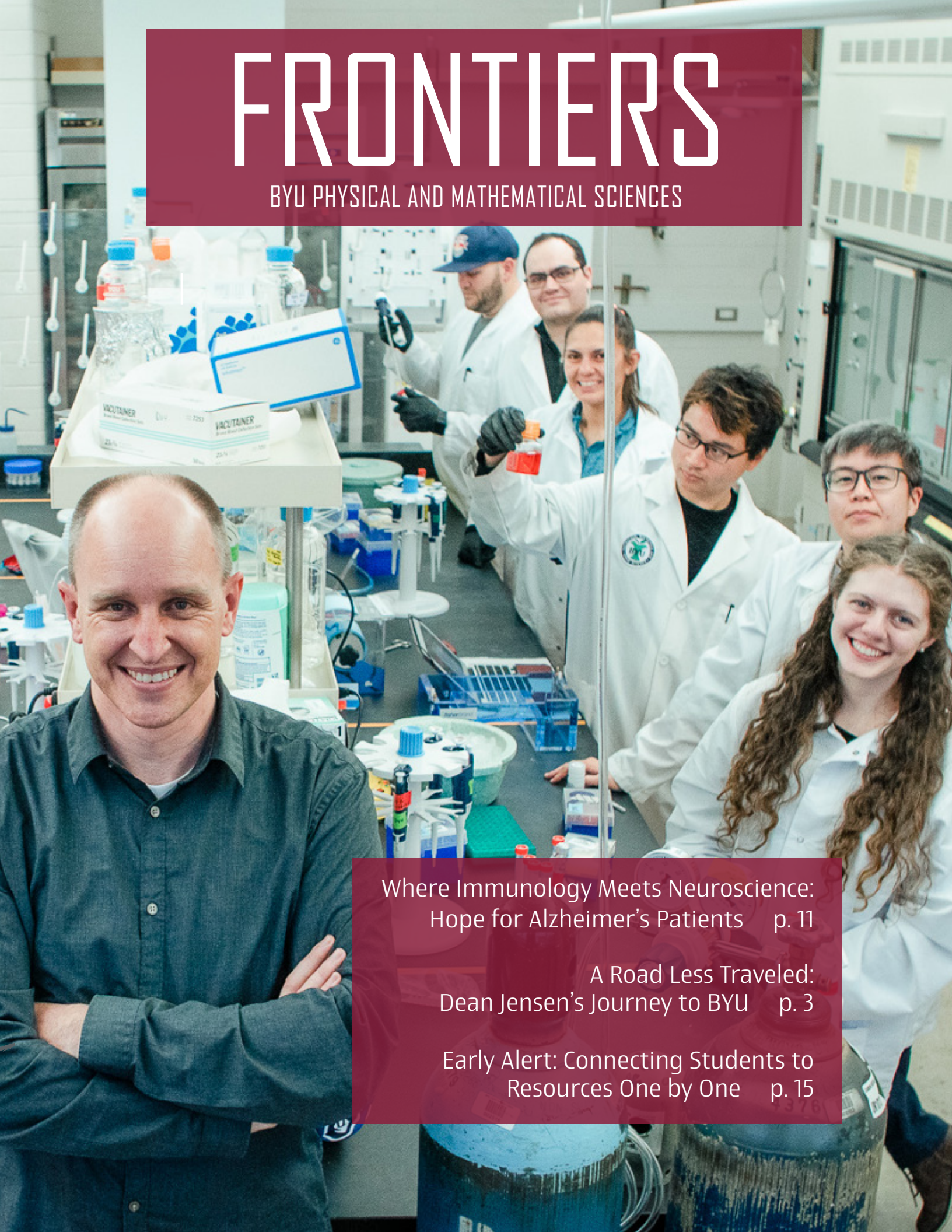
FRONTIERS

BYU PHYSICAL AND MATHEMATICAL SCIENCES



Dear Alumni,

I am excited to have this opportunity to introduce myself to you as the new Dean of the College of Physical and Mathematical Sciences. Just two years ago, I was in the same position as most of you—an alumni of BYU with a deep love of everything it stands for. Now that I'm back on campus, I have a strong desire to recommit myself to being a more involved BYU alum.

As you know, Brigham Young University has a unique mandate to deliver a world class education while striving to increase the faith of our students. This combination provided me a solid foundation as an undergraduate student, one that later launched me into a fulfilling career as a scientist. The messages I heard at BYU from inspired faculty, staff, and visiting General Authorities positively influenced many of my most important life decisions. I share more about my career and journey back to BYU in "The Road Less Traveled" article included in this issue.

Our college aspires to deliver the world's best undergraduate education in a spiritually strengthening environment. In President Spencer W. Kimball's Second Century address, he challenged BYU to become an Everest of Education. The aspiration to deliver the best undergraduate education available in *all the world* is daunting in every sense, but our students deserve it! We simply can't aspire to anything less, and you are an integral part of making President Kimball's vision a reality (take a moment to read his talk at tinyurl.com/2ndCenturyAddress).

In order to achieve success, I want you to know that the college fully supports President Kevin J Worthen's direction to help every member of the BYU community feel a true sense of belonging. I applaud BYU's new Statement on Belonging because it's wonderfully founded in the teachings of the restored gospel of Jesus Christ. Please read it here: science.byu.edu/belonging.

As we celebrate our college's 50th anniversary as this fall, you're going to hear from us more than you usually do. Your many accomplishments have inspired us to do our part to further build the reputation of BYU which will continue to open doors for alumni and students. With your support, we truly believe BYU will become an Everest of Education. Thanks for all you do!

Sincerely,

Grant Jensen

Dean, College of Physical and Mathematical Sciences

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A ROAD LESS TRAVELED

DEAN GRANT JENSEN'S JOURNEY TO BYU

By Lauren Nelson

Throughout his career, Dr. Grant Jensen has been willing to walk the road less traveled. In early 2020, Jensen stood at the crossroads of two divergent paths. One would allow him to continue to lead a cutting-edge research team at the California Institute of Technology (Caltech). The other would give Jensen the opportunity to make a broader, more lasting difference in the lives of faculty and countless students. Fortunately, the Lord continued to reach out in personal, but unmistakable ways to help Jensen see the choice from an eternal perspective, one that would help him choose the road less traveled and become the new dean of the College of Physical and Mathematical Sciences.

For the past eighteen years, Jensen's professional path immersed him in the molecular architecture of microbial cells as head of the Jensen laboratory research team at Caltech. When it comes to his research, Jensen has already learned that being sensitive to the Spirit allowed him to forge his own direction—a path which ultimately led him and his research team to uncharted discoveries. Unlike other scientists who generally begin their research with a formal hypothesis, Jensen's journey of developing the field of cryotomography-ET (cryo-ET) started with the notion that if scientists could see the whole cell, they would more clearly understand how it functioned.

As a result, Jensen and his research team decided "to take pictures of cells like nobody's taken before," he commented, "and sure enough, all kinds of things were inside cells that people didn't know about!" Jensen's team has been credited with being the first to use correlated light microscopy and cryo-ET to identify subcellular objects and produce 3D images of them at the microscopic level. "We take cells, put them in the electron microscope, and take pictures of them as we tilt them. Then we put all these pictures together into three-dimensional reconstructions," Jensen explained.

Jensen's work with cryo-ET has produced phenomenal discoveries, such as new cytoskeletal filaments that help organize and give shape to cells; flagellar motors that allow bacteria to swim; and within the thin tubes of the endoplasmic reticulum, a left-handed double helix! Jensen's work lays the groundwork for other scientists to make biochemistry discoveries. It could ultimately lead to medical treatment applications like creating new species of bacteria with specific abilities such as curing disease, cleaning up toxic waste, or capturing sunlight to produce fuel.

To date, Jensen has nearly 200 publications about his work with cryo-ET and over 10,000 citations pertaining to his innovative research. One of his most recent projects is the production of a digital book consisting of hundreds of images from his lab's most compelling findings. Before becoming a world-renowned researcher, however, Jensen had to face another crossroad. He had to decide which area to concentrate in while pursuing his doctorate in biophysics from Stanford


“Two roads diverged
in a wood, and I—
I took the one
less traveled by,
And that has made
all the difference.”[1]

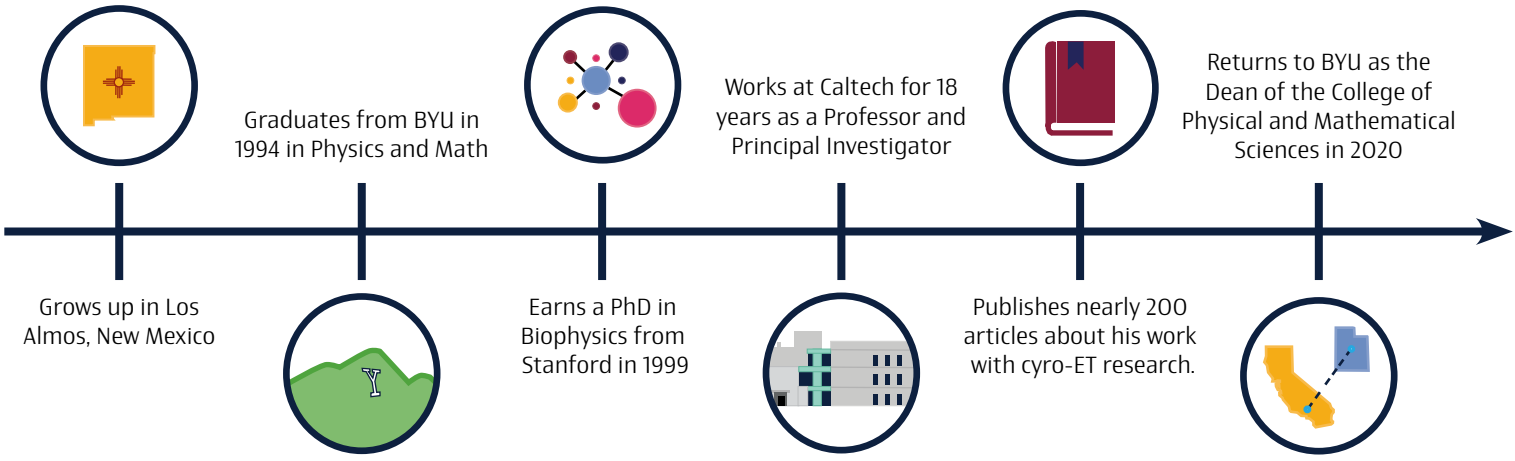
University. When he heard scientist Roger Kornberg speak about his research using an electron microscope to take pictures of the protein complex that reads DNA, the Spirit confirmed which direction Jensen should pursue--the first step on the road that would lead him to BYU.

Jensen soon came to realize that cryo-ET is "the happy union of a lot of things I love," he explained. "There's a lot of physics involved in how electron microscopes work, for example, and there is an enormous amount of image processing that needs to be done which involves a lot of math and programming." As his work immersed him in these different fields, Jensen kept one goal in mind: to try to understand how "these amazing macromolecular machines make cells work." For him, cryo-ET was the perfect combination and an answer to which direction his career path should take.

But Jensen's passion for science began long before his time at Stanford and Caltech. Growing up in Los Alamos, a small government town in New Mexico with one McDonald's and a nuclear development lab, Jensen was surrounded by physicists. Describing the effect this had on him, Jensen recalled that, as a child, he had always thought he was going to be a physicist "like everybody else." When Jensen was pursuing his undergraduate degree at BYU, he decided to go back to his roots and chose to major in physics and math. Jensen is especially grateful for every opportunity he had to attend BYU devotionals with other young people who shared the same values, and for professors who unapologetically shared their testimony as he pursued his education in the sciences. Jensen fondly recalled that, "they helped me develop a sound strategy to simultaneously learn about science and religion because wherever and whenever we discover truth, our faith can stand strong." The combination of inspired secular and religious training has made all the difference for Jensen's career.

After finishing his PhD at Stanford, Jensen completed a post-doctorate at Lawrence Berkley National Laboratory. Since then, Jensen has worked solely at Caltech. But after nearly two decades at Caltech, Jensen had the distinct and repeated impression that more was expected of him—that who he was and what he was doing was not good enough—and that he should stop praying for professional success as he saw it and start praying for the Lord's will to be done in his life. Not long after that, BYU contacted him about the Dean position. Jensen knew that choosing to leave a prestigious position at one of the world's most competitive research facilities was a decision most scientists would likely balk at.

When the opportunity to return to BYU presented itself, Jensen realized that it was time to act on an impression he received when he was an undergraduate. He recalled that while he was a student, he had the thought that someday he would like to contribute as



a faculty member or leader at BYU. "That thought has been kicking around in the back of my mind," he commented. Even as an undergrad, Jensen knew that such impressions could only come to fruition if he continued to walk the road the Lord wanted him to take.

As Jensen contemplated how he could contribute to BYU's divine mandate, "precious, impactful signals came," he said. In the process, Jensen more fully recognized the vital role BYU is playing and needs to continue to play in the growth of the Lord's kingdom. More than ever, Jensen appreciates how unique BYU is. "BYU prepares students for their careers while strengthening their testimonies and commitment to the gospel," he said. That's why Jensen chose to invest the second half of his career building the kingdom of God by helping to fulfill the mission of BYU. As a result, Jensen willingly took the road less traveled when he decided to leave his prestigious research position at Caltech to serve as the new dean of the College of Physical and Mathematical Sciences. "My colleagues were astonished," Jensen remarked. "My decision was totally baffling from their point of view." But the road he needed to travel was crystal clear from the Lord's point of view and helped to clarify some of his goals as the new dean.

"As a college, my goal is to offer the best undergraduate education in our fields so no one has to choose between the spiritual and cultural benefits of a BYU experience and the academic benefits of somewhere else." Jensen knows this mission requires a world-class faculty full of faith—exactly what BYU has. "There is no other place with a higher concentration of people trying to live the gospel," Jensen mused. When he walks around campus, Jensen is touched by the impression he gets that every student is a part of his family (indeed, two of his children are current undergraduate students!). "We all have so much in common," he said.

Life is often full of difficult choices, but Jensen concluded that, "If the Lord is going to direct His church to own and operate a university, I'm honored and excited for the chance to help it thrive." Jensen is confident that if he continues to ask which path the Lord wants him to take, he will be guided to find the right direction both for himself and the college, even if it might sometimes be the road less traveled. ■

1. Robert Frost, "The Road Not Taken," in *Mountain Interval* (New York: Henry Holt and Company, 1916), p. 9.

BINGE-WATCHING

What Three Statistics Professors Discovered

By Brendan Murphy

If you're like most people, you probably watched television more than usual the last several years as the spread of COVID-19 meant more time at home for many. Although watching TV may be a regular part of our day-to-day lives for many people, have you ever wondered why random shows keep popping up in the "suggested for you" queue? By gathering data about your current and past viewing habits, streaming services create a mountain of data, which they hope to monetize by analyzing your overall consumption.

The dramatic increase in streaming services subscriptions is responsible for much of this viewer traffic.[1] Statistics professor Dr. Natalie Blades keenly observed that "this change in [consumer] access has led to massive changes in media consumption."

Along with Blades, statistics professors Dr. Scott Grimshaw and Dr. Candace Berrett wanted to find out more about how viewers consume newly released content. Specifically, they sought to understand how releasing several episodes at once, rather than one episode per week, affects consumer watching patterns.

Thanks to BYUtv, the researchers were given a rare opportunity to conduct a project that would provide answers to those very questions.

BYUtv informed Grimshaw a few years ago that they were moving toward expanding their programming from content directed to a local audience to ongoing family-friendly content directed to a national audience.[2] BYUtv paired up with Adobe analytics in order to make more informed decisions about programming as they acquired content to reach a broader audience. In an effort to understand whether the exclusive digital season three release of Granite Flats[3] resulted in binge-watching, BYUtv provided the data collected from the digital-only premiere to the researchers to find out more about their viewing behavior. Grimshaw still remembers getting handed the data, especially the moment when he realized that he wasn't aware of a way to statistically model data to determine binge-watching. That's when he reached out to his fellow colleagues for their expertise.

Blades noted that one of the benefits of being at BYU is working in an atmosphere where disciple-scholars can come together to pursue truth. While admitting that BYU isn't the only university where gospel living and academic study can be combined, Grimshaw is appreciative that he can share both secular and spiritual knowledge with his colleagues, as well as his students.

Working together, the team was able to differentiate between the types of binge-watching present in the study data. They could more easily quantify them thanks to Berrett, who teaches a graduate course in count data and does research with Bayesian spatial categorical data.[4] Blades was then able to create a model of how a show becomes viral via binge-watching by applying her previous experience studying the spread of disease caused by bio-weapons during the 2001 anthrax outbreak.[5]

Just as virologists utilize statistics to predict and track the prevalence of a disease, TV networks can predict what would make a show go viral. Applying this type of analysis to a television show may seem odd, but it is the viral nature of the content which makes the comparison an innovative and effective tool.

During the research process, Grimshaw noted that their study concentrated on two things. First, they focused on when people start watching a program after it's released. Second, they focused on how much time passes before viewers watch the whole series. "If you give people thirty new shows to watch on the first day of the month, by the time you get to the third or fourth week nobody remembers any of those new shows and so they go unwatched," Grimshaw observed.

By utilizing count data, the research team identified three groups of viewers: 1) those who watched the entire show in one or two sittings; 2) those who watched the show over a longer span of time; and 3) those who watched the whole show in sporadic chunks. Grimshaw, Blades, and Berrett found that Granite Flats viewing went viral with almost 43% of viewing coming within the first three days.[6] The analysis of the data also led the team to identify a TV-watching behavior they term "attention cannibalism." When two or more shows are released at the same time, for example, viewers are inherently forced to decide which show to watch. Attention cannibalism is the process of one show capturing a viewer's attention over another show.

The team's research findings enabled them to determine optimal show release intervals, ones that would allow viewers to watch more new content. This type of

Just as virologists utilize statistics to predict and track the prevalence of a disease, TV networks can predict what would make a show go viral.

analysis could enable streaming services to estimate when viral viewing of a show could potentially end so the service could better predict when an optimal time to introduce new content would be. Their research also provides evidence to streaming companies that releasing content in a staggered manner optimizes viewership. By keying into the role attention cannibalism can play in viewer behavior, networks can increase monthly revenue by spacing out new releases. In fact, "some new content is reverting to more traditional weekly releases instead of [a] full season release," Blades noted.

While studies in the past have examined content from streaming service catalogs, this study focused on the release of original content. "Entertainment is no different from sports or business or anything else," Grimshaw said regarding the role of statistics in media. "We're all looking at how to engage people, and then at some level, trying to monetize that attention." But data science analytics don't just benefit streaming services' bottom lines. They can also improve consumer experience.

As streaming services seek to understand binge-watching trends, viewers will ultimately reap the benefit as they learn how to identify optimal release intervals. After all, nobody should have to choose between binging BYUtv classics like *Studio C* and *Granite Flats*. ■

1. "Covid-19 Accelerates Digital Adoption," transunion.com, June 2020 Media Consumption Infographic, https://content.transunion.com/v/dgt-jun-20-infographic-media-consumption.
2. "BYUtv launches original series to bring back family-friendly programming," news.byu.edu, BYU University Communications, March 27, 2013, https://news.byu.edu/news/byutv-launches-original-series-bring-back-family-friendly-programming.
3. *Granite Flats*. Directed by Scott Swofford, Brian McNamara, and Blair Treu. Written by John Christian Plummer. BYUtv, April 7, 2013.
4. Candace Berrett and Catherine A. Calder, "Bayesian Spatial Binary Classification," *Spatial Statistics* 16, ((May 2016): 72–102, https://doi.org/10.1016/j. spasta.2016.01.004.
5. Ron Brookmeyer, Natalie Blades, Martin Hugh Jones, and Donald A. Henderson, "The Statistical Analysis of Truncated Data: Application to the Sverdlovsk Anthrax Outbreak," *Biostatistics* 2, no. 2 (2001): 233–247, https:// doi.org/10.1093/biostatistics/2.2.233.
6. Scott D. Grimshaw, Natalie J. Blades, and Candace Berrett, "Going Viral, Binge-Watching, and Attention Cannibalism," *The American Statistician* 74, no. 4 (2020): 380–391, https://doi.org/10.1080/00031305.2020.1774415
7. "About BYUtv," byutv.org, accessed May 30, 2022, https://www.byutv.org/about.

BYUtv, who partnered on this project, broadcasts into 54 million homes across the nation.[7] *Photo by Jonathan Hardy/BYU Photo*

BENJAMIN FRANDSEN

Ending 70 Years of Uncertainty

By Kanae Lee

The focus of one of Dr. Benjamin Frandsen's research projects is a seemingly bizarre type of salt called FLiNaK (pronounced FLY-nack). Frandsen has been investigating FLiNaK since his arrival in the Department of Physics and Astronomy four years ago when a casual chat session between him and Dr. Matthew Memmott blossomed into a groundbreaking collaboration in connection with chemical engineering assistant professor Dr. Stella Nickerson.

The research team's goal was to study FLiNaK on a "very detailed atomic level" to use it in molten salt reactors, an alternative nuclear reactor design concept that has many advantages over the designs most commonly used today. All three team members brought their unique skills to the project. With Frandsen's expertise in neutron scattering, Memmott's skill in examining the macroscopic properties of salts, and Nickerson's efficiency in creating simulations, the team set out to ascertain the structure of the molten salt.

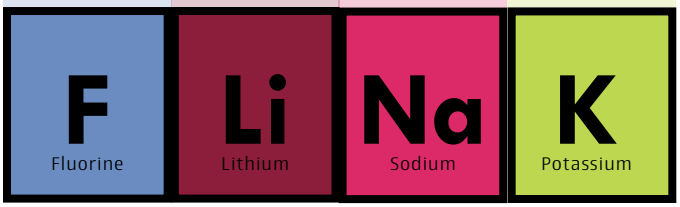
First, Memmott created a high-purity sample of FLiNaK using techniques he has been developing over the last few years. Next, he passed the sample on to Frandsen and his graduate student Raju Baral to test it at a specialized neutron scattering facility. Meanwhile, Nickerson was responsible for constructing a simulation that could both predict and explain the observed results. Together, they have revitalized FLiNaK, which first came under study in the 1950s. After pinning down the exact structure of the molten salt, the doors have flung open for FLiNaK's commercial use in molten salt reactors for electricity generation and medical applications such as the diagnosis and treatment of cancer. Frandsen estimates that the commercialization of FLiNaK could happen within the decade.

For Frandsen, the significance of this research does not lie solely in the impact FLiNaK can have on the world. In fact, there are two significant accomplishments that bear mentioning. First, Frandsen and Baral had the gratifying opportunity to perform neutron scattering experiments on the sample at Oak Ridge National Lab in Tennessee, where molten salt reactors were first invented. When asked about his experience researching in the historic lab, Frandsen said that he marveled at the opportunity he had "to go to these facilities and interact with the scientists there." It made him really appreciate the incredible technology that allows these experiments to be done since not everyone with a research project is allowed to perform experiments in the Oak Ridge National Lab. The screening process is rigorous. After researchers submit their proposals, for example, a committee reviews them to select only those that "demonstrate [a] very valuable scientific objective," Frandsen noted.

Second, the team's research project was an exhilarating experience because the contributions from the three faculty members fit together so seamlessly. Frandsen observed that their findings were "in excellent agreement" with the simulations. "You have to do a good experiment to get good data, but that's just the start," he said. Frandsen credits the results of the project to the relationships he developed with Memmott and Nickerson. "I think it was just a matter of getting the right people together at the right time so that [we] could collaborate and make progress together."

All three members of the team look forward to continuing this collaboration in the future. With the assistance of federal funding, they hope to accomplish three things: study the structure of FLiNaK with nuclear fuel, find ways to remove the fission products resulting from the reaction, and discover the structure of more salts that might be even better to use than FLiNaK.

Frandsen firmly believes that the collaboration between Memmott, Nickerson, and himself is what led to the discovery of FLiNaK's exact structure. Though the success in the team's research results is satisfying in and of itself, Frandsen will long remember the colleagues he worked with the most. "I feel that BYU really is an excellent place to work with people who are experts in their field," Frandsen said. Without doubt, a great team mixed with Frandsen's fascination of FLiNaK has resulted in a recipe for success. ■




BYU

Where Immunology Meets Neuroscience

Hope for Alzheimer's Patients

By Allison McArthur

When Dr. David Hansen was hired by Genentech (South San Francisco, CA) in 2011, he was given the freedom to decide what he wanted to research. Hansen narrowed down the host of possibilities as they related to his background in neuroscience, and he ultimately chose to explore the intricacies of neuroinflammation to discover its connections to neurodegenerative diseases.

At first, Hansen wanted to better understand the brain's immune cells and the significant role they play. As his work focused more specifically on Alzheimer's disease (AD), he became more acutely aware of how many people suffer from this neurodegenerative disease. There are approximately 6.5 million Americans living with AD, and for people age 65 and older that number is projected to increase to nearly 13 million by 2050.[1] "The physical and emotional tolls of dealing with Alzheimer's disease are tremendously challenging for patients, and even more so for many more millions of families and caregivers," Hansen commented. This realization was especially poignant for Hansen when he later learned the genetic variant most associated with increasing a person's risk of AD is present in his own family.

Understanding the ways to best prevent AD, or delay its manifestation, "will be of incredible value to my family and to society in general," he said. Hansen's decision to conduct research on Alzheimer's disease is also influenced by his religious beliefs. "Another important value to me is having the work that I do be beneficial to society," he said, "and that's partly motivated by my faith which encourages us to be engaged in worthwhile endeavors that help the society in which we live."

At the start of Hansen's research, it was assumed by most researchers that neurodegenerative diseases were partly caused by neuroinflammation. However, in his preliminary studies, Hansen's research team was "unable to reproduce a lot of what had been published in the scientific literature," he said. For example, the team "couldn't see any pronounced role for the proinflammatory signaling in causing neurodegeneration. Instead, we did see very strong evidence that the immune cells play a protective role and help prevent Alzheimer's disease pathology from accumulating," Hansen recalls. The discovery of that protective role has changed the course of AD research for Hansen and many other researchers like him.

With the assistance of geneticists, the research team at Genentech began analyzing common gene variants found in the general population that affect AD development. In the process, they came to understand that several genes expressed by microglia, the brain's immune cells, alter the risk of AD development. Hansen noted that researchers often struggle with cellular clarity when analyzing tissue samples due to the challenges of knowing how different cell types contribute to the overall transcriptomic data from frozen tissue. However, his team was able to develop a novel method for isolating multiple cell types from frozen brain tissues. They identified 66 genes differentially expressed in microglia from AD patients compared to normal microglia, including the well-known AD risk gene APOE.[2] The team also recognized multiple states of microglial activation and the disparate roles they play in the AD pathology.[3] As a result, Hansen and his colleagues realized that they needed to focus their research even more on the role and functions of microglia.

To identify direct correlations between AD-related gene variants and microglial function, Hansen began studying the proteins encoded by these AD-associated genes and their molecular functions in hopes of developing a pharmacological intervention to halt AD development. The research team first studied the paired immunoglobulin-like type 2 receptor alpha (PILRA), a microglial inhibitory receptor that recognizes O-glycosylated proteins. In 2018, they published their discovery of a common variant in PILRA, a glycine-arginine substitution encoded in the gene that reduces the ability of PILRA ligands to bind properly and reduces AD risk. Thus, the alteration of a single amino acid in PILRA protects individuals from AD risk via reduced inhibitory signaling in microglia.[4]

Hansen's current research also performs manipulation in animal disease models to better observe how molecules and pathways impact AD pathologies. TREM2 (triggering receptor expressed on myeloid cells 2) is another microglia-expressed gene associated with AD so the researchers experimented with deleting TREM2 in the PS2APP mouse model. They observed increased accumulation of toxic Aβ peptides which cause amyloid plaque formation and neuronal injury. Their findings also suggest that compaction of β-amyloid into dense plaques is a protective microglial activity and "may prevent AD or delay its progression."[5] This new perspective on AD and how it develops in the brain will allow scientists to make monumental steps toward knowing how to fight the development of the disease.

Though many family members of AD patients may fail to see a hope for an Alzheimer's cure, Hansen sees the possibility of developing both a treatment for it and the ability to prevent it. That ray of hope has spurred Hansen's eleven-year journey in Alzheimer's research and his quest to make AD intervention a reality. That quest continued here at BYU as Hansen assumed his new role as an associate professor in the Department of Chemistry & Biochemistry in 2020. Along with

"This new perspective on AD and how it develops in the brain will allow scientists to make monumental steps toward knowing how to fight the development of the disease. "

Hansen's lab provides an opportunity for students to engage in state-of-the-art research.

three biochemistry graduate students and an array of undergraduate students, Hansen is enjoying researching and working with his students to find new pharmaceutical targets. "It's really rewarding for me to just be able to interact with them, mentor them, and help them develop into strong scientists," Hansen said. "It's also rewarding to be able to conduct my research and interact with students in an environment that embraces both faith and science."

Hansen is especially grateful for the significant contribution the research he and his colleagues at Genentech have made toward the prevention and treatment of AD while he was there. "It's quite realistic that within a decade or two we'll have some very effective drugs for AD," Hansen said. "Having effective drugs will allow us to identify people who have Alzheimer's pathology accumulating in their brain 10 years before they actually develop dementia." Future medicine will recognize the presence or signs of AD pathology before they are manifest as dementia, and put a halt to the development of the disease.

As Hansen continues his ongoing research at BYU, the combination of his optimism and long-term commitment to AD research will not only give hope to his own family, it will also change the lives of millions of people. ■

1. "Alzheimer's and Dementia: Facts and Figures," Alzheimer's Association, 2020, https://www.alz.org/alzheimers-dementia/facts-figures.

2. Karpagam Srinivasan et al., "Alzheimer's Patient Microglia Exhibit Enhanced Aging and Unique Transcriptional Activation," *Cell Reports* 31, no. 3 (2020): 107843, https://doi.org/10.1016/j.celrep.2020.107843.

3. David V. Hansen, Jesse E. Hanson, and Morgan Sheng, "Microglia in Alzheimer's Disease," *Journal of Cell Biology* 217, no. 2 (2018): 459–472, https://doi.org/10.1083/jcb.201709069.

4. Nisha Rathore et al., "Paired Immunoglobulin-like Type 2 Receptor Alpha G78R Variant Alters Ligand Binding and Confers Protection to Alzheimer's Disease," *PLOS Genetics* 14, no. 11 (2018): 1–20, https://doi.org/10.1101/325936.

5. William J. Meilandt et al., "Trem2 Deletion Reduces Late-Stage Amyloid Plaque Accumulation, Elevates the Aβ42:Aβ40 Ratio, and Exacerbates Axonal Dystrophy and Dendritic Spine Loss in the PS2APP Alzheimer's Mouse Model," *Journal of Neuroscience* 40, no. 9 (2020): 26, https://doi.org/10.1523/JNEUROSCI.1871-19.2019.

EARLY ALERT

Connecting Students to Resources One by One

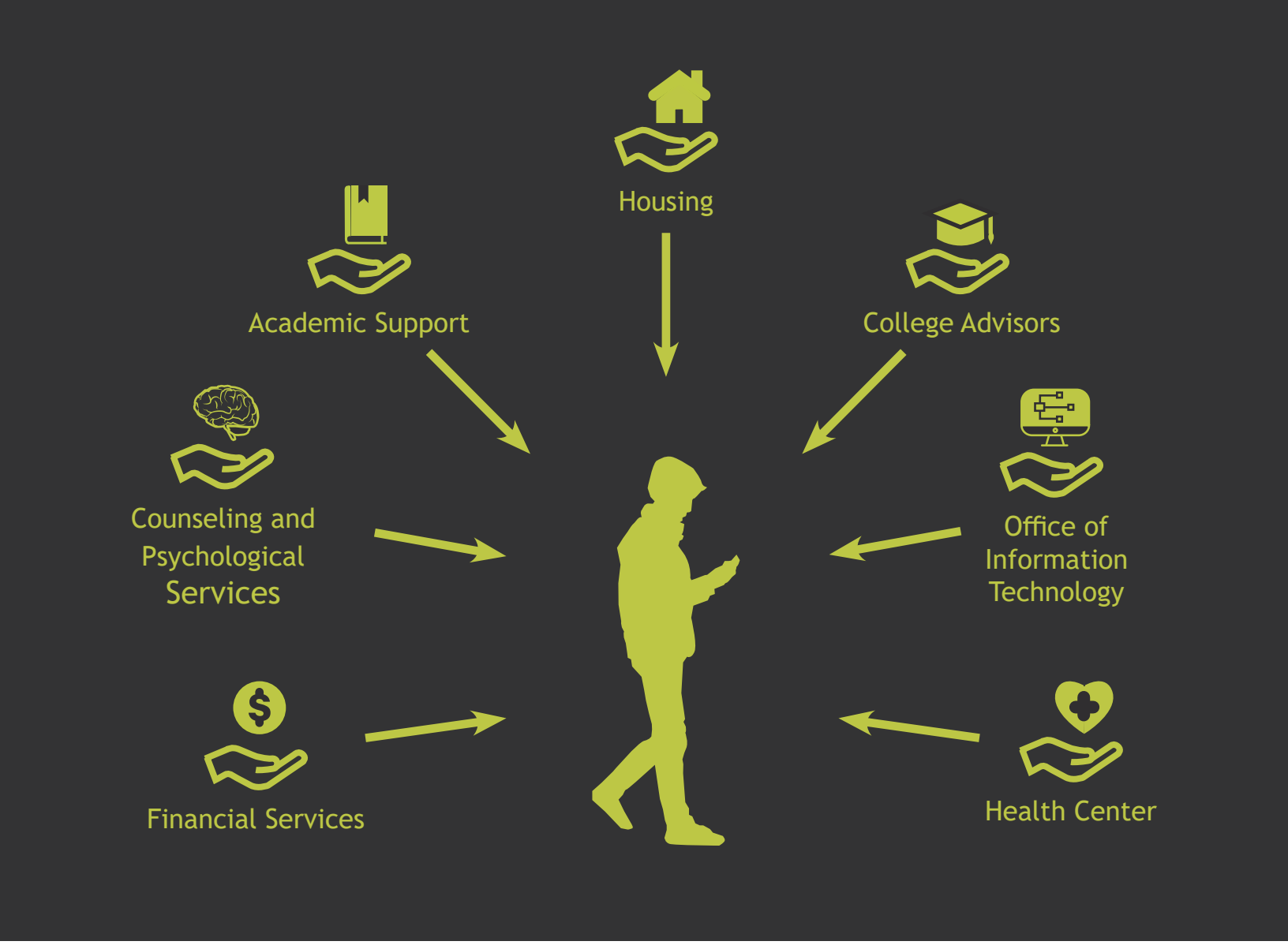
By Angela Cava

Eric Todd worked on Early Alert as an undergraduate in applied computational mathematics and is now working on MS in computer science at BYU. *Photo by BYU Photo/Tyler Richardson.*

With an enrollment of more than 34,000[1] students, it could be easy for any student to get lost in the crowd at Brigham Young University. Some students at BYU may feel overwhelmed by the large general education class sizes. Others could fall through the cracks simply because they don't know where to turn for help when they need it. Between managing rigorous classes, student jobs, and personal responsibilities, each student is dealing with all kinds of unique stressors. Struggling students may not know where to go for help, however. That's where the Early Alert program comes into play.

For instance, when the COVID-19 pandemic shut down campus in March 2020, BYU students faced many new challenges: some lost their student jobs, some lost long-awaited opportunities, and all had to adjust to independent learning outside the classroom. Understandably, a number of students struggled to keep up with coursework and other demands..

Early Alert helps students connect to campus resources that facilitate their academic, physical, and emotional success. Using predictive modeling, Early Alert identifies students who are at risk of earning a 2.0 GPA or lower by the end of the semester. The word "early" is intentionally in the name because the programmers behind Early Alert especially wanted struggling students to be given enough time to raise their grades before the end of the semester. According to Rachel Jenkins, a data scientist who works on Early Alert with the Academic Research and Reporting Team in Enrollment Services, the program's purpose is to identify students who need help before it's too late. "The earlier we can figure it out," Jenkins said," the easier helping them is."



Early Alert uses over 250 unique risk factors, and the algorithm changes throughout the semester. For example, the algorithm looks at different risks more closely than others depending on how far into the semester students are. "At the very beginning of the semester, we have no grades, we have no test scores, we have no attendance at labs...so those things don't matter nearly as much," Jenkins explained.

There are some students who may be at risk at the beginning of a semester, however. First-year or first-generation students, or students taking a combination of challenging courses, may face additional risks. Once the semester progresses past a certain point, the algorithm focuses in on grades, attendance, and other decision-based factors that can affect student success. After Early Alert identifies an at-risk student, the program generates a customized email to the student regarding his or her risk factors. For example, if Early Alert predicts a first-year student is more than 50% likely to earn lower than a 2.0 GPA for the semester, the student receives a message encouraging

"We're working to help students find the right resources."

BYU has over 31,000 undergraduate students. BYU students take on average two classes in our college each year resulting in over 60,000+ enrollments taught by our professors. *Photo by BYU Photo*

her or him to meet with a mentor. Similarly, a student in an especially difficult class may get a high-risk score from Early Alert and subsequently receive a message about academic resources for that specific class.

But the program is more than an algorithm that sends out emails. "There's an entire community that's been developed, and that community works together to help the students," said Jenkins. Members of the community include advisors who utilize Early Alert data to identify the students who need help so they can reach out and work directly with them. Other community members include staff in the First Year Experience office, the Academic Support Office, the Multicultural Office, and Enrollment Service Counselors. These four teams have supported the Early Alert program since its inception in 2018. The Early Alert community now includes personnel from most colleges' advisement centers and other student-serving offices across campus.

Early Alert is primarily "a way to connect [student] needs with the resources that are already there," Jenkins said. Choosing which resources to connect the students to depends on their individual circumstances. For instance, first-generation students may struggle financially if they don't know how to access financial aid resources. Advisors who work with Early Alert data can connect those students with the Financial Aid Office to find out what funding resources are available to them. For other students, difficult life circumstances may be the underlying cause of their academic struggle. Advisors can connect these students to Counseling and Psychological Services (CAPS) to get the support they need. And, sometimes, a student just needs to meet with an advisor and know that someone at BYU cares.

The biggest change Early Alert data has fostered is the added ability it gives to advisors and faculty to identify the students that may need their assistance before the student would normally ask for help. One example of Early Alert connecting a student to the right resources happened when one senior enrolled in an especially rigorous schedule. Before classes began,

"There's an entire community that's been developed, and that community works together to help the students."

Early Alert notified the advisor that the student's risk level was high. When the advisor met with the student, the student explained that he was taking a difficult course load so that he could graduate at the end of the semester. The advisor and student then discussed a plan that helped the student have a successful semester and graduate. After the meeting, the student expressed gratitude that someone at BYU was aware of his challenge and reached out to help.

While the program has certainly aided the students who have received help from Early Alert, it has also benefited the students who worked on the program. From the beginning, this project has been students working to make a difference in the lives of other students. David Reber, a recent master's degree student in mathematics, originally worked on the design and created the first team of students. Later the team included Eric Todd, a recent graduate of the applied and computational mathematics emphasis (ACME) undergraduate program. Todd was instrumental in fine-tuning the Early Alert algorithm when he interned for Enrollment Services. He learned that the practical applications of the academic principles he was learning in class can be used to help students stay on course as they progress toward graduation. "My internship was valuable to me because it allowed me to see that what I am learning in my classes is useful," Todd said. He has since completed other faculty-mentored research and is nearing completion of master's degree in computer science at BYU.

Early Alert is not be a magic wand, but it can help identify struggling students. The program has especially proven to be a valuable tool that can connect students to a myriad of individuals that are waiting and ready to help. "BYU truly cares about their students," Jenkins said. And Early Alert is just one more way "we're working to help students find the right resources." ■

1. "Facts & Figures," Brigham Young University, byu.edu, accessed May 4, 2022, https://www.byu.edu/facts-figures.

Faculty Highlight

Making the World Better for Women

PERPETUA LYNNE NIELSEN

By Kanae Lee

Dr. Perpetua Lynne Nielsen in the Department of Statistics recently co-authored T*he First Political Order: How Sex Shapes Governance and National Security Worldwide*. The book is the culmination of years of research into how governments around the world promote treatment of women and their correlating national success.

The book explores the outcomes of laws and systems rooted in unjust practices and suggests what the international community can do to promote fair treatment toward women. For example, governments can enact laws that improve the rights of women such as allowing women to inherit, sell, and buy land. They can also enact policies mandating equitable family laws and criminalizing normalized violence against women. Documenting their findings in minute detail, Nielsen and her colleagues present a sobering reality: nations that don't give women equal protection under the law are more unstable, insecure, corrupt, and prone to conflict. However, there is potential for national outcomes to improve when steps are taken by governments and individuals to reduce prejudiced laws and practices.

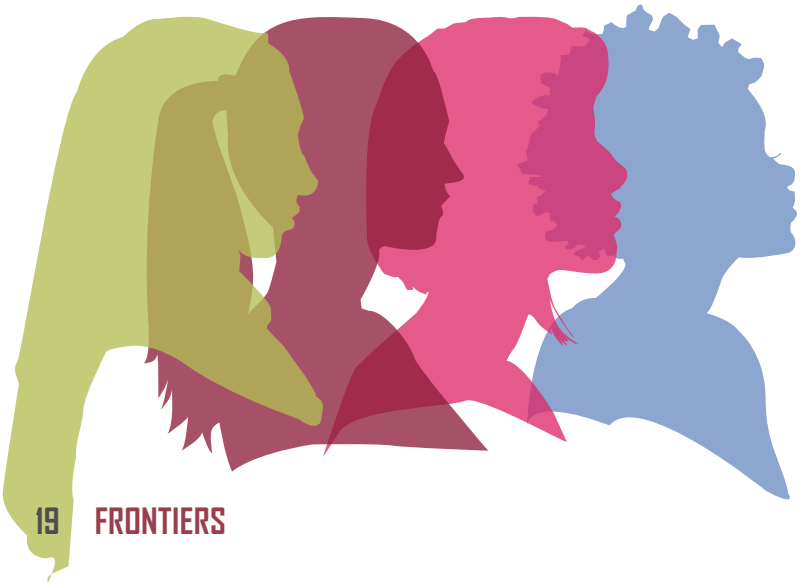
Nielsen and her co-authors, Valerie Hudson and Donna Lee Bowen, received a $1.2 million Minerva grant from the US Department of Defense in 2014 to gather the necessary data and conduct this research project.[1] They examined 176 nations around the world and found that in many countries, maltreatment toward women is systematic and persistent. Nielsen's research also shows how laws protecting women benefit all citizens including children and men. Not only has the book been praised in academic settings, it has also been highlighted in top news outlets.

In harmony with the gospel, Nielson believes that treating others with respect is a way to honor their eternal identity as children of God. Each member of the campus community—alumni, students, faculty, and staff—has an important role in showing respect to others through our actions. By doing so, we are doing our part to fulfill the BYU mission which states that "all relationships within the BYU community should reflect devout love of God and a loving, genuine concern for the welfare of our neighbor."

A convert to the Church from the Philippines, Nielsen said it was a dream come true to attend BYU and to now be a professor. Before joining the BYU faculty full-time, she taught part-time at a community college in Arizona while raising her family. Nielsen served as the course lead for several key courses including Statistics 121 which serves thousands of BYU students each semester.

"Statistics is a tool to find truth with a lowercase 't,'" she said. "Our students need statistical literacy so when they read anything in the media, they will be able to ask questions and figure out for themselves whether they believe the claim being made." She hopes her students can tell that she is a person who seeks truth in her life, not just academically and intellectually, but also spiritually. "I hope they know I'm trying to be Christlike, and that they feel the Spirit around me." ■

1. "The WomanStats Project," womanstats.org, accessed 15 April 2021, http://www.womanstats.org/aboutoverview.html.



Treating others with respect is a way to honor their eternal identity as children of God.

Faculty Highlight

SHARON CHRISTENSEN

Sharing the Knowledge of Her Labors

By Kanae Lee and Eden Garcia

Every year, twenty to thirty aspiring math educators from BYU spend a semester student teaching at one of five partnering school districts. Over the past thirty-three years, assistant teaching professor Sharon Christensen has been involved in this rite of passage for potential teachers. Before coming to BYU in 2017, Christensen worked in public education as a junior high school teacher in the Alpine School District where she often mentored student teachers. "I love teaching math," Christensen recounted, and her love for teaching hasn't diminished one bit over the years.

As coordinator of the Math Education Department's student teaching program, Christensen is in a unique position to cultivate a passion for teaching math in aspiring educators. She is currently involved in implementing an innovative model of student teaching developed by two of her colleagues, Dr. Keith Leatham and Dr. Blake Peterson. The model pairs each student teacher with another student teacher in the classroom, and assigns them to a mentor teacher as well as a faculty advisor. The crux of this revised model is that paired student teachers can share the load of lesson preparation. This strategy improves the quality of feedback student teachers receive, enables them to craft more developed math lessons, and gives them more time to reflect on their teaching effectiveness.

Christensen marvels at how the gospel provides singular circumstances to prepare BYU students to be teachers. "We think about Christ as the master teacher and use the strategies of His love and teachings to help our students grow and become better teachers," she said. "I hope my BYU students see that I have a testimony, that each of their ideas is important, and that they can...share the gospel through their actions as they teach."

As a consummate math educator, Christensen also advises math student teachers to develop their own conceptual understanding of math topics. She plays an instrumental role in assisting math education majors to create lesson plans that help their students learn how to discuss mathematics. She firmly believes that creating an environment where students naturally want to talk about mathematics helps them to become better learners. Christensen has consistently found that the more teachers experience math, the better they will understand how their students are processing math concepts.

For Christensen, the knowledge we are all children of our Heavenly Father with divine potential aids teaching, even in subjects like mathematics. "I hope our BYU students take into their own classrooms the belief that everyone can learn and do mathematics and that every child is important. I especially hope they learn strategies here that help them share that knowledge with their students." ■

STEWARDS OF THE EARTH

New Environmental Geology Major

By Allison McArthur

In Fall 2020, the College of Physical and Mathematical Sciences added environmental geology as a new major to the Department of Geological Sciences. Not only does this major prepare students for a career in environmental geology, it also enables students to step into their gospel role as stewards of earth. Environmental geology students will have the opportunity to focus on the preservation of the Earth's natural resources.

Environmental scientists seek to protect the environment and human health by tackling pertinent issues like pollution and climate change.[1] Under the umbrella of environmental science, environmental geology applies principles of geology to solving environmental problems.

The creation of the environmental geology major comes as a direct response to the emerging field of environmental science and the rising interest of BYU

students. "One of the great things about this program is that environmental geology is growing [and] it will continue to grow. There is a large demand for it across all different aspects of society," said assistant professor Dr. Joshua LeMonte.

LeMonte's goal is to work locally and nationally to create new research opportunities for students that enable them to "focus on today's problems." He recognizes that environmental geology is all about finding solutions to important global issues. "We are at that nexus point where the earth and its materials can impact humans and where humans can impact the earth and its material," LeMonte observed.

This new major gives students the flexibility to focus on an environmental geology area of their choice with designed electives that allow students to achieve specialized training at the bachelor's level. For example, students can enroll in courses in hydrogeology, contaminant hydrogeology, and geochemistry to specialize in water resources.

The environmental geology program also offers students the opportunity to complete important certifications for the field of environmental geology. For example, students in the major will become certified to work in hazardous environments, one of the Occupational Safety and Health Administration (OSHA) requirements to work in the consulting industry. The major also prepares students to take the Fundamentals of Geology Examination, which is offered by the National Association of State Boards of Geology (ASBOG). A passing score is one of the requirements to become a licensed professional geologist.

Professor Dr. Stephen Nelson said students who have these certifications will be equipped with the qualifications to be successful in their careers. Nelson also explained that requiring students to register and complete these certifications shows future employers that the students have accomplished necessary steps toward professional registration.

"We wanted to have a program that would give the students the necessary skills and qualifications that would make them competitive in the environmental geology careers," said hydrogeology and environmental geology professor Dr. Greg Carling. As a result, students in the environmental geology major will be prepared to work in consultation firms, research labs, or government geological agencies.

LeMonte explained how there are a lot of options available to students regarding careers and research. All of these options will help educate others outside of the field who may not understand what environmental geologists do. Increasing awareness and understanding of the environment will also enable students to gain a new perspective of the world around them.

"We are taught at the university, we are taught at church, and [we are taught] in the gospel that we are stewards of earthly blessings," Nelson said. "I really think this is an opportunity for those who choose to follow this major to become stewards." Whether students' career goals lead them to work in government, research, or consultation, majoring in environmental geology will help them find meaning and purpose in their stewardship as they learn how to take care of Mother Earth. ■

1. "Finding a Job: 20 Jobs You Can Pursue with an Environmental Science Degree," Indeed Career Guide, indeed.com, December 16, 2021, https://www.indeed.com/career-advice/finding-a-job/environmental-science-degree-jobs.

Photos by BYU Photo/ Matthew Norton

These photos are from a BYU Geological Sciences student visit to Topaz Mountain in March 2022. Students applied the skills learned in their minerolgy and field work classes.

BYU College of Physical & Mathematical Sciences

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"It's quite realistic that within a decade or two we'll have some very effective drugs for Alzheimer's disease."

—David V. Hansen