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## Extreme Technology Sites

From the “science of small” to the aerospace frontier, locations that match scientific breakthroughs to public support are reshaping their economies

By Brian Donahue



*Dr. Kelly Tiller and Dr. Tim Riels, leaders of the biofuels initiative at the University of Tennessee, which will build a \$40 million “grass-o-line” plant to create ethanol from switchgrass and other plants.*

**W**hen like-minded business people, education, and public dollars come together, big things can happen. It’s not a prerequisite for technological innovation, but a sampling of locations around the world where scientific breakthroughs are taking place shows that the combination can bring about vibrant economic communities producing leading-edge products and services.

Take the Knoxville-Oak Ridge, TN region, for example. Also known as the Innovation Valley, the Oak Ridge National Laboratory (ORNL) here works in tandem with the private sector and the University of Tennessee (UT) toward common goals that include biotechnology initiatives such as developing alternative fuels, nanotechnology research, and neutron production.

“We have a really unique situation here,” says Dr. Kelly Tiller, an agricultural economist at the university who has helped develop a business plan for the production of biofuels. She notes that with UT managing the ORNL in partnership with Battelle, an Ohio-based science and technology enterprise, researchers can share joint institutes and coordinate efforts. “We have an opportunity to become a hub for a lot of science and for the application of that science,” Tiller says.

This tightly knit research community may soon take the lead in the worldwide race to develop transportation fuel and offset much of our reliance on petroleum-based fuels. Two major alternative fuels projects taking place in the Innovation Valley were announced this year: In June, the U.S. Department of Energy awarded ORNL \$125 million to build a bioenergy science center to address science and technological challenges to cellulosic ethanol production, while UT will build a \$40 million “grass-o-line” plant to create ethanol from switchgrass and other plants. The university will operate the demonstration scale facility in partnership with



*The Spallation Neutron Source, a \$1.4 billion research facility at Oak Ridge National Laboratory, has established a new record as the world's most powerful accelerator-based source of neutrons for scientific research.*

## Mascoma Corp.

“There is a tremendous need for good, sustainable alternatives to using petroleum-based transportation fuels,” says Tiller, adding that the initiative will bring new economic opportunities to farmers for growing switchgrass, and bring jobs and income to the industrial sector. Construction will soon begin on the new biorefinery, which will be about one-tenth the size of a commercial production facility, but will allow researchers to create a system that can be expanded to larger plants across the state in the coming years.

In another part of the Innovation Valley, a three-person biotech startup is doing groundbreaking work to help scientists improve yields of a wide range of crops, including those grown to provide biomass for alternative fuel production. Phenotype Screening Corp., founded in 2004, is located in Seymour, TN, where commercial rent is lower than in Knoxville, says Ronald Michaels, the firm’s technical director. Phenotype, which works with researchers at UT, uses a non-destructive system of studying plant roots that enables scientists to develop stronger, more pest- and drought-resistant crops. The company’s work can also help to improve production of switchgrass, willows, poplars, and other plants used as feedstock in biofuels.

“The understanding of the genetic basis of plant root architecture is important in that roots play a critical role in plant growth. However, compared to the above-ground portions of the plant, there is a profound lack of knowledge,” Michaels says. Phenotype’s method of study is based on the use of low-density growth soil, special plant containers, and low-energy digital X-ray radiography. “Our method is greenhouse stage and nondestructive,” Michaels says, “so a single plant can be followed, and, if it is interesting, it can be planted out in soil and grown to maturity.”

Among the myriad innovations in East Tennessee are recent developments in the field of neutron science—an example of a technological edge lost and regained. Neutron scattering was developed in Oak Ridge in the wake of the Manhattan Project. But in the following decades, larger and more powerful neutron sources were built in Europe and Asia, often forcing researchers to go abroad to perform their experiments. The Spallation

Neutron Source (SNS), a \$1.4-billion research facility at the ORNL, has reestablished U.S. leadership in neutron scattering. Now, many of the world’s top researchers are or will be coming to Tennessee.

ORNL Director Thom Mason says the SNS “will provide scientists with an unprecedented ability to analyze and understand the molecular structures and behaviors responsible for the properties of advanced materials.” In August, the SNS set a record as the world’s most powerful accelerator-based source of neutrons for scientific research.

“As we learn how to make materials stronger, lighter, or cheaper, we can help American industry develop an unlimited variety of new products,” Mason says. For example, new materials might make it

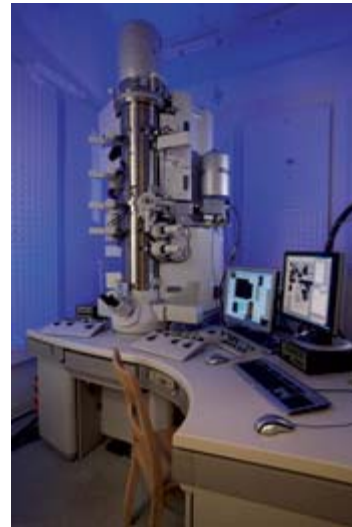


*The National Institute of Nanotechnology in Edmonton, Alberta, Canada*

possible to design lighter airplanes that fly with less fuel or bridges that are more resistant to stress and fracture.

Tennessee is also positioning itself to become the destination of choice in the coming nanotechnology era, according to the East Tennessee Economic Development Agency, which notes that \$2 billion of research facilities will soon be available to companies for work on nanoscale materials. Also, UT is working with ORNL to align its curriculum and training programs to prepare a nanotech-enabled workforce.

Many companies are being drawn to the Innovation Valley by the state, local, and utility incentives offered to new and expanding businesses, economic development officials note. The newly formed East Tennessee Nano Initiative will help companies by offering technology transfer services, capital formation, and incubation and technical business assistance, and will serve as an outreach and public education forum on nanotechnology. Additionally, a public-private partnership called Technology 2020 has established a Center for Entrepreneurial Growth at ORNL to aid startups with advice, mentorship, and other services.



*A transmission electron microscope at the National Institute of Nanotechnology*

Another place where nanotechnology, known as “the science of small,” has become big business is Edmonton, a city in the Canadian province of Alberta. Long known for its oil and gas sector, the city has in recent years established a world-renowned research community centering on the facilities and expertise at the University of Alberta (U of A). Furthermore, the CA \$120 million National Institute for Nanotechnology (NINT) opened its doors at the U of A campus last year. The National Research Council of Canada, the university, and private tenants who lease lab space are sharing the 230,000-square-foot building, which has enhanced Edmonton’s research and development and commercialization capabilities in the biosciences, agri-food, and information and communication technologies.

While NINT researchers use four floors of the building, and the university uses two others, a 30,000-square-foot section called the Innovation Centre has been set aside for industry tenants. This section, a research transfer facility that offers lab and office space, opened earlier this year and is already being used by a handful of local startup firms working on nanotechnology commercialization, says Rick Brommeland, director of business development at NINT. Also, the Xerox Research Centre of Canada operates at NINT, making Xerox the first multinational company to collaborate on research projects there.

“It’s early for us. We’re just beginning to get traffic, and a broader interest on what the value proposition of the center is,” Brommeland says. “But inquiries are becoming more and more steady.”

Brommeland hopes to have the Innovation Centre fully occupied within the next 18 months. “The value proposition is almost last about space, and is more first about the opportunities to get access to expensive equipment,” he says, noting the CA \$40 million worth of the latest generation of scientific tools. Just as important, he adds, is access to the energy and expertise at the institute, the campus, and the city as a whole.

Such assets only raise Edmonton’s place among the world’s leaders in the research and commercialization of nanotechnology, which in practical terms means controlling tiny pieces of matter—atoms and molecules—to produce revolutionary products and processes. According to

Canada's National Research Council, there are 19 commercial organizations now making up the Edmonton nanotechnology cluster. Examples of these are VisibleDust, which uses biochip technology to remove dust from the surface of delicate objects such as digital camera imaging sensors, and BigBangwidth, which uses lightpath technology to bring remote science facilities to individual desktops.

Another Edmonton firm, Quantiam Technologies, is developing wear-resistant materials that are able to withstand extreme environments. The company applies nano-based materials to produce surface coating for parts used in industrial equipment in the aerospace, automotive, mining, and chemical industries, among others.

"Quantiam is a pioneer in the field of nanotechnology with its scientists working at the angstrom level of materials, which is an order of magnitude smaller than nano, before nanotechnology became a popular buzzword," says Steve Petrone, president and founder of Quantiam. "As such, we were very pleased to see the critical elements of a potentially new and strong cluster coming together in the Edmonton area." The company, which obtains some of its staff for R&D and pilot operations from the U of A, is forging strong ties with NINT to collaborate on new product developments, and also for the commercialization of technology developed at the institute.

"Overall, our nanotechnology cluster is in its infancy," Petrone says, "but the critical elements for growth and success are coming together. It needs a few additional elements, primarily a stronger venture capital community, some enhancements to our taxation systems, a stronger alignment by our educational systems ... and then the rest is up to us—the entrepreneurial pioneers forging ahead in this new frontier."

NINT's Brommeland notes that one of the main drivers for the growing cluster in Edmonton is the support of public sector groups that are making funds and technology available. The province of Alberta, for example, recently announced a CA \$130 million investment in nanotechnology, focusing on healthcare, energy, agriculture and forestry, and technology commercialization. The funds will be earmarked over the next five years to grow new nanotech businesses, garner nanotech talent, and build nanotech infrastructure. By 2020, the government hopes, Canada will secure a CA \$20 billion share of the nanotech industry.

## *Extreme Europe*

In Finland, there is a high-tech city that has been developing since the 1970s in an unusual place: just a few hours south of the Arctic Circle. Dark and bitterly cold much of the year, the city of Oulu is a shining example of how industry, education, and economic development organizations can team up to spark a bustling economy in research and development.

The city, which is home to the University of Oulu, became known as a wireless technology hub in the decades since Nokia built an R&D facility there more than 30 years ago. Today, some 800 high-tech businesses, mostly specializing in wireless technology, employ about 18,000 people



*An employee for Gurit, located on the Isle of Wight, checks on the quality of finished wind turbine blades.*

within a region of 230,000 inhabitants, according to Oulu Innovation Ltd., a nonprofit development company that focuses on regional economic development in the high-tech and high-growth business sectors. These sectors realize annual revenue of €5 billion, making Oulu one of the world's most important centers of wireless communication.

While Nokia is known for breaking ground in mobile services, Oulu's innovators span a much broader range. Polar Electro Ltd. developed the first wristwatch heart rate monitor; Buscom Ltd. came up with a zero-contact fare collection system for public transportation; and WinWind Ltd. devised wind turbines that are efficient even at low wind speeds. Among the more exciting startups is Ball-IT, whose Smart Ball Platform is the first wireless consumer-level platform that implements six degrees of freedom motion control, along with revolutionary user interface features. It works as a portable computer mouse, measuring tape, 3-D compass, pedometer and fitness logger, and PC remote control. Another exciting innovation to come out of the city is from Newtest Ltd., which developed a bone health monitor that keeps track of daily exercise, including everyday physical activity.

The two main factors that have helped Oulu become what it is today are Nokia, which employs about 5,000 people there, and the university, which has produced many of the city's researchers and business leaders. But the cooperative relationships between the university, the government, nonprofits, small- and medium-enterprise businesses, and the big companies play such a role that they've given it a name: "Oulu spirit." The city has also been active in directly contributing to technology development, having worked with local companies and research institutions to found a technology village, now called Technopolis, in 1982.

"[Technopolis] was the first science park in Europe, and is today (measured by the number of corporate customers) one of Europe's largest technology center operators, with 13 sites in Finland and operations in many other countries," says Pertti Huuskonen, CEO of Technopolis. "Technopolis is also very active in supporting companies, as it runs separate incubator activities and also focuses on consulting and business development programs, thus being different from traditional science parks."

Another European location that many Westerners may not associate with technological advances is the Isle of Wight, long a holiday resort off the south coast of England. There is no university here, but innovation has been part of the culture for many decades, beginning with pioneering achievements in the aircraft industry. Over the years, innovative ideas have led to new products through "a truly organic process," says Pippa Phillips, marketing and communications manager for the Isle of Wight Economic Partnership. The majority of the scientists and engineers involved in early aircraft-related projects have stayed on the island, developing ideas, passing on skills, and setting up new businesses.

A prime example of this process is Gurit, a composite design and engineering company, which grew out of the Isle of Wight's marine industry and developed partly due to the population's skills in aerospace and automotive innovation. The company's local operation specializes partly in marine design, and in particular, racing yachts. Similarly Vestas Blades, the UK's largest manufacturer of wind turbine blades, also builds on the Isle of Wight's experience in the marine and aerospace industries.

"Because the Isle of Wight has this cluster of like-minded companies, it naturally attracts more [people] who want to be part of our ever-evolving creativity," says Phillips. "The island is small enough to have a real sense of community—people want to help others to achieve success."



Technopolis in Oulu, Finland

Two notable Isle of Wight companies breaking new ground are GKN Aerospace and Radiation Watch. With over 50 years experience in aerospace products, GKN specializes in the design, development, manufacture, and support of turboprop and turbofan nacelles, large composite structures, and primary structures. Radiation Watch provides innovative technological solutions for radiological detection and measurement. From its Isle of Wight base, the company's scientists have developed technology known as Direct Dose Detection, or D3, aimed at solving many of the problems normally encountered in today's radiological instruments, and enabling real-time isotopic measurement in handheld instruments. The business serves a diverse range of customers worldwide in the health, defense, homeland security, and nuclear markets.

Part of the Isle of Wight's appeal, says Phillips, beyond its 60 miles of beach and coastline and the countryside's beauty, is the fact that it is only a 20-minute ferry ride from the international ports of Southampton and Portsmouth, and two hours from London. Also, there are two major universities just 40 minutes away.

## *New Heights in Space Travel*

Back in the U.S., technology is being taken to new heights—quite literally—in New Mexico, where the nascent space tourism industry is being created. Ideal flying weather and wide open spaces have contributed to an expanding aerospace industry that



*Rendering of the entrance at Spaceport America, the first purpose-built commercial space terminal, which will be built starting next year near Las Cruces, NM*

dates to 1929, when Robert Goddard relocated to Roswell, NM to build experimental rockets. Through the decades, the area continued to draw rocket scientists, and in the 1980s and '90s, the White Sands Missile Range was the site of many NASA missions.

The plans for Spaceport America, the first purpose-built commercial space terminal, promise a new chapter in New Mexico's aerospace history. The spaceport, a partnership between the state and Virgin Galactic, will be built starting next year near Las Cruces, NM, located just east of the Rio Grande and home to New Mexico State University.

In September, a team of U.S. and British architects and designers unveiled the design of Spaceport America, which will use passive energy for heating and cooling, with photovoltaic panels for electricity and water recycling capabilities. The low-lying, organically shaped building will be housed under a rolling concrete shell with massive windows that will offer views of the runway and spacecraft. The terminal and hanger are projected to cost about \$31 million, and will include Virgin Galactic's pre- and post-flight training facilities and lounges, as well as a maintenance hangar. The building will also be home to the New Mexico Spaceport Authority.

"The spaceport will set a new standard for how commercial spaceports are constructed and operate," says David Wilson, spokesman for the spaceport authority. "Spaceport America will be a catalyst to the

whole emerging commercial spaceport industry. Once up and operating, the spaceport will advance the aerospace industry.”

In related news, New Mexico officials heralded the recent announcement that Rocket Racing League, an aerospace entertainment organization that is developing a market for low-altitude, rocket-powered aircraft racing, will locate its headquarters and technology development facility in Las Cruces. The 50,000-square-foot building will be located on 10 acres of land donated by the city of Las Cruces. The league will generate revenues through sponsorships, merchandising, ticket sales, video games, broadcast rights, and tours.



*Rendering of a flight at dawn at the Spaceport*

The New Mexico Economic De-velopment Department had Futron Corporation, a technology management consulting firm for organizations in the aerospace and telecommunications industries, study the potential economic impact of Spaceport America and the related Rocket Racing League operation. It estimated that the spaceport has the potential to create \$460 million in new economic activity in New Mexico and 3,460 new jobs by 2015, which could grow to \$550 million and 4,320 new jobs by 2020.

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