



Newsletter

College of Physical and Mathematical Sciences

July/August 2007

Tiny victory for BYU chemists Way to drill holes on silicon chip could aid screening for diseases

By [Lois M. Collins](#)
Deseret Morning News
Thursday, July 26, 2007

BYU chemists have figured out how to drill 10,000 tiny wells that will hold protein antibodies in an inch-square silicon chip — a process that puts within reach the possibility of testing for many diseases at the same time, with less chance of outside contamination.

They introduced their method in Wednesday's issue of the *Journal of the American Chemical Society*. "What we were interested in was developing ways to put chemical patterns down on surfaces," said Matthew Asplund, assistant professor of chemistry and biochemistry.

That's typically done by making "teeny tiny drops of different reagents and hoping they stay where we put them. But anything in the air that floats down can contaminate them, so we wanted a nonreactive surface."

They coated the silicon chip with a polymer film that's only a molecule thick, to which proteins won't stick, then tightly focused a laser through a very small optic lens to create about 10,000 beams that each made itty-bitty holes where the silicon burned off and the polymer evaporated.

Those wells can capture proteins intact, and the process of drilling them is very fast. In the past, they've done them manually — and laboriously.

The proteins stick where the holes are, but not where the polymer's intact, Asplund said.

They're interested particularly in its possible use to screen for diseases, because illnesses can be detected from the presence of specific protein antibodies in the blood. It's a matter of capturing those proteins in a clean way and testing them.

The chip could have many applications, and Asplund said that researchers "are always bouncing between the grand vision and the stark reality" with such innovations. "We've shown you can attach different proteins in different sections of the chip," he said, adding that from a diagnostic standpoint, that would allow the potential to test for many different diseases, using different proteins in different tiny wells. Sections of the chip could be used to test for various antibodies.

The next step is forging collaborations that would help with precise placement of minute amounts of protein. And they hope to collaborate on disease testing using the new method.

The BYU chemists have already been working with an associate professor of mechanical engineering at the University of Utah, Bruce Gale, and others on refining how small an area of the chip could be filled with any one substance.

They're also experimenting with different substrates. Silicon was initially selected because it absorbs laser light well. "We are looking to get to new substrates to find new chemistries we can put down on this chip."

Asplund and BYU professor Matthew Linford have founded a company they call LaserArray Technologies and have applied for a patent to the process they developed.

The lead author on the paper is Feng Zhang, a BYU doctoral candidate. In a release about the work, he said he hopes their efforts will help encourage mapping proteins in the human body to determine their role. The field, called proteomics, holds great promise but is somewhat daunting because there are so many proteins and they change a lot.

In this issue:

Tiny Victory for
BYU chemists 1

Statistics welcomes
new faculty 2

Dennis Eggett Rides
Again 2

Could a statistical
model detect
cheating NBA ref? 3

American Statistical
Meeting Held in Salt
Lake 4

Department of
Statistics Hosts
Summer Institute of
Applied Statistics 4

Reema Al-Kamha:
one student's
journey from the
Middle East to the
American west and
back 4

BYU professor wins
chemistry award 5

College Publications 6

Important Dates & Events in the College

August/Sept. 2007

Computer Science

Friday, September 7

6:30-8:30 pm, Gordon B. Hinckley Alumni Center--
Microsoft Alumni Dinner and Social

Wednesday, September 12

6:00-8:00 pm, Kiwanis Park
--Computer Science Opening Social

Thursday, September 13

11:00-11:50 am, 1170 TMCB--
Computer Science Colloquium, Dr. Peter Young

Friday, September 21

6:00-8:00 pm, WSC Terrace--
Computer Science Alumni Homecoming Dinner

Department of Statistics Welcomes New Faculty



Dr. David Engler received his BA in Philosophy from BYU and enjoyed a brief stint in the corporate world managing computer networks before returning to BYU for graduate studies. After obtaining an MS in Statistics, David completed his doctorate in Biostatistics at Harvard University. While at Harvard, he worked with Rebecca Betensky and Yi Li, developing methodological advances in the area of high-dimensional data analysis. His research was recognized with an award in the 2006 ENAR Student Paper Competition and with the Biostatistics Department Faculty Memorial Prize. David served a mission in Washington D.C. If he finds a spare minute he likes to read, backpack, and participate in sports. David and his wife Lisa have three children and live in Mapleton, Utah.



Dr. Evan Johnson received his BS degree in Mathematics from Southern Utah University and subsequently completed an MS degree in Statistics at BYU. He then earned his PhD in Biostatistics at Harvard University, focusing on the analysis of data from high-throughput genomic technologies, working under the direction of Jun S. Liu and X. Shirley Liu. Evan and his wife Holly are both originally from St. George and, despite a few major Boston withdrawals, are enjoying being back in Utah. They have three children and are currently residing in Mapleton. Evan served his mission in Greece and Cyprus and enjoys basketball and distance running.

Dennis Eggett Rides Again!

True to his word, Department of Statistics Professor Dennis Eggett participated in the 35th RAGBRAI (Registers Annual Great Bike Ride Across Iowa.) This recreational ride spans 400 miles across Iowa and is sponsored by the Des Moines Register. The ride is spread out over seven days but participants can elect to ride less. Dennis shortened his ride to three days since he was accompanied by his wife Loretta, and their two daughters Allison and Kimberly and he wanted to break them in slowly! To help prepare for the ride the Eggetts rode extensively for several months. Dennis covered an impressive 1050 miles in less than a month in June. The Eggetts were joined by 10-12 thousand other participants. Last year, through no fault of his own, Dennis finished the last 10 miles of the ride with a broken arm. This year, we're happy to report, there were no accidents!



Could a statistical model detect cheating NBA ref?

BYU Professor calls for 'early warning system'

By Tad Walch

The NBA could create an "early-warning system" to detect cheating by a referee, says a Brigham Young University professor who uses statistical models to analyze sports. Statistics professor Shane Reese said mining data about every call made by officials during games might catch one who fixes games, as did Tim Donaghy, the former NBA referee who pleaded guilty Wednesday to betting on games he officiated. "I think the NBA has enough information to construct an early-warning system," Reese said. "Would one have caught Donaghy? I don't know, but the granularity of the statistics the league keeps could be used to devise such a system." The league compiles statistics about which referees made each call and when they made them, but it doesn't share the information. NBA commissioner David Stern has said the league's current system didn't indicate wrongdoing by Donaghy. Reese, who turned down a job in the front office of the NFL's Philadelphia Eagles last year, said access to the NBA's information would allow statisticians to build a better model. Without the league's data, several groups have attempted less-sophisticated ways to analyze Donaghy's games. One type of bet drew the most attention, the over-under. Bettors can gamble whether the total points scored in game will be over or under a line set before the game.

The president of one gambling information Web site, Pregame.com, issued a news release that showed the over bet won 57 percent of the time Donaghy refereed an NBA game in the past two years. The previous two years, the over bet won 44 percent of the time Donaghy was an official. The swing was a strong indication of foul play, the news release claimed. Reese created a model to test the claim. "It was a fairly naive calculation," he said, "and it seemed to me it was unlikely to be accurate." Reese studied all NBA referees and the over-under outcomes for games last year and found that Donaghy was not an outlier. "This kind of

data probably has no hope of finding out if an NBA ref is a cheater," he said. The NBA has not responded to e-mails and a phone call from Reese.

"My recommendation to the NBA, whether it would include me or not, is they ought to do it in the form of a grant to an academic institution," he said. "That way, they could avoid any issues about objectivity and transparency while making a statement about academic pursuit."

A grant also would cost less. Reese and fellow BYU statistics professor Gil Fellingham did consulting work for the Eagles. They concluded team officials did not have the right data to answer the questions they were asking. The professors also determined the team could collect the right data and that it would be valuable.

Philadelphia owner Jeff Lurie, team president Joe Banner and coach Andy Reid interviewed Reese and offered him a job. Reese said Lurie had read "Moneyball" — the book that introduced statistical analysis in baseball to the mainstream — and was convinced "Moneyball" needed to be implemented in the NFL and that the Eagles were positioned to be the pioneers. Reese declined the offer, and the Eagles hired David Lewin.

"There is substantial interest in the professional sports community," Reese said. "It used to be just the Oakland A's and the Boston Red Sox, but now the Cleveland Cavaliers have someone, and the Seattle Sonics and the St. Louis Cardinals." Several college football programs have approached Reese about consulting, but discussions are on hold until after the coming season. He approached BYU coach Bronco Mendenhall during his first year as head coach. Mendenhall expressed interest but has not asked for a meeting.



Shane Reese

Reese said analyzing the impact of each player on football and basketball games is much tougher than in baseball, which is largely an interaction between pitchers and batters. "It requires much more data," he said. "You can't evaluate player contributions with the standardly available data." Reese said the Bayesian hierarchical modeling used in the analysis of over-under bets might result in an academic paper. He has published on a wide range of topics, including a study estimating gestation in bowhead whales. Reese also is working on a national panel studying the reliability of U.S. biological weapons detectors and with the National Center of Atmospheric Research in an attempt to better understand the impact of the upper atmosphere on climates.

Deseret Morning News August 16, 2007

American Statistical Association/Joint Statistical Meeting Held In Salt Lake City

Twenty Department of Statistics faculty members and two students participated in the ASA/JSM meetings held in Salt Lake City, Utah July 29-August 2, 2007. Patti Collings served as the Program Chair for the Session on Statistical Education. Four faculty members and both students made a presentation at the meeting. The Department of Statistics hosted an early morning Breakfast/Open house at the Joseph Smith Memorial Building on Tuesday, July 31, 2007 which was attended by statisticians and student alumni from all over the country. The ASA/JSM meeting will be held in Denver, Colorado in 2008.



Department of Statistics Hosts Summer Institute of Applied

The 32nd annual Summer Institute of Applied Statistics took place June 20–23, 2007. Dr. Randall Eubank, Professor in the Department of Mathematics and Statistics at Arizona State University and Dr. Tailen Hsing, Professor of Statistics at The Ohio State University were the featured speakers. Their presentation was entitled “Functional Data Analysis,” which is the statistical concept of observations consisting of sample paths from a stochastic process. The techniques include flexible modeling of complex stochastic processes. This year’s participants included faculty, students, alumni, and other statisticians from around the country. Next year’s Summer Institute will be held June 18-20, 2008.

BYU undergraduate makes 'cents' of rare coins (BYU News)

Historically, coin collectors used crude methods of testing the authenticity of coins, such as biting into them, to see if they were really made of genuine gold or silver. For experts, this method has proven to be archaic. Luckily, coin collectors can spare the bite. A Brigham Young University student has demonstrated a way to test counterfeit coins using an X-ray machine.

Physics student Jeff Brown developed the new method of testing the authenticity of collectible coins for his senior thesis by using an X-ray machine and electron microscope. Brown began working on his project two years ago. He is one of 2,372 students who will graduate from BYU this week. Commencement exercises will be held Thursday at 4 p.m. in the Marriott Center.

“The most crucial thing to find out if it’s counterfeit or not, is to find out what it’s made of. You can’t do that by just looking at the coin, you have to be able to get inside of it somehow,” Brown said. “My goal was to be able to do that without having to cut or melt the coin, especially if it turned out to be an authentic coin.”

Using the microscope, Brown was able to examine minute details on about 50 coins dating from 1899 to 1965. Brown said in the past counterfeiters shaved off a coin’s metal to create a new coin; however, today’s counterfeiters manipulate small details that carry a big impact on the price, such as

changing a coin’s date or mint mark.

The most valuable coin Brown researched was an 1893 U.S. Morgan Silver dollar. People attempted to counterfeit this coin by stamping an ‘S’ mint mark, which represents its origins from the San Francisco Mint. The 1893 U.S. Morgan Silver dollar without a mint mark and in pristine condition is valued at \$700 according to “The Official Red Book Guide to United States Coins.” If the coin was made at the San Francisco Mint, with an original ‘S’ mint mark, the value jumps to \$52,500 because only 100,000 of this mint stamped coin were made.

The most accurate way to test a coin’s authenticity is to find what elements are present. Brown uses an X-ray fluorescent spectrometer to help identify the metal makeup. To help stabilize the process, Brown begins by placing a thin strip of titanium on the sample holder because titanium was not present in any of the coins and is a very stable element. He then places a coin with the titanium and closes the top

of the X-ray machine to create a vacuumed, air tight atmosphere. The X-ray machine allows him to view several different coins at the same time. A computer translates the elemental makeup of each coin in a graph to a computer. Brown is then able to analyze data from the chart and compare it with information from the U.S. Mint which shows what the original coin’s elemental makeup should be.

“The most important part of this project is what I learned about problem analysis: figuring out how to get past bugs and hiccups,” Brown said. “It’s a lot different than just having to go to class. It really prepares you for graduate school and similar situations that require critical thinking.”

Brown has been accepted to a nuclear engineering graduate program at Idaho State University, but has deferred entrance for one year to accept a computer

programming job with an Orem company. His dream job is to teach physics at the collegiate level.

“When I chose to study physics, it was one of the happiest days of my life,” Brown said.



BYU physics student Jeff Brown came up with a method to detect counterfeit versions of rare coins using X-rays and electron microscopes.

Reema Al-Kamha: one student's journey from the Middle East to the American west and back

The city of Damascus, capital of the Syrian Arab Republic, is the oldest continually inhabited city in the world. Nestled in the “Cradle of Civilization,” at the meeting point of Asia, Africa, and Europe, Damascus is a witness to the great sweep of history which has paraded past, and, often through, its walled borders. It is in this ancient city, where echoes of the past mingle with voices from the present, that Reema Al-Kamha, a recent graduate with a doctorate in Computer Science from BYU, first developed a love for computer science. As soon as she entered college, Reema knew that she wanted to be a professor at Damascus University. She began her baccalaureate studies in mathematics but soon found herself leaning towards the field of computer science (known as Informatics in Damascus). She was drawn by the challenge and the novelty of the discipline, which was fairly new to Syria when she began her studies, and was “eager to know what it was all about.” Reema completed her bachelor’s degree in mathematics with an emphasis in informatics from Damascus University. She then went on to earn her diploma (a degree in advanced studies) and masters degree in informatics as well.



By the time she completed her masters degree, Reema had a family, made up of her husband Ghassan and two little boys named Ylwael and Yaman. Going to school while raising a young family had been a difficult journey for Reema and Ghassan, a doctor in Damascus. However, Ghassan and Reema’s parents, a pharmacist and a homemaker who had helped care for Ylwael and Yaman while Reema studied at Damascus University, were supportive of her dream to become a professor. Knowing she needed a doctorate to teach at the university, Reema began to look for programs abroad and discovered that Brigham Young University was offering a scholarship through Damascus University. Reema applied for the scholarship and was accepted. Soon she found herself, her husband, and her two little boys, ages one and three, living in Provo, Utah.

For Reema, the strangest thing about living in Provo was that it didn’t seem very strange at all. She found that America wasn’t radically different than Syria, and that particularly in Utah, a place Reema describes as having lots of children and strong families, she felt comfortable and welcome.

Upon arriving at BYU, Reema began another masters degree in Computer Science, working under Dr. David Embley in the Data Engineering Laboratory. Her research focused on conceptual XML for systems analysis. Conceptual XML is a tool for systems analysts, which facilitates better analysis of different systems’ designs. Reema enjoyed her research and the progress she was making in her field, so in 2003, with the support of her husband and family, which now included a daughter named Maya, she began work on her doctoral degree.

In June of 2007, Reema graduated with her doctoral degree in Computer Science from BYU. On August 1, she returned to Damascus with her family, including her newest little one, a son named Ameer. Although she has treasured her time in America, she was thrilled to return to her homeland. She says she missed everything there—her family, her neighbors, her city—and is she excited to embark on her dream career—she has been hired as a professor in the Informatics department at Damascus University.

For those who are just beginning their journey towards an advanced degree in computer science, Reema’s advice is to, “be patient.” She says that for any new graduate student, there will be a lot of difficulties and discouraging problems, and the key is to take advantage of the challenges and grow from them. Reema recognizes that everyone’s situation is different, but says no one can succeed without hard work and effort.

Finally, Reema wishes to thank those who have aided her as she’s worked for her degree. She says she had a great experience at BYU and feels lucky to have had the chance to study here and meet so many great people. In specific she wishes to thank her family, her adviser, Dr. Embley, and her committee members.

BYU Professor Wins Chemistry Award

Paul B. Farnsworth, a Brigham Young University professor, has received the annual Utah Award presented by a section of the American Chemical Society. The chairman of the BYU Department of Chemistry and Biochemistry faculty, Farnsworth was recognized by the central Utah and Salt Lake sections of the ACS. "The award recognizes individuals who have lived in Utah for 10 years or more and have made significant contribution to the field of chemistry in the areas of research, chemical industry, teaching and/or service to the ACS," a press release from the group said.

Farnsworth has been teaching chemistry for nearly 24 years. His research, for which he has 65 publications and two patents, is in the field of atomic spectroscopy. According to the ACS, Farnsworth is an avid biker, hiker and backpacker. He and his wife, Elizabeth Laycock Farnsworth, have four children and three grandchildren.

July 27, 2007 Deseret Morning News

College Publications

Chemistry and Biochemistry

R. Liu, S.R. Herron, S.A. Fleming, "Copper-catalyzed Tethered Aziridination of Unsaturated N-tosyloxy Carbamates," *J. Org. Chem.*, **72**(15), 5587-91 (2007).

J. Fields, X. Ouyang, S.R. Herron, K.A. Kantardjieff, A. Jabalameli, F.A. Gomez, "1-[ferrocenyl(hydroxy)methyl]-1,7-dicarba-closo-dodecaborane, Synthesis and X-ray Crystal Structure," *J. Chem. Crystallog.*, **37**(1), 55-62 (2007).

A. Navrotsky, M. Dorogova, F. Hellman, D.W. Cooke, B.L. Zink, C.E. Leshner, J. Boerio-Goates, B.F. Woodfield, and B. Lang, "Application of Calorimetry on a Chip to High-pressure Materials," *PNAS*, **104**(22), 9187-9191 (2007).

D.J. Henderson, "The Potential Distribution Theorem and Models of Molecular Solutions," *J. Am. Chem. Soc.*, **129**, 4857 (2007).

F. Zhang, R.J. Gates, V.S. Smentkowski, S. Natarajan, B.K. Gale, R.K. Watt, M.C. Asplund, and M.R. Linford, "Direct Adsorption and Detection of Proteins, Including Ferritin, Onto Microlens Array patterned Bioarrays," *J. Am. Chem. Soc.*, **129**(30), 9252-9253 (2007)

J. Liu, X. Sun and M.L. Lee, "Adsorption-Resistant Acrylic Copolymer for Prototyping of Microfluidic Devices for proteins and Peptides," *Anal. Chem.* **79**, 1926 (2007).

J.M. Armenta, B. Gu, C.D. Thulin, and M.L. Lee, "Coupled Affinity-hydrophobic Monolithic Column for On-line Removal of Immunoglobulin G, preconcentration of Low Abundance Proteins and Separation by Capillary Zone Electrophoresis," *J. Chromatogr. A*, **1148**, 115 (2007).

L. Zhou, D.C. Collins, E.D. Lee, M.L. Lee, "Mechanical Ion Gate for Electrospray-Ionization Ion-Mobility Spectrometry," *Anal. Bioanal. Chem.*, **388**, 189-194 (2007).

P.H. Humble, J.N. Harb, H.D. Tolley, A.T. Woolley, P.B. Farnsworth and M.L. Lee, "Influence of Transport Properties in Electric Field Gradient Focusing," *J. Chromatogr. A*, **1160**, 311-319 (2007).

L. Lin, M.L. Lee, D.J. Eatough, "Gas Chromatographic Analysis of Organic Marker Compounds in Fine Particulate Matter Using Solid-Phase Microextraction," *J. Air & Waste Manage. Assoc.*, **57**, 53-58 (2007).

Geological Sciences

D. T. Griffen, and Wendy R. Nelson, "Mössbauer spectroscopy of Zn-poor and Zn-rich rhodonite," *American Mineralogist*, **92**, 1486-1491.

Mathematics

Robert W. Bradshaw and Stephen P. Humphries, Randomized methods in Artin groups of finite type. *International Journal of Algebra and Computation*. Vol. 17, No. 4. 859-858.2007

Kening Lu and Björn Schmalzfuß. Invariant manifolds for stochastic wave equations. *Journal of Differential Equations*. Vol. 236. 460-492. 2007

Stephen P. Humphries. Subgroups of pure braid groups generated by powers of Dehn twists. *Rocky Mountain Journal of Mathematics*. Vol. 37, No. 3. 801-828. 2007