Jonathan Bacon and Benedict du Boulay

Overview: doing science

Sussex in the 1980s was one of the leading places where the study of man as a thinking, feeling, perceiving and active being was thriving. Artificial Intelligence was being taught within the School of Social Sciences as part of the Cognitive Studies Programme which later became the School of Cognitive and Computing Sciences (COGS), and this is what brought me (Benedict du Boulay) here. The essays by Boden, Husbands and O'Shea, and Seth provide vivid evidence of that interdisciplinary intellectual ferment which has continued to this day.

I had wanted (Jonathan Bacon writes) to come to Sussex in 1969 but must have looked too dull on my UCCA form to even get an interview. But I was determined, and when, in the early 1980s, the government decided that British universities needed some invigoration via the New Blood Lectureship Scheme, I finally got in. For my research area, invertebrate neuroscience, Sussex was (and still is) firmly in the Premier League – as attested by Land's essay.

Though neither of us arrived in Sussex until the 1980s, we found a modern institution which was nevertheless still based on the strong vision of its founding fathers, a legacy described in the essays by Harper and Moore. Indeed, many of these science essays, either overtly or by implication, show how the various science disciplines at Sussex were established and subsequently evolved, and in at least one case (Cognitive and Computing Science) emerged *de novo*. Such developments work best when academically driven, though the more parochial responses to the vicissitudes of external research funding, and our own internal organisational changes, have also been strong drivers.

In this increasingly competitive research world, one way to stay ahead of the game has been to continue to develop multidisciplinary and interdisciplinary approaches.

Another way to thrive has been to focus, and drill down deep into a single discipline, as some of the essays describe. Several essays reflect the fruitful crossover of disciplines; for example Prance speaks about her group's work on the intersection of engineering, physics and medicine. In the early decades of the University, this belief in the value of approaching a problem from more than one discipline was reified in the Arts-Science scheme at undergraduate level; in this scheme initially all BA students took at least one mathematical, scientific or technical course, and all B.Sc. students chose something from the arts, humanities or social sciences. This sense that a fully-educated person was a broadly-educated person was very much part of the way things were.

John Gribbin told us that:

> When I came to Sussex as an undergraduate in 1963, the Arts-Science scheme was a major feature of the University's ambitions to provide something new. As a physicist, I can only recapture a flavour of how the scheme impacted on science students, which was generally (and specifically in my case) to create a sense of alarm at the prospect of being forced to think … outside the box. In truth, the requirement was very modest, and required a minimum of effort in finding source materials in the Library and a modicum of skill at writing something a little more literate than the average answer to a physics exam question (my chosen subject was the revival of English Test Cricket after the Second World War). But the rewards, with hindsight, far exceeded my expectations. It forced the student to develop at least some skills in the use of resources, and encouraged an improvement in the ability to communicate well. This clearly did not exceed the expectations of the people who came up with the idea, who realised that even a facetiously chosen topic, if carried through to fruition, would indeed bear fruit. This was for me and most of my peers the first experience of working on a project independently, and directly benefited later and tougher assignments.

This would have pleased John Maynard Smith (JMS) who, at the celebration of 30 years of the School of Biological Sciences (BIOLS), called it 'a bloody disgrace' that the arts had pulled unilaterally out of the scheme.[1] The arts had gradually withdrawn from the scheme from the late-1960s, with the sciences finally stopping in 2005. We hope some semblance of this scheme will come back, and our impending wholesale refreshing of courses and programmes to fit the new shape of the academic year, commencing 2012, affords the opportunity. In the meantime we celebrate our cross-cultural links through the artist in residence scheme. The artist Paul Brown writes:

> Artists, in their search for new modes of expression, have always innovated with technology. Occasionally they have helped new scientific disciplines to emerge. Weaving, an ancient method for storing and re-creating texture and pattern, was formalised as punched cards by Jacquard in the early 19th century and this methodology was adopted first by Babbage, then by Hollerith and Zuse and became an essential enabling technology for the field of digital computing. Then in the 1970's a group of artists, focussed around the Slade School of Fine Art Experimental and Computing Department began working with cellular automata and non-linear deterministic systems and are now recognised as early pioneers of the field that was named, some 10 years after their pioneering work, Artificial Life or A-Life ... So it's not surprising that artists, musicians and other creatives have made a substantial contribution to the work of one of the World's largest A-life centres: the Centre for Computational Neuroscience and Robotics ... at the University of Sussex.

However, not all work in science at Sussex has taken an interdisciplinary route and the organisation of science disciplines into units has always been, in contrast to the early decades of the arts, largely hierarchic and boringly conventional: MOLS for example, was essentially a Department of Chemistry. The essay by Lehmann describes how the outstanding success of the Genome Damage and Stability Centre (GDSC) in understanding the ways in which cells deal with damage to their genetic material has come from a highly focused approach using molecular and cell biology, genetics and biochemistry. The essays from our two Nobel Prize Laureates, Leggett and Kroto, are rooted in their specific subfields of physics and chemistry. Hare provides a fascinating perspective as a D.Phil. student on Harry Kroto's prize-winning work. As Murrell notes in his essay, other Nobel Prize winners, John (Kappa) Cornforth and Archer Martin, came to Sussex after doing their Nobel work elsewhere and worked largely within single disciplines.

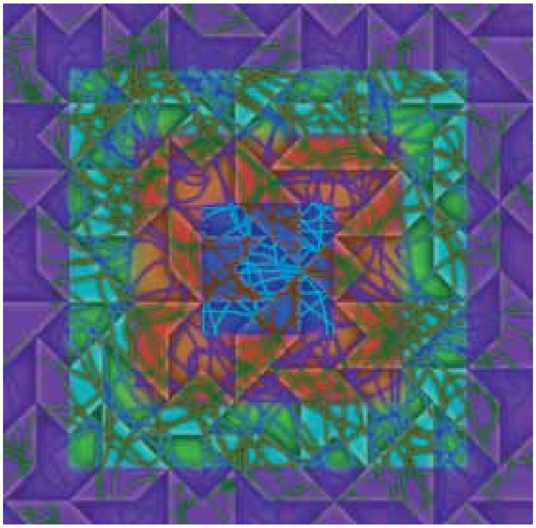
Another part of the Sussex-Nobel Prize saga is the one who got away. Paul Nurse had been using classical genetics in Edinburgh to study the yeast cell-cycle, but felt he needed to take the work into the molecular-genetic realm. He was attracted to Sussex by our growing reputation in bacterial molecular genetics (David Sherratt and Neville Symonds), excellent all-round biology, and southerly climate. He arrived in 1980 for what he described to us as the most interesting four years of his scientific career, and he fondly remembers sitting in the BIOLS tearoom discussing and arguing with JMS and others. He would have stayed but didn't get the lectureship in molecular genetics. Instead, he moved on to the Imperial Cancer Research Fund laboratory in 1984. A big loss, but his work at Sussex was an important element of his major scientific contribution, the understanding of the control of the cell-division cycle for which, along with Tim Hunt and Lee Hartwell, he was awarded the Nobel Prize in Physiology or Medicine in 2001.

When discussing prestigious awards, JMS' many prizes and medals figure large. In particular, the Crafoord Prize awarded to JMS in 1999 is regarded as equivalent of the Nobel Prize in disciplines not covered by the Nobel. So for an institution of our size, we punch way above our weight for science prizes.

In Engineering, much of the work has been within that single discipline, but often with direct links into the world outside the University; here Bayley and Turner discuss our collaboration with Rolls-Royce. Other advances in engineering have also had their effects elsewhere. Denis Edwards, describing the magnetic levitation work from 1965–2002, writes that:

> Professor John Clifford West was appointed Dean of the new School of Applied Sciences in 1965. Distinguished in the fields of control and electrical engineering, John West brought with him from Queen's University, Belfast, Bhalchandra (Jay) Jayawant and Graham Williams. Controlled electromagnetic levitation and suspension, commonly known as maglev, soon became a focus for the research group led by Jay Jayawant. With a grant from the Wolfson Foundation, the first UK 1-tonne passenger-carrying maglev vehicle was completed in 1974; it ran on a 30-metre track in what is now the John Clifford West building.

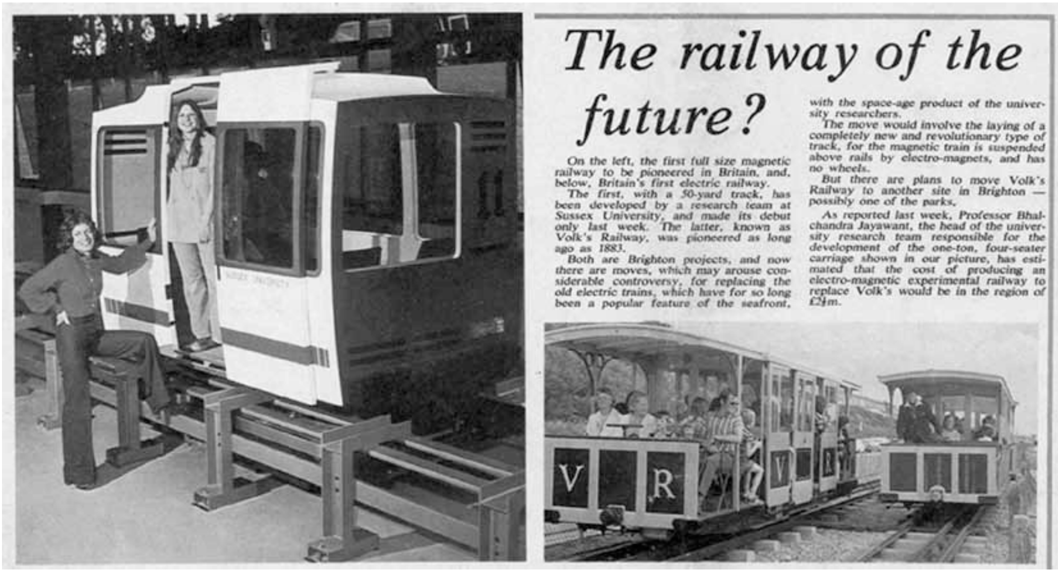
A worker honey bee takes nectar from an artificial flower during a project on 'flower constancy' in the Laboratory of Apiculture and Social Insects (LASI). Undergraduates Heather Moore and Nicola Firmin worked with Professor Francis Ratnieks on this project, which they published in 2011.



Paul Brown, A Hunting of the Quark, Giclée Print, 50 x 50 cm, 2006. Copyright © 2011 Paul Brown. Used with permission of the artist.

Some of these science essays have described major disciplinary changes. For example, the essay by Goldie & Hirschfeld describes the metamorphosis of Mathematics from largely Pure to largely Applied, partly resulting from the need to secure greater research income. Psychology has changed dramatically; from its early origins as geographically dispersed groups, Bond describes its recent merger into a single school. In this discipline, Sussex has become more conventional, and it is working well. The struggle to maintain research momentum and to plan over timescales often greater than the lifetime of the organisational structures is described in the essays by Smith and Liddle. Reductions in the income to Physics and Astronomy forced it to specialise to a much greater extent than it might have wished. The short-term nature of research funding sits uneasily with the long timescales over which fundamental work is planned and executed, and is exemplified in the essay by Grozier on narrowing down the bounds on the value of a particular physics constant – the electric dipole moment. This possible tiny asymmetry at the sub-atomic scale may be linked to the shape, structure and properties of the Universe we inhabit – a powerful argument for the link between Physics and Astronomy as disciplines.

Sussex is not big enough to do everything, and as some disciplines have grown or even emerged *de novo*, it has been inevitable that some areas have declined. One example is Plant Physiology, which was an integral part of JMS's original concept for BIOLS, in which our students should receive a very broad biological education. The founding group comprised James Sutcliffe, Alistair Nielsen, John Hall and David Streeter. Research highlights have included Tim Flowers' contributions to one of the



The railway of the future?

On the left, the first full size magnetic railway to be pioneered in Britain, and, below, Britain's first electric railway.

The first, with a 50-yard track, has been developed by a research team at Sussex University, and made its debut only last week. The latter, known as Volk's Railway, was pioneered as long ago as 1883.

Both are Brighton projects, and now there are moves, which may arouse considerable controversy, for replacing the old electric trains, which have for so long been a popular feature of the seafront, with the space-age product of the university researchers.

The move would involve the laying of a completely new and revolutionary type of track, for the magnetic train is suspended above rails by electro-magnets, and has no wheels.

But there are plans to move Volk's Railway to another site in Brighton — possibly one of the parks.

As reported last week, Professor Bhalchandra Jayawant, the head of the university research team responsible for the development of the one-ton, four-seater carriage shown in our picture, has estimated that the cost of producing an electro-magnetic experimental railway to replace Volk's would be in the region of £2¼m.

Magnetic Levitation. Jo Robinson (left) and June Flanagan are in the main picture. *West Sussex Gazette*, 5 September 1974. Reproduced with permission.

World's major pressing issues, salinity resistance in cereal crops, and Mike Hutchings' groundbreaking work on plant-population biology. Despite this illustrious history, there will be virtually no plant science on the campus by the end of 2011, and no doubt the centenary of Sussex will note the passing of areas now vibrant.

But *doing* science rather than any particular science is the key, and so we conclude our introduction with a thank you for the crucial contribution – described by Burns, Leech and Strong – of the technical and workshop staff who built and maintained the equipment, with which many academic reputations were made.