MATH IN THE VALLEY

Unlocking the secret of Navier-Stokes

SPRING 2023

Oregon State University

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Contents

On the cover —Navier-Stokes equations, which represent the conservation of momentum, can be a powerful tool for understanding of the mechanics and behavior of fluids. Studied as early as the 18th century, unlocking their secrets has remained a tantalizing goal for mathematicians including **Enrique Thomann**. Read more about his illuminating research on p.9.

From the head

Bill Bogley, Department Head

Dear mathematicians and friends of mathematicians!

This spring 2023 edition of Math in the Valley features updates on professors Enrique Thomann and Mary Beisiegel. These days, Professor Thomann's sabbatical travels include a visit to the African Institute for Mathematical Sciences in Rwanda and a visit with former OSU colleague Dr. Andre Weideman, who recently retired from Stellenbosch University in South Africa. Professor Beisiegel continues a tradition of teaching excellence as the 2023 recipient of the Fred Horne Award for Excellence in Teaching, the top teaching distinction in the College of Science. Also in this edition, Professor Emeritus Edward Waymire provides a fascinating retrospective of early 20th century mathematics at OSU.

New faculty colleagues are bringing tremendous energy to the department. In this issue we introduce five new instructors, two postdoctoral scholars, a visiting assistant professor and two new tenure-track assistant professors. Professors Chad Giusti, Axel Saenz Rodriguez, and Nicholas

Marshall are all playing leading roles in weekly departmental seminars— check the department website for details! Professor Swati Patel, aided by Professor Saenz Rodriguez, brought the Math For All conference to OSU last year after having founded the conference in 2019. This conference attracted more than 40 participants to OSU this past winter with the objective to broaden participation in mathematics and break down barriers to engagement with mathematics. Not to be outdone by our younger colleagues, Professor Malgo Peszyńska has been elected to the Executive Board of the Pacific Math Alliance and just this past March was spotlighted by SIAM in honor of Women's History Month!

Our graduate students engage vigorously with the national mathematics community. Austin Bosgraaf, Chung-Ping Lai and Peter Cowal have all been accepted to attend Summer Graduate Schools sponsored by the Simons Laufer Mathematical Sciences Institute (SLMath—formerly MSRI). Madison Phelps shared her motivational journey to Ph.D. studies at the annual Grad Inspire event hosted by the OSU Graduate School. Jeremy

Lilly participated in an internship sponsored by the Department of Energy and Fernando Angulo Barba holds a prestigious GEM Fellowship. This May 25 we welcomed alumna Corina Constantinescu (Ph.D. '06) as the speaker for the 38th Annual Lonseth Lecture.

With much gratitude, we wish you health, safety and prosperity.

Bill Bogley
Professor & Head

LAND ACKNOWLEDGEMENT

Oregon State University in Corvallis, OR is located within the traditional homelands of the Mary's River or Ampinefu Band of Kalapuya. Following the Willamette Valley Treaty of 1855 (Kalapuya etc. Treaty), Kalapuya people were forcibly removed to reservations. Today, living descendants of these people are a part of the Confederated Tribes of Grand Ronde Community of Oregon (https://www.grandronde.org) and the Confederated Tribes of the Siletz Indians (https://ctsi.nsn.us).

At the helm
Advancing mathematics through leadership

While in graduate school at the University of Alaska - Fairbanks, Mahmud Alam had the opportunity to visit Denali National Park where this photo was taken.

Strong numbers at SIAM

Oregon State's mathematics faculty and students had a strong presence at the Society for Industrial and Applied Mathematics' Pacific Northwest Section Annual Meeting in May at Washington State University in Vancouver.

Among the student presenters were Louis Detweiler, Alireza Hosseinkhan, Amir Nayyeri, Naren Vohra, Lisa Bigler, Brady Bowen, Madison Phelps, Nachuan Zhang, Tyler Fara, Nicholas Pantuso and Rachel Wofford.

Vrushashali Bokil

Faculty speakers included Enrique Thomann, Nathan Gibson, Ralph Showalter, Mujibur Rahman Chowdhury, Małgorzata Peszyńska, Robert Higdon and Patrik Nabelek. Session organizers included Elaine Cozzi, Radu Dascaliuc and Vrushali Bokil.

Bokil delivers three SOU talks

Vrushali Bokil, currently serving as interim dean of the College of Science, gave three lectures as part of the Kieval Lecture Series at Southern Oregon University May 9 and 10.

Her lectures were titled "Mathematics: A Language for Understanding Love, Life, and the Universe," "Optimal Control of Plant Disease Epidemics" and "Diversity, Equity, Access & Inclusion Lecture: Mindfulness and Anti-Oppression in Science."

The annual lecture series was endowed by the late Harry S. Kieval for speakers to address broad popular

aspects of mathematics that are attractive to undergraduates and the general public. The speakers meet with students and faculty informally in addition to giving two to four public lectures.

Fighting future pandemics

Benjamin Dalziel, an associate professor in the Departments of Integrative Biology and Mathematics, and a team of Oregon State researchers received a $1 million grant from the National Science Foundation to identify, model, predict, track and mitigate the effects of future pandemics.

The grant is part of a new foundation program called Predictive Intelligence for Pandemic Prevention (PIPP). Its basic goal is to help the world prepare for the next pandemic. Phase 1 PIPP grants are 18-month awards aimed at defining research priorities, developing interdisciplinary teams and pursuing initial research.

"The evidence is overwhelmingly clear that the next pandemic is going to happen in our lifetimes and I think everyone would agree that we would like the next one to go differently, in fact, we would like it to go really differently," said Dalziel.

"It's important to start working as fast as we can on what 'really differently' means so that we don't end up in a Groundhog Day scenario," he said. "To avoid that, we need projects like this."

Benjamin Dalziel

McGee earns promotion

Samantha McGee was promoted to Senior Instructor I. McGee started as an instructor at Oregon State in the fall of 2017 following her master's degree in the department. She now coordinates the Learning Assistant program in the mathematics department and teaches algebra courses. She is also involved in the lower-division math education sequence.

Swisher featured on LGBTQ+ poster

Holly Swisher, a professor of mathematics, was featured on an American Mathematical Society poster featuring LGBTQ+ mathematicians. The posters are offered for free by the AMS to commemorate Spectra, an organization for LGBT mathematicians.

Holly Swisher

Spectra was formed out of the Joint Mathematics Meetings scheduled for Denver in January 1995 but moved to San Francisco due to a letter writing campaign co-organized by our own **David Pengelley** to protest anti-gay legislation in Colorado.

Kovchegov studies probabilities

Yevgeniy Kovchegov, a mathematics professor at Oregon State since 2017, has been exploring the field of probability and stochastic processes.

His research looks at the mathematics of data science, mathematical models of statistical mechanics, models of mathematical biology, stochastic self-similarity, mathematical statistics, interacting particle systems and quantum computation.

His work is centered on random self-similar trees, stochastic coupling

Yevgeniy Kovchegov

method, orthogonal polynomials in stochastic processes, probability and statistics, mixing times, quantum walks and quantum computation, chaos and fractals, applications of probability theory in biological systems, geomorphology, seismology, computer and wireless networks, network coding and environmental sciences.

NEW FACULTY

Math department welcomes new additions

In mathematics, addition is always a welcome part of the ongoing equation. New faculty members include:

Nick Marshall. An assistant professor, Marshall completed his Ph.D. in applied mathematics at Yale University in 2019 after receiving his undergraduate degree from Clarkson University. Before coming to Oregon State, Marshall was a National Science Foundation postdoctoral researcher at Princeton.

Nick Marshall

His research interests are focused on problems that involve interactions between analysis, geometry and probability, especially such problems motivated by applications to data science. Examples include problems involving spectral theory, group actions and invariance, data analysis and machine learning and wavelet approximation theory.

Chad Guisti. The new assistant professor earned his bachelor of science degree and doctorate in mathematics from the University of Oregon, working in algebraic topology. In between his degrees, he worked as a software engineer at Microsoft and Network Associates.

Chad Guisti

Afterward, he spent two years as a visiting assistant professor at Willamette University, during which time he was a Mathematical Association of America Project NeXT fellow. Giusti then moved to a postdoctoral researcher position at the University of Nebraska Lincoln before spending three years as a Warren postdoctoral fellow at the University of Pennsylvania and subsequently taking a faculty position at the University of Delaware.

His research focuses on applied topology, which uses recent ideas in geometry, topology and algebra to analyze nonlinear structure in high-dimensional data. From there, he develops mathematical and computational tools for the study of complex systems – primarily applied to neuroscience.

Our new postdocs and visitors are:

Bella Tobin received her Ph.D. from the University of Hawaii in 2019 under the supervision of Michelle

Bella Tobin

Manes, and has been a post-doctoral fellow at Oklahoma State University. Tobin does research in arithmetic dynamical systems and number theory, with a particular interest in classifications of post-critically finite maps and dynamical Belyi maps. Tobin was a faculty co-sponsor of the Oklahoma State Student Chapter of the Association for Women in Mathematics, a co-organizer of the Distinguished Women in Mathematics Colloquium Series at Oklahoma State University, and has organized "Be A Scientist Night" at the Honolulu Institute for Human Services.

Zachary Hilliard graduated with his Ph.D. in Mathematics in 2020 from Washington State University. His earlier degree was from Washington State Universities in Tri-Cities in 2014, and he was an intern at Pacific Northwest National Laboratory from 2011 to 2016. His Ph.D. work was on

Zachary Hilliard

analysis and numerical modeling of Cahn-Hilliard equation for modeling refugee flow and mammal migration. Although Hilliard is interested in most topics related to analysis, his primary passion is in differential equations; especially finite element methods for parabolic partial differential equations. Outside of math, he likes to draw and play volleyball. During 2020 through 2022 he has been teaching and coaching volleyball at a private school in Virginia, but is looking forward to working at OSU.

Murat Kol earned a bachelor's degree in mathematics education, master's degree in secondary science and mathematics education and a doctorate in secondary science and mathematics education in 1999, 2014 and 2022, respectively, at Middle East Technical University.

After graduation, he worked as a mathematics teacher, textbook author and administrator at various school levels for 12 years. During this teaching experience, he realized that if technology is used effectively, it can make a significant contribution to mathematics education. By carrying this awareness to the academic field, he decided to carry out his academic studies at the center of technology in mathematics education.

We have also added several new instructors to the department.

Ali Ahammed Mozumder received his master's and doctorate degrees in mathematics from the University of Texas at Dallas in 2021 and 2022. Ali's research interests include mathematical modeling and numerical simulation of photoacoustic trace gas sensors, sensitivity analysis and scientific computing. He spent 11 years teaching various levels of mathematics across multiple public

and private colleges in Bangladesh after receiving bachelor's and master's degrees in mathematics from the University of Dhaka.

Derek Eby earned bachelor's degrees in mathematics and Spanish from the University of Indianapolis in 2009 and a master's degree in mathematics from the University of Colorado at Boulder in 2012. His research was in the probability and statistics field developing a method to fractionally differentiate autoregressive integrated moving average time series. He has spent 11 years teaching math, most of that full-time as an assistant professor at the University of Alaska Southeast at Juneau and back at his alma-mater UC Boulder as a lecturer.

Lee Klingler earned a bachelor's degree in mathematics and philosophy from Lebanon Valley College and a master's degree and doctorate in mathematics from the University of Wisconsin-Madison, a long time ago. He spent his professional career at Florida Atlantic University, from which he retired last August. His mathematical research has centered on commutative ring theory and modules over Noetherian rings, but he also has a deep interest in the teaching and learning of mathematics at all levels.

Lee Klingler

Before his retirement, he helped design learning assistant materials for precalculus and calculus classes

Mahmud Alam received his doctorate in mathematics from the University of Alaska at Fairbanks in 2022. His dissertation was related to solving control problems for partial differential equations on quantum graphs.

Alam earned his master's degree in applied mathematics at Stockholm University in 2013. His master's thesis was on "The Iterative Solution of Large Scale Statistical Inverse Problems" at the Max Planck Institute for Dynamics of Complex Technical Systems in Germany.

Before joining as a doctoral student at the University of Alaska at Fairbanks, he worked as an assistant professor at the Military Institute of Science and Technology in Bangladesh.

Previously, he worked as a lecturer and assistant professor at the Bangladesh University of Business and Technology in Bangladesh.

Nina Gydé earned a bachelor's degree in mathematics at the University of Oregon, and also completed her secondary education program for an Oregon teaching certification in advanced mathematics.

She earned her master's degree in mathematics at Oregon State University with an emphasis in applied mathematics. She has held teaching positions at colleges, community colleges and public schools in Oregon and Washington. In addition to her specialty of applied mathematics, her academic interests include music, physics, curriculum and instruction, biology and engineering.

Christine Hoogendyk earned her bachelor's degree in mathematics from California State Polytechnic University, Pomona in 2019 and her master's degree in mathematics from Oregon State University in 2022 under the guidance of mathematics professor Mary Beisiegel. Hoogendyk enjoys learning about mathematics education and is always looking for new ways to introduce the topics in the courses she teaches.

Murat Kol

Derek Eby

Christine Hoogendyk

A QUANTUM LEAP WITH NVIDIA

Tim Costa (Peszyńska, '16) parlayed his doctorate from Oregon State to become the director of high-performance computing and quantum products at the Nvidia Corporation. Nvidia is a technology company known for designing and manufacturing graphics processing units and driving innovations in gaming, creative design, autonomous vehicles and robotics.

Costa has played a key role in the development of new tools that harness quantum and classical computing to boost scientific research. These tools have been adopted by a growing number of researchers and companies, including collaboration partners IBM, Pascal and Oak Ridge National Laboratory. "Quantum-accelerated supercomputing has the potential to reshape science and industry with capabilities that can serve humanity in enormous ways," said Costa.

Above —Costa first joined the Santa Clara-based tech giant in 2019.

Thinkers & Doers
Alumni of distinction

Honoring a legacy of service

Małgorzata Peszyńska, an Oregon State mathematics professor since 2003, has been named the inaugural Joel Davis Endowed Faculty Scholar. Honoring late College of Science Professor Joel Davis, the award supports a faculty member in the Department of Mathematics who focuses on numerical analysis research.

Davis worked at Oregon State University for 31 years, serving on the Faculty Senate and the Mathematics Department Advisory Committee. Tragically, two weeks after retiring, Davis died in a bike accident in Corvallis in 1995.

Jerry Jacoby, one of Davis's former students, wanted to honor his mentor by creating the award. Jacoby earned three degrees from Oregon State: a bachelor's degree in political science in 1962, followed by a stint as a supply officer in the army. Wanting to change career tracks, Jacoby went back to OSU for bachelor's and master's degrees in mathematics in 1966 and 1968.

After OSU, Jerry Jacoby went on to a three-decade career at the Los Alamos National Laboratory in New Mexico. He lived his last years alongside the Sandia Mountains of that state and passed away in 2020.

At the College of Science winter awards in 2022, Peszyńska also received the Champion of Science Dean's Award to recognize her academic and teaching excellence.

Helping governments plan

James Hansen ('20, actuarial science minor) works as a full-time actuarial analyst at GovInvest, helping government agencies with their fiscal planning. He credits his success to determination and decisiveness during his time at OSU.

Based in Portland, GovInvest advises public institutions and private companies in their pension and benefits planning. Hansen said he likes the non-traditional nature of his work, and the leadership opportunities afforded by running with a small team. "It's a rewarding accomplishment to see how everything kind of lines up in the end," he said.

Scholarship helps marginalized students

Mathematics alumni and longtime supporter **Judy Faucett** ('70) established the first scholarship in the College of Science specifically for LGBTQ+ students experiencing homelessness or other extreme circumstances.

When working in New York City earlier in her career, Faucett said, "you couldn't walk three blocks without encountering homelessness." When she moved back to Oregon, she realized the problem was everywhere. "It was something I've been aware of, but something I thought was too big of an issue to have much of an impact on," she said.

Though LGBTQ+ students make up roughly 10% of the student population, it's estimated that they account for 25% to 50% of the homeless student population. When she heard this statistic, Faucett decided to create the scholarship known as the Leonardo Fund.

Named after Leonardo da Vinci, the fund provides emergency aid to LGBTQ+ students in the College of Science who experience sudden, extreme circumstances or life events. "It's for kids who are a little bit different because Leonardo was really different and very special," she said.

Faucett hopes others will be inspired by this fund and support it as well. "This is a fund I want people to know about. I want people to know that there is a need and they can make a difference," she said.

Loke gets CWU promotion

Sooie-Hoe Loke (Thomann, '15) has been promoted to associate professor at Central Washington University in Ellensburg, Washington. He is taking a sabbatical this year at the University of California at Santa Barbara where he has a visiting associate professor position.

Recent grads land in prominent places

Michael Allen (Swisher, '22) is a postdoctoral student at Louisiana State University, working with professors Ling Long and Fang-Ting Tu. His research interests are in analytic number theory and arithmetic geometry, particularly in the intersection of hypergeometric functions, abelian varieties and automorphic forms.

Rachel Wofford (Gibson, '22) started a job as a data scientist at Pacific Northwest National Laboratory after earning her master's degree at OSU.

Her research focused on using machine learning models and singular value decomposition (SVD) dimension reduction to predict survival outcomes of cancer patients. This research began as part of an National Science Foundation internship through Oak Ridge National Laboratory. Her career interests include data science, machine learning and optimization.

Lisa Bigler (Peszyńska, '22) and **Evan Rajbhandari** (Gibson, '22) both accepted postdoctoral positions at Sandia National Laboratories.

Bigler is an applied and computational mathematician interested in multiscale, multiphysics and multilevel methods. Her goal is to apply these skills to modeling of real-world applications. While at OSU, she focused on numerical methods for modeling phase transitions at different scales in porous media.
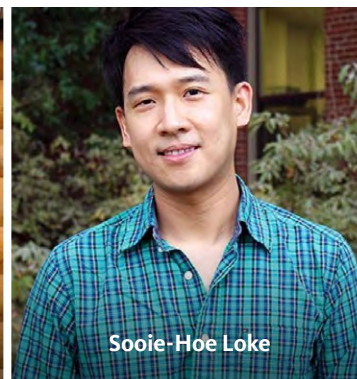
Rajbhandari's research focused on mathematical modeling, uncertainty quantification, parameter estimation and optimization. He has experience with multi-physics problems, national lab code implementation and engineering-based team cooperation from working at the National Energy Technology Lab in Albany.
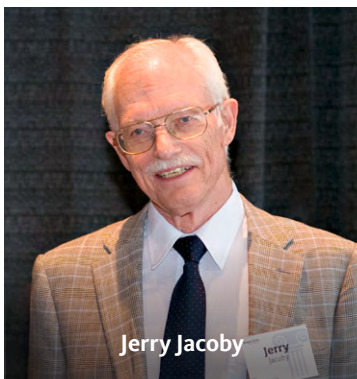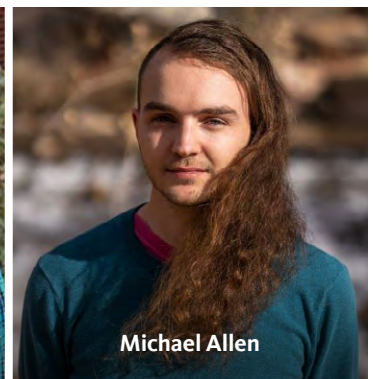

Jerry Jacoby

Judy Faucett

Sooie-Hoe Loke

Michael Allen

Unlocking the secret of Navier-Stokes

A significant feature of Professor Enrique Thomann's career is his collaborative nature. Since arriving at Oregon State University in 1987, he has worked with students, faculty and industry experts across a broad number of fields, touching many different areas of applied mathematics.

Soon after joining OSU, Thomann began collaborating with fellow mathematics department colleagues Ron Guenther and Ed Waymire on mathematical aspects of fluid mechanics. Guenther and Thomann used analysis tools to study the properties of the boundary layer potentials vis a vis regularity and far field behavior of the solutions. A byproduct of this research has been the determination of fundamental solutions for linearized equations of fluid mechanics.

Starting with an initial National Science Foundation (NSF) Focused Research Group grant in 2000, the analysis of problems in fluid flows using methods from probability and stochastic processes has been a major area of Thomann's research. This first grant involved Guenther, Waymire, Larry Chen and Mina Ossiander, as well as former students Chris Orum and Scott Dobson, and Professor Rabbi Bhattacharya, at that time at University of Indiana.

The Navier-Stokes equations, which mathematically express the conservation of mass and momentum for Newtonian fluids, are routinely used as modeling tools in engineering, physical oceanography and environmental studies. The mathematical theory of the Navier-Stokes equations is challenging because the pivotal questions of their solutions' existence and uniqueness have not been settled.

"Understanding turbulent flows, with the various scales of motion and mechanisms for energy transfer and dissipation, is a major scientific and engineering challenge," said Thomann. It is in this context that the ongoing study of the Navier-Stokes equations takes place. All advances in discerning the properties of these equations can have substantial scientific and engineering impact.

This line of research was also supported by an NSF grant that involved Nicholas Mikalowski, a former postdoctoral scholar at Oregon State, and more recently by a funded project involving Professor Radu Dascaliuc and Tuan Pham, another former postdoctoral fellow. Thomann and his colleagues combined tools from analysis and probability to study a representation of solutions of the Fourier transformed Navier-Stokes equations. They were able to considerably extend early groundbreaking results, leading to several recent publications in prestigious journals, including in the Journal of Functional Analysis, Annales de L'Institute Henri Poincaré and the Transactions of the American Mathematical Society.

Understanding the world by the numbers

Thomann has also been involved in numerous interdisciplinary projects with collaborators from across OSU, spanning disciplines such as ecology, oceanography, hydrology, forestry and the management of natural resources.

In one example, Thomann and Waymire were a part of an NSF-funded project that involved former College of Science Dean Roy Haggerty and Professor Brian Wood (Chemical, Biological and Environmental Engineering at OSU). Controlled experiments showed that heterogeneous media created by packing beads of different sizes caused a sharp discontinuity of the diffusion coefficient that resulted in an asymmetry in the break-through curve measuring the passage time of particles as they are transported by the flow.

In their work, which included Thomann's former Ph.D. student Jorge Ramirez ('07, co-advised by Ed Waymire), the group showed that the observed asymmetries were due to

> **Understanding turbulent flows, with the various scales of motion and mechanisms for energy transfer and dissipation, is a major scientific and engineering challenge.**
>
> **ENRIQUE THOMANN**

a skewness in the stochastic particle trajectories. This area of research was further developed in collaboration with Professors Vrushali Bokil and Nathan Gibson, as well as postdoctoral scholar Son Luu Nguyen and former Ph.D. student Thilanka Appuhamillage ('11). The group obtained closed form formulae for the distribution of particles undergoing these skew diffusions and developed numerical methods for solving the associated differential equations.

Another significant aspect of Thomann's research involves mathematical aspects of Risk Theory and its applications to Actuarial Mathematics and management of natural resources. This line of research was initiated in collaboration with Ed Waymire in the 1990s as a consequence of a grant from US Bank to organize talks and train students in the stochastic modeling of interest rates.

"This was a very exciting time for mathematics in finance, and it continues to serve as the area of research for some of my students," Thomann said. Thomann continues to collaborate with former Ph.D. student Corina Constantinescu ('06) in this line of research. Constantinescu is currently the director of the Actuarial Program at the University of Liverpool and is the mathematics department's 2023 Lonseth Lecturer. Thomann also collaborated with Sooie Hoe Loke ('15), now at Central Washington University.

"A particular gratifying and challenging experience comes from my work with students in Forest Science, Ecology and Applied Economics," said Thomann.

Projects with students from applied economics ranged from weighing abatement versus sequestration to reduce carbon dioxide emissions, to developing mathematical frameworks for the analysis of forest leases and pricing of contracts by cooperatives.

He recently participated in a study published in the Journal of Ecology to examine how changing ecological composition affects the landscape's ability to resist fire damage in the future. Given all the variables that influence how ecosystems respond to disturbance, mathematical models calibrated to a specific study tell scientists a lot about how an ecosystem responds to changes brought by fires and climate change.

"It's an under-researched subject," he said, "but critically important as wildfires become more prevalent throughout the West and alter the landscape to make it more or less resilient to fire."

Thomann's contributions to understanding fire damage are not new. He was a key member of the IGERT 'Ecosystem Informatics' graduate program, a multi-year NSF-funded program from 2003-2010 that was led by OSU Distinguished Professor Julia Jones and had Co-PI's from Forest Science, Computer Science and Mathematics.

As the planet warms, wildfires have become a growing problem that researchers like Thomann are intent upon solving.

A respected instructor, Thomann has taken a sabbatical year to visit universities in Europe and Africa.

I co-directed students from ecology and forest science to develop mathematical models to study the impact of changes in fire regimes in the age distribution of trees in a forest, in particular on the resilience of the resulting forest due to changes in the fire regimes.

"I co-directed students from ecology and forest science to develop mathematical models to study the impact of changes in fire regimes in the age distribution of trees in a forest, in particular on the resilience of the resulting forest due to changes in the fire regimes," he said.

Origins

Much of who Thomann is today as a mathematician and scientist can be traced to his earliest days as a college student in Argentina. It highlights the importance of early mathematics education in his own life. "Credit should be given to professors in Córdoba for the excellent training in real analysis and differential geometry obtained while an undergraduate," he said. After earning his Licenciatura in 1978, he completed his Ph.D. at Berkeley in 1985. There, Professors Alexandre Chorin, Alberto Grunbaum and Ph.D. Advisor Andy Majda introduced him to connections between stochastic processes and differential equations, in particular in the context of simulations of fluid flows.

After Berkeley, he completed his postdoctoral studies at the Courant Institute of Mathematical Sciences at New York University. He has held visiting positions at Indiana University; Institute of Mathematics and its Applications in Minnesota, and at the Universities of Liverpool and of Stellenbosch in South Africa.

He also participated in summer internships at the IBM – TJ Watson research center in Yorktown Heights, NY. Those internships, he said, "were instrumental in developing an interest in relating industrial problems with mathematical models." With collaborators Claude Greengard and Christoph Börgers, their paper in SIAM Applied Mathematics in 1990 established the appropriate time scaling required for a diffusive limit to hold in the description of forces acting on 'read-write' hard disk devices used at that time.

The technology was such that the heads that would record and retrieve information flew only a few microns away from the surface of the hard disks where the information was stored. Due to the rarefied state of the gas, it was necessary to model the forces starting from the Boltzman equations, with a particular interest in determining the appropriate time scales at which randomization of the interactions of the gas particles with the read-write head and the storing disk could be approximated as a diffusion. Interestingly, the classical central limit theorem could not be applied directly, instead a modification was needed to identify the appropriate time scaling.

Thomann is currently on a sabbatical year visiting colleagues at the Universities of Liverpool, Stellenbosch and Arizona. As part of this sabbatical, he is also visiting centers of the African Institute of Mathematics Sciences in South Africa and Rwanda, promoting OSU's international reach.

Thomann had the opportunity to visit students at the African Institute for Mathematical Sciences (AIMS) in Muizenberg, South Africa, along with colleagues André Weideman and Annie Cuyt.

Delivering Impact

Students make their mark through mathematics

Saki Nakai

Evelyn McCue

Dominic Daprano

Emily Gemmill

Liam Armstrong

UNDERGRADUATE STUDENTS

The Department of Mathematics graduated 58 students with bachelor's degrees in 2022, seven students with master's degrees and four students with doctorate degrees.

SUMMIT-P embraces student's work

Lynn Gumpinger finished her bachelor's degree during winter 2022. Her honors thesis focused on best practices for developing applied problems in calculus courses.

Lynn Gumpinger

Her work supported the National Science Foundation's SUMMITP (Synergistic Undergraduate Mathematics via Multi-institutional Interdisciplinary Teaching Partnerships) project she had been working on at Oregon State for six years.

She helped create three categories of questions that curriculum designers can use. Researchers from the 11 SUMMITP institutions now use her work to guide their curriculum development. She presented her work at Math Fest in Philadelphia in August 2022.

Nakai 'psyched' about mathematics

Saki Nakai double-majored in mathematics and psychology and spent the last two terms studying abroad to complete a French minor.

She is also one of two College of Science students and alumni to receive the 2022 Fulbright Student Award. This award supports Nakai for one year of independent study in cultural psychology at the University of Luxembourg.

The pre-med student weaved her diverse research interests into a thesis project to address how math could be used to answer questions of medicine and psychology.

"Sticking with the math major gave me a more enriching college experience," she said.

Nakai combined math and psychology, through the College of Science's Summer Undergraduate Research Experience program. SURE students are paid for 11 weeks of full-time research over the summer with faculty from any college.

She completed a project using ordinary differential equations and dynamical systems theory to model bipolar disorder under the mentorship of Vrushali Bokil, professor of mathematics and College of Science associate dean of graduate studies and research.

"SURE was a completely new perspective on medicine," said Nakai. "The project was important to me because it was the first time I saw

how I can use mathematics to actually answer questions in psychology and medicine, and that's my ultimate career goal."

McCue begins student teaching

Evelyn McCue will be student teaching and attending graduate school at Oregon State next year to earn her master's degree in education. After graduating in the spring, she plans to teach high school or middle school math.

She particularly liked working with Mary Beisiegel during her undergraduate years. "She cares so much about her students and is one of the most understanding and caring professors I have ever met," she said. "It is an honor to have been in her class."

Student goes on to Fermilab internship

Dominic Daprano, a computer science minor, plans to attend graduate school after an internship at Fermilab — working on its boiling water reactors. "I enjoy the problem-solving and the diversity of work opportunities that these majors make possible," he said.

Gemmill working on doctorate

Emily Gemmill spent the summer after graduation resting in a hammock and not thinking about homework for the first time since 2017. It was a short break.

A 2021 Goldwater Scholar, Gemmill majored in biochemistry & biophysics and mathematics while minoring in chemistry. She is working on her doctorate degree in biomolecular sciences and engineering program at the University of California at Santa Barbara.

Johan Huurman

UNDERGRADUATE RESEARCH

Huurman confronts Python

Johan Huurman combined his physics and math majors as a 2022 scholar in Oregon State's Summer Undergraduate Research Experience (SURE) program.

He spent the summer studying computational chemistry and learning more about the programming language Python. "The main skill I'm going to take away is how to effectively find research papers and then effectively read those research papers for what you need," he said.

"Asking questions no one has asked before is really empowering," he added. "Answering those same questions gives a feeling of fulfillment that I just can't experience elsewhere. For my specific research project, it would be amazing to find a clear-cut and generalized way to calculate group electronegativity. With group electronegativity being easily computable, many chemists would not need to be guessing at what the electronegativity of a molecule is anymore."

It's no longer a matter of conjecture

Liam Armstrong worked on a research team with two other undergraduates during the summer as part of a National Science Foundation-funded Research

Experience for Undergraduates (REU) program led by Oregon State mathematics Prof. Holly Swisher.

At the intersection of number theory and combinatorics, the project aimed to prove a conjectured partition inequality. The researchers not only proved the conjecture, but a fully generalized inequality. Their success was due in large part to Armstrong's insights and determination.

The results have been submitted for publication in a professional research journal.
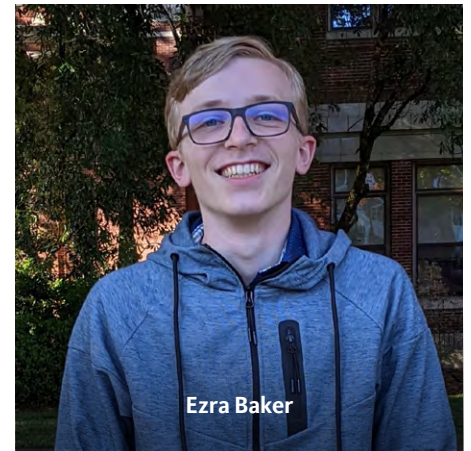
Ezra Baker

Every picture tells a story

Ezra Baker spent his summer on an REU project through Oregon State's Electrical Engineering and Computer Science Department.

He used mislabeled image files (such as an image of a frog mistakenly identified as an image of a cat) to train neural network classification models. The goal was to observe the performance of these models when trained with noisy data (with the mistakes) against clean data (without the mistakes).

Baker presented his work at the annual Summer Undergraduate Research Symposium showcase in September.

Holding a fluid discussion

Undergraduates **Madison Collins** and **Nicholas Zitzelberger** worked with computer science student Ishanshi Bhardwa and mathematics instructor **Hoe Woon Kim** on a project titled "Stokes Flow of Incompressible Fluids" during winter term 2022 through the Office of Undergraduate Research, Scholarship and the Arts.

Nicholas Slugg and **Seth Alderman** also worked with Kim. Their project was titled "Analytic Solutions to Stoke's Equations on Unit Disk." Both teams presented their work at the Celebrating Undergraduate Excellence program in May along with **Henry Sprueill** (a math and physics double major) who presented a physics project titled "The Two Wells System: A Benchmark for Statistical Physics."

GRADUATE STUDENTS

Math students show their work

Holly Swisher, Michael Allen and **Ben Toomey** co-organized the 2022 Winter Showcase as part of Oregon Number Theory Days for regional graduate students in number theory to present their work.

The showcase included talks by OSU graduate students Michael Allen, Leah Sturman, Andres Valloud, Peter Oberly, Ben Toomey as well as panel discussions on navigating a work-life balance and applying for jobs and funding.

Mathematics fellowships prove a definite plus

Fernando Angulo Barba received The GEM Fellowship, a national program that promotes the participation of underrepresented groups in postgraduate science and engineering by

Fernando Angulo Barba

combining academic fellowship support with internship opportunities at national laboratories or industrial partners.

Founded in 1976 at the University of Notre Dame, the fellowship supports students pursuing doctoral degrees in the natural science disciplines – chemistry, physics, earth sciences, mathematics, biological sciences and computer science.

The program covers full tuition, fees and an annual stipend in collaboration with a sponsoring GEM university. Fellows also participate in a minimum of one paid summer internship. Angulo Barba spent nearly three months in Idaho Falls, Idaho, working with Idaho National Laboratory computational mechanics and materials group.

Erwin Cornelius is a second-year scholar with ARCS Foundation Oregon. Scholars are chosen by the selection committees at Oregon Health & Science University, Oregon State and the University of Oregon. The ARCS Foundation Scholar Award is $18,000, payable over three years.

The Oregon foundation was created in 2004 by a group of women philanthropists dedicated to advancing science and technology. It is one of 15 chapters in the United States that provides financial awards to academically outstanding students

completing Ph.D. degrees in science, technology, engineering and math at Oregon's research universities.

Cornelius received the Bergen/Kern Scholar Award given by Marilyn Bergen and Mary Kristen Tooze Kern. His research interests include machine learning methods, in particular random forests and neural networks and their applications to biological data.
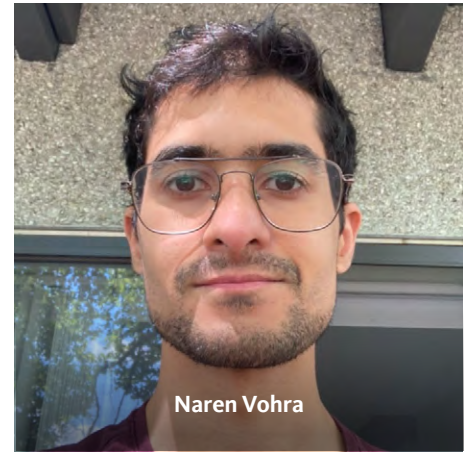
Naren Vohra

A summer spent on climate

Naren Vohra, a graduate student in mathematics, pursued two internships last year. He spent part of spring term at the Woodwell Climate Research Center in Falmouth, Mass., where he worked on modeling deformation due to permafrost thaw by analyzing the poroelasticity system. He also analyzed the effect of unfrozen water content on the active layer depth settlement.

He then spent the summer at Los Alamos National Lab in New Mexico, studying well-balanced, depth positivity preserving numerical schemes for solving the shallow water equations. He placed second out of 63 in Lightning Talks presented by all the lab's summer interns.

Vohra also visited Prof. Barbara Wohlmuth's group in the Department of Mathematics at Technical

University of Munich for an ongoing collaboration. He rounded out his accomplishments with a travel award from American Mathematical Society. Along with help from Oregon State's mathematics department, he traveled to the society's conference in Texas in September and delivered a talk.

Student heads to Livermore Labs

Greg Detweiler participated in a summer internship at Lawrence Livermore National Laboratory's Nondestructive Characterization Institute, where he worked on two projects. The first helped the lab implement an algorithm described in a 1996 paper, which provides a theoretically exact 3D tomographic reconstruction of cone-beam projection data collected with the X-ray source moving on multiple trajectories.
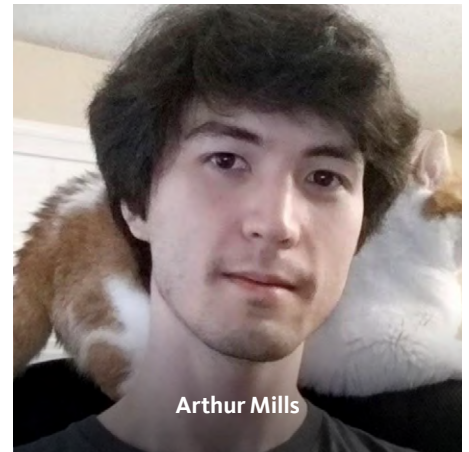
The goal of Detweiler's second project was to predict the intensity of ring artifacts in a cone beam Feldkamp, Davis and Kress reconstruction, before doing any scanning. The team merely assumed prior knowledge of the object being scanned and some given parameters of the scanning technique, such as the X-ray tube voltage and which X-ray filters and collimators were used.

Helping out at Los Alamos

Jeremy Lilly worked remotely with scientists from Los Alamos National

Lab (Doctors Mark Petersen and Giacomo Capodaglio) on time-stepping schemes for ocean modeling in MPAS-Ocean. The graduate student was awarded a Department of Energy Office of Science Graduate Student Research Award.

He also gave a talk in June "Speeding Up Ocean Simulations with Local Time-Stepping" at the 2022 Ocean Sciences Meeting.

Arthur Mills

Internship held at Fermilab

Ph.D. candidate **Madison Phelps** spent her summer at Fermilab, America's premier particle physics and accelerator laboratory.

A recipient of the prestigious National Science Foundation's Mathematical Sciences Graduate Internship, her project was titled "Deepening Our Understanding of Numerical Integration Techniques".

Madison Phelps

Internship looks at 3-D imaging

Arthur Mills worked with the National Science Foundation's Mathematical Sciences Graduate Internship program during summer at the National Energy Technology Laboratory with Wu Zhang. He worked on a 3-D imaging project.

Bigler speaks in Europe

Lisa Bigler presented a talk at the European Seminar on Computing in Czechia in June, which focused on computational methods for climate modeling and analysis. She received the College of Science Student Travel Award to attend the meeting.

Talk delivers on adelic measures

Peter Oberly gave a talk titled "An Inner Product on Adelic Measures" at the Equidistribution and Arithmetic Dynamics Conference in Stillwater Oklahoma in June.

Greg Detweiler

Jeremy Lilly

Lisa Bigler

Peter Oberly

Mary Beisiegel gets to the heart of the equation

Associate Professor of mathematics **Mary Beisiegel** loves teaching freshman calculus classes, especially if students just arrived for their first term at Oregon State.

Many of them are more than a bit intimidated by college-level mathematics. She knows how they feel. "I was lost for a few years," Beisiegel said. "I actually started college as a psychology major. I wasn't always good at math. I really had to work at it."

She tries to remember, she said, that her students have grown up in a different era. "My students' experiences are so different from mine," she said. "I want to be aware of that every day I step into a classroom to make sure that my teaching practice meets them where they are."

The joy of teaching is connecting with students and making them feel seen and understood. For Beisiegel, mathematics is all about the human equation.

Beisiegel approaches teaching by letting students know she's honored to have them in her classroom. "There are so many other places they could be, but they're with me in my classroom," she said. "I have to honor that. I tell them, 'I'm so glad we're here together. Let's do this.'"

Then she asks them questions. By the end of the second week, she is already seeking their feedback about how the class can better suit their needs. "I can tailor my instruction to the voices I hear," she said. "Not every class needs to be taught the same way."

The road to researching and understanding mathematics teaching

Having attended Oregon State University, Virginia Tech and the University of Alberta for her bachelor's, master's, and Ph.D., respectively, Mary Beisiegel has spent a lot of time in classrooms as a learner and teacher of mathematics and mathematical concepts.

As a mathematics graduate teaching assistant (MGTA) at Virginia Tech, she got to experience mathematics classrooms from a very different vantage point. By her Ph.D. she had worked in two different departments, one which offered no preparation for teaching, the other which offered a week-long training program.

During her experience as a research fellow at the Harvard Graduate School of Education, she had the opportunity to learn about an observational tool called the Mathematical Quality of Instruction, which has the observer look at different features of mathematics lessons.

For example, what are the mathematical representations, solution methods and procedures and explanations used to convey a mathematical idea to learners? How are students contributing to the lesson?

Beisiegel watched dozens of mathematics lessons from school

districts across the U.S. and reflected back to her own teaching. What representations had she used when teaching calculus? What mathematical language did she emphasize?

A new approach to preparing MGTAs for teaching

Mathematics teaching has become the main focus of Beisiegel's research. Her lack of preparation as an MGTA, she has found, was not unique. And yet MGTAs are often the main points of contact for mathematics instruction to undergraduate students. Beisiegel now recommends that they should receive sustained professional development for their teaching practice.

Toward this goal, Beisiegel collaborated with fellow mathematics education researchers at San Diego State University and Virginia Commonwealth University on a five-year, $2.2M National Science Foundation-funded study aimed at preparing MGTAs to implement teaching practices to improve the success of students in undergraduate mathematics courses.

Part of the grant funds the development of a program entitled Engaged Learning, Inclusive Teaching and Equity Professional Development (ELITE PD) to investigate the impact and effectiveness of more inclusive teaching practices in three different mathematics departments. The goal of this project is that it will prepare future post-secondary mathematics teachers to implement instructional practices that are grounded in the research literature and that center inclusivity and equity.

Beisiegel thinks a lot about how to prepare MGTAs to think about access, inclusion and equity in their classrooms as well. "Inclusivity means an awareness of students' lives and

how they're affected by what is pulling their minds away from your classroom and how we can be compassionate about that," she said.

> "Inclusivity means an awareness of students' lives and how they're affected by what is pulling their minds away from your classroom and how we can be compassionate about that."

Beisiegel and her colleagues are confident that this study will transform the field of MGTA professional development by providing researchers and practitioners with new knowledge of how to support MGTAs as they learn about and adopt practices that support access, equity and inclusivity.

Beisiegel was awarded a second three-year, $124K NSF grant in 2020 that will help inform her work with MGTAs as it is focused on college algebra classrooms, with a goal of defining mathematics teaching practices that support access, equity and inclusivity.

The joys of teaching

If her current students like Beisiegel's style, they can thank two of her math teachers at Grant High School in Portland. She wasn't much of a standout student, Beisiegel said. She felt like she was off everyone's radar – everyone, that is, except her two math teachers.

"I felt seen and cared for," she said. "And on top of that, of all the adults in my life at the time, they really seemed to love what they did."

It is clear Beisiegel is now extending that same care to our students. In February 2023, she received the College of Science Fred Horne Award for Sustained Excellence in Teaching Science. One student nominator wrote: "She always made sure that each and every student in her class felt safe and welcome regardless of their math learning background or personal experiences."

Out there

Diversity, outreach, news and events

SciRIS helps fund a wide range of research

Seed funding from the College of Science Research and Innovation Seed (SciRIS) program in 2022 bolstered three projects by Oregon State mathematics professors.

Radu Dascaliuc, an associate professor, used SciRIS to research stochastic cascades and energy transfer in equations of fluid dynamics. Deeply rooted in questions of applied science and engineering, Dascaliuc's project explores connections between the mathematics of equations of fluid motions and physics of fluids.

Part of his work included organizing a two-week summer collaborative research program, connecting students from backgrounds traditionally underrepresented in STEM and especially in the field of fluid dynamics.

Alex Saenz Rodriguez explored a greater understanding of quantum mechanics. According to quantum mechanics, one only knows the probability for the location of an electron at any given moment. Yet, if the electrons are confined to a one-dimensional space, the system exhibits certain symmetries that may allow one to obtain exact formulas for the statistics of the electrons.

Last fall, Rodriguez hosted a conference focused on this research topic.

Funds for Saenz Rodriguez's SciRIS project, titled "Probability Law for 1D Quantum Electrons," are provided by a generous gift made to the Robert W. Lundeen Science Faculty Development Award Fund.

Swati Patel, an assistant professor, used the Disease Mechanism and Prevention Fund and SciRIS support to combat soil-transmitted helminths – parasitic worms that infect an estimated 1.5 billion people worldwide, particularly in developing tropical countries that lack adequate sanitation.

Periodic de-worming is necessary to treat and prevent infection, but the worms develop resistance to the drugs used. Patel investigated how the worms build resistance and created strategies to prevent it through systematic mathematical modeling.

MEETINGS
Meeting space for moduli spaces

Clayton Petsche, an associate professor, co-organized a workshop from September 27 to October 1, 2021, at the American Institute of Mathematics in San Jose, California.

This workshop was devoted to the study of the geometry and arithmetic of moduli spaces associated with dynamical systems on algebraic varieties, with a particular emphasis on dynamical systems on projective space.

Meeting held in the Black Forest

Małgorzata Peszyńska helped organize a workshop at the Oberwolfach Research Institute for Mathematics in Germany's Black Forest January 23 to 29, 2022.

The workshop addressed "Multiscale Coupled Models for Complex Media: From Analysis to Simulation in Geophysics and Medicine."

Oberwolfach gathers experts from all over the world to pursue research, discuss recent developments and generate new ideas.

OUTREACH
Students given a leg up

Ezra Baker works with OSU's Educational Opportunities Program, a support program for students in

Swati Patel

Clayton Petsche

Małgorzata Peszyńska

Bill Bogley

Rachel Wofford (M.S. '22) presents her poster 'Using Machine Learning Models to Predict Cancer Outcomes' at the 3rd Biennial Meeting of SIAM Pacific Northwest Section.

groups that have been traditionally denied access to higher education.

During 2021 and 2022, he was a leader for the bridge program to orient and guide new students. He has also been a teaching assistant and grader for EOP mathematics courses.

Recognizing student excellence

Bill Bogley, mathematics department head, presented medals at the Oregon Invitational Mathematics Tournament May 14, 2022, along with tournament coordinator **Tom Dick**.

More than 50 of Oregon's brightest high school mathematics students came together for a day of competition, learning and fun.

That year marked the 40th anniversary of the tournament. Several mathematics faculty and staff registered students, proctored exams, graded work and pitched in with a scavenger hunt and mathematics games and puzzles.

How sexism enters the equation

Małgorzata Peszyńska talked about "The Hardest Subject in Mathematics" November 5, 2021, when European Women in Mathematics met at the Berlin Mathematics Research Centre.

Peszyńska focused on obstacles women in mathematics face, stressing the importance of traditional groups being willing to change and encourage junior faculty members.

Peszyńska is serving on the Pacific Math Alliance Executive Board. "Our goal is to build a regional community of mentors that will help underserved students to pursue advanced study or a career in the mathematical sciences," she said.

Grad student looks at critical issues

Sarah Jones, a mathematics graduate student, attended the Critical Issues in Mathematics Education Workshop in March 2022 at the Mathematical Sciences Research Institute in Oakland, California.

Topics addressed included the transformation of introductory courses. Jones also participated in the NSF's teaching course on inclusivity in STEM. Her attendance was funded by the institute.

Representation at Conference for Women

Graduate students **Leah Sturman** and **Rachel Wofford** were invited speakers at the 24th annual Nebraska Conference for Undergraduate Women in Mathematics held in January 2022. The conference aims to encourage and mentor undergraduate women in pursuing graduate study and careers in mathematics.

2022 Lonseth Awards

Established in 1985, the Lonseth Awards recognize students and faculty who excelled throughout the previous year. The awards are named in honor of Arvid T. Lonseth, professor emeritus and former chair of the mathematics department.

UNDERGRADUATE AWARDS
Joel Davis Student Award
Liam Armstrong

Botond Gabor Eross Math Memorial Scholarship
Ezra Baker, Griffin Brandstetter, Rachel Hansen and Lodewyk Petrus Jansen Van Rensburg

Edward H. Stockwell Award
Daphny Chen, Emily Gemmill, Evelyn McCue, Riley Skyles and Labib Zakaria

Gary L. Musser Award
Evelyn McCue

WIC Culture of Writing Award
Maxwell Siebersma

William Lowell Putnam Competition
Jack Dickinson, Elaine Swanson and Brandyn Tucknott

GRADUATE AWARDS
William F. Burger Graduate Teaching Award
Jordan McCaslin

Outstanding Performance In Coursework Award
Peter Cowal, Tyler Fara, Nicholas Harrison, Lucas Perryman-Deskins and Rachel Wofford

Graduate Student Excellence Award
Evan Rajbhandari and Naren Vohra

Excellence In Qualifying Exams Award
Jonathan McCollum, Nicholas Harrison, Fernando Angulo Barba and Tyler Fara

The Charles Leslie Johnson Years

By Ed Waymire, Professor Emeritus & Bill Failing, grandson to Charles Johnson

Charles Leslie Johnson

The WINTER 2015 issue of Math in the Valley includes a wonderful retrospective piece on the OSU mathematics department by our colleague and Professor Emeritus Harold Parks – a nontrivial feat in view of scant data from the earliest years. The focus of Parks' article, aptly entitled Retrospect, covered a period from the university's early inception in 1855 until 1967, and naturally includes an especially interesting period (1917-1922) for Oregon State University (then the Oregon Agricultural College (OAC)), when Linus Pauling was an undergraduate OAC student. As noted in Retrospect, Charles Johnson headed the Mathematics Department for the period 1908-1932.

Fast forward to 2022, when the authors of this addendum to Retrospect happened to meet during an intermission at a summer concert series in Troutdale, OR. After bonding as amateur banjo players (Bill Failing's son Billy Failing is the banjo player for the Grammy award winning Billy Strings Band, currently touring the world stage), the two realized that they shared a deeper connection through the OSU mathematics department.

Our subsequent conversations permit us to fill in between the lines pertaining to Bill's grandfather Charles Johnson. Charles died in an automobile accident in Corvallis in 1941, when Bill was one year old. Charles' brother Will survived the accident and served as a Corvallis medical doctor, as well as a term as President of the American Medical Association for Oregon. It is a tribute to Johnson that, according to a historic October 7, 1917 Linus Pauling diary entry, he offered a genuine welcome and encouragement to a budding sixteen-year-old new undergraduate:

"Last night at the train I met Mr. Johnson, and his small son. He asked me if I was new, and said he was the head of the math department. According to the catalogue he is Charles Leslie Johnson, B.S., Professor of Mathematics. I intend to take every one of the courses offered."

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The letter (copied here) from Pauling to Bill's son Josiah is further testimony to Charles Johnson's impact on Linus Pauling in the context of a dedicated educational mission in the earliest years of the OSU Mathematics Department. Josiah Failing is currently working with numbers for Bonneville Power Administration. Pauling's correspondence with Charles Johnson and with members of the Failing family will be donated to the OSU Linus Pauling Archives.

The impact of Johnson on the evolution of Oregon State University goes beyond mathematics. As an athlete, he and his OAC faculty colleague John Fulton in the chemistry department engaged in a fundraising track and field event that would provide "the first gate receipts of any sizeable amount from an athletic event at the college, according to Mark Weatherford, '07," as quoted from an article in the May 1942 Oregon Stater entitled "Athletic Boards Then and Now."

According to Fulton in the same Stater article, Johnson "did more to place O.A.C.'s athletics on a better financial basis than any member of the faculty." In addition to exhibiting a delight for teaching mathematics, Charles Johnson's good will and service to students was clearly far reaching and impactful within the larger academic environment.

LINUS PAULING INSTITUTE of SCIENCE and MEDICINE
440 Page Mill Road, Palo Alto, California 94306-2025
Telephone: (415) 327-4064
Facsimile: (415) 327-8564

26 September 1991

Josiah Failing
1708 S.W. Hawthorne Terrace
Portland, OR 97201

Dear Josiah:

Your father has told me that you are doing well in arithmetic and enjoy working with numbers. I think that this is a fine interest to have, and I hope that you will continue to study mathematics.

When I was in my first year in Oregon Agricultural College, in Corvallis, I learned a great deal from your great-grandfather, Prof. Charlie Johnson. He taught me a branch of mathematics called calculus. He was an excellent teacher, and I was pleased to be a student in his class.

He was, in fact, the first teacher of Oregon Agricultural College to speak to me. On the day that I arrived in Corvallis I was walking on the sidewalk near the campus. Your great-grandfather came along, and stopped, asking if I were a new student (I was 16 years old then). I told him that I was, and I think he mentioned that he was teaching mathematics. I did not know until a few days later that he would be one of my teachers.

With best wishes to you, I am

Sincerely yours,

Linus Pauling

LP:dm

Oregon State University
College of Science

Department of Mathematics

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