BYU COLLEGE OF PHYSICAL & MATHEMATICAL SCIENCES · SPRING 2016

FRONTIERS

The Art of Mathematics
p.12

FRONTIERS MAGAZINE

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BYU's Department of Physics and Astronomy created Astrofest to celebrate the International Year of Astronomy in 2009. As an annual event for the whole family, Astrofest welcomes the community to BYU's campus for learning activities and adventures in astronomy. Guests have the opportunity to watch Sounds to Astound demonstrations, build and launch cardboard rockets, and visit the Royden G. Derrick Planetarium for stargazing shows.

PHOTOS: cover courtesy of Pixabay; right, Josh Siebert

Photo courtesy of BYU Photo

I hope you take the opportunity to look back, appreciate your accomplishments, and assist those who come after you. We have already done so much—we hope we continue to do so much more.

Welcome to our latest edition of Frontiers magazine. With this new year I have had the opportunity to reflect on our growth as a college. When I was appointed dean in 2007 we had 1,670 majors. Now we have 2,554 majors, a 53 percent increase over the course of 9 years.

Esteemed author C.S. Lewis said, "Isn't it funny how day by day nothing changes, but when you look back, everything is different." Each day at BYU we are striving to become better and wiser. Each of us is learning, from the freshmen taking their first classes on campus to the "experienced students"—the faculty, staff, and administrators—returning year after year. We are all given this remarkable opportunity to become improved versions of ourselves.

Our alumni are fantastic examples of daily improvement. Years after their first semester on campus, they have gone on to accomplish magnificent things. Sebastian Acosta (p. 6) is putting his mathematical degrees to work in the Department of Pediatrics-Cardiology at the Baylor College of Medicine and Texas Children's Hospital. Ben Pratt-Ferguson (p. 7) has gone from being a physics graduate to building the structures that perform evaluations on state-of-the-art equipment for the military. Randall Barnes (p. 24) has taken his chemistry degree and gone on to publish extensive research on *in vitro* fertilization and reproductive medicine. We as a college are in awe of their achievements and glad that we were able to help them grow while they were students on our campus.

Mark Brown (p. 8), who earned his degree in actuarial science, is now the CFO and Vice President of Select Health. He is also serving as a member of BYU's Actuarial Advisory Board—he has been a vital piece that has helped connect countless skilled students to jobs and internships across the country. Mark's desire to give back to the college has been invaluable, and we are so grateful for his service. Success for our students is in part made possible through the support they receive from our wise alumni and from endowment funds. See how our fund is growing on p. 9.

We are also blessed to have incredible role models on our campus. For example, Greg Carling (p. 18) was recently awarded a large grant to research factors that may be polluting Utah's water sources. Steve Jones (p. 16) is developing a unique teaching method to help science and engineering students better apply mathematical concepts. Pace Nielsen (p. 12) is researching prime numbers and the patterns found within them. We are grateful to have such hardworking and progressive faculty and staff at the college.

Our own students are already making important contributions to the world around them. Chris Fortuna (p. 11) is working on gesture recognition technology to help fight obesity and encourage a healthier lifestyle. Andrew White (p. 11) is studying the structure of biological systems and how to better reverse-engineer them. Andrew Wallace (p. 32) has been working with NASA to better determine airplane takeoff and landing times, a study which could decrease flight delays and lessen the congestion in airports.

Even our campus buildings can show us how far we've come. Last October we were able to celebrate the 20th anniversary of the Benson Building, housing the Department of Chemistry & Biochemistry (p. 22). Earl Woolley, who was the department chair when the Benson Building was completed, reminisced about how things have changed since that time. We have accomplished so much in 20 years, and we will strive to keep up the momentum for the next 20 years.

I hope you take the opportunity to look back, appreciate your accomplishments, and assist those who come after you. We have already done so much—we hope we continue to do so much more.

Wishing you all the best,

Scott Sommerfeldt

TABLE OF CONTENTS

DEPARTMENTS

FEATURES

CURRENT HAPPENINGS

CHEMISTRY & BIOCHEMISTRY

1961 | **Jack R. Livingston** (BS Chemical Engineering '61, Brigham Young University) has retired from the Los Angeles County Sanitation Districts, but he was recently called out of retirement to consult for the waste-water treatment facilities in Orange Country, California.

2006 | **Paul Jones** (BS Biochemistry '06, Brigham Young University; BS Mathematics '08, Brigham Young University–Idaho) is a graduate student at Arizona State University where he is conducting research on bacteria's resistance to the antibiotic Gentamicin. He is the leading author on the article "Biophysical separation of *Staphylococcus epidermidis* strains based on antibiotic resistance," which was published in the Royal Society of Chemistry's peer-reviewed journal *Analyst*.

COMPUTER SCIENCE

2005 | **Dan Olsen III** (BS Computer Science '05, MS Computer Science '06, Brigham Young University) is the founder and owner of Straight Bit Interactive. He and his team of 20 are software engineers for up to four clients at a time. His past employment includes working as an IT analyst for the State of Utah, the engineering services consultant team lead for Adobe, and a software engineer at Leading2Lean LLC. He and his wife, Emily, have five children.

2014 | **A. J. Creek** (BS Animation '14, Brigham Young University) is working as a 3D Depth Artist for Stereo D, LLC. He is responsible for creating and sculpting depth maps in order to convert 2D film images into 3D stereoscopic files, using Nuke and other proprietary software tools. Creek is also taking online courses in the 3D Character Program from AnimSchool, and he has a desire to start his own company. While studying at BYU he worked on Estefan (1st Place Winner of 2013 College Television Award and 2013 Siggraph Best Student Project), Boss Arena (2014 video game project where he was Team Lead), and OWNED (1st Place Winner of 2014 Student Academy Award and 1st Place Winner of 2014 College Television Award).

GEOLOGICAL SCIENCES

1981 | **Gary Chapman** (BS Geology '81, Brigham Young University) was hired after graduation by Texaco's Near East/Far East division as a geophysicist. Gary continued working for the same company (now Chevron), and he only recently retired in 2015. Gary has evaluated geophysical projects in several countries and has also taken assignments analyzing exploration risk and international economics.

2006 | **Teresa Pett** (MS Geology '06, Brigham Young University) is a volunteer for a worldwide humanitarian effort. She maps geographical regions that experience natural disasters and epidemics. Pett's contributions will help identify people who live in dangerous locations in order to improve rescue efforts.

MATHEMATICS

1962 | **Ronald Rex** (BS Mathematics '62, Brigham Young University; MS Applied Statistics '72, Utah State University) worked for four years at the US Census Bureau in Washington, DC, as a mathematical statistician, evaluating the accuracy of the 1960 Decennial Census. He then worked for 33 years for the United States Air Force at Hill Air Force Base near Ogden, Utah. He performed reliability analyses on the Minuteman Missile and other major components, and he used the results to predict future failure rates and spare parts requirements. Rex taught evening classes in statistics and quality for the BYU Ogden Center, the University of Phoenix campuses in Salt Lake City and Ogden, Weber State University, and Utah State University–Brigham City campus. Rex retired in 1999, served an LDS mission in Houston, Texas, and recently returned with his wife, Sharon, from an LDS mission in the Boston area. He and his wife have 12 children (most are BYU alumni) and 52 grandchildren.

2009 | **Sebastian Acosta** (BS Mechanical Engineering '09, MS Mathematics '11, Brigham Young University; PhD Computational and Applied Math '14, Rice University) is at the Baylor College of Medicine and Texas Children's Hospital. He works as a postdoctoral research assistant in the Department of Pediatrics-Cardiology. Acosta's research includes mathematical medicine, statistical prediction of patient deterioration, and computational simulation of cardiovascular dynamics and imaging.

MATHEMATICS EDUCATION

2006 | **Christine Johnson McKnight** (BS Mathematics Education '06, MA Mathematics Education '08, Brigham Young University) interned at Midvale Middle School from 2005 to 2006 before returning to BYU for graduate school. She then taught at Sunset Ridge Middle School in West Jordan, Utah, for four years. Christine has also taught adjunct courses at Utah Valley University and Salt Lake Community College. She now stays at home to raise her two daughters.

2013 | **Erica Bradshaw Perich** (BS Mathematics Education '13, Brigham Young University), taught high school in Arizona, then returned to her home state of Texas to teach seventh-grade math in Dallas. She met and married her husband, an Air Force pilot, while in Texas. The two now live in New Mexico, where she is teaching at the local high school. At only 23 years old, Erica has taught school in four different states. She hopes to eventually return to BYU to attend graduate school.

PHYSICS AND ASTRONOMY

1972 | **Gary Stradling** (BS Physics '72, MS Physics '74, Brigham Young University; PhD Applied Science '82, University of California, Davis) is the Chief of the Treaty and Verification Technology Office in the Defense Threat Reduction Agency (DTRA). The Agency focuses on compliance with international agreements, specifically in arms control. Before working at DTRA, he worked for 31 years as the Program Manager at Los Alamos National Lab, where he dealt with intelligence systems and surveillance.

1992 | **Ben Pratt-Ferguson** (BS Physics '92, Brigham Young University; MS Physics '97, Vanderbilt University) has been working for 16 years at Raytheon Company, which specializes in defense, civil government, and cybersecurity markets around the world. Pratt-Ferguson helps provide state-of-the-art electronics, mission systems integration, and other sensing capabilities for US and allied troops. He is responsible for building the structures necessary for testing and doing performance evaluations on the technology created there.

STATISTICS

1971 | **Robert M. Egan** (BS Statistics '71, MS Statistics '73, Brigham Young University) entered a career in marketing and management with IBM in 1973. He retired from IBM after 30 years of service. He then taught mathematics and statistics at LDS Business College and was chair of the Department of Mathematics there for two years, while at the same time serving as Director of Institutional Research. Egan was the LDS mission president of the South Africa, Cape Town mission from 2005 to 2008 and is currently serving a second mission in South Africa as the In-Field Representative for the continent of Africa, assisting 30 mission presidents and over 4,000 missionaries.

2005 | **Aaron Henrichsen** (BS Statistics '05, Brigham Young University; MS Statistics '12, Arizona State University) served in the US Navy for seven years as an officer on submarines, attaining the rank of Lieutenant (O-3) and receiving various awards. From 2010 to 2012 he was a Naval ROTC Instructor at Arizona State University. Since 2012 Henrichsen has completed all the coursework necessary for a PhD in Business Administration at Penn State University, and he anticipates completing his dissertation and becoming a professor of finance in the summer of 2017. Henrichsen is married to Christine Baker Henrichsen (BS Microbiology '04, MS Biochemistry '06, Brigham Young University) and they have four children.

MEMORY BYTES

Have a Memory Byte to Share?

Who was your favorite professor? What was it that he or she did that made the class special? Send your responses to cpms@byu.edu with "Memory Bytes" in the subject line. Submissions may be edited for length, grammar, appropriateness, and clarity.

This is what previous students are saying about chemistry professor Steven Wood:
Responses taken from www.ratemyprofessors.com

"You will not find a man more converted to his subject."

"Dr. Wood is a phenomenal professor. Although his class is challenging (daily homework and readings combined with 5 free-response midterms) he really cares about the success of his students. He will modify any lecture to meet the needs of his students and usually incorporates an explosion into the lesson plan. I would definitely take from him again."

"By far my favorite class I've ever taken at BYU. Dr. Wood cares about his students more than life itself."

"Dr. Wood is awesome! I took this class my first semester of college and it's definitely a difficult class but not as scary as I expected. Dr. Wood is very kind and his lectures are hilarious. He makes chemistry exciting and fun. I would love to take another class from him and I would recommend him to anyone."

"Chem 105 is normally a killer, weed-out class, but with Dr. Wood, it was an amazing experience. Both the hardest and best class I took this semester! You need to really work in this class, Dr. Wood expects you to understand the concepts in depth, but he wants to help you learn. His lectures are engaging, enlightening, and helpful."

"I would take this again in a heartbeat. Dr. Wood gives you work sheets each class. If you know these worksheets you will ACE the tests."

"Dr. Wood is an amazing professor! My favorite ever. His lectures are really interesting and really informative. He blows something up pretty much every class. His magic show was cool. It's kind of a tough class, but it's totally worth it. He is an amazing guy, and I looked forward to his classes."

BUILDING BYU'S RÉSUMÉ

Text by Jeremy Stanford
Photo courtesy of Mark Brown

You can take Mark Brown out of BYU, but you can't take BYU out of Brown.

BYU alumnus Mark Brown graduated from BYU in 1989 with a bachelor's degree in actuarial science. He currently works as the CFO and Vice President of Select Health, an insurance provider operating in both Utah and Idaho.

Despite his busy profession and family life, Brown takes time to give back to his alma mater. He currently serves as a member of the Actuarial Advisory Board and has been a crucial link between several BYU students and the professional world.

"BYU has the most comprehensive program for actuarial students here in the state," Brown said. "As we look to hire actuarial talent, we find that BYU has a broad and talented pool [of candidates]."

Brown has also been instrumental in helping students in the Department of Statistics find internships. In recent years, these internships have been tailored to accommodate the busy life of an undergraduate.

"A couple of years ago, we were able to start a different type of internship program, an ongoing internship program," Brown said. "With improvements in technology and data security, we've been able to allow a more flexible work schedule and enable the student interns to work from home as well as in the office. As a result, they can manage their work assignments within their class schedules, get paid a decent wage as a student, and participate in a meaningful internship as they build their resume. It's been a great win-win situation for us and the students."

Brown was a student when he first heard Dennis Tolley, now department chair, talk about creating the advisory board that Brown now serves on. Today it consists of professionals in various fields associated with actuarial science and statistics, all of whom are former BYU students. Its main purpose is to provide feedback and generate ideas necessary to keep improving the program. Brown considers serving on the board to be a privilege.

Along with his position on the advisory board, Brown has had the opportunity to speak to students in the statistics department and the actuarial club. Brown said he is always happy to speak to BYU undergraduates, answer questions, and provide advice.

"Enjoy your experience while you're here," Brown said of BYU. "Ask lots of questions and learn as much as you can."

It's clear to see that Brown is proud of his academic heritage. He met his wife at BYU, and they now have five children, two of which are well on their way to becoming BYU alumni.

"We've always been big BYU fans," said Brown. "My wife and I both came here and had an awesome experience. Not only do you get a top notch education in your chosen field, but you have the opportunity to grow spiritually and maintain a focus on what's most important in life. For me personally, BYU has always been a special place."

Not only do you get a top-notch education in your chosen field, but you...maintain a focus on what's most important in life.

CURRENT HAPPENINGS

NEW ALUMNI NEWSLETTER

The monthly Alumni Newsletter has been updated and given a face-lift. The newsletter now features one department story per month, one alumnus feature article, and three additional articles of the interesting goings-on in the college. If you haven't seen the new-and-improved newsletter, send an email to cpms@byu.edu to subscribe and stay *CONNECTED*.

BYU | The College of Physical and Mathematical Sciences

CONNECTED

The CPMS Alumni Newsletter

FORMER DEAN WINS GRAMMY

The Recording Academy recently awarded a posthumous Technical Grammy to Dr. Harvey Fletcher, BYU's first physics graduate and former dean of the College of Physical and Engineering Sciences. Fletcher was nominated for the award because of his work with Leopold Stokowski and the Philadelphia Orchestra. This partnership produced over 100 of the world's first stereophonic recordings, or recordings using multiple independent audio channels. His work with the Philadelphia Orchestra would later become the foundation for electronic sound recording. Today, Fletcher is known as the father of stereophonic sound.

STILL GROWING

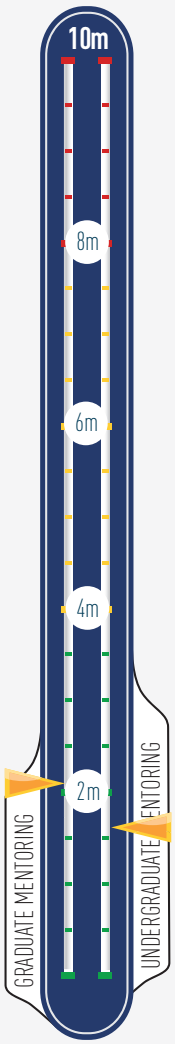
Our college continues to use donated endowment funds to support undergraduate and graduate research and to keep our programs competitive. Your donations help us to further the high-quality research taking place at BYU, and to continue providing vital research experience to our outstanding students.

The endowment funds we receive are sent directly to hardworking students, like theoretical chemistry graduate student Doo-Hyun Kwon. Kwon models reactions using computer simulations in the theoretical chemistry lab. The calculations are run on the supercomputing nodes in the Fulton Supercomputing Lab at BYU.

Kwon participates in other research projects, as well, including a collaboration with Chevron Phillips Chemical. He is investigating new methods to enhance their current technology, and Kwon and his fellow researchers recently published a paper on the low-coordinate platinum work they are doing. Kwon is also working on mechanical reactions and transition-metal catalysis and catalyst design.

"[We are] understanding how reactions work by elucidating the mechanistic details," Kwon said. "This allows us to either control or optimize a certain reaction in a way we want it to."

"I'm really grateful for the fellowship to help in our research to contribute our discoveries to society," he said.



HELP FUND THE FUTURE

There are many students like Kwon who could benefit greatly from your contributions. If you would like to donate or if you know someone who would, please visit http://giving.byu.edu/cpms15, or contact Brent Hall by phone at (801) 422-4501 or by email at brenth@byu.edu.

CHEMISTRY & BIOCHEMISTRY

RETIREMENT—Milton Lee, H. Tracy Hall Professor of Chemistry, has retired after 39 years of teaching and research at BYU. Lee is best known for his research in capillary separations and mass spectrometry detection. He has helped author over 550 scientific publications and is listed as a co-inventor on at least 20 issued patents. He co-founded Lee Scientific, Sensar Corporation, and Torion Technologies.

AWARD—Adam Woolley received the American Electrophoresis Society Mid-Career Award at the SciX Conference, which took place in Providence, Rhode Island. The award honors those who have made exceptional contributions to the field of electrophoresis during their career. He was also invited to speak at the conference about his current research. Woolley is the author or co-author on over 100 publications, he has given over 130 presentations on his work, and he currently has received 10 patents.

COMPUTER SCIENCE

AWARD—Thomas Sederberg earned the distinction of being a "Highly Cited Researcher," ranking him among the top one percent most cited of all publishing scholars in his field. Sederberg has been the author or co-author of 150 publications (listed on Google Scholar), and his papers have been cited more than 1,800 times on the Web of Science database and more than 10,700 times on the Google Scholar search engine.

GEOLOGICAL SCIENCES

RESEARCH—Brooks Britt presented a new pterosaur at the 75th annual Society of Vertebrate Paleontology conference in Dallas, Texas. The research was titled, "A New, Large, Non-Pterodactyloid Pterosaur from a Late Triassic Interdunal Desert Environment within the Eolian Nugget Sandstone of Northeastern Utah, USA Indicates Early Pterosaurs Were Ecologically Diverse and Geographically Widespread." This new dinosaur appears to have been the largest flying reptile of all time.

MATHEMATICS

RETIREMENT—William Smith has retired after 30 years at BYU. Smith taught classes both in the classroom and online—including a calculus class written by himself. He is the author or co-author on over 25 publications. Smith's specialties include the equations of classical physics and problems in the application of mathematics to biology.

RETIREMENT—David Wright has retired after 27 years at BYU. Over the course of his career Wright has assisted in the publication of over 40 works, including scholarly articles, textbooks, and conference proceedings; and he has spoken at over 50 colloquia, conferences, and workshops. Wright has also been an honorary fellow at the University of Wisconsin, a visiting associate professor at the University of Tennessee, and a visiting scholar at the University of Utah.

AWARD— Tyler Jarvis, professor and former department chair in the BYU Department of Mathematics, recently received the Deborah and Franklin Tepper Haimo Award presented by the Mathematical Association of America. The award honors university professors whose influence and success are recognized beyond their own institutions.

MATHEMATICS EDUCATION

RESEARCH—Dawn Teuscher recently published a research paper about the new content covered in grades six, seven, and eight due to the effects of Common Core. Specifically, Teuscher addresses the geometry content that has been added to the curriculum. The paper acts as a guide for teachers who are new to teaching this new geometry content.

PHYSICS AND ASTRONOMY

RETIREMENT—Clark Christensen has retired after 43 years of teaching astronomy on the undergraduate and graduate levels. He has taught 14 different classes over the course of his career at BYU.

AWARD—Jean-François Van Huele has been accepted as an Academy Fellow in the Utah Academy of Sciences, Arts & Letters. This award is given to a member of the academy who has made significant contributions to the state of Utah and the academy. Van Huele has authored or co-authored over 60 publications.

RESEARCH—Timothy Leishman is researching how teaching can cause problems with the vocal cords and how classroom acoustics standards may help reduce the strain. His research was published in Architectural Acoustics, titled "Classroom acoustics for vocal health of elementary school teachers."

STATISTICS

RETIREMENT—Bruce Schaalje has retired after 23 years at BYU, where he taught a wide variety of courses. He has also authored or co-authored 194 publications, and his work has been cited over 3,300 times on the Google Scholar search engine. Schaalje's areas of interest include mixed linear models, small sample inference, design of experiments, and authorship attribution.

OUTSIDE OF THE CLASSROOM

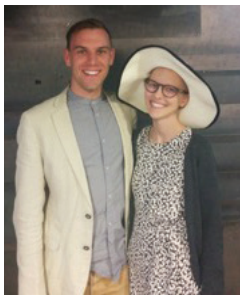


Photo courtesy of Derek Miller

Mathematics

Derek Miller is the recipient of the Marc and Shirley Burton scholarship, a full-tuition scholarship for the 2015–16 academic year. The scholarship is a tribute to the late Shirley Burton and is available to mathematics students who exemplify outstanding scholarship. Miller is working hard in his studies and recently presented his research at the Mathematical Association of America's Mathfest 2015, taking place in Washington, D.C., on August 5–8. His presentation was titled "#Math vs. The Tonight Show."

Miller and his wife, the former Sarah Kay Brimhall, recently spent a summer in New York City. While his wife completed an internship, Miller started a private math tutoring business.

Miller is hoping either to enter the field of entrepreneurs soon after graduating, or to continue his education and receive a PhD in Mathematics, Statistics, or Economics. He aspires to be a data scientist or data analyst working in the field of information economics.

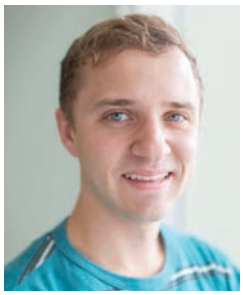


Photo by Rob Johnson

Computer Science

Chris Fortuna has been working with computer science professor Christophe Giraud-Carrier on hand-to-mouth gesture recognition technology. They're creating an application with health science professor Joshua West that measures how many bites a person takes and, consequently, how much food he or she eats. Users will be able to wear a sensor on their wrists and set goals for how many bites they will take each day, fighting obesity and encouraging overall health.

Fortuna and a few peers have developed the technology into a startup company, SmartBites. In June 2015, Fortuna was one of two students from BYU to participate in the Geekdom 3-Day Startup competition in Austin, Texas, where both students received guidance and the opportunity to demonstrate their practical research and ideas. Fortuna built a demo of SmartBites running off an Android watch, which performs with 97 percent accuracy. Fortuna will graduate in April 2016, and he hopes to work full time with SmartBites after he receives his degree.

Chemistry & Biochemistry

Rebecca Plimpton was recently awarded a PhD and is working as a post-doc in the Department of Chemistry and Biochemistry. She recently published a significant paper in the Proceedings of the National Academy of Sciences, presenting her research on how the assembly of G proteins could help treat heart disease and some forms of cancer.

Geological Sciences

Keryn Ross is a master's student and mother of five. She graduated with a BS in geology in 1999 and is now returning to finish her thesis. Ross is researching the Cottonwood Wash Tuff, which was erupted from a super volcano located on the border between Utah and Nevada. She is now completing her thesis under the supervision of professor Eric Christiansen.

Mathematics Education

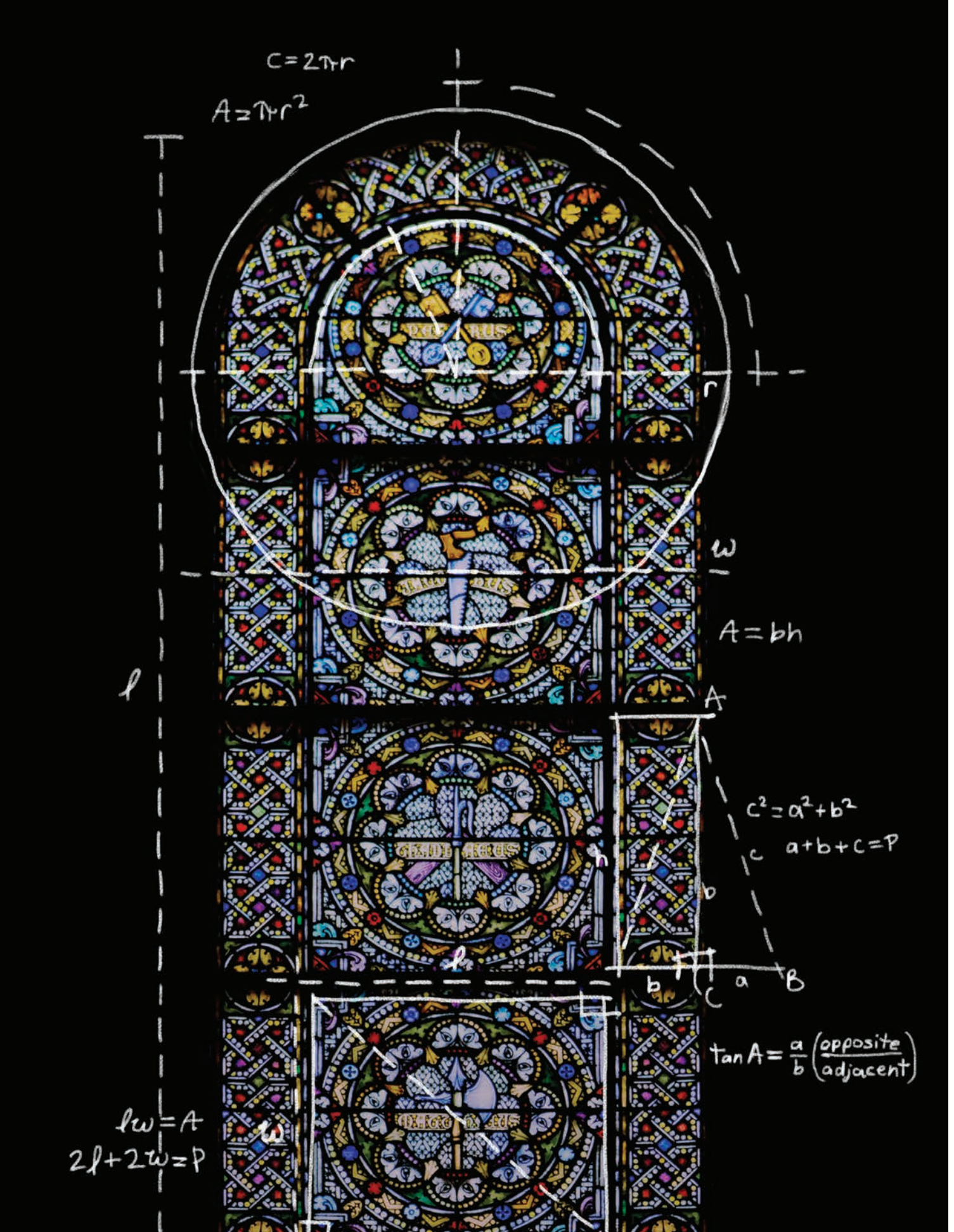
Kylie Palsky presented at the Association of Mathematics Teacher Educators conference in Irvine, California, in January, 2016. Her presentation was titled, "Learning to Teach Through Video Analysis: Preservice Teachers Learning and Engaging in Participation Questions Discourse." She presented with BYU professor Dawn Teuscher and TCU professor Matt Switzer.

Physics & Astronomy

Andrew White is researching the structures of biochemical systems and physics modeling techniques with Mark Transtrum. White has presented at several research conferences, including two 4 Corners Section conferences, the college Student Research Conference, and the q-bio Conference. He has received awards for outstanding presentations.

Statistics

Zach Knowlton is conducting research on college football and working to predict players' and teams' performance levels. His calculations include determining the expected points based on down, distance, and field position. Knowlton finished first in the undergraduate research competition at the 2016 Joint Statistical Meetings in Seattle, Washington.


C=2πr
A=πr²
r
w
A=bh
l
A
c²=a²+b²
a+b+C=P
c
h
b
l
b
C
a
B
tan A = a/b (opposite/adjacent)
lw=A
2l+2w=P
w

the ART *of* MATHEMATICS

text by Camilla Stimpson
photos by Rob Johnson
illustrations by Sarah Thulin

Though most people see art and math as two unrelated subjects, mathematics professor Pace Nielsen has learned that these two topics are more related than we realize.

Solving mathematical problems has been a passion for Nielsen since a young age. Nielsen recalled a time in the first grade when he and his fellow classmates were being rowdy and disruptive during choir class, and their choir director gave a specific warning:

"The teacher said to us, 'Would you rather be singing or doing mathematics?' I didn't realize it was a threat. I saw it as a choice. I said, 'Math!' and I raised my hand. She got really mad, gave me a giant stack of papers, and sent me out to do mathematics," Nielsen said. "Only after I had done them and all the other kids got to go to recess did I realize I was being punished."

His love for mathematics did not end with elementary school, but continued throughout high school. With the help of his teachers, Nielsen learned just how many levels there are to math.

"I had a great teacher who encouraged me and showed me another level of beauty in mathematics," Nielsen said. "It can be an act of beauty, just like painting."

Today, Nielsen still applies and sees the art of mathematics. Nielsen views it as much more than numbers and concepts—he sees the intricacy of it all.

"The way I look at mathematics in my mind is like things fitting together," Nielsen said. "It's like a well-running machine. When you have another piece come in and fit into this machine that you've already built, and you can now make [the machine] do something new, that can be exciting and fun."

Although there are many aspects of mathematics, Nielsen's area of interest is number theory—the study of whole numbers. With these numerals, Nielsen studies prime numbers and the patterns within them, the distance between each prime, and other properties the figures hold.

"Number theory has many applications in cryptography, in codes, and trying to keep things secure — like bank security and online security," Nielsen said. "They run on encryption algorithms, and these things are developed by number theorists and other mathematicians."

Nielsen has been fascinated with number theory since he was a new student at BYU. The problem he is most interested in solving is the "Odd Perfect Number," a theory which has been open and unsolvable for thousands of years. The idea is to discover a situation in which all the proper divisors of an odd number add up to the number's value.

"I love truth. I really enjoy that act of discovery, understanding, and knowledge that comes from finally being able to prove this is the truth."

"On the purely math side of things, it's just beautiful. It's an art form, if you will," Nielsen said. "Not only is it beautiful, it is enlightening. It tells you something about how the universe works." In his latest work, Nielsen collaborated online with many people who held a wide range of mathematical understanding.

"Working online was very difficult, but it was also very rewarding to be able to work with these really good mathematicians," Nielsen said. "One of the challenges was being able to communicate openly and let the world see all of the mistakes you make."

These people worked together on what is called the "Polymath 8 Project." This project focused on discovering prime numbers that are just two apart from each other, particularly as the numbers go into infinity.

"In math research, you are constantly making guesses, trying things that won't work, and [fixing things] that are wrong for silly reasons. You just have to discover [these] as you work on the mathematics," Nielsen said. "Sometimes you feel like you're working in this area where maybe only five people understand what you're doing. But it's still rewarding to be able to understand these things."

Throughout his time researching, Nielsen has been led to discoveries that may have seemed impossible to complete when he first started studying them. In one instance, Nielsen finally had an epiphany while jogging in the rain on how to solve a mathematical problem he had been working on for many years.

"It was like a lightning strike, how to solve this problem that I had been working on for years. It was this glorious moment," Nielsen said. "I had to get home before some accident befell me because I needed to write it down. It was so many years in the coming, and I had to finish, write it down, and explain it to other people."

Nielsen acknowledges that big, profound discoveries are few and far between and they require countless hours of work; but when they come, they are accompanied with a special thrill. Nielsen also finds joy in sharing his findings with others.

"I enjoy the act of discovery: Finding truth, finding light, then sharing it with others," Nielsen said. "In turn sometimes they share back new things and we have this collaboration. I enjoy being able to express something new and something that makes mathematics go forward."

It is the excitement of uncovering mathematical mysteries that interests Nielsen in the subject. This enjoyment keeps him motivated through the difficulties that come with teaching and research.

"I love truth. That's essentially why I went into mathematics," Nielsen said. "I really enjoy that act of discovery, understanding, and knowledge that comes from finally being able to prove this is the truth."

What Makes a Perfect Number?

6 is a perfect number:

1 x 6 = 6
2 x 3 = 6

Divisors of 6 = 1, 2, 3

1 + 2 + 3 = 6

28 is a perfect number:

1 x 28 = 28
2 x 14 = 28
4 x 7 = 28

Divisors of 28 = 1, 2, 4, 7, 14

1 + 2 + 4 + 7 + 14 = 28

ENGINEERED MATH

The Nuts and Bolts of Teaching Mathematics

Text by Jennifer Johnson
Photo by Rob Johnson

Steven Jones is a mathematics education professor who loves to teach calculus. Most of his students in these classes are not mathematics or mathematics education majors — instead, his students are studying engineering, physics, computer science, biology, and other fields. Jones helps them to apply their math skills in scientific and engineering situations.

Having always planned to be a pure mathematics professor, Jones earned both his bachelor's and master's degrees in mathematics from BYU. He taught classes as a master's student, and he noticed that students could sometimes solve pure math problems without fully understanding the underlying concepts.

> "We owe it to our students to help them learn in a way that's going to help them in their fields of study."

"I got more interested in how we can teach things so that students are making better sense of them," he said. "How do people think, how do they reason, and how do they learn?"

When Jones went to the University of Maryland for his doctoral degree, he officially switched his studies to mathematics education.

He taught at Sierra College in California for a few years before coming back to BYU to teach in 2013. He researches how instructors can more effectively teach math concepts to scientists and engineers. Overall, he wants to prepare his students for their careers.

"I feel like we owe it to those students to help them learn math in a way that's going to help them in their fields of study," said Jones.

He has found a disconnect between students learning mathematical concepts in their math classes and then applying those concepts to science and engineering problems. Even if students can find the right answer to a math problem, they might not have any idea how they apply those ideas in another class.

"A lot of students find it very difficult to go to a science class and use even simple math," Jones said. "They have a hard time figuring out where to use it and when to use it."

Jones works with those who are interested in better connecting how math instructors talk about math and how scientists and engineers talk about math. The first step is to better understand both sides.

"[Mathematicians and scientists] use and talk about math in very, very different ways," Jones said. "I think that helping mathematicians and scientists… to be aware of the differences can help bridge some of the communication gap."

Jones performs studies in which he talks with students about a math concept and works out problems with them. Recently he followed this pattern with integrals. A few days after discussing the math with students, he asked them to do the same kinds of problems, this time within a science or engineering context.

"Students could solve a math problem, and there would be a science problem that was really the exact same problem but couched in a science context, and they had no idea how to do it," he said.

Differences between pure math and scientific math come in several forms, from variables used in the different disciplines to simply the way each discipline looks at solutions. Where mathematicians might reason abstractly to create more mathematical discovery, engineers or scientists reason about the physical world, using formulas to solve interesting, real-world problems.

As Jones researches, he consciously incorporates his findings into his teaching style. For example, he develops formulas together with his students instead of giving them the formula outright. This approach helps students recognize how — and why — formulas are developed in the first place.

"The end result of me and the students thinking together is we create the formula I want them to learn and focus on, but they understand more about why the pieces fit together," said Jones.

"It demystifies where equations come from and how 'genius' you have to be to actually be able to do it."

Jones recognizes that not everyone agrees with his approach, and a different teaching style might not be necessary for upper-level math students, but he's willing to make changes where he can to help his calculus students.

"Since I'm teaching students that are largely science students, [I look at] what I can learn from the way that science uses, writes, and talks about math," Jones said. "I incorporate some of those ideas into how I . . . discuss math in my class, so that when students get out there they're doing a little bit better."

FROM TOP TO BOTTOM

HYDROGEOLOGY IN THE PROVO RIVER

TEXT BY JENNIFER JOHNSON | PHOTOS COURTESY OF GREG CARLING

For many of the approximately two million people on Utah's Wasatch Front, the Provo River is home to first-class recreation. It's also a major source of drinking water for the area.

The Department of Geological Sciences' Gregory Carling is more concerned with the river's role as a water source than a tubing run. Carling studies hydrogeology, which includes urban rain runoff, nutrients found in lakes and wetlands, and dust deposition on snowpack. Much of his research is centered on factors that affect the quality of local water, including both natural processes and human causes.

"The Provo River is an important drinking water source for two million people on the Wasatch Front," Carling said. "We're looking at processes that might negatively impact water

chemistry or water quality. Then that can help drive decisions as to how to help improve water quality."

Carling recently published a paper in Applied Geochemistry with fellow geology professors David Tingey and Stephen Nelson, life sciences professor Zachary Aanderud, and students Timothy Goodsell and Tucker Chapman. In it they describe the trace element and isotopic chemistry of the Provo River. One of the motivations for the study was to examine the effects of humans versus natural processes on water quality.

Carling and his students are continuing with the Provo River Project, now funded by the National Science Foundation (NSF), to examine the effects of dust on water chemistry.

They're working to find out whether desert dust — blown onto snowpack at the river's source — actually affects the chemical makeup of the river. If so, it would affect the people who eventually use that water. Most desert dust comes from dry lakebeds, so it has a high concentration of salt. With salt comes possible contamination from trace elements like lead, uranium, and boron, among others. When the dust gets blown onto a snowpack, it brings those trace elements with it.

"We know that dust changes the snow chemistry, but is that a big enough change to actually see it in the water?" Carling said.

Carling has enlisted the help of a few graduates and several undergraduate students to work with him on this project. The team goes out in the field to gather samples — Carling said that each sample requires up to an hour of filter work and then up to ten hours of lab work. After that, there are even more hours devoted to analyzing the results.

"What they [the students] are not realizing is that most of the work is here on campus in the lab, analyzing the data," Carling said.

After hours of analysis, Carling and his students found a distinct change in the chemical makeup of the river.

"During snowmelt we could see that the composition of the river actually changes to look more like the dust, which indicates that maybe dust really does have an impact on water chemistry," Carling said.

The NSF grant will allow Carling's team to study that impact more extensively.

"Now we have three years of funding to really dive in and

investigate this," Carling said. "That's going to provide support for several students to continue to work on that project."

This research will build on an earlier project Carling did, studying glaciers in the Teton Range in Wyoming, which was funded by the National Park Service. Specifically, he and his team were looking at the chemistry of the glacier before it melted into water and interacted with rocks. They found that some contaminants — including mercury, lead, and zinc — were found in higher concentrations in the glacier than in the river downstream.

"Contaminants are coming in from the atmosphere and potentially impacting the watershed," Carling said. "It is a unique thing. You would think that rain and snow is perfectly clean, but there are actually some contaminants that can come through atmospheric deposition."

As they look deeper into the upper portion of the Provo River, Carling and his students will be able to identify if and where steps should be taken to improve water quality. His focus on the Provo River is driven partly by his affiliation with iUTAH (innovative Urban Transitions and Aridregion Hydro-sustainability), a National Science Foundation-funded project to better understand the water around Utah. iUTAH involves researchers from different organizations throughout the state.

This research is satisfying to Carling personally because it provides real-world applications and student experience, while fulfilling Carling's own desire to learn.

"I get really excited about research. Really, it drives me and keeps me going," he said.

Carling didn't originally plan to be a professor, and he only decided to pursue a doctoral degree when he was in his second year of master's work at BYU. His advisor, former professor Alan Mayo, suggested he continue his education and perhaps return to Provo to teach.

"I thought, 'Oh. Well, that would be an amazing job, to be able to work at BYU and be a professor,'" Carling said.

He earned a doctoral degree from the University of Utah, not knowing where he would end up teaching. He returned to BYU in 2012.

"Luckily everything worked out and I actually got this job I was hoping I would get from the beginning," Carling said. "I'm glad I'm here."

THE BENSON

HOUSING 20 YEARS OF CHEMISTRY AND BIOCHEMISTRY

Text by JEREMY STANFORD | Photo by JOSH SIEBERT

Filled with bright scientists and pleasant memories, the Benson Building celebrated its twentieth birthday last year.

The BYU Ezra Taft Benson Building, home of the Department of Chemistry and Biochemistry, was dedicated on October 9, 1995. The faculty who worked at BYU 20 years ago remember it like it was yesterday.

Dr. Earl Woolley, who was department chair from 1989 through 1995, spoke about the history of the Benson Building at a department alumni reunion on October 9, 2015. Many of the chemistry faculty and alumni attended who were present for the three-year construction project.

As department chair, Woolley's primary responsibility was the oversight of the Benson Building project. To this day, he describes it as both fulfilling and overwhelming.

Woolley gave a chronological account of the facilities that the department used from its founding until the completion of the Benson. In 1879, the department was first housed in the Education Building on lower campus, and moved to the Eyring Science Center in 1950. In 1995, the Benson Building became the permanent home of BYU's Department of Chemistry and Biochemistry.

During his speech, Woolley read from the memoirs of former BYU chemistry professor Ab Swenson, which Swenson shared with the BYU graduating class of 1980. Swenson recalled several humorous accounts from before the completion of the Eyring Science Center, when all of the students knew all of the other students by name and shared the Education Building for their classes.

"Perhaps significantly, chemistry, physics and math were in the basement," said Woolley, quoting Swenson. "[The department] once did their quantitative analysis based on sulfide separations in the spring term, and the artists really complained because it turned all their paint black. They needed new facilities."

Even after his arrival at BYU, Woolley recalls that certain faculty worked without fume hoods, shared office space, and completed some of the construction for the labs themselves.

"We planned the Benson building for a 6,000-student enrollment," Woolley said. "It was almost 12,000 by the end of the 90s."

Perhaps the greatest concern, however, was safety. Without enough space, proper ventilation, chemical storage, or electrical power, fire regulations and chemical disposal were very pressing matters.

"There came a point where [we] could either get a new building, or pay a fine that would match the price of a new building," said Woolley. "'Safety' and 'liability' became buzzwords."

We've got the best undergraduates in the world. My hope is that we will give chemistry undergrads the best experience, and never cut back on it.

As they began to drum up funding and seek approval for the new facility, Woolley and the rest of the department kept their chins up, despite several bureaucratic hurdles. Woolley said that he continued to encourage the faculty to do the best job they could in teaching and research.

Under university president Rex Lee, the approval was granted. Lee's secretary called the chemistry department one day and asked for a 100-word justification within two hours for why they needed a new building. The justi-

fication was to be presented at the university board meeting.

"For the life of me I can't find that document," Woolley said. "I wish I still had it, because it worked."

The groundbreaking ceremony is remembered fondly by these dedicated workers who finally got their new building approved. President Gordon B. Hinckley spoke at the ceremony.

"This is the great age of science," Hinckley said. "This is the age of chemistry. When you reflect on it, the greatest of all chemists was the Creator."

After the groundbreaking, Woolley personally surveyed the construction every day, spending 30 hours per week or more at the site until it was completed. During that time, he recalls being very occupied.

"The building was 192,000 square feet, and in a science building, there's a decision made every two square feet," Woolley said. "The industry standard is that if you get 95 percent of them right, you're doing really well. They estimated that we scored 97 percent, but that's still 3,000 errors in the building."

After years of planning and a lot of paperwork, the Benson was finally occupied by the department in 1995. The BYU chemistry faculty and leadership from the 1990s now look back on it with pride.

"The building is functional first, not a palace," Woolley said. "It's a showcase if you're a chemist, not an architect."

Now retired from BYU, Dr. Woolley still holds high hopes for what can be accomplished within the walls of the Benson.

"We've got the best undergraduates in the world," Woolley said. "I am a proponent of mentoring. My hope is that we will give chemistry undergrads the best experience, and never cut back on it."

The completed Benson now stands as a monument to the perseverance of these chemistry enthusiasts. In fact, it has been called "Dr. Woolley's 9th child." Since 1995, thousands of chemistry students and faculty have benefitted from the privilege of having their own building.

RANDALL B. BARNES

HONORED ALUMNI LECTURE

IN VITRO FERTILIZATION:

PAST, PRESENT, & FUTURE

When we are young we all dream of what we want to become, best summarized by Mark Twain: "Now and then we had a hope that if we lived and we're good, God would permit us to be pirates." I never much wanted to be a pirate, but I knew I wanted to be a chemist when I was nine years old.

I was a chemistry major at BYU and had the opportunity to be a research assistant in Dr. Tracy Hall's high pressure lab working on synthesizing high-temperature superconductors. The director of the project was former faculty member John Cannon, and another student was Paul Farnsworth, who is now a professor of chemistry at BYU.

I was very interested in organic chemistry, and my senior year I took a couple of classes from Smith Broadbent, including "systematic identification of organic compounds." I learned something important from Dr. Broadbent: I was much better at learning chemistry than I was at doing chemistry. About that time I decided that I would go to medical school. It turned out to be a very good decision. I was tremendously influenced by the professors I had at BYU and the quality of my education.

There probably aren't very many people who are sentimental about their organic chemistry text. My friend had a friend named Claire Taylor. Claire was taking organic chemistry and needed a tutor, so I volunteered. We both learned a lot of chemistry that semester, and the chemistry was fantastic. We were married in 1976, while I was in medical school.

Here is my first bit of advice: To prepare for the unknown future, you have to prepare for the short-term future, because we're better at predicting that. You have to do the very best at what you're doing. If you do, then chances are you'll be better prepared for the long-term, unpredictable twists of the future.

Louise Joy Brown was the first child born from *in vitro* fertilization (IVF) in July 1978. It was between my third and fourth year of medical school, and it caught my eye. I had always been interested in endocrinology, and I decided I was going to pursue reproductive endocrinology.

Louise's birth was the result of a collaboration between Dr. Robert Edwards, who was a basic scientist, and Dr. Patrick Steptoe, who was a clinician. IVF is a great example of the value of collaboration between the basic and clinical sciences. Dr. Edwards was the sole recipient of the Nobel Prize in medicine in 2010 for the development of IVF.

What was IVF like back in the early days? In the first five years, there were about 825 egg retrievals and 32 deliveries reported. That's a four percent live birth rate. There were studies in the early days of IVF that showed you were more likely to have a baby while waiting for your IVF procedure than you were from having your IVF procedure. But IVF success rates have changed dramatically. In 2013 there were about 1.5 million IVF cycles and 350,000 live births worldwide, which is a 23 percent live birth rate per cycle start.

IVF is far and away the most effective infertility treatment. Over five million IVF babies have been born since 1978. In Japan

Photos by Rob Johnson

Dr. Randall Barnes received his bachelor's degree in chemistry from BYU in 1975, and he graduated from Johns Hopkins University School of Medicine in 1979. Since that time, he has published extensive research on in vitro fertilization and reproductive medicine. Barnes is currently practicing medicine at Northwestern Memorial Hospital.

Lecture delivered on October 8, 2015

and some European countries, three percent of all births are from IVF. In the United States 1.5 percent of all births are from IVF.

IVF was first developed to treat tubal disease, but now it is more commonly done for other reasons. It is the best treatment for male factor infertility, where it has dramatically improved the chance of having a child when the husband has a very low sperm count.

In the early days IVF was done in a natural menstrual cycle where a single follicle is usually produced in one ovary. The cycle was monitored for the onset of the luteinizing hormone surge, which indicates ovulation is about 36 hours away. A laparoscopic egg retrieval was done 34 hours after the onset of the luteinizing hormone surge before ovulation took place, and 70 percent of the time an egg was collected. Of those eggs

only about two-thirds would fertilize. Thus the chance of having a single embryo to place in the uterus was about 50% per retrieval. We now stimulate cycles with injections of gonadotropins, which are hormones that make the follicles grow in the ovary. This treatment produces multiple follicles from which we collect multiple eggs which result in multiple embryos.

How do we do the egg retrieval? It was first done by laparoscopy, which required an operating room and general anesthesia. Because the retrieval was done in a natural cycle, the team had to be available 24 hours a day. And let's face it, one reason we went into this field was because we didn't want to deliver babies in the middle of the night. We didn't want to deliver eggs in the middle of the night either. In a stimulated cycle, we give a surrogate LH surge in the evening, for example 9 pm, and then we'd do the retrieval at 9 am two mornings later, which is much more civilized. We do ultrasound-guided aspiration of eggs from the follicles using a vaginal probe ultrasound. It's an office procedure done under conscious sedation. By 1985 everyone was using this technique. It's easy, patients are comfortable, and they wake up very quickly.

There have been dramatic changes in the laboratory — and this is where all the magic happens — where Dr. Edwards and many, many people since him have worked. In the early days of IVF, everyone made their own culture media, and they jerry-rigged their own incubators. Generally we would culture embryos for two or three days. Now, we have very high quality, commercially available culture media and incubators specific for use with IVF, which has made a huge difference. We oftentimes culture embryos for five days to the blastocyst stage. By culturing longer we get a better idea which embryos are more likely to result in a successful pregnancy. We are also adept at freezing both embryos and eggs, which gives us flexibility in the number of embryos we transfer. We are able to freeze excess, good-quality embryos for later use, and many patients now have had two or three or more babies from a single egg retrieval.

Probably the most important laboratory advance since the beginning of IVF is intracytoplasmic sperm injection, or ICSI, for male infertility. Using a microscopic glass needle a single sperm is injected into the egg to fertilize it. ICSI was described in 1992, and within a year or two, everyone was doing it. When something spreads so quickly, you know it's good. With ICSI we can usually overcome any male infertility issue, and it has revolutionized fertility treatment.

The final step in IVF is the embryo transfer. The embryos have been in culture for three to five days, and now we have to put them into the cavity of the uterus. In the old days this was done blindly, using catheters that weren't specifically designed for embryo transfer. The catheters then were stiff and could damage the lining of the uterus. Because success rates were low, we transferred multiple embryos, if they were available. If a patient became pregnant, she was at risk for having multiple births, which is still the greatest health risk to babies born after IVF. Even twins have a high risk of being born prematurely and having

"You have to do the very best at what you're doing. If you do, you will be better prepared for the long-term, unpredictable twists of the future."

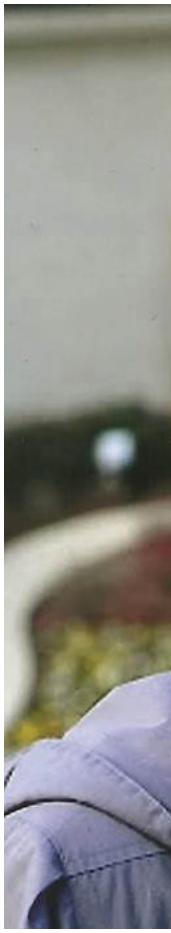
all the problems associated with premature delivery.

We now have catheters specific for IVF that are very soft and flexible. We use ultrasound to guide our catheter placement so we can get it exactly in the mid cavity of the uterus. More and more often we transfer a single embryo, especially in patients under 35. If we transfer two embryos in someone who's 32 years old and she becomes pregnant, she has a 30 percent chance or higher of having twins. If we transfer a single embryo, she only has a 1 to 2 percent chance of having twins, which would be identical twins. In good IVF programs the live birth rate after a single embryo transfer in young patients is greater than 50%.

IVF has an extraordinary future because of its intersection with the genetic revolution. We routinely biopsy blastocysts (day 5 embryos). The blastocyst is then frozen, and the biopsied cells can be tested for conditions such as cystic fibrosis and/or to see if the embryo is chromosomally normal. Blastocysts that are unaffected by disease and/or chromosomal abnormalities can subsequently be thawed and transferred. This technology has become well established over the past few years, but its exact role is still to be determined. But even more remarkable uses of genetics in IVF are possible. The CRISPR/Cas9 system is a very inexpensive way to insert genes into embryos and other cells. CRISPR stands for "clustered, regularly interspaced, short palindromic repeats" DNA. Cas9 is an enzyme that splices DNA to allow insertion of a portion of the CRISPR DNA. This technology has been used to replace an abnormal gene in the liver of rats affected with congenital liver disease. More remarkably it has been used to alter genes in animal embryos which would then be inherited by future generations. Monkeys have been born from eggs fertilized in vitro. When the embryo was a single cell, CRISPR/Cas9 technology was used to alter a few genes, so that the monkeys that were born had the genes altered in every cell in its body. This permanent alteration in the DNA will be passed on generation to generation. When the monkey is older it will be bred to see if the altered genes are present in its offspring.

There are great concerns about the use of this technology in humans. Last April editorials were published in both Science and Nature by experts that strongly discourage any use of CRISPR/Cas9 to alter human germ cells or embryos. We know the technology is very good, but we don't know it's perfect. Let's say in one percent of rats or one percent of monkeys, something goes awry and the DNA doesn't get put in the right place. Well, that's not going to matter so much. But if it's one percent of human embryos, it's a disaster.

When we alter genes, biology is so complex that we can't always predict the outcome. Altered genes may have unpredictable and unfavorable effects in the organism. The editorials very strongly recommended that CRISPR/Cas9 should not be used in human embryos until we know a lot more about what can and can't go wrong. I don't know if CRISPR/Cas9 or similar technologies will ever be used in human embryos. If I had to place a bet, I bet it will happen, and it will probably happen faster than I think it's going to happen.



I have received a number of birth announcements, Christmas cards, and birthday announcements from my patients. The letters accompanying these announcements are very touching. It makes me realize what a great blessing it's been in my life to help people fulfill their dream of having families. It is a rare privilege. Our children bring us great joy and great sorrow, and I'm sure children will say the same thing about their parents, but we bring each other such a tremendous amount of happiness.

All of this has left me thinking about the story of Abraham. Many have thought and wrote about it. I've asked myself: What did God teach Abraham and Isaac through this heart-wrenching trial? I

believe that he taught them, in part, that it was only through Christ's Atonement that Abraham and his descendants could receive the blessings promised in the Abrahamic covenant. In the Jewish faith this story is referred to as the Akeda, or "Binding." Are we not all bound by our mortality and our sins? If there were no Atonement to loosen these bonds, we would be sacrificing each child brought into this world to a meaningless death as surely as if we were to offer the child on the altar of a pagan god.

Our lives would be without faith, without hope, and grim beyond telling. But God did provide a Savior for us who willingly atoned for our sins to bring to pass the immortality and eternal life of man. Every child who comes into this world comes with that hope. Each of us can prepare for the unknowable future by having faith in Christ. It is the sole but sure preparation for our future. Many prepare for the future in fear of the future, but we should prepare with hope born of our faith.

"It makes me realize what a great blessing it's been in my life to help people fulfill their dream of having families. It is a rare privelege."

Photo courtesy of Randall Barnes

BYU College of Physical & Mathematical Sciences

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Your Contributions Help Students Take Flight

Computer science major Andrew Wallace is developing software tools aimed at making air traffic controllers' jobs easier and more efficient.

Wallace uses simulations to help air traffic controllers see the best times for airplanes to take off and land. Wallace hopes to minimize flight delays through his simulations by increasing the number of planes taking off between landings.

"As an end result, it would decrease the workload for air traffic controllers," Wallace said.

This work affects not only air traffic controllers, but also passengers, pilots, and others whose lives involve airplanes and travel.

"What we're doing could have a huge effect for everyone; anyone that flies, really," Wallace said. "Knowing that is cool."

To build on his knowledge, Wallace had the opportunity to participate in a 10-week-long internship with NASA in California during the summer of 2015. While there, he collaborated with experts and got a clear idea of what research is like outside of the classroom.

"You get to go into the professional world, see possible situations of where you could be working, and interact with all the professionals there," Wallace said. "It provides for greater learning and greater productivity."

Donor funds have provided Wallace and a number of other students with funding to support them in their research. Mentored research has helped Wallace and other undergraduate and graduate students get much-needed experience, including various nationwide conferences and experience in the world of research.

There are many students who need financial aid and scholarships to fund the invaluable experience they need in order to truly take flight with their careers. We invite you to help these students gain that experience by helping to fund a scholarship or mentorship for CPMS students. Please donate online at give.byu.edu/cpms16.

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