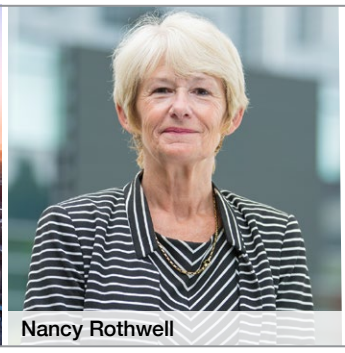

Nancy Rothwell

Konstantin Novoselov

Find the best of both worlds in Manchester

At the 2016 EuroScience Open Forum (ESOF), Manchester will flaunt its stuff. With over £500 million (US$720 million) flowing in from both public and private sources to support new science facilities and research, the city has lots to show off. For job seekers, Manchester offers an atmosphere where industry works seamlessly with academia, making it possible to have a foot in both worlds. **By Gunjan Sinha**

Melissa Denecke was anxious. She had spent the past 30-plus years in Germany—her entire postgraduate and academic career—successfully conducting nuclear-related research. Then in 2011, the Fukushima catastrophe happened. The 15-meter tsunami that hit Japan damaged several nuclear power plants, which then leaked radioactive contamination into the environment. Shortly afterwards, the future of nuclear research in Germany turned grim. The government announced a phase-out of all nuclear power by 2022. "There was a department meeting where I felt very apprehensive about future funding prospects," she recalls. At the time, Denecke was at the Karlsruhe Institute of Technology in Germany, where she was quite content as a department head. But the political fallout from Fukushima made her consider a new home. In 2012, The University of Manchester offered her a job as codirector of its Dalton Nuclear Institute. She jumped at the chance.

At a time when many institutions are scaling back nuclear research, The University of Manchester is forging ahead. The effort is part of a broader initiative to grow the regional economy by identifying the city's strengths and capitalizing on them, says **Michael Contaldo** of New Economy Manchester—an organization created to help Greater Manchester's economy grow. "Science is a key area," he says. Two years ago the university identified five broad research areas in which it already excelled and classified them as "research beacons." Those beacons are energy (including nuclear), advanced materials, industrial biotechnology, cancer, and addressing global inequalities. The beacons highlight areas of excellence and impact within a diverse range of inquiry to give focus and demonstrate "how some of our best research is being used to solve global challenges," says Professor Dame **Nancy Rothwell,** the university's president and vice-chancellor. "We asked ourselves, 'What is Manchester excellent at?' We needed to define that."

In all five beacon areas, major developments are either already in the works or planned for the near future—developments that will strengthen the authority and reputation of both the university and Manchester itself. The initiative places a strong emphasis on application and translation: Industry is either already involved or will be heavily courted. Manchester already has a strong history of collaboration with industry, says Rothwell. By focusing on the research beacons, the university hopes to attract even more investment to the city. Outsiders have taken note of its massive investment in science: ESOF, Europe's largest scientific meeting, chose Manchester as the European City of Science for 2016, and the city will host the biennial ESOF meeting this summer.

For job seekers, synchronicity between academia and industry means that students and researchers have many opportunities to experience both worlds, Rothwell adds. Manchester's expansion as a technological science hub also brings more opportunities than ever to study or work in the city.

Energy research

Manchester's prominence in nuclear research spans over two centuries: John Dalton, Ernest Rutherford, and Niels Bohr—to name just a few—all conducted significant research there that helped form modern theories of chemistry and physics. October 2016 will mark the 60th anniversary of the opening of the world's first civil nuclear energy power plant, which was located in northwest England at Calder Hall and decommissioned in 2003. That legacy of nuclear energy development continues today at The University of Manchester in the form of research on new reactor technologies and related areas, says Denecke.

At the Dalton Nuclear Institute, Denecke "wears two hats," she says. She is now the scientific director of Dalton, where she is responsible for coordinating nuclear research at the university; she also holds a chair in chemistry. The university hosts a broad range of nuclear-related research that not only encompasses the operation and decommissioning of nuclear power plants and their fuels, but also cuts across various other disciplines including health, medicine, and the environment. For example, researchers in biogeochemistry study how microbes interact with radioactive elements in the environment—especially long-lived elements such as uranium, plutonium, and neptunium. Other researchers build robots that can be sent to investigate nuclear disaster sites where the status of the radioactive components is unknown.

A huge advantage of carrying out nuclear-related research at Manchester is the university's proximity to Calder cont.>

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Nigel Scrutton


Melissa Denecke

"People come in from different disciplines and they need time to form a community that grows."
—Nigel Scrutton

Hall and Sellafield—a nuclear fuel reprocessing and decommissioning site, and home to the United Kingdom's National Nuclear Laboratory Central Laboratory. These sites provide opportunities to study technologies and processes in the real world. In addition, says Denecke, "We have facilities that are not available elsewhere, like the Dalton Cumbrian facility"—a research facility connected to the Dalton Nuclear Institute that hosts national nuclear research activities. Considered in combination, these resources comprise a vast and almost unparalleled array of equipment available to researchers, she adds.

Through collaboration with industrial partners such as Areva and EDF Energy, the Dalton Nuclear Institute also trains students to work in the nuclear industry. A critical mass of the nuclear workforce will retire soon, says Denecke. The University of Manchester, in collaboration with other universities, industrial partners, and various other agencies, sponsors training centers where students can earn doctoral degrees in areas that target such skill deficits as next-generation nuclear technologies or materials for demanding environments. For anyone looking for an education or a job, "there's a huge range of things that we do," says Denecke. "There are even opportunities in the humanities, such as studying the anthropology of technology."

Nuclear-related research activities are set to expand. Space in the new Sir Henry Royce Institute for Advanced Materials Research—a £235 million (US$338 million) publicly funded facility scheduled to open in 2019 that will be supported by six UK partner universities—is already dedicated to research on nuclear technologies. Among the new center's goals is to accelerate the use of advanced materials in existing and emerging industrial sectors.

Advanced materials research

Another materials research center, the newly opened National Graphene Institute (NGI), aims to capitalize on Andre Geim and **Konstantin Novoselov**'s isolation of graphene from graphite in 2004, which took place at The University of Manchester and for which they won a Nobel Prize in 2010. At NGI, academics work with industrial partners to investigate new applications of 2D, atomic-scale material. Novoselov, a professor of physics at the university, was very involved in the design of the NGI's new facility. According to Novoselov, the facility was designed with three goals in mind: to expand existing research on graphene, to capitalize on that research by commercializing applications, and to take research on atomic-scale materials beyond just graphene.

Rahul Raveendran-Nair, for example, is developing graphene-based membranes. A few years ago, his lab made graphene oxide—a functional form of graphene—and fabricated it into a multilayer, micrometer-thick, paper-like membrane. The membrane allows only water to pass through, but no other solvents, "not even helium atoms, which are the smallest atoms," he explains. The membrane's most obvious application is to filter water, but it could be developed for other industrial applications as well, he adds.

Raveendran-Nair left India to join a Ph.D. program at The University of Manchester in 2007. He had been studying carbon nanotubes while in India and seized the opportunity to work with graphene pioneers Geim and Novoselov. For his doctoral thesis, he studied the physical properties of graphene, which turned into a landmark paper published in *Science*. "It was a really successful project that gave me a lot of motivation," he says. Working with other researchers, he captured the first image of the atomic structure of graphene and synthesized two new chemical derivatives, graphane and fluorographene. He now runs his own lab and was recently promoted to full professor.

For anyone interested in graphene research, "in terms of equipment, we probably have the best in the world," says Novoselov. In an ironic twist on the scientific method, however, in his case equipment played no role at all—he isolated graphene using double-sided tape! Nevertheless, his no-tech method of achieving this Nobel-Prize winning result is the exception rather than the rule, he says. Equally important in promoting award-winning science is collaboration, he adds. At the NGI, Novoselov has worked diligently to use architecture to create a "collegial" environment that facilitates interaction. The effect, he hopes, will be faster results. "You don't want to have a slow start in redoing what people have done already."

The UK government contributed £38 million (US$55 million) toward the construction of NGI, as part of £50 million (US$72 million) allocated to graphene research; an additional £23 million (US$33 million) came from the European Regional Development Fund (ERDF). Another materials research facility scheduled to open at the university in 2017 is the £60 million (US$86 million) Graphene Engineering Innovation Centre. It has been financed through a combination of public and private funds. The centre's goal is to accelerate applied R&D of advanced materials in partnership with other research organizations and industry.

Industrial biotechnology

Taking **Nigel Scrutton's** experience at the Manchester Institute of Biotechnology (MIB) as a measure, it takes several years to develop a truly interdisciplinary culture. The MIB opened in 2006, and was the first "university-based, purpose-built interdisciplinary research institute of its kind in the UK," according to the MIB website. Its aim was to come up with biotechnological solutions to problems at the interface of medicine, biology, physical sciences, engineering, mathematics, and computation. The result was researchers from disparate scientific disciplines working together on large, collaborative projects. "It took time to embed a common sense of purpose," says Scrutton, who has been at the MIB since it opened. "These things don't happen from day one. People come in from different disciplines and they need time to form a community that grows."

It was into this well-established interdisciplinary environment that **Eriko Takano** arrived in 2012 to lead synthetic biology research at the MIB. She came from the University of Groningen in the Netherlands, where she had been an associate professor. She was drawn to the MIB specifically because of the environment. "It's time-consuming to make contact with colleagues who aren't around you. Here you can talk to the right people immediately," she says. She also enjoys the collaborative work ethos at MIB as well as the welcoming attitudes toward women.

PHOTOS: MATT THOMAS/THE UNIVERSITY OF MANCHESTER

FEATURED PARTICIPANTS

Cancer Research UK Manchester Institute
www.cruk.manchester.ac.uk

Dalton Nuclear Institute
www.dalton.manchester.ac.uk

EuroScience Open Forum
www.esof.eu

International Centre for Advanced Materials
www.icam-online.org

Manchester Cancer Research Centre
www.mcrc.manchester.ac.uk

Manchester Institute of Biotechnology
www.mib.ac.uk

New Economy Manchester
neweconomymanchester.com

The Christie
www.christie.nhs.uk

The University of Manchester
www.manchester.ac.uk


Eriko Takano


Rahul Raveendran-Nair

"It's time-consuming to make contact with colleagues who aren't around you. Here you can talk to the right people immediately."
—Eriko Takano

"You really feel like ideas that may be different from the norm are heard and supported."

Takano uses synthetic biology to create microbes capable of producing novel antibiotics and other chemicals. Her team of scientists includes experts in biochemistry, engineering, informatics, and social science.

Public perception of biotechnology in Western Europe remains negative. "We are looking at how we can be really responsible about our innovative technologies and how we can make people aware of the potential benefits of what we are doing," Takano says. "Synthetic biology could potentially revolutionize industrial biotechnology, and MIB is the perfect place to do this research because it is so interdisciplinary."

Cancer research

Manchester has brought the translation from bench to marketplace into life science research as well, particularly in cancer research. **Dan Wiseman's** career exemplifies how integrating basic research and clinical science benefits both researchers and patients. Wiseman is a clinician scientist specializing in acute myeloid leukemia. His lab is located in the Cancer Research UK Manchester Institute, in a building that sits adjacent and is connected to The Christie—the largest single-site cancer center in the United Kingdom, where more than 44,000 patients a year are treated.

The proximity of the two buildings enables Wiseman to treat patients and also use their samples for his research. In his lab, Wiseman studies whether the oncometabolite 2-hydroxyglutarate (2HG), which has been shown to drive leukemic cells to proliferate, can serve as a biomarker to both monitor the disease and its response to treatment. Cells secrete 2HG when the isocitrate dehydrogenase 1 (*IDH1*) or *IDH2* genes are mutated. He also investigates the effects of 2HG inhibitors on cancer cells.

"I can identify patients with these mutations in real time, obtain material for the lab, and take it to the research institute on the same day," Wiseman explains. He says obtaining his own samples allows him to gain a detailed understanding of the clinical context of each individual patient sample, "rather than be at the mercy of the information that has been provided." He is also directly involved with the patients. "It's a great model for integrating clinical and translational research."

The Manchester Cancer Research Centre (MCRC), which moved to a new purpose-built facility last summer, will intensify translational cancer research in the city even more. The new building is a £28.5 million (US$41 million) partnership between Cancer Research UK, The University of Manchester, and The Christie NHS (National Health Service) Foundation Trust, and sits across the street from The Christie. Like the other new buildings that have resulted from Manchester's research initiative, the MCRC is designed to promote collaboration. It will house 150 researchers and clinician scientists, as well as an additional 100 people working in clinical trial design and administration. The Christie has the largest phase 1 clinical trials unit in the world, and its cancer researchers also work closely with industry to take their drugs through trials.

Such an open-arms reception of industry benefits job seekers in myriad ways, says **Robert Sorrell,** British Petroleum's (BP's) vice president of public-private partnerships. Researchers working at the intersection of both worlds "have a much better appreciation of the challenges that industry faces. They can also make more informed decisions as to whether they want to work in industry," he says.

In 2012, BP launched the International Centre for Advanced Materials, with an investment of US$100 million over 10 years. The center is an initiative spearheading research collaboration between The University of Manchester and three other universities, in technologies related to the oil and gas industry. "We have really been impressed with the university's skills in project management and in forming these highly effective collaborations. They really understand what industry needs," Sorrell says. The initiative includes financial support for students and professors; and all projects require a BP mentor, providing academic collaborators with even closer contact to industry.

Manchester's breadth of scientific prowess is unfortunately far less renowned than its soccer teams and music scene, laments Rothwell.

Through the 2016 ESOF City of Science designation, however, she hopes that perceptions will start to change. Indeed, the motto for ESOF is "Science as Revolution," an overarching theme that aims to encourage debate and exploration of how science and technology transforms our lives, as well as a nod toward Manchester's heritage as a science city. The university plans to showcase its cutting-edge research and the opportunities available for anyone to do science in Manchester. "This is a great European city and a fantastic place for science," says Rothwell. "I want people to see and remember that."

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PHOTOS: MATT THOMAS/THE UNIVERSITY OF MANCHESTER