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Reducing the Drag of Vehicles to Improve Gas Mileage

Filling up a gas tank can be very expensive. A mechanical engineer at Washington University is developing techniques that will lessen our monetary pain at the pump by reducing the drag of vehicles—planes, autos, and trucks. Drag is an aerodynamic force that is the result of resistance a body encounters when it moves in a liquid or gaseous medium (such as air). Reduction in drag means less fuel would be required to overcome the fluid resistance encountered by the moving vehicle.

Working with undergraduate and graduate students, Ramesh K. Agarwal, the William Palm Professor of Engineering at Washington University, has successfully demonstrated that the drag of airplane wings and cars/trucks can be reduced by employing the active flow control (AFC) technology. The idea behind the AFC is to

deploy actuators on the surface of these vehicles to modify the flow in a way that the overall resistance is reduced. Using computational fluid dynamics software, Agarwal has found that the actuators modify the flow, which results in drag reduction, which in turn reduces the fuel amount needed.

“The most promising actuators are the so-called synthetic jet or oscillatory jet actuators that are embedded in the surface of the body (an airplane wing for example), and essentially perform injection and suction of the fluid from the surface in a periodic manner,” says Agarwal. He has demonstrated that the transonic drag of an airplane wing can be reduced by 12 to 15 percent with the incorporation of three-ounce actuators, about 20 to 30 spaced optimally on the surface of the wing.

“We use the genetic algorithms and artificial neural net algorithms to optimize the placement of actuators,” he says. His students recently applied the concept on cars and trucks and have achieved 15 to 18 percent reduction in drag by placing the actuators on the back surface of these vehicles. Although the technology has not yet been deployed on any commercially available vehicle,

airplane and automobile companies worldwide are researching and investigating this concept.

“There are approximately 100 million vehicles on the road in the United States alone and hundreds of millions more worldwide,” says Agarwal. “Similarly, there will be a substantial increase in air transportation worldwide. The AFC technology therefore can play an important role in fuel conservation and reduction of greenhouse gas emissions.”

Agarwal is one of the most decorated engineers in the United States and a fellow of 10 national science and engineering societies including the American Association for Advancement of Science, American Physical Society, American Society of Mechanical Engineers (ASME), American Institute of Aeronautics and Astronautics (AIAA), and the Institute of Electrical and Electronics Engineers.

On April 30, 2009, Agarwal received the James B. Eads Award from the Academy of Science. It is the latest of several distinguished awards he has received in just the past three years. An internationally renowned scholar who is considered a leading authority in aerodynamics and computational fluid dynamics, Agarwal has been the recipient of almost all the major national and international awards in these fields.

In 2007, he received the Gold Award from the Royal Aeronautical Society of

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Jillian Murphy

Aayush Munjal, BSAS '08, consults with his teammates at the “Battle of the Brains” programming contest in Stockholm, Sweden.



Joe Angeles

Ramesh Agarwal, the William Palm Professor of Engineering, is developing techniques that will lessen our monetary pain at the gas pump by reducing the drag of vehicles.

At the 'Battle of the Brains' Programming Contest, Engineering Students Take on the World

by Laura Miller

A principle of the ACM International Collegiate Programming Contest (ICPC) states, "Solve all solvable problems; then resolve all resolvable problems; finally, avoid the rest."

And this is the creed Sean Fellows, BSCS '09, MSCS '09; Doug Li, BSCS '09; and Aayush Munjal, BSCS '08, have followed throughout the "Battle of the Brains" competition to help them adjust to new ways of thinking about problems.

After taking second place at the Mid-Central Regional round of the IBM-sponsored ICPC, the team competed at the 33rd World Finals in Stockholm, Sweden, receiving an honorable mention. More than 7,100 teams entered the competition, with only 100 teams making it to the finals.

Though the Washington University team finished in the bottom half at the World Finals, coach Bill Smart still credits them among the top collegiate programmers.

"We came in the top 100 in the world. Just getting to the World Finals is such a great thing," says Smart, an assistant professor of

computer science in the School of Engineering & Applied Science. "You can look at it as they're in the best 300 programmers in the world."

In 1979 and 1980, Washington University pulled off back-to-back wins, but since then has been unable to capture a first-place finish at ICPC, an event that began in 1977. American teams dominated the early years of the competition, but the last U.S. win was in 1997.

"Teams that consistently do well have full-time faculty members that teach their team. These schools are devoted to training their teams; they have a level of seriousness that we don't have here," says Smart. "Our students are typically involved in many other activities."

Washington University's team practiced for the regional round a month beforehand—up to three hours each week. Mimicking the competition's structure, the three teammates huddled around a single computer, solving problems and learning to work together.

"This was the last time I would compete in the ICPC, and I really wanted to attend the

World Finals in Sweden,"

says Munjal, who had been involved with the competition since his freshman year, and had been on a team with Fellows for the last three years.

"The ICPC regional competition was actually my first programming competition, so I was a little jittery, but the practice we had before helped," says Li, who had never heard of the contest until Munjal invited him to join the team.

In the competition, each team is given a number of

problems to solve in a set amount of time, and the team that correctly solves the most in the least amount of time wins. Problems range in difficulty. An easier problem might be to create a program to add three plus four. A more difficult problem might be to create a program that puts tollbooths in a city so that the perceived cost in time and money of traveling was the same for all possible routes.

After the regional round, the team was disadvantaged by a geographic split from teammate Munjal, who graduated in December 2008 and went to work as a developer for Microsoft in Redmond, Washington.

"I went to both competitions expecting to win, because I knew we possessed the necessary skills," says Li. "For the World Finals, the same mentality obviously failed me. I thought we would be able to carve Washington University's name on the base of the cup, but I was wrong. We were very significantly outmatched in both skill and teamwork. Part of it was that we did not get enough practice for the finals."

However, due to this year's success, increased interest led other engineering students to create a class centered on the competition, and they are practicing much harder in preparation for the next regional contest.

"I expect to win, of course!" says Smart when asked about next year's competition. "I'm optimistic we'll make it to the World Finals."

Two other teams from the University also competed at the Mid-Central Regional round. One team, with members Neil Munjal, Medicine Class of '12; and C.J. Carey and Gordon Sommers, both Engineering Class of '11, finished in eighth place. g

The other team, with members Walker Burgin, Engineering Class of '11; Nathaniel Roman, BSCS '09; and David Ross, BSCS '09, MSCS '09, finished 51 out of 135 teams. ✂



David Hill, davidhillphoto.com

Engineering students Doug Li (far left), Sean Fellows, and Aayush Munjal competed at the 33rd World Finals of the ACM International Collegiate Programming Contest, under the guidance of team coach Bill Smart (far right), assistant professor of computer science.

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the United Kingdom, an award given to fewer than five Americans in more than 50 years. In 2008, he received the Aerodynamics Award for outstanding contributions to aerodynamics; it is the highest national award given by the AIAA in aerodynamics. In 2008, he also was the recipient of the William

Littlewood Award given jointly by AIAA and SAE (Society of Automotive Engineers). Established in 1971, the award has only been given twice to a member of academia. It is normally given to CEOs and senior executives of aerospace companies worldwide. Agarwal received the Fluids Engineering

Award in 2001 from ASME—the highest national technical award given by ASME in fluid dynamics.

Agarwal is working for the U.S. Air Force on developing techniques to predict heat transfer and to design improved thermal protection systems for space access vehicles. ✂

Alumni Profile

By Improving International Communication, Chu Integrates China into the Global Arena

Dedicated to improving international communication in both sports and society, Carol Chu, EMBA '04, focuses on integration between China and the global community. For more than a decade, she worked with the Olympics, serving as the communications advisor to the 2008 Beijing Olympics bid committee and helping organize the games. She also was involved with a global public relations lobbying and crisis management campaign for the games. Chu even trained and managed more than 12,000 volunteers at the Olympics Family Hotel during the games.

In another role, Chu advised the Shanghai government on its bid for the hosting of the 2010 World Expo. During this time, she enrolled in the Washington University–Fudan University Executive MBA Program.

"As senior management for any enterprise, one needs to process the skill to lead and the ability to ask questions," she says. "The Washington University–Fudan University EMBA Program really equipped me with the ability to ask the right questions to formulate the winning solutions to many bid campaigns and business negotiations."

In the past decade, Chu has earned a reputation as the "bid girl" in China for orchestrating a series of award-winning communications campaigns, including the 2009 East Asian Games in Hong Kong, the 2010 Asian Games in Guangzhou, and the 2011 University Games in Shenzhen, China.

"These major projects acted as a catalyst toward social-economical integration between China and the global community," she says. "The intangible legacy they generated also brought a major transformation in perception for the international community on China."

Chu currently serves as the executive director of Mission Hills Group and Mission Hills Golf Club, founded by her father, David Chu. Mission Hills started from a humble origin—a wasteland located between two counties—to become a 12-golf-course facility within 12 years, acclaimed by the *Guinness Book of World Records* as the "World's Largest Golf Club." Other accolades include "Asia's Largest Country Club" (featuring 51 tennis courts, 5-star luxury hotels, and an international convention and exhibition center) and "Best Golf and Spa Destination." The club has other world-class amenities, such as golf academies by distinguished golf instructors.

Over the past 12 years, Chu has negotiated for the golf club to host more than 50 international sporting events, such as staging Tiger Woods' first visit to China in 2001. With her help, the club has been the home of the Omega Mission Hills World Cup, the "Olympics of Golf," for an unprecedented 12 editions.

Chu's work with the Olympics, the World Expo, Mission Hills, and countless other projects has brought recognition to China and helped the country become an increasingly important player in the global community.

Chu and her husband, Brian, reside in Hong Kong, China. ✂



Carol Chu carried the torch for the 2008 Beijing Olympics in recognition of her work with the games.

Courtesy Photo

NEWS BRIEFS

Yokoyama elected to American Academy of Arts and Sciences

Wayne M. Yokoyama, the Sam J. Levin and Audrey Loew Levin Chair for Research on Arthritis, was one of three Washington University professors to be elected fellows of the American Academy of Arts and Sciences. The academy was formed in 1870 to cultivate the arts and sciences and to recognize leadership in scholarship, business, the arts, and public affairs. Yokoyama is internationally recognized for his research into an important component of the immune system that protects against viruses and tumors. A Howard Hughes Medical Institute investigator, he also is professor of medicine, clinical attending physician in internal medicine and rheumatology, and director of the Medical Scientist Training Program.

Mock Trial Program places in top 15 at national championship tournament

After qualifying two teams at the 25th Annual American Mock Trial Association Regional Tournament, the Washington University Mock Trial Program joined 194 other teams at the Opening Round Championship Tournament. Both teams finished in the top 10 at the Opening Round Championship, and one team qualified for the 2009 National Championship tournament. This team placed in the top 15 at nationals. The Mock Trial Program is led by Warren Davis, assistant dean in the College of Arts & Sciences. Team members included Jun Yoon, Ashley Brosius, and Hillary Conkey, all Arts & Sciences Class of '12; Ben Graham, Arts & Sciences Class of '11; Jessica Cooper, Arts & Sciences Class of '10; and Brandon Harper, assistant director of admission at the University, and Whitney O'Byrne, both AB '09.

Lecture focuses on the material culture of late imperial China

The 16th Annual Stanley Spector Memorial Lecture on East Asian History and Civilization featured Susan Naquin, professor of history and East Asian studies at Princeton University. She presented "No Antiques Roadshow! Exploring the Material Culture of Late Imperial China." Naquin discussed how little is known about the material culture of China in the 17th and 18th centuries. She also examined the problem of finding and studying the objects and buildings that made up late imperial Chinese culture using illustrations from her larger research project on Chinese temples and religious paraphernalia. Specializing in the social, religious, and cultural history of China from 1600–1900, Naquin is particularly interested in Qing material culture. Her most recent published work is *Peking: Temples and City Life, 1400–1900* (Berkeley: University of California Press, 2000).

Ye awarded 2009 Spector Prize

Each year, the Department of Biology in Arts & Sciences awards a prize in memory of Marion Spector, a 1938 Washington University graduate who studied zoology under the late Viktor Hamburger. Hamburger was professor of biology and a prominent developmental biologist who made many important contributions while a faculty member at the University. Musi (Audrey) Ye was one of two recipients of the 2009 Spector Prize. He was nominated by his research mentor Maurine Linder, professor of cell biology and physiology at the School of Medicine, for his outstanding work in research and the substantial contributions Ye made to the field. Ye's thesis was "Elucidating the Role of Erd1 in Localization and Function of Pfa3, a Protein Acyltransferase in Yeast."

VOLUNTEER SPOTLIGHT

Stef Saño, Jr., BSSSE '98, MSSSM '03
Assistant Vice President and Head of Project and Process Management at Generali Philippines

Volunteering for Washington University and its growing community in Manila is a steady part of Saño's life. He organizes events with alumni and parents, hosts University guests, welcomes alumni from abroad, and represents the local association at University gatherings and in local forums. Their local association is now a registered nonprofit with the Securities and Exchange Commission: Washington University in St. Louis Association Philippines, Inc.

He volunteers for the University "to gather and learn from the extraordinary talent of alumni and friends, holding activities and events that raise the profile of our community," he says. "In turn, this will create recognition of the University that can translate into prestige and eventually, academic connections or recruitment."

A preface to one of the association's group dinners says it best: "As the local Washington University family grows with each graduating class, we find occasion to renew old ties, make new friends, and nurture those Washington University values and traditions."



Courtesy Photo

Stef Saño helped form a nonprofit organization: Washington University in St. Louis Association Philippines, Inc.

Ahn starts new chapter with pediatrics career

Christina K. Ahn, MA '09, MD '09, a pediatric resident at St. Louis Children's Hospital, worked with Robert Rothbaum, professor of pediatrics, to establish the Family Connection while she attended the School of Medicine at the University. The group, a support program for families of children with chronic gastrointestinal diseases, such as Crohn's disease or ulcerative colitis, connects families of children who have been newly diagnosed with families who have been dealing with the diseases longer. Through her work with the program, Ahn realized she was interested in both pediatrics and gastroenterology. She attended the School of Medicine with an esteemed Spencer T. Olin Fellowship for Women and received a prestigious Doris Duke Fellowship between her third and fourth years of medical school. Ahn's talents extend beyond science and medicine. A violinist since age 3 and a pianist since age 5, she formed a piano trio with her medical school classmates. ✂

Robert Boston



Robert Rothbaum (left), professor of pediatrics, and Phillip Tarr, the Melvin E. Carnahan Professor of Pediatrics, work with Christina K. Ahn on a mannequin in the clinical simulation center. Ahn was mentored by the two professors while a medical student.





glimpses

The McDonnell International Scholars Academy traveled to Washington, D.C., in the spring 2009 semester to gain a better understanding of the American political system.

Joe Angeles

Sundeep G. Keswani (left), a pediatric surgery fellow; Brad Warner, pediatric surgeon-in-chief at the School of Medicine and St. Louis Children's Hospital; and Kate Bernabe, a pediatric surgery fellow, tend to patient Orion Decker in the pediatric surgery unit at St. Louis Children's Hospital.



Robert Boston

Robert Boston



Aaron Hamvas (right), the James P. Keating, M.D., Professor of Pediatrics and director of the Neonatal Intensive Care Unit (NICU) at St. Louis Children's Hospital, discusses the levels of care provided in the NICU to a group of neonatologists from China and to Heather Haeberle (third from left), nurse manager of the NICU.

Kathy Steiner-Lang (left), assistant vice chancellor and director of the Office for International Students and Scholars, meets with Dah-Eun Chung, a freshman biology major in Arts & Sciences.



David Kilper

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