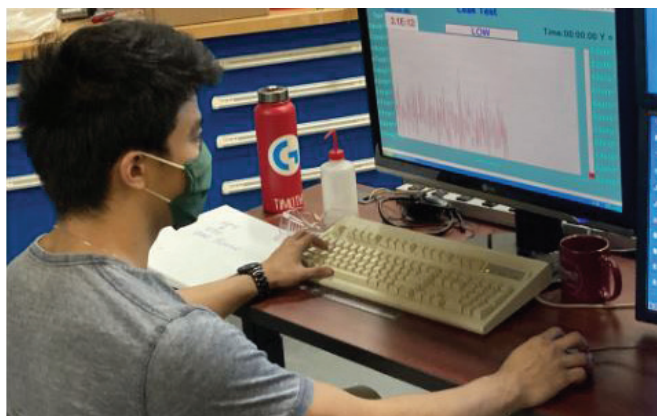
Senior physics major Arian Dovald assists in a research project research that marks the beginning of Southern's collaboration with the national laboratory's physics division.

The Physics and Engineering Department is now one of three collaborative affiliations working with ORNL and the National Aeronautics and Space Administration to investigate X-ray-induced charge transfer as part of research that seeks to better understand cosmic ray background.

During the first Hickman Science Center research luncheon of the Fall 2021 semester, Suzuki and Dovald reported on their ORNL experience, motivating their peers and getting more students involved and engaged with Southern's new ion beam apparatus (see sidebar). As a result, students now receive mentoring every Friday afternoon as part of a regular Physics Club activity.

Such an experience "is a big deal for the Physics Club and for Southern students in general," Andrianarijaona said, and "has generated a sense of ownership, excitement, and enthusiasm within the department."

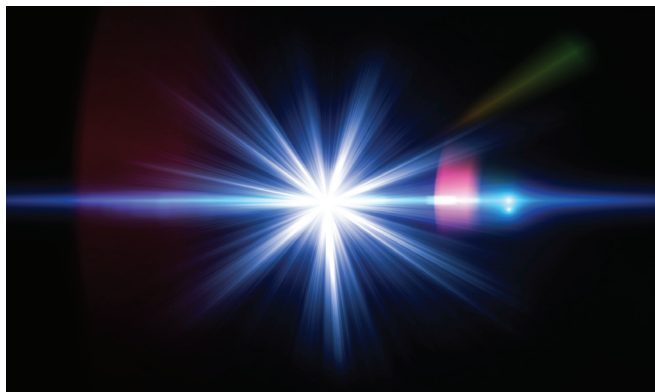
By Madison Reinschmidt and staff



The opportunity to work at Oak Ridge National Laboratory was a dream come true for junior physics major Tim Suzuki.



Students now volunteer on Friday afternoons to move and reassemble equipment for a physics advanced laboratory that will serve as the university's first ion-beam research facility.




Southern Leads the Way in Experimental Physics

The Physics and Engineering Department is in the process of setting up an ion beam facility on campus. To accommodate the equipment needed for ion beam experiments and other advanced physics research, Room 1502 on the first floor of Hickman Science Center will be renovated to accommodate the specific conditions required. The target date to complete this renovation is during Spring Break 2022. Once fully assembled and operational, the new ion beam facility will make Southern one of the first Adventist educational institutions with a dedicated space for research in experimental physics. This facility offers great potential as a powerful tool to recruit, mentor, and retain physics students.

In the meantime, faculty are developing training sessions to prepare students to properly operate the ion beam facility. These trainings use consumable products such as copper gaskets, chemical cleaning products for ultra-high vacuum, wipes, aluminum foil, gas supply, etc. Some equipment is still needed, especially the residual glass analyzer, gas bottles, and appropriate cables for the nuclear instrument modules. We also anticipate costs related to publication of the research, including conference fees, material printouts, and travel expenses.

The department set a goal to raise \$5,000 in research funds for this year. If you would like to participate, visit southern.edu/physics and click on "Make a Gift" in the right-side navigation bar.



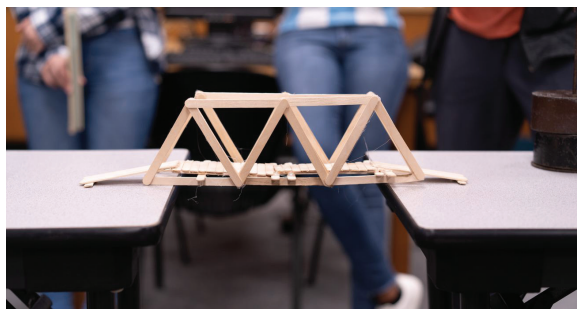
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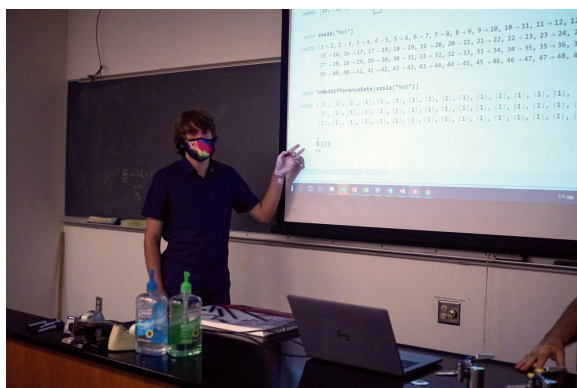
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Chris Hansen, PhD, Adjunct

Dennisse Blood, Office Manager



Club activity Saturday night: bridge building!



Colton Davis explains his research during the HSC Research Lunch Program.

Physics and Engineering Club Officers 2021-2022

President - Arian Dovald

Vice President - Tim Suzuki

Secretary - Ben Juarez

Treasurer - Sean Ives

Pastor - Micah Hansen

Social Vice President - Anjali Filinovich

Public Relations - Andrea Stevens