The importance of maintaining chemistry within universities

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The high profile closure of a number of chemistry departments alongside a string of similar cuts at other institutions led the Royal Society to issue warnings that the subject was in meltdown across the university sector. The argument that chemistry needed expensive laboratories and sophisticated equipment and so, on economic grounds, was not sustainable in many UK universities was seen to gain increased credibility.

It would perhaps be logical to ask why, in this environment, has the University of Central Lancashire relaunched BSc Chemistry with plans to launch a further range of additional defined field chemistry courses? To understand the importance and logic of this decision it is necessary to understand the context in which the science strategy at the University has developed over the last three to four years and to realise the fundamental importance of this essential scientific discipline with respect to some of the key issues facing society today.

What is the future of chemistry?

Chemistry could be simply summarised as the study and manipulation of molecules. It is important in its own right as an intellectual discipline but also for its ability to produce new molecules, materials and methods on which other fields depend.

For the last 50 years, chemistry has focused on a range of problems based on synthesis, catalysis, the understanding of bonding and the development of methods but societal drivers for new technology are changing. The focus is no longer the need for fuels or the need for polymer-derived products such as paints and fabrics. Instead, they are, amongst others, environmental management, public health and new technologies for defence against terrorism.

Chemistry is changing to meet these new challenges and is now engaging with a different set of problems derived from, for example, chemical biology and materials science. The next phase of chemistry is in some ways so different from that of the last 50 years it could be considered a new field(s) of science, connected to the previous by the common themes of atoms, molecules, synthesis, and measurement, but differing in subject, scope, and objectives. It is my belief that such changes will require Universities to adopt a different approach to the subject in the future if we are to be internationally competitive.

How is this new paradigm incorporated into our university science strategy?

Issues of resource are important and the changes to the Faculty have required multi-million pound investment over recent years and changes to the staff profile but one of the biggest challenges was that of the general insular nature of academic departments. The funding systems that support research and teaching do not tend to drive interactions between academic disciplines, and these interactions are essential for the emergence of globally competitive science. Chemistry in the future will I believe remain a core science but its focus and development will be significantly different. The aim at the University of Central Lancashire was not therefore to create a department of chemistry but stimulate couplings of chemistry programmes to physics, biology, environmental science, engineering, and other disciplines to enable a focus on issues and applications within society and industry. This required the creation of multidisciplinary environments which are recognised features of the multidisciplinary research carried out in other nations but which tend to be uncommon in UK universities. These groupings were assembled around key themes but aligned with areas of research strength.

a) Medical Chemistry

Medicinal chemistry is an important discipline for its potential to support the pharmaceutical industry, but it has never been a major part of chemistry departments in the UK. With the creation of a new school of Pharmacy and Pharmaceutical Sciences within the faculty we have been able to invest significantly in research and teaching facilities focused on pharmaceutics. This investment has attracted a number of high calibre research and lecturing staff from the UK (eg Manchester and Imperial) as well as overseas. This will form the focus for a range of courses around pharmaceutics and medicinal chemistry.

The Faculty structure has also been reviewed to bring areas of biomedicine and related areas of bioscience under this same umbrella. It is recognised that the integration of chemistry and biology is important for the future yet is lagging behind in the UK. Here we hope that by bringing specialists together from biology and chemistry with focused investment in medical science we can enable significant progress in this area. Chemical genetics, the use of small molecules to probe cellular pathways, is an example of an area that combines chemical synthesis and cell biology both to reveal metabolic and signalling pathways and to discover potential targets for the early stages of drug discovery.

b) Green and Sustainable Chemistry
There is significant opportunity for chemistry to participate in all aspects of green and environmental chemistry. Low-pollution chemical processing, waste management recycling, atmospheric and environmental science all draw heavily on chemistry. At present, however, in the UK this type of research is still relatively limited. In the faculty we are bringing together expertise around the built and natural environment within one School to focus on issues of sustainability. This work builds on existing recognised research areas within the faculty, such as waste management, which already attracts multi-million pound income streams from industry and European sources.

Sustainable growth depends on the efficiency and nature of energy usage, the sources of raw materials used by industry, and the cleanliness of industrial processes. The new course in chemistry which starts this September has a number of specialist modules with a theme around sustainability – ensuring the students get to compare and contrast new and traditional types of synthesis – comparing yields and by-product formation for example in the two different cases to gain greater understanding of these key issues.

Eliminating the detrimental legacies of past practices, and halting the degradation of the environment by pollution will also require what are essentially chemical solutions. For example, our work in the area of nuclear science and technology, based at Preston and our Institute for nuclear science in West Cumbria, contribute strongly to this theme. We launched the UK's first course in nuclear decommissioning this year with support from the Nuclear Decommissioning Agency and other stakeholders and this has a core chemistry theme.

c) Forensic Chemistry
The UK is just beginning to engage the academic community in work in the area of crime and national security. The US, Israel, Germany, Sweden, Russia, and many other countries entered the area of defence against chemical and biological weapons some years ago, and have much larger and/or more advanced programmes. Organisational structures that promote this type of research and development are generally weak in the UK. The faculty currently leads a national knowledge exchange in this area and has created a School of Forensic and Investigative Sciences – the first to bring together scientists alongside police officers, crime scene officers and members of other uniformed services such as the fire service. Building on our expertise in fire and explosion, policing and analytical and material chemistry, this School has been able to launch a range of Chemistry courses such as Forensic Chemistry and defined field chemistry and looks at applications linked to crime and national security.

The vulnerability of open societies to terrorism is increasingly clear, and unquestionably a matter of national concern in the UK. Chemistry for sensors, agents for decontamination, protective gear, and materials for hardening against chemical, biological and radiological attacks are all key areas of science required to support the development of defences against weapons of mass casualties. New technologies for detection of explosives, materials diagnostic of nuclear weapons, and drugs are also needed and this will require a strong chemistry core.

d) Engineering & Materials Chemistry
Materials science has emerged as a major area of research in chemistry. It combines opportunities for invention and fundamental science with immediate applications in high technology products. While well advanced in other nations, materials chemistry is still taking form in the UK. The field of materials science is not yet as strongly integrated into academic chemistry departments as it is in the US, Japan, the Netherlands, and others.

Nanoscience is an area that requires seamless integration of electrical engineering, applied physics, chemistry, and mechanical engineering, and access to specialised facilities, and to this end these subjects have been brought together in the faculty to focus on a School of Advanced Technologies. This builds on our expertise in tribotechnology and materials (both materials physics and chemistry) coupled to investment in a high performance computing environment to enable advanced molecular modelling. A range of masters courses in nanotechnology and related areas have been developed. This School also enables consideration of all issues in the product cycle hopefully helping address a criticism that materials-related sciences in the UK have, in general, been late to couple synthesis to function.

In summary, we have relaunched our BSc courses in chemistry and will be launching more over the next few years. This has not been, though, in the context of a traditional chemistry department but by recognising chemistry as an integral part of future advances in many of society's priority areas. The research and teaching has therefore been facilitated across areas such as those shown above by creating multidisciplinary environments which aim to facilitate research opportunities at the interfaces between disciplines. It thus represents the type of multicentre, multidiscipline research at which the UK is traditionally weak. Key areas of chemistry research that offer particular scientific and industrial opportunities are therefore supported and the use of such applications as those listed provide the interest for many of the students who select these courses.

Is this a successful strategy? That remains to be seen but in the last few years the Faculty has had one of the fastest growth rates in terms of research in the UK (as measured by key indicators such as peer reviewed output and grant capture), it has attracted significant increases in student demand at undergraduate and postgraduate level, is being successful in recruiting high quality staff from the UK and overseas and is already in the process of launching a number of dedicated overseas Science Institutes based on this multi-disciplinary approach. I believe that as a fundamental science chemistry must be supported but the UK can only afford a limited number of Universities with dedicated chemistry departments large enough to cover the breadth of chemistry needed, and at sufficient level, to be successful internationally. For others, though chemistry as a fundamental science must also be supported, and if the challenges around the insularity of academic areas can be overcome, the above is one approach that may have merit.

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