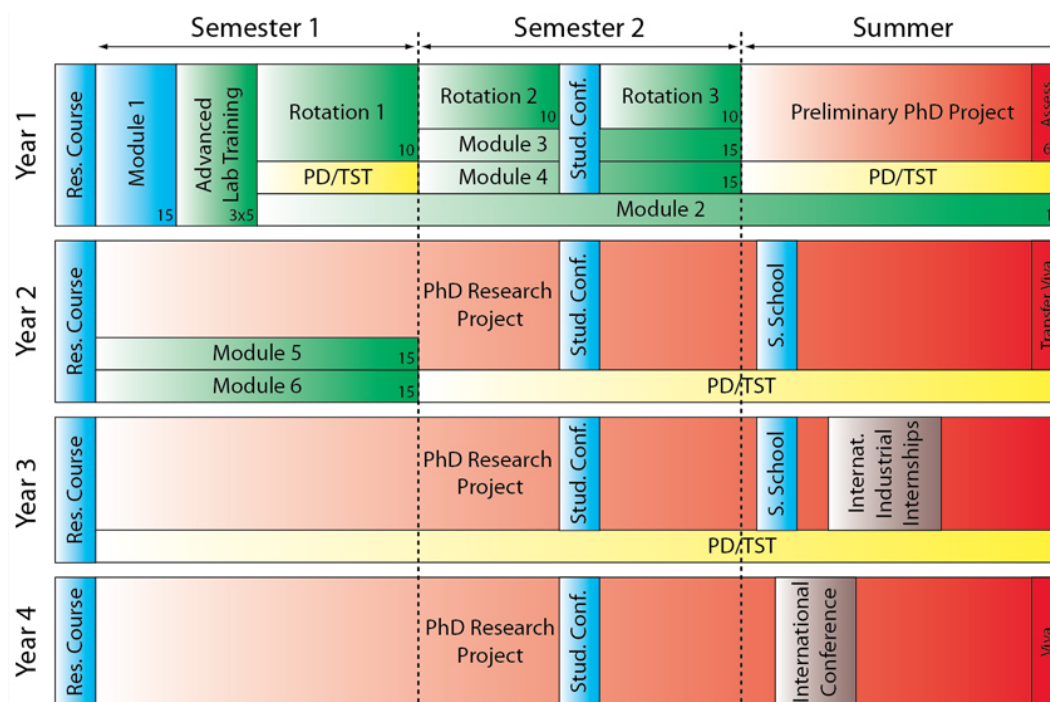




Centre for Doctoral Training in Molecular-Scale Engineering

Universities of Leeds and Sheffield



Year 1

Residential Course

The Centre's programme will commence with a four-day Residential Course, off-campus, to foster personal relationships and build a sense of cohesion. A team-building exercise on one afternoon will be used to deepen relationships. Students will receive plenary lectures from the Director and Deputy Director, and from industrialists and other members of the Centre.

Students will receive a series of presentations from potential supervisors – this will give the students an overview of the scientific scope of the Centre; it will introduce students to a breadth of disciplines and encourage them to begin thinking outside the confines of the subject in which they received their initial degree training; and, it will also give them an idea about the nature of work being carried out and help them choose their laboratory rotations (qv).

The Residential Course will culminate on Thursday afternoon with a lecture by a leading international authority in the control of molecular function at the nanometre scale, an exhibition of posters by second- and third-year students, and a Conference Dinner. The dinner will involve not only the new students, but also students already working in the Centre, academic staff, the international speaker and members of the Industrial and Scientific Advisory Board.

During the Residential Course, each student will be assigned to one of the four investigators (the Management Group), who will act as their personal tutor until the start of their preliminary PhD project (qv). Each student will meet with their tutor at least fortnightly.

Lecture-based Modules

All students will attend four compulsory taught modules in the first year. Immediately after the Residential Course, they will attend the Nanofolio module 'Generic Methodologies for

Nanotechnology' which is delivered at Leeds at the beginning of the academic year over an intensive period of three weeks and which provides a comprehensive overview of preparation and characterisation techniques for nanostructured molecular complexes (Module 1).

In the subsequent time blocks in the first year, students will take the module 'Translational Mechanistic Biology' from Sheffield's Krebs Institute MSc programme which is spread across both semesters (Module 2). Furthermore, they will attend the 'Self-Assembling Nanostructured Molecular Materials and Devices' (Module 3, Leeds) and 'Biophotonics and Bioimaging' modules (Module 4, Sheffield). These carefully selected modules will provide the cohort with a well-balanced training in the fundamental aspects related to their PhD work.

Advanced Laboratory Training

We will provide the students with hands-on experience in key enabling methodologies in the control, manipulation and interrogation of complex molecular environments at molecular resolution.

All students will attend three one-week intensive practical modules where they will be trained in a number experimental and/or modelling techniques. The first two courses are compulsory for all students, and comprise semiconductor clean-room training in the Leeds cleanroom, where the students will fabricate a functional semiconductor device from scratch (e.g. a resonant tunnelling diode); and surface analysis and scanning probe microscopy training, where the students will be trained in atomic force microscopy (AFM) and scanning tunnelling microscopy (STM) in a custom-built laboratory in Leeds, and in X ray photoelectron spectroscopy (XPS) and secondary ion mass spectrometry (SIMS) in the Sheffield surface science laboratory.

For the third training course, the students choose between experimental training in electron microscopy (scanning electron microscopy (SEM) and transmission electron microscopy (TEM)), electron-beam lithography, or on simulation and modelling techniques, including molecular dynamics, quantum chemistry and *ab initio* electronic structure simulations. The advanced laboratory courses will be taught in small groups to ensure adequate hands-on access to facilities, and the students will be sub-divided into two cohorts with mixed composition (i.e. students from both Leeds and Sheffield). The students' performance will be evaluated by continuous assessment and via a short report.

Transferrable Skills Training (TST) and Personal Development (PD)

Besides offering subject specific training, the Centre will also provide a wide range of generic skills training. In the first semester, the students will attend generic health and safety training (specialized H&S training will be provided later), as well as the popular two-day 'Starting Your PhD' course. These courses are delivered by specialised personnel in the Faculty of Engineering at Leeds. In the second semester, a course on 'Finding and Managing Information for your PhD' will be delivered by the Leeds library. The students will also attend a course on 'Writing for Academic Publication' in Sheffield.

Rotations

A further component in our strategy of broadening students' experience will be a requirement that they complete three 'Rotations' in different areas. In each Rotation, students will be embedded in a research group to gain an understanding of the problem on which the group is working and experience the methods used. Students will complete a report following each Rotation, which will be assessed and feedback provided. The students will discuss their selection of Rotations with the Centre's Management Group during one of the formal meetings to ensure that the Rotations align with the student's strengths and interests.

Preliminary PhD Project

After the three Rotations, the students will meet with the management team to discuss their PhD project. Students will only select a PhD research topic and potential supervisory team after they have completed their rotations; we wish to encourage students to leave preconceptions behind when they enter the Centre, and to explore the Centre's research areas with an open mind, from a broad perspective. A student's PhD topic is likely to be based upon one of their Rotations, but not

necessarily. Importantly, the PhD project does not have to be in the same University that the student originally registered.

The students will carry out a six-month full-time 'preliminary PhD' research project in the group of their potential principal supervisor. The project will be designed to lead seamlessly into the main PhD project, should the student decide to carry out his/her PhD in this area. Each project will be cross-disciplinary with a lead supervisor and a second supervisor from different disciplines. Students will meet formally at least fortnightly with both supervisors. These meetings will provide a focus for the reporting of progress and for the provision of feedback by supervisors. Upon completion of the preliminary PhD project, the students will complete a short report, which will be assessed and feedback provided during an informal 'viva'. At the end of each year the students will be provided with a transcript summarizing their progress in the taught component of the programme and listing the elements that they still need to complete. This enables them to keep track of their progress and plan their remaining time effectively.

Year 2

PhD Project

At the start of the second year, the students will meet with the Management Group to discuss their preferences for PhD projects. We anticipate that the majority of the students will be satisfied with the supervisors and research programme of their preliminary PhD project. If, however, the students are not entirely satisfied, the Management Group, together with the preliminary PhD project supervisors and potential new supervisors, will help the student identify a suitable PhD project. Ideally, we would expect this to be in the area of one of their Rotations.

At this point, registration will formally transfer to the Department in which the principal supervisor is based. Each project will be cross-disciplinary with a lead supervisor and a second supervisor from different disciplines. Students will meet formally at least monthly with both supervisors. These minuted meetings will provide a focus for the reporting of progress and for the provision of feedback by supervisors. Each student will additionally be appointed a mentor, not directly involved in the project, who will provide support and guidance on personal development. Students will compile monthly personal development reports signed by the supervisors/mentor, which will be submitted to the Director's office and filed in the student's personal development portfolio (PDP) log. Normal university QA regulations will apply for completion and award of the PhD degree.

Taught Training

The volume of training activities will be scaled down in the second year, reflecting the increase in research. The training in Year 2 will be designed to provide support for these early stage researchers. Students will study two lecture-based modules in the first semester, selected together with their supervisors from the various MSc programmes in Leeds and Sheffield, aligned to the students' research activities.

The Year 2 training programme will also include a series of courses and workshops on transferable research skills. Featured topics will include enterprise (industrial opportunities for nanotechnology, business innovation and nanomanufacturing), ethics and societal issues, and external workshops on presentation skills and on team building using previously tested suppliers. We will also offer a one-day course on 'Intellectual Asset Management' for the students to learn about the assessment of commercial opportunities. In addition, students will attend university courses on research study skills, and paper/poster writing.

Student Conference

Second year students will make poster presentations at the CDT Student Conference (see below).

Summer School

Second and third year students will attend a four-day Summer School in July. The summer school will consist of a programme of intensive advanced-level training on the state-of-the-art in control, manipulation and interrogation of complex molecular environments at the nanoscale, reflecting the particular interests of the Centre and placing them in a wider context. Lectures will be given predominately by specially selected national and international experts, complemented by staff from

the Centre. The Summer School will also be open to attendance by researchers from outside the Centre. This will be an important part of our outreach, and will assist in developing a wider community/network of UK researchers focused on nanoscale molecular control. We will organise the Summer School from the third year of the Centre onwards in order to ensure a critical mass audience; the first cohort of students will instead attend a suitable externally organized summer school in their second year.

Other Activities

Second year students will also make poster presentations on their PhD project to new entrants at the Residential Course (see above).

Year 3

International and Industrial Internships

The student experience will be broadened through internships at carefully selected laboratories of industrial partners and leading international groups, as appropriate to the student project. We have strong academic interactions with a number of international universities, and will also use these funded internships to foster two-way exchanges, facilitating the building of international relationships. Where appropriate, students will also have the opportunity to have an internship based at an industrial research laboratory.

Other Activities

Third year students will make poster presentations on their PhD project to new entrants at the Residential Course (see above). They will also attend the Summer School (see above) and make a poster presentation at the Student Conference (see below).

Year 4

Student Conference

At the mid-way point in the second semester, a one-day Student Conference will be organised off-campus where fourth year students will present their work to fellow students. By this stage, most of their PhD work will be complete, and this event will showcase the accomplishments of the students, and inspire and encourage students earlier in their training. We will invite two external plenary speakers as well as the Industrial and Scientific Advisory Board. The fourth year students will also by now have explored and identified career plans beyond the Centre, guided by their supervisors and mentors; the Conference will be used as an opportunity for the Management Group to liaise with each student on their future plans and assist if necessary.

Thesis

Students will be expected to complete their theses in the four-year period of their studies.

Added value

There are many elements in the above plan that deliver added value compared to a conventional PhD student training programme. These include: the cross-disciplinarity built into the programme; the greater depth of taught material; the hands-on training in the use of state-of-the-art instrumentation, and the associated access to facilities; the greater depth of transferable skills training; the international dimension, encouraging students to aim for world-leading standards of excellence; the involvement of industry, and the opportunity for industrial internships, ensuring that the training remains relevant to national needs; and, the depth and breadth provided by opportunities such as the Summer School.

Above all, we aim to stretch and challenge students. We will create a dynamic environment in which they will strive to excel themselves as they work towards ambitious goals. We will create an environment in which disruptive thinking and innovation are normal, and not the exception.

For further information, please contact Professor Christoph Wälti (C.Walti@leeds.ac.uk).