

Bulletin of the



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P&W's New Engine Technology a Game Changer for Airline Industry

"Disrupt: to interrupt the normal course or unity of"
— Webster's New American Dictionary

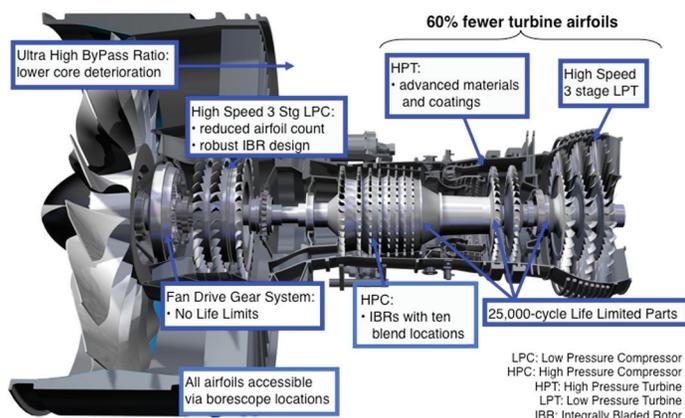
People at Pratt & Whitney like to call their newest engine, the PurePower® Geared Turbofan™ (GTF), "disruptive technology." That is because it has changed the normal course of commercial jet engine development in a very significant way. New airplanes are designed around it. Airlines can look at new routes and new economics. There is a whole new standard of engine performance.

Since the 1960s, improvement in engine performance has been measured at best in single digits. The GTF engine is entirely different:

- Fuel consumption is as much as 16% lower than current, best-performing conventional engines.
- Noise is 15dB – 20dB lower than the latest regulations.
- Nitrogen oxide emissions are 50% below the latest standard.
- Maintenance costs are less than for current engines.

It has been a long and expensive journey for Pratt & Whitney, more than 20 years and \$1 billion in research and development. But the rewards are significant. The company has already sold, or has option orders for, more than 2,000 engines before the first one even enters service. Only a few years ago, industry observers were speculating that Pratt & Whitney would never regain leadership in commercial aviation. Now it is well on its way.

Improvement in commercial jet engine performance depends to a large degree on bypass ratio. That is the amount of air the large fan at the front of the engine pumps outside the engine and the amount of air the fan moves through the engine core, the compressors, combustor and turbines. A 5-to-1 bypass ratio means an engine fan pushes five times the volume of air around the engine as it does through it. Since the introduction of the turbofan engine in



In the PW1000G engine, a gearbox between the turbine and the fan results in quieter, more efficient performance. [Graphic: Pratt & Whitney, a United Technologies Company]

Pratt & Whitney's Paul Adams to Present Keynote Address at CASE Annual Dinner

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the 1960s, engine builders have gradually increased the bypass ratio to 5 or 6-to-1 on single-aisle aircraft and as much as 8-to-1 on the largest wide body aircraft. The concept is that it is more efficient and quieter to accelerate a large amount of air relatively slowly around the engine than accelerating a smaller volume of air

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From the National Academies

The following is excerpted from press releases and other news reports from the National Academies (www.national-academies.org).

◆ National Research Council Calls for Coordinated Plan to Manage Potential Risks of Nanomaterials

A new report from the National Research Council finds that despite extensive investment in nanotechnology, there is insufficient understanding about the environmental, health, and safety aspects of nanomaterials. The report calls for a "coordinated research plan" to help guide efforts to manage and avoid potential risks, and warns that without such a plan, the "future of safe and sustainable nanotechnology is uncertain." The report found that there has been considerable effort internationally to identify research needs for the development and safe use of nanotechnology, including those of the National Nanotechnology Initiative (NNI), which coordinates US federal investments in nanoscale research and development. It also noted that there has not been sufficient linkage between research and research findings and the creation of strategies to prevent and manage any risks. To help guide research, the report noted the following four research categories, which should be addressed within five years:

- identify and quantify the nanomaterials being released and the populations and environments being exposed;
- understand processes that affect both potential hazards and exposure;
- examine nanomaterial interactions in complex systems ranging from subcellular to ecosystems; and
- support an adaptive research and knowledge infrastructure for accelerating progress and providing rapid feedback to advance research.

http://www.nap.edu/catalog.php?record_id=13347

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very rapidly through the engine. The traditional design, however, involves a compromise in efficiency because the fan and the turbine that powers the fan are linked directly and spin at the same speed.

"From a thermodynamic and aerodynamic standpoint, the turbine wants to run very fast and the fan wants to run very slow," explains CASE member Paul Adams, senior vice president of Operations & Engineering at Pratt & Whitney. "So you trade off between fan speed and turbine speed in a conventional engine."

As fans got bigger, they reached what Adams calls "the inflexion point" where the design tradeoffs create weight and drag issues that overwhelm the improved fuel burn. "Historically, this has limited the ability to improve fuel burn on conventional jet engines," says Adams.

"All these issues made us look at putting a gearbox between the turbine and the fan so each runs at its optimum speed," says

Adams. "When you do that you shift the inflexion point out to a higher bypass ratio." The first generation GTF engines use a gear reduction of about 3-to-1 and can more than double the bypass ratio to 12-to-1 or better for single-aisle applications. "

Pratt & Whitney had been working on the idea of gearing an engine since the 1980s, but airplane builders and airlines were skeptical. They were getting relatively good performance out of conventional designs and fuel prices were relatively stable. Airframers and airlines had to be convinced that introducing a gear system would improve performance while maintaining reliability. The situation began to change with the new century. The rapid growth of the so-called BRIC countries (Brazil, Russia, India and China) as well as the rest of the developing world put a tremendous demand on fuel supplies. As fuel prices climbed, it was also clear that conventional engine designs had reached their limit.

"We recognized that we were not going to get year-over-year incremental improvement, and there was a change where fuel prices were rising quickly and becoming a destabilizing force," says Adams. With oil at more than \$100 a barrel, airlines suddenly saw their fuel prices soaring to where they represented 50% or more of operating costs in what is a slim margin business.

Pratt & Whitney's task now became winning credibility in the marketplace. Would a Geared Turbofan engine be a reliable product that delivered on its promises?

There were lots of doubters when the company announced in 2005 it would build a demonstrator GTF engine. There were no airplanes being built for the engine at that time and there were no customers committed to the program.

Initially the gearbox was a big concern with potential customers. Wouldn't it have to be heavy with a big oil cooler to handle 30,000 horsepower, about the power range of a plane like the Airbus A320? Pratt & Whitney engineers started investigating the issue of cooling a gearbox. They discovered that most of the oil in a conventional gearbox basically "sloshed around" getting hot and did not lubricate the gear teeth efficiently. They designed a gear system for the GTF to direct the oil right on the vital parts and a pump to scavenge oil out for cooling very quickly, keeping the temperature down.

Meanwhile other engineers were completing more than 30 technology readiness tests: roller bearing rig tests, rotating seal rig tests, combustor rig tests, low and high pressure compressor and turbine rig tests. Beginning in 2007, a complete demonstrator engine was ground tested for 250 hours. Then a demonstrator engine flew on Pratt & Whitney's 747 flying test bed. The next step was the big one.

"The big thing we did was to build a demonstrator engine and we convinced Airbus to fly it," says Adams. "Even as the economy was crashing around the world in 2008 we found the money to do the demonstrator. We knew it was our strategic future."

Airbus flew the engine on an A340 test aircraft and came back with its verdict. The GTF engine did exactly what Pratt & Whitney promised and it could be put into service with the normal schedule and the normal amount of risk of a conventional design.

"Once we flew it everybody understood it could be done," says Adams. "It was this demonstrator program that overcame customer concerns. It's a different aerodynamic scheme with the key being a large diameter, high efficiency, low-speed fan."

Some of Pratt & Whitney's competitors were talking about an "open rotor" system. This would essentially be a very large diameter,

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IN BRIEF

Science and Engineering Notes from Around Connecticut



Biomedical Research

BACTERIA FIGHT FLUORIDE PROTECTION. Yale researchers have uncovered the molecular tricks used by bacteria to fight the effects of fluoride, which is commonly used in toothpaste and mouthwash to combat tooth decay. Researchers reported that sections of RNA messages called riboswitches—which control the expression of genes—detect the build-up of fluoride and activate the defenses of the bacteria, including those that contribute to tooth decay. “These riboswitches are detectors made specifically to see fluoride,” said **Ronald Breaker**, the Henry Ford II Professor and chair of the Department of Molecular, Cellular and Developmental Biology and senior author of the study. Fluoride in over-the-counter and prescription toothpastes is widely credited with reducing dental cavities. This effect is largely the result of fluoride bonding to the enamel of teeth, which hardens the teeth against the acids produced by bacteria in the mouth.

GENDER AFFECTS ADDICTION. When it comes to addiction, sex matters. A new brain imaging study by **Yale School of Medicine** researchers suggests that stress activates areas of the brain associated with craving in cocaine-dependent women, while drug cues activate similar brain regions in cocaine-dependent men. The study, published online Jan. 31 in the *American Journal of Psychiatry*, suggests men and women with cocaine dependence might benefit from different treatment options. **Marc Potenza**, professor of psychiatry, child study, and neurobiology and first author of the study, said the findings suggest that women with cocaine dependence might benefit from stress-reduction therapies that specifically target these cravings whereas men might derive more benefit from cognitive behavioral therapy.

GRAY MATTER LOSS LINKED TO STRESS. Experiencing stressful life events, such as a divorce or job loss, can reduce gray matter in critical regions of the brain that regulate emotion and important physiological functions, according to a recent study by **Yale** researchers. A brain imaging study of more than 100 healthy subjects suggests these differences are apparent soon after stressful events occur and may serve as warning signals of future psychiatric disorders and chronic diseases, such as hypertension and diabetes, said **Rajita Sinha**, the Foundations’ Fund Professor of Psychiatry, and professor in the Department of Neurobiology and the **Yale Child Study Center**. Yale researchers looked at the volume of gray matter—the tissue containing nerve cells and their branching projections called dendrites—in a group of study participants. They found that even the brains of subjects who had only recently experienced a stressful life event showed markedly lower gray matter in portions of the medial prefrontal cortex, an area of the brain that regulates not only emotions and self-control, but also physiological functions such as blood pressure and glucose levels.



Business & Industry

\$1.1 BILLION RESEARCH CENTER GETS GREEN LIGHT. An agreement between the State of Connecticut and Maine-based Jackson Laboratory to build a \$1.1 billion genomic research facility at the **University of Connecticut Health Center** in Farmington was finalized

in January, when the **State Bond Commission** granted final approval to spend \$291 million for the project. Jackson will raise the \$860 million balance through federal research grants. The new facility—to be called **The Jackson Laboratory for Genomic Medicine**—is intended to anchor a planned bioscience cluster known collectively as the **Connecticut Bioscience Collaboration**, part of Governor **Dannel P. Malloy’s Bioscience Connecticut** initiative. Calling the agreement historic, Malloy noted that the project has the potential to make Connecticut one of the top centers in the world for personalized medicine, which tailors treatments to patients based on their genetic makeup. Jackson researchers will collaborate with researchers from the UConn Health Center, the **University of Connecticut School of Medicine** and the **Yale School of Medicine**. “What we’re talking about is the creation of the next generation of jobs,” said Malloy. Jackson’s president and CEO, Edison Liu, said the ultimate goal of the collaborative project is to apply new technologies to help people live longer and healthier lives. “If we are successful here in Connecticut, we can imagine a future where your doctor can scan your genome and that of your cancer and tailor a treatment that is personalized and unique for you that will work better than anything we have today,” he said. **Centerbrook Architects and Planners** in Essex will partner with a Cambridge, MA, firm, Tsoi/Kobus & Associates, to design the 173,000-square-foot facility, to be built on 17 acres near the UConn Health Center.

SOLARCITY TO SETTLE IN HARTFORD. California’s SolarCity—the largest installer of solar panels in the United States—is relocating to Connecticut, drawn by the state’s renewable energy credits. The company expects to sign a lease for **Hartford** office space, authorities say. SolarCity is the largest of at least half a dozen solar panel installers that have moved their operations to Connecticut since passage last July of the state’s energy-reform law, which created several programs to fund renewable energy. The San Francisco company has a 14% share of the solar-installation market and operates 25 centers in 12 states, including Massachusetts, New York, New Jersey and Maryland.

HIRE FOR ATTITUDE, TRAIN FOR SKILLS. Shelton power manufacturer **Lex Products** utilizes a rare, yet simple, solution to address the workforce shortage in Connecticut manufacturing: hire people who fit into the company’s culture; train them for the job they were hired to do; and retain them with enough compensation, promotions and respect that they stay with the company. “We haven’t had the hurdles that other companies have been experiencing,” Lex’s president **Mike Scala** said. Manufacturers often hold positions vacant for months or years searching for the right candidate to step immediately into productivity. They fear spending the time and money training a new hire and then losing that new asset to a higher-paying competitor. Scala said the expectation of a new hire stepping immediately into a productive role is unrealistic. Manufacturing work is unique to each individual company, so any new employee will need training on the company’s equipment and practices. “We hire for attitude and train for skills,” Scala said.



Communication

CREATIVE CONNECTICUT PR CORRIDOR EXPLORED. Could southern Connecticut become a marketing-communications rival to New York City’s renowned Madison Avenue? The **Fairfield**

Items that appear in the In Brief section are compiled from previously published sources including newspaper accounts and press releases. For more information about any In Brief item, please call the Academy at (860) 571-7143, write the editors at CASE Bulletin, 805 Brook Street, Building 4-CERC, Rocky Hill, CT 06067-3405, or email us at acad@ctcase.org

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County Public Relations Association (FCPRA) and other marketing-communications pros are pitching a nesting concept they say could become a reality. Together, they are promoting the establishment of a "Creative Corridor" in Connecticut in which Stamford and Greenwich would be the epicenter for marketing and PR pros. One such firm, Euro RSCG Worldwide PR (erwwpr for short)—a unit of France's Havas—has produced a white paper detailing some of the ingredients to enable such a corridor to thrive. "Connecticut is home to a wealth of talent—but all too often, these creative workers are commuting out in the morning and home late in the day," said erwwpr CEO **Marian Salzman**, who also is FCPRA president. "What we're proposing," Salzman said, "is a Creative Corridor that brings talent in, networks it together, and enables it to grow and create lasting value. We think it's vital to the future of the state to engage our communities and optimize the talent here to create a creative and stimulating culture."

COURANT EDITING FARMED OUT TO CHICAGO. When the *Hartford Courant* lands in driveways this fall, it will look much as it has for years—local news, sports, business and features, interspersed with photos and ads. But the nation's oldest newspaper, a local institution since Connecticut was a colony, will be different. Much of the Tribune Co.-owned Courant will be produced in Chicago. Joining the struggling newspaper industry's trend toward centralization, the Hartford paper announced plans this month to outsource all copy editing and design to Tribune Co.'s *Chicago Tribune*, eliminating 19 newsroom positions—about half related to the outsourcing—according to **Rich Graziano**, the Courant's CEO and publisher. "It was a meaningful and significant cost savings," Graziano said. The move to consolidate editing and design is gaining traction as newspaper groups search for ways to offset plummeting ad revenues.



Education & Cognition

COMMUNITY COLLEGES GET MANUFACTURING CENTERS. **Housatonic Community College** (NCC) is one of three campuses in the state selected to host manufacturing centers to train workers, the **Board of Regents for Higher Education** announced in February. The **General Assembly** provided \$17.8 million in bond money to create the centers and expand manufacturing technology programs. The other two colleges participating in the program are **Naugatuck Valley Community College** in Waterbury and **Quinebaug Valley Community College** in Danielson. The center will feature a manufacturing lab, an engineering/design studio and a welding lab to be used to support the college's credit and non-credit manufacturing courses. In addition to creating the manufacturing center at the college, the grant will contribute to the manufacturing laboratories at Housatonic's partner vocational-technical schools, which include **Platt Technical High School** in Milford and **Emmett O'Brien Technical High School** in Ansonia. "We see manufacturing as one of the growth areas in Connecticut," said HCC President **Anita T. Gliniecki**.

CLOSING THE ACHIEVEMENT GAP. The **D.C. Moore Elementary School** in East Haven has invested in technology as a way to address the district's achievement gap, spending more than \$120,000 on 220 iPads and software. By using the equipment, the school hopes to help teachers identify struggling readers faster, use time previously spent reviewing reading assessments to work with students or adjust lesson plans, and offer students another learning tool to use in the classroom. At the halfway point in the school year, educators say that the district's widespread iPad use has had a considerable impact. "They're really serving many purposes

while transforming the environment of teaching and learning. And we can better communicate with parents about student growth and progress over time," said Assistant Superintendent of Curriculum & Instruction **Erica Forti**. She believes that while the money could have been spent on new desktop computers, wireless and mobile technology was more beneficial.

MATH FAIR A WINNER. Spearheaded by **Ron Rapice**, who teaches gifted students in the **Bridgeport Public Schools**, a district-wide math fair with a Wizard of Oz theme took place in February. The fair, which drew more than 200 students in grades one through five along with their parents, was held at the **University of Bridgeport's** student center. Participants were sent through six stations where they were challenged with problems of algebraic thinking; measurement and approximating measures; geometry; estimation; computation; and science/math/technology. The last station included an obstacle course. "I wasn't sure if we could pull off such a huge undertaking," said Rapice, who had help from a number of math teachers, coordinators and curriculum specialists from throughout the district, as well as student volunteers.



Energy

TWO STORM PANEL ISSUES 'WAKE-UP CALL.' Calling the impact on Connecticut of Tropical Storm Irene and the October Nor'easter of 2011 a "wake-up call," the **Two Storm Panel**—a working group formed by Governor **Dannel P. Malloy** in the wake of the two devastating storms to review the state's preparedness, response and recovery efforts—issued its final report in early January. Containing 82 recommendations ranging from utility issues to municipal assistance to statewide readiness, the report found that while there is now considerably more utility and data infrastructure in Connecticut than 25 years ago, the manpower for maintaining those systems has "decreased significantly." The panel's recommendations range from strengthening the state's building code to developing performance standards for power restoration after a storm, along with financial penalties for utility companies that fail to perform. It also called for improving staffing levels and worst-case scenario planning at utility companies and improving collaboration among municipalities, the state and utilities and phone companies for tree trimming. The report is available at http://www.governor.ct.gov/malloy/lib/malloy/two_storm_panel_final_report.pdf.

ENVIRONMENTAL FUND TO INTERVENE IN UTILITIES MERGER. The **Connecticut Fund for the Environment** (CFE) has filed requests for intervention in the state's review of the proposed merger between Hartford-based **Northeast Utilities** (NU) and Boston-based NStar. CFE is not opposing the \$4.7 billion merger between the two utilities, but the fund wants to ensure the 9,500 acres of open space owned by NU remain protected after the merger is complete. The merger first was proposed in October of 2010, and the companies are waiting on approval from the **Connecticut Public Utilities Regulatory Authority** and the Massachusetts Department of Public Utilities. If approved, the merger would create the largest New England utility parent with 3.5 million customers in six electric and natural gas subsidiaries in Connecticut, Massachusetts and New Hampshire, including Berlin-based **Yankee Gas** and **Connecticut Light & Power**.

CUSTOMERS GET NU BILL CREDITS. Hartford-based **Northeast Utilities**, CL&P's parent company, has set up a \$30 million fund to provide bill credits to customers who were still without electricity

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after noon on Nov. 5—eight days after the Oct. 29 storm caused the power outages. CL&P had 225,000 customers eligible for the credit. The company recently announced that 192,000 customers will receive a bill credit, 4,200 declined the bill credit, and 26,000 never responded. The 192,000 who signed up will receive a \$140 storm fund credit on their February bills. The fund disbursements to customers total \$27 million. Another \$1 million each was donated to **Connecticut Food Bank, Foodshare** and **Operation Fuel** in December. CL&P's preparation and response to the storm and subsequent power outage caused public outrage and led to condemnations from local and state officials, including **Governor Dannel Malloy**. NU initially offered \$10 million in bill credits to customers, but after Malloy said that figure was too low, the company increased the amount to \$30 million.



Environment

BED BUG KILLER STRIKES OUT. An insecticide class widely used by pest control experts to kill bed bugs has been found to be of questionable value, according to a **Connecticut Agricultural Experiment Station** scientist. "Pyrethroids—insecticides used for 40 years to combat bed bugs—are still being utilized," said station entomologist **Richard Cowles**, "though their value has been shown to be far less than that of other products." Two years ago, CASE member **John Anderson**, former station director and Emeritus Scientist, invited Cowles to determine how effective various insecticides are against bed bugs. After many laboratory experiments with the blood sucking temporary ectoparasites, Cowles found four products that effectively killed them: Drione, Tempo Dust, Delta Dust, and TechDust. Dust is the key word here, according to Cowles. His tests found that Drione combines a silica aerogel dust, which does the job, with pyrethrin—which he said is largely ineffective.

DEEP ANNOUNCES GREENCIRCLE AWARD WINNERS. The **Department of Energy and Environmental Protection (DEEP)** recognized thirty-seven Connecticut civic organizations, individuals and businesses for their environmental efforts at a GreenCircle Award ceremony in December. "This program marks the thirteenth anniversary of the GreenCircle Award program, which celebrates voluntary efforts, both large and small, that make a difference in our state of Connecticut," DEEP Commissioner **Daniel Esty** said at the event. Since the agency launched the GreenCircle Award program in 1998, approximately 1000 entities have been recognized for more than 1425 projects dedicated to preserving natural resources and protecting the quality of the state's air, water and lands. The GreenCircle Award program is an ongoing award program with award categories for both common and innovative activities in the environmental field. For a complete list of GreenCircle Award recipients and a description of the program, visit the DEEP website at www.ct.gov/deep/GreenCircle.

CHINA'S ENVIRONMENTAL MANAGEMENT REVIEWED. A team jointly led by researchers from **Yale** and Columbia University, has released a report that introduces a framework for assessing China's environmental management and performance. This analysis offers the first independent review of Chinese provincial-level environmental performance by international researchers. The report, "Towards a China Environmental Performance Index," introduces a model framework for environmental performance indicators to assist the Chinese government in tracking progress toward policy goals, as well as recommendations for how the Chinese government can apply more aggressive performance metrics to environmental decision-making. "As the world's most

populous country and second largest economy, China is confronting significant environmental challenges across the board, from air and water quality to natural resource management, waste management, toxics exposure, biodiversity conservation and greenhouse gas emissions," said **Douglas Kysar**, interim director of the **Yale Center for Environmental Law and Policy** and professor of law at **Yale Law School**. Beijing's air quality has dominated recent media headlines with scores of articles demonstrating public concern over hazardous air quality. Much of the debate has stemmed from the failure of the central Chinese government to release accurate air quality measurements and allow public access to data.



Food & Agriculture

FUNGUS THREATENS BOXWOOD. A fungus first seen in the United States last year is threatening to wipe out boxwood—a broad-leaved evergreen plant that is considered one of the staples of the landscaping industry. "We've been working to find a way to kill the fungus since last October," said **Connecticut Agricultural Experiment Station** **Plant Pathologist Sharon Douglas**. Called Boxwood Blight, the fungus infects the plants and in time, reduces them to a state where they appear as "sticks in the ground," according to Douglas. "We have not found any curative fungicides so far," she said, "and are just starting to explore methods to kill it." Called *Cylindrocladium pseudonaviculatum*, the fungus could have a big financial impact on Connecticut's horticulture industry, which uses boxwood for a variety of garden and landscaping needs, Douglas said.

HONEY BEE DEATHS STUDIED. The collapse of numerous honey bee colonies all over the state and nation has prompted seven research institutions to join a study to determine what is killing them and what to do about it. **Brian Eitzer**, an associate scientist at **The Connecticut Agricultural Experiment Station** who has been working on the project for the past four years, pointed out that since 30% of the fruits, vegetables and grains produced in this country would not exist without honey bee pollination, protecting the bees is a "very big deal." Eitzer said the Station has established its own apiaries to conduct the study, funded by a \$40,000 a year grant from the US Department of Agriculture. "We have found a host of problems that are killing honey bees including mice, viruses, bacterial diseases and pesticides," he said. "We sample the pesticides found on dead bees and our goal is to discover what exposure can be avoided or redirected." While some of the causes of the reduction in the honey bee population cannot be eliminated or even mitigated, he said, others can and "we are hopeful our research will lead to solutions that will save many of them."

WINEGRAPE EVALUATION UNDERWAY. **The Connecticut Agricultural Experiment Station** is participating in "NE-1020: Multistate Evaluation of Winegrape Cultivars and Clones," a 29-state study to determine which wine grapes grow best in a specific climate. Assistant Scientist **William Nail** explained that grapes are being grown and studied at two research farms: **Lockwood Farm** in Hamden and **The Valley Laboratory** in Windsor. Supported by funding from the US Department of Agriculture, more than 30 varieties of grapes were planted in 2008 and began producing fruit two years later. "The idea is to determine such things as which winegrape cultivars produce the best yields of high quality fruit for growers in various climates," Nail said. So far, he said, it is too soon to make definitive conclusions, although three varieties of white grapes have not performed well due to fruit rot. Nail explained that there are significant climatic variations in the state, which is why two experimental locations are being used for the project.

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Health

DIABETES IMPACTS EARNING POWER. While the health implications of diabetes are well understood, a new study from researchers at the **Yale School of Public Health** finds that the disease also comes with high non-medical costs for young patients in the form of lost education and future earnings potential. The study was published in the journal *Health Affairs*. "One of our most important findings was the large increases in high school drop outs associated with growing up with diabetes versus not," noted lead author **Jason Fletcher**, an associate professor with the Division of Health Policy and Administration at Yale's School of Public Health. Researchers found that young people with the disease are less likely to earn a high school diploma and that their lifetime earning potential will be significantly curtailed as a result of the disease. High school students with the chronic illness were found to be 6% less likely than their healthy peers to complete high school, and they can also conservatively expect to lose over \$160,000 in earnings over a lifetime. A young adult with diabetes is also 10% less likely than others to find employment, the study found.

GENETIC BASIS OF SOME INFERTILITY FOUND. Researchers at the **Yale School of Medicine** have, for the first time, described the genetic basis of endometriosis, a condition affecting millions of women that is marked by chronic pelvic pain and infertility. The researchers' discovery of a new gene mutation provides hope for new screening methods. The study explored an inherited mutation located in part of the KRAS gene, which leads to abnormal endometrial growth and endometrial risk. "We found that 31% of the women with endometriosis in the study carried this mutation, compared to only 5.8% of the general population," said senior author **Hugh S. Taylor**, professor and chief of the Division of Reproductive Endocrinology and Infertility in the Department of Obstetrics, Gynecology & Reproductive Sciences. Endometriosis, in which uterine tissue grows in other parts of the body, such as the abdominal cavity, ovaries, vagina, and cervix, is often hereditary and is found in 5%-15% of women of reproductive age, affecting over 70 million women worldwide.



High Technology

A QUANTUM LEAP. According to research reported in the journal *Nature* in February, **Yale** physicists have taken another significant step in the development of quantum computing, technology that promises exponentially faster information processing than today's most sophisticated computers. The Yale team demonstrated a way to compensate for quantum computing's intrinsic susceptibility to errors. Quantum computers use quantum bits ("qubits") to represent information. These qubits can take many forms; the Yale researchers made their qubits from "artificial" atoms using superconducting circuits. Any qubit must be able to take either of two states, "0" or "1", or both states simultaneously; quantum computers must be able to correctly recognize and interpret these qubit states. But qubits are prone to accidental changes of state, confounding interpretation. The Yale team, led by CASE member **Robert Schoelkopf**, developed a technique for identifying a qubit's original state, detecting changes and reversing them when necessary, demonstrating for the first time quantum error correction in a solid-state system—an electronic device analogous to a computer chip.

ION TORRENT INTRODUCES NEW SEQUENCING TOOLS. Guilford-based **Ion Torrent Systems Inc.** showed off a new DNA

sequencing machine and chip that it claims can map a human genome in 24 hours for a cost of \$1,000 at the J.P. Morgan Healthcare Conference in San Francisco in February, according to a news release from parent company Life Technologies Corp. Last summer, Ion Torrent reported that it had developed a DNA sequencing technique to target the \$1,000 genome industry goal. At the time, CASE member and Ion Torrent CEO and founder **Jonathan Rothberg** said "Sequencing on an ion semiconductor chip makes the \$1,000 genome both inevitable and predictable." The Ion Proton Sequencer and a new chip, the Ion 318, have begun shipping commercially and are expected to deliver up to 1 Gb of DNA sequencing data per run, 10 times more throughput than the current Ion 316 chip released six months ago, the company said. **Yale University** is one of three institutions that will get the first Ion Proton Sequencers, along with Baylor College of Medicine in Houston and the Broad Institute in Cambridge, according to the company. They are to receive the devices, which are about the size of a desktop printer, before the end of March.



Transportation

TWEED AIRPORT HAS BIG YEAR. The number of passengers flying out of **Tweed New Haven Regional Airport** rose 11% in 2011, its second-busiest year ever. A total of 39,791 passengers left Tweed on US Airways Express flights last year, the second highest number of any year since 1999, when the flights were first offered. The record high came in 2005. Airport Manager **Lori Hoffman-Saunders** attributed the increase to the increasing number of start-up companies and manufacturers in New Haven, driving business interest in the airport. US Airways Express operates several flights a day from New Haven to Philadelphia, allowing passengers to connect to any US Airways destination.

HYBRID BUSES UNVEILED IN HARTFORD. CTTransit recently unveiled its 10 new, larger capacity hybrid buses, two of which are already in service in Hartford. The **Connecticut Department of Transportation (ConnDOT)** and the **Department of Energy & Environmental Protection (DEEP)** previewed the new 60-foot articulated buses. The 57-seat hybrid-electric buses have a flexible connector linking the front and rear units. The buses each cost \$813,100, with the purchase fully funded through federal grants, said **Philip Fry**, CTTransit spokesman. The remaining eight will be rolled out throughout the year in the transit district's Hartford Division. ConnDOT and DEEP officials anticipate that hybrid buses—which have lower emissions and get dramatically better fuel economy than their gasoline and diesel counterparts—will become a major component in bus fleets all over Connecticut.

NEW FAIRFIELD METRO STATION OPENS. After more than a decade of planning and controversy, MTA Metro-North Railroad began train service to the newly built **Fairfield Metro Station** in early December. Every train that stops at Fairfield now stops at Fairfield Metro, which is located midway between the **Fairfield** and **Bridgeport** stations. The station was built by the **Connecticut Department of Transportation** and the **Town of Fairfield**. The station and parking lot is operated and maintained by **Fusco Management Company** for ConnDOT, which owns the entire station facility. Fairfield Metro Station is fully handicap accessible with elevators on each platform. In addition, the new station has two, high-level platforms with full-length canopies that can accommodate 12 rail cars each, along with 1,400 new parking spaces for automobiles. Metro-North said this week that train schedules have been adjusted to accommodate the stops at Fairfield Metro. —*Compiled and edited by Robert C. Pollack*

Mystic Aquarium Offers Hands-On Learning Opportunities for All Ages

Mystic Aquarium is the public interface for the living collections, science and conservation work of its parent organization, Sea Research Foundation, a nonprofit organization whose reach extends worldwide through a unique combination of research, education and exploration initiatives designed to protect our ocean planet. As New England's hands-on aquarium, Mystic Aquarium's 5,000 specimens, 70 exhibits, unforgettable animal encounters, extensive collection of marine mammals—including New England's only beluga whales—and dynamic educational programming offer learning opportunities for people of all ages.

Diving beneath the sunlit seas, Mystic Aquarium's Ocean Exploration Center, a deep-sea exhibit hall sponsored by United Technologies, opens April 12 to showcase the work of CASE member Robert Ballard, Sea Research's renowned oceanographer who famously discovered the sunken Titanic in 1985. Marking the 100th anniversary of Titanic's maiden voyage and sinking, the Ocean Exploration Center is highlighted by "Titanic—12,450 Feet Below," an exciting new exhibit that combines Ballard's innovation with former Disney Imagineer Tim Delaney's vision to bring Titanic's timeless history to life through the eyes of the team that found her. Captivating imagery, breathtaking recreations, emotional soundscapes,



Young visitors meet an African penguin during the Aquarium's popular Penguin Encounter program. [Photo: Mystic Aquarium]

hands-on activities and thrilling entertainment will transport you on a riveting journey to new depths of discovery.

In addition to its regular programming, Mystic Aquarium has more summer camps than you can shake a flipper at; young explorers, animal and nature lovers, and budding marine biologists can all find something to suit their interests. Offered June through August, aquarium camps are for children ages 3 to 17.

Mystic Aquarium, at 55 Coogan Boulevard in Mystic, is open daily year-round. For more information, visit mysticaquarium.org.

From the National Academies *(from page 1)*

◆ Framework For the Future of K-12 Science Education

A new report from the National Research Council offers a framework to serve as the basis for new K-12 science education standards, a framework that represents a significant shift in how science and engineering are taught. Currently, the report says, science education in the United States tends to place too much emphasis on having students learn an unconnected array of facts, and too little on helping them understand how scientists established those facts. The framework describes key practices that all students should learn and be able to do by the time they graduate from high school. It also identifies eight "crosscutting concepts"—ideas that have value across many fields of science and engineering—that students should learn and be involved with over the course of their education. By encountering the same ideas in different fields, students can connect knowledge across many disciplines into a coherent, scientific view of the world. The framework also identifies core ideas in each of four disciplinary fields—physical sciences; life sciences; earth and space sciences; and engineering, technology, and the applications of science—that should be the focus of K-12 science education. All three parts of the framework—the key practices, crosscutting concepts, and disciplinary core ideas—need to be integrated, the report said, if students are to understand how science works. To implement the framework, 26 states have committed to work with the nonprofit education group Achieve to develop new K-12 science education standards. It will then be up to each state whether to adopt the new standards to guide science education in its public schools. Connecticut is not one of the 26 states.

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◆ New Study Calls for Change in Attitudes Toward Pain

At least 116 million adult Americans experience chronic pain each year, costing the nation between \$560 billion and \$635 billion annually in costs related to disability days and lost wages and productivity, according to a new report from the Institute of Medicine. The report found that much of this pain is preventable or could be better managed, and urges coordinated, national efforts of both public and

private organizations to create a cultural transformation in how the nation understands and approaches pain management and prevention. Some of the recommended changes can be implemented by the end of 2012, while others should be in place by 2015 and maintained as ongoing efforts. The report calls on Medicare, Medicaid, workers' compensation programs, and private health plans to find ways to cover pain care. Due to its significant toll on individuals and society, pain warrants a higher level of attention and resources within the National Institutes of Health as well, according to the report. The study recommends that NIH designate a lead institute to move pain research forward and increase the scope and resources of its existing Pain Consortium. NIH, academic researchers, and other public organizations should collaborate with private firms to advance research and development of new and improved therapies.

http://books.nap.edu/openbook.php?record_id=13172

◆ Reuse of Municipal Wastewater Could Augment Future US Drinking Water Supplies

A new report from the National Research Council concludes that new technologies for treating municipal wastewater and reusing it for drinking water, irrigation, industry, and other applications could significantly increase the nation's total available water resources, particularly in coastal areas facing water shortages. It adds that the reuse of treated wastewater, also known as reclaimed water, to augment drinking water supplies has significant potential for helping meet future needs. Moreover, new analyses suggest that the possible health risks of exposure to chemical contaminants and disease-causing microbes from wastewater reuse do not exceed, and in some cases may be significantly lower than, the risks associated with existing water supplies. The report examines a wide range of reuse applications, including potable water, non-potable urban and industrial uses, irrigation, groundwater recharge, and ecological enhancement, and outlines wastewater treatment technologies for mitigating chemical and microbial contaminants, including both engineered and natural treatment systems.

http://www.nap.edu/catalog.php?record_id=13303

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Engine *(from page 2)*

counter-rotating propeller. Although in theory the open rotor has great fuel efficiency, putting a 20-foot diameter set of propellers on a commercial aircraft poses all kinds of installation, noise, and certification issues. It is a concept that has been studied for many years and is many years away from implementation. The GTF demonstrator program proved that the engine could achieve double-digit improvements in fuel burn, noise and emissions today without the issues associated with the open rotor concept.

Another key benefit of the GTF engine is maintenance cost. The engine is so efficient it needs fewer stages; rows of compressor and turbine blades mounted on rotating disks. A conventional engine has nominally 21 to 23 stages. The GTF has 17. That translates into thousands fewer compressor and turbine blades and other parts and thus lower maintenance costs.

The GTF engine will enter service on the new Mitsubishi Regional Jet and the Bombardier C-Series in 2013-2014 and on the Airbus A320neo (New Engine Option) in 2015. It has also been selected by Irkut Corporation in Russia for its new MC-21 commercial airplane. So, in seven years Pratt & Whitney has gone from no new

narrow body airplanes and no customers to four airplanes and 2,000 engines on firm and option order.

Qatar Airways picked the engine for its A320neo aircraft, and the comment of its CEO, Akbar Al Baker, is typical. "We required both the improvement in fuel burn and reduction in maintenance cost which is exactly what the PurePower engine provides." With a nominal service life of at least 30 years, and next generation designs in development, the GTF engine helps build a "bright future" for Pratt & Whitney. For instance, it is estimated that about 2,000 Pratt & Whitney engineers are working on the GTF engine program today.

What about the future? Paul Adams believes today's 12-plus bypass ratio can be moved up to 15 plus and better with the gear ratio going 3-to-1 to 4-to-1. "This is a step in a new configuration that has a lot of potential. We're going to keep bringing new technology to it. It doesn't just stop. There's a lot of runway left."—**Mark Sullivan.**

[Mark Sullivan is a former communications executive at Pratt & Whitney and author of "Dependable Engines: The Pratt & Whitney Story," published by the American Institute of Aeronautics and Astronautics in 2007.]

P&W's Paul Adams to Give Keynote Address at CASE Annual Meeting

CASE member Paul R. Adams, Senior Vice President, Operations and Engineering, at Pratt & Whitney, will give the keynote address at the CASE's 37th Annual Meeting and Dinner, to be held May 31 at the University of Connecticut.

Adams joined Pratt & Whitney, a world leader in the design, manufacture and service of aircraft engines, space propulsion systems and industrial gas turbines and a unit of United Technologies Corporation, from Williams International in 1999. He was appointed to his current position in October 2011.

He currently directs Pratt & Whitney's global Operations and Engineering organizations. His responsibilities include new product development, technology strategy, manufacturing operations, and supply chain management. Previously, he served as P&W's Senior Vice President of Engineering and Vice President of Engineering Module Centers, where he has been instrumental in the development of both the Joint Strike Fighter and Geared Turbofan™ products.