MSc in Surveying

For entry in September 2013
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1 Introduction

The MSc in Surveying at UCL is a full-time twelve-month programme, run by a department that is renowned throughout the world for its teaching in geomatics, based in one of the world’s premier academic institutions.

The department first ran a surveying programme in 1949, with the first graduates of that course leaving in 1950. Since that time, hundreds of students from around the world have followed them, and you will find our alumni working on every continent.

The equipment that our students use has changed enormously since the early years, and in most respects so have their careers. Once we trained students in the delicate arts of survey observation and they went on to map in detail parts of the world that were only sketchily known about. Now we build our programme around our outstanding research work in areas such as Global Navigation Satellite Systems, Terrestrial Laser Scanning and GIS, and our graduates are just as likely to be working in satellite research, crime scene analysis or on a new railway tunnel as mapping deserts and forests.

However, our core aims for the course are in many ways fundamentally the same: we are interested in producing graduates who understand the underlying principles behind the equipment and methodology that they are using, who can understand its limitations and evaluate its errors, who can work in novel and challenging situations as their careers develop, and who are capable of rising to the top of the profession.

This document gives a full description of the course for prospective students and employers. It includes details of the aims and strengths of the course, the institution, the entry requirements, the facilities available, the research environment and individual projects, professional accreditation and profiles of the careers of some of our students.

I hope that you find the information that you’re looking for here. If you are interested in joining us then I look forward to hearing from you.

Dr Jonathan Iliffe, Senior Lecturer, Head of Geomatic Engineering, Course Director.
2 Structure of the programme

The overall length of the programme is 12 months, split into a first term from September to December, with the modules assessed in early January; a second term runs from January to late March, with assessment in late April/early May. The final part is the individual project, running from May to September.

There are three sections to the course, each given equal weight: the first term taught material; the second term taught material; and the individual project. Each of these is worth 60 credits.

The first term is organised into four 15 credit modules as:

<table>
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<tr>
<th>Data Analysis</th>
<th>GIS Principles and Technology</th>
<th>Principles and Practice of Surveying</th>
<th>Mapping Science</th>
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The second term is organised as:

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<tr>
<th>Positioning</th>
<th>Management/Group Project</th>
<th>Option 1</th>
<th>Option 2</th>
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The optional modules currently available are: Terrestrial Data Acquisition, Airborne Data Acquisition, Ocean and Coastal Zone Management, Geographic Information System Design and Research Methods.

The individual project runs from mid-May to mid-September.

It is possible for students to graduate with a Postgraduate Diploma after following the taught part of the course but not doing the individual project. However, only the full programme, leading to an MSc, is recognised by the Royal Institution of Chartered Surveyors (RICS).
3 Aims and Strengths of the course

Overall aims

The UCL surveying programme aims to provide a broadly based education in geomatics and surveying, combined with a strong practical element. It is a feature of the teaching in the department that we aim to move rapidly from a theoretical classroom-based exposition of a subject to its practical implementation. This practical element might take the form of using surveying or scanning equipment, or it might involve acquisition and processing of GPS data, or handling digital map data, or even using a pencil and paper to work out the functional link between an observational type and parameters to be derived by least squares.

As the above implies, we cover a very broad range in terms of instrumentation on the course. We do cover data acquisition types such as satellite and aerial imagery, and expect students to have an understanding of the use of this in mapping projects, but the main focus is on terrestrial survey equipment, global navigation satellite systems such as GPS, and laser scanning: students gain practical hands-on experience of all of these, and also gain a good understanding of their principles of operation, their limitations and error sources, the environmental factors influencing their operation, and so on.

We also take a very broad view of the application areas that students are likely to be using this equipment in. For example, a terrestrial laser scanner is something that can be used to survey ancient monuments, crime scenes, railway infrastructure, or film sets – we have graduates working in all these areas, and also reflect this in the individual projects.

Acquiring the data is only part of the story, however. We also make sure that our students have a full understanding of issues such as coordinate reference systems, and experience of using geographic information systems to manage and display spatial data. We teach students about project management, and give them experience of working in groups to deliver work under tight time constraints. Importantly, we also place a great deal of emphasis on data quality issues, using mathematical techniques to ensure that data acquired is reliable and fit for purpose.
Strengths and specialisms

So to sum up: why come to UCL? What are the specialist areas that you get from studying here as opposed to anywhere else? We believe that these are:

- Deep study of error theory, least squares analysis and quality control;
- In depth study of GNSS, geodesy, and coordinate reference systems;
- Practical hands-on use of the latest laser scanning equipment;
- Use of latest equipment on a range of survey fieldwork projects.
- Close collaboration of academic staff with industry.
- Opportunity to carry out an in-depth study into one particular topic as part of the individual research project.

These particular strengths can best be illustrated with direct examples.

Study of error theory

Error theory and quality control are taught through the Data Analysis module, and further reinforced through applications in the Positioning and optional modules. For one of the practical assignments in the Data Analysis module the students are given a scenario of a rig being towed offshore from the yard where it was constructed, and its movement along a precisely defined path being monitored. Students are required to devise an observational scheme that meets certain pre-defined requirements for precision and reliability (expressed in terms of the marginally detectable errors being within a defined limit). This has to be simulated mathematically, with the students being responsible for the derivation of all the relevant equations and their implementation in Excel. Having devised the appropriate algorithms, they then refine the observational scheme to meet the quality criteria with the minimum number of observations.

Working with the latest equipment

From the outset of the MSc programme, students gain hands-on experience of the latest equipment. In the Principles and Practice of Surveying module, having received training in AutoCAD, students work in groups and use reflectorless total stations and automatic levels to deliver topographic and detail surveys of an area within the UCL vicinity, and set-out structural designs according to given criteria,
within a realistic engineering survey workflow. Small-scale deformation monitoring is also carried out in this module. In Positioning, students use integrated GIS/GPS Leica Zeno mobile mapping devices, and our Leica 500 and Leica Viva GPS receivers. The Isle of Wight fieldtrip brings together various practical and computation elements. For example, one fieldtrip task is to set-out a road curve and check the results using RTK GPS.

**Collaboration with industry**

We maintain good relations with colleagues in the Geomatics industry. As part of the Mapping Science module, we run an annual MSc Mapping Day with Leica Geosystems. We also welcome a number of industry guest lecturers to our modules, and run visits to organisations such as the Ordnance Survey. A number of our MSc projects are also run in collaboration with industry – including projects with Arup, Plowman Craven, and Leica HDS. These close relationships are also beneficial for recruitment of our students to permanent positions on completion of the MSc.

**Study of Global Navigation Satellite Systems**

One example of student work involves calculating a position fix from GPS pseudo-ranges. Students are given five pseudo-ranges measured by a GPS receiver at the site of Herstmonceux Castle in Sussex at the epoch 2001 9 14 13 45 0.00, as well as the satellite positions in WGS84 at the epoch of signal transmission and the approximate location of the receiver. The students are told to estimate the position (in ECEF Cartesian coordinates) of the receiver, and the receiver clock offset, using all the pseudo-ranges. They are also instructed to assume that the standard deviation of a pseudo-range measurement in metres is the cosecant of the satellite elevation angle. The students have to set up the appropriate observation equations, carry out a linearisation and invert for updated coordinates, using several iterations. The students then convert the answer to latitude, longitude and height. The quality of the position fix must be assessed (analysis of residuals, estimation of variance factor, scaling of covariance matrix) and the GDOP, PDOP, HDOP and VDOP values are to be calculated from the variance-covariance matrix.
Specialising in laser scanning

Terrestrial laser scanning continues to see rapid technological advancement through improvements in data quality, system miniaturisation, the integration with digital imagery and our capability to process and understand vast quantities of 3D spatial data. Widespread adoption by the surveying community makes an understanding and practical ability to use this technology an essential skill for the field surveyor. To address this need, the department has significantly enhanced its laser scanning capabilities with a combination of leading edge research systems including two Arius3D close range colour scanners which are unique in the EU University sector and a metrology class Nikon K-Scan MMDx unit which incorporates not only an optically tracked scan head, but also a touch probe and a photogrammetric tracking system. More conventionally we have a Leica ScanStation 2 which, along with its industry standard Cyclone software, forms our teaching backbone. A phase based FARO Photon 120 system equipped with a Nikon D300s camera and FARO Scene software is shared with the Bartlett school of Architecture and provides a unique opportunity for project work.

Individual MSc projects

Individual MSc projects form one third of the total credit value of the course, and are a means through which students can demonstrate a deep understanding of the subject. The aim of the project is to produce work that has a research element and is in principle of interest to a wider community than those immediately involved. That is, the MSc project is something distinct from a routine professional job and is intended to launch students to some extent into the unknown: in several cases it has led to published papers. In most cases it fosters resourcefulness, as they are expected to act as the liaison point between their academic supervisors and other bodies involved (such as industrial sponsors). In all cases it encourages students to think deeply about their chosen field, to research widely in published literature, and to write clear and concise reports.

This is a significant part of the course – there is a separate section giving examples of students’ individual projects.
In 2009 UCL climbed to fourth place in the annual Times Higher Education - QS World University Rankings, confirming its standing as London’s global university. The meteoric progression up the tables in recent years reflects the outstanding quality of UCL’s community of academics and students. The university is one of the foremost in the UK for research and innovation, and is dedicated to harnessing its exceptional research for positive social and economic benefit: no fewer than 21 Nobel prizewinners have come from the UCL community.

This community continues to pursue the highest standards of academic rigour and has earned admiration in the higher education domain for its strategies to pool research expertise across a wide range of disciplines, to deliver the highest standards in teaching, and to attract the brightest students from all over the globe. Student life at UCL is rich and challenging; we provide the opportunities and leadership in teaching, research, entrepreneurship, volunteering and overseas study. 34% of UCL students come from outside the UK, from approximately 140 countries around the world, and our research reaches the farthest corners of the globe; from the conservation of antiquities in Iraq to the transformation of engineering research in Kazakhstan.

UCL was founded in 1826 as a secular alternative to the universities of Oxford and Cambridge. Prior to this, the benefits of a university education in England were restricted to men who were members of the Church of England. UCL was founded to challenge this discrimination, providing a radical alternative to Oxbridge’s social exclusivity, religious restrictions and academic constraints, thus opening up English higher education for the first time to people of all beliefs and social backgrounds. Today, it remains fervently progressive and is one of the world’s leading multidisciplinary universities, with a global reach and global vision.
5 Research Environment

UCL is a research intensive university. In a department such as Civil, Environmental & Geomatic Engineering, the annual income from research is around £5 million. Rather than being seen as a distraction from teaching students, the philosophy at UCL is that the whole learning experience is enriched by contact with academic staff who are clearly at the forefront of their fields. This is true for staff involved in the MSc in Surveying as it is for all staff, and students on the course come into contact with research into the latest developments in the field.

To give a very brief flavour of this, some examples are given below of current or recent projects in the department that are relevant to the surveying course.

*GNSS positioning aboard vessels*

A recent project led by Professor Paul Cross, and involving PhD student Alex Parkin, and running from 2005 to 2009 has examined the future positioning requirements of the IMO (resolution A.915) and tested the acquisition and processing of data in a marine environment against the IMO requirements.

A data collection exercise was held in Harwich Harbour, in collaboration with Trinity House, and saw *THV Alert* navigate into the harbour whilst GPS data was acquired on board and at reference stations on shore. In addition, total stations at shore based reference stations were used to track the vessel and provide a truth model.

The data acquired was processed under different scenarios and the positioning performance was analysed against the IMO requirements. A principal finding was that providing integrity through single-epoch real-time kinematic positioning, required to meet the strictest IMO requirements, was particularly difficult. However, the work carried out in this project has significantly improved the vital ambiguity resolution success rate, and increased the maximum baseline length over which the highest requirements are met from 1 km to 66 km.

Example impact on MSc teaching: in 2009 Christopher Bubb did an MSc project on “Characteristics and impacts of new GNSS signals”, exploring what the impact of new developments in satellite positioning would be on the offshore industry.
SnakeGrid

The SnakeGrid coordinate system is a means of projecting the curved surface of the Earth onto a flat plane (as with any map projection) but doing it in such a way that the distortion along a long gently curving feature such as a railway is minimised. It was developed at UCL, supported by Network Rail, and first applied to the London to Glasgow West Coast Main Line. After that initial application the software was developed further and has been used to develop very low distortion grids along all the major rail routes in the UK, and some overseas.

The advantage of this system is that as far as a surveyor or a design engineer is concerned, the Earth appears flat over the whole length of a very large project, and there is no distortion between the design and the reality on the ground. The SnakeGrid software can be used as a standalone system to convert between geographic and grid coordinates, or can be incorporated into other programs – such as the SnakeGrid Transformer software used to handle Microstation files.

Example impact on MSc teaching: in 2009 Stephen Hudson did an MSc project on “Performance Characteristics of SnakeGrid”, setting up a series of simulations to test the errors induced in various survey operations by different configurations of the designed grids.

Laser scanning

Recent student projects in laser scanning are highly varied for example Sandrine Whitmore undertook a critical analysis of English Heritage Metric Survey Specifications for Cultural Heritage, in association with Norwich Cathedral using their medieval cloisters as a case study. Given the civil engineering activity in London it is not surprising that engineering monitoring projects have generated student project interest. Notable projects include working with Network Rail at the Shard, where Chris Booth carried out scanning surveys to look at the feasibility of monitoring a column located deep within the structure whilst Thomas King explored the potential of the technique for deep excavation with Skanska. Another project was carried out by Peter Costanzo who drew upon the resources of UCL’s Digital Manufacturing Centre and our close range scanning systems to assess the metric capability of small volume rapid prototyping technologies. These examples are drawn from a broad range of projects which extend from sensor evaluation and modelling, through image and point cloud understanding to a diverse range of real world applications.
6 Equipment and Facilities

The Civil, Environmental & Geomatic Engineering Department at UCL has a suite of dedicated surveying software including Leica GeoOffice, Cyclone, AutoCAD Civil 3D, Clourworx and Starnet. In addition to this specialist software, students also have access to ArcGIS, ENVI, Hypack, Fledermaus, Cadcorp, and GeoDAS. Students are introduced to, and trained in this software throughout the teaching terms and utilise the suite in their individual research projects in the third term.

In July 2011, the department upgraded and enhanced its standard survey equipment. We now have a suite of reflectorless Leica TS06 total stations, one robotic imaging total station, static and RTK GNSS receivers (Leica 500 and Viva kit), a range of automatic levels and 10 new Leica Zeno handheld GIS/GPS devices. We also have a ScanStation 2 and a FARO Photon 120 laser scanner, and on the close-range side we have a Nikon MMD and 2 Arius 3D colour scanners. We also have 2 Nikon D700 digital SLR cameras which are used for photogrammetry.

The laser scanners have been used in MSc Surveying projects to monitor deformation on construction sites; the reflectorless total stations are often used to validate control for a number of laser scanning and GPS projects, and the GNSS kit is frequently used to tie projects into national coordinate systems. As with the software, students are trained in the surveying kit in the first and second terms before using the equipment when undertaking their projects in the summer.
7 Staff

Jan Boehm

Jan Boehm has a background in Computer Science, for which he holds a Masters’ degree from the University of Massachusetts, Dartmouth, USA, and a Diploma degree from the University of Stuttgart, Germany. He holds a doctoral degree from the department of Aerospace Engineering and Geodesy at the University of Stuttgart. Since 2010 has been a lecturer in Photogrammetry and 3D Imaging at University College London. He actively participates in the International Society for Photogrammetry and Remote Sensing (ISPRS), where he regularly serves on organising and programme committees and as a reviewer for related journals. He is co-chair of the ISPRS working group on Image-based and range-based 3D modelling. He serves on the VDI panel for optical metrology, where he works on the the VDI/VDE 2634 guidelines.

He has published more than 50 papers on the topics of close-range photogrammetry, three-dimensional point cloud processing and robotics. His current research projects include creating building information models (BIM) from point clouds, detailed façade modelling from terrestrial and mobile laser scanning and developing a human measurement system from low cost natural user interface sensors.

Jan contributes to the teaching on Mapping Science; Terrestrial Data Acquisition; Airborne Data Acquisition and Image Understanding.

Paul Groves

Paul Groves joined UCL in 2009 after 12 years at DERA and QinetiQ. He leads a programme of navigation and positioning research within UCL’s Space Geodesy and Navigation Laboratory. Paul specializes in the integration and mathematical modelling of all types of navigation system. He is interested in all aspects of navigation and positioning, including multi-sensor integrated navigation, robust GNSS under challenging reception conditions, and novel positioning techniques. Current research projects include GNSS multipath mitigation, positioning using signals of opportunity, pedestrian motion modelling for aiding indoor and outdoor positioning, novel GNSS-based positioning techniques for urban canyons and ultra-low-cost inertial sensors integrated with multi-antenna GNSS.

He is an author of about 40 technical publications, including the book Principles of GNSS, Inertial and Multi-Sensor Integrated Navigation Systems. He holds a BA/MA and a DPhil in physics from the University of Oxford. He is a Fellow of the Royal Institute of Navigation and an associate editor of both Navigation: Journal of the ION and IEEE Transactions on Aerospace and Electronic Systems.

Paul runs the Positioning module and contributes to the Data Analysis and Mapping Science modules, and the Isle of Wight Field Course.
Muki Haklay

Muki Haklay is Professor of Geographic Information Science and the director of UCL Extreme Citizen Science group. The group is dedicated to allowing any community, regardless of their literacy, to use scientific methods and tools to collect, analyse, interpret and use information about their area and activities. His research interests include Public access and use of Environmental Information; Human-Computer Interaction (HCI) and Usability Engineering aspects of GIS; and Societal aspects of GIS use - in particular, participatory mapping and Citizen Science.

He contributes to the Mapping Science module.

Jonathan Iliffe

Jonathan Iliffe's expertise lies in the area of geodesy, and specifically those issues that relate to coordinate reference systems – national or local, on land or at sea. Current or very recent research projects include determining the height corrector surfaces for use in the British Isles (transforming GPS data to the local height system in each country), the UKHO-sponsored VORF project (transforming GPS data to the different coordinate reference systems used on land and at sea) and the development of the SnakeGrid system (which gives near-unity scale factor along very large linear engineering projects such as railways, highways and pipelines). He acts as a consultant on international land and maritime boundary delimitations, and advises governments, survey and engineering companies, and railway organisations on the geodetic aspects of large infrastructure projects. He is the author with Roger Lott of Datums and Map Projections, a standard textbook for students and professionals around the world. In 2008 Jonathan Iliffe was awarded the Richard Carter Prize (Geospatial Engineer 2008) by the Institution of Civil Engineering Surveyors, for his work on SnakeGrid and projects such as OSGM02 and VORF.

Jonathan is the programme director for the Surveying and Hydrographic Surveying courses and contributes to the teaching on Data Analysis; Mapping Science; Principles and Practice of Surveying; Hydrographic Applications and Ocean and Coastal Zone Management.

Richard Simons

Richard's main research interests lie in the field of Coastal Engineering, where he has made a major contribution to the study of wave-current interaction, providing an insight into fundamental fluid processes and related interactions with the seabed. Richard oversaw commissioning and management of the UK’s National Coastal Research Facility at Wallingford, and was influential in the introduction of the UK coastal wave monitoring programme WaveNet (now managed within the UK Coastal Monitoring & Forecasting Service). He has a particular interest in marine aggregate dredging and supervised a recent project using a new cellular automata model to predict the long-term behaviour of the seabed and benthos after dredging. In the broader
field of coastal morphology, another project has applied novel statistical methods to predict long-term morphological development of the seabed. In the field of fluid-structure interaction, extensive tests are being performed to train and validate a neural network model of 3D wave effects around submerged breakwaters, advanced 3D flow measurements are being made to assess the stability of scour protection for various levels of rock misalignment, and an EngD project with HR Wallingford is investigating scour around complex foundations relevant to the marine renewables industry.

Richard contributes to the *Ocean and Coastal Zone Management* module.

**Marek Ziebart**

Marek is Professor of Space Geodesy - this is the science and engineering of using satellites in orbit around planets to measure dynamic characteristics, such as the gravity field, sea level and ice cap variations, as well as plate tectonics. In 2007, GPS World named him as one of the 50 Leaders to Watch for his contributions to the global navigation and positioning industry. He holds a PhD in Satellite Geodesy and Astrodynamics, and is a member of the NASA/CNES Ocean Surface Topography Science Working Team. He is a contributor to news items and documentaries on BBC Radio 1, BBC Radio 4 (Today programme), BBC Radio 5 live, BBC News 24 and the World Service. He has carried out numerous consultancies and research contracts, including for the UK Hydrographic Office, the European Space Agency, Tritech Rail, NASA, US Air Force, QinetiQ, and Ordnance Survey. The UCL Satellite Geodesy and Navigation Research Group has 12 members: 4 academics, 3 PDRAs and 5 PhD students.

Marek contributes to the Positioning, Principles and Practice of Surveying, Ocean and Coastal Zone Management, and Hydrographic Applications modules.

**Claire Ellul**

Claire Ellul joined the department as a lecturer in Geographic Information Science in 2010, following a 10-year career as a GIS consultant in the UK, Europe and the Middle East. She is interested in technical and data-related research in GIS, and specializes in spatial databases and software development. Current research themes include three-dimensional GIS, spatial data management, data quality and metadata and she is conducting research into how to persuade non-GIS research teams to capture and use spatial metadata, the use of GIS in Citizen Science and Community Engagement, teaching GIS principles to researchers from other disciplines.

Claire contributes to the Mapping Science module in Term 1, and runs the Web and Mobile GIS module and contributes to the databases and spatial databases element Geographic Information System Design in Term 2.
Liz Jones

Liz Jones is a Senior Teaching Fellow in Geomatics and a Geomatic Systems Manager. She joined the department after working as a surveyor in the 3D team of Plowman Craven, a UK survey company. Prior to this, she completed an MA in Egyptology (Liverpool) and an MSc in GIS (UCL).

Liz runs the Principles and Practice of Surveying module, teaches on the Terrestrial Data Acquisition and Positioning modules and provides practical support on Ocean and Coastal Zone Management and on the MSc projects.

In addition to this role, Liz is the GIS officer and surveyor for a number of archaeological projects, including the Gurob Harem Palace Project and the Saqqara Geophysical Survey Project. She also maintains the UCLGeomatics blog and is the Departmental Advisor to Women Students.

Dietmar Backes

Dietmar Backes is one of the department’s geomatics systems managers, providing support for the use of equipment and software in the department, particularly focusing on the Lidar and imagery side. He coordinates the Mapping Science module, which draws upon the expertise of several of the departmental staff, and contributes to Ocean and Coastal Zone Management.

Tao Cheng

Tao Cheng is Professor of Geoinformatics and Director of the SpaceTime Lab. Her background is in spatial information science, from the acquisition, management and modelling to application of spatial data. She leads the GIS Principles and Technology module and has supervised MSc projects such as Creating a Global Database of Submarine Landslides for Hazard Prediction.
Stuart Robson

Professor Stuart Robson heads the Photogrammetry, 3D Imaging and Metrology Research Group. His personal research focus is in the traceable on-line dynamic 3D co-ordination and monitoring of engineering, medical and cultural objects and structures using photogrammetric image networks and sequences, vision metrology and laser scanning. Following these themes he has active research projects in the engineering sector with Network Rail, Airbus, NASA and NPL and in heritage with the British Museum, the Science Museum, Arius3D and the SME IET.

He has an on-going programme of continued photogrammetric software development with Prof. Mark Shortis of RMIT University with the Vision Measurement Software (VMS) suite of photogrammetric software which is used by some 30 international research institutions and universities for applications as diverse as the underwater measurement of fish, the monitoring of engineering, aeronautic and spacecraft structures, and the monitoring of active lava flows.

Stuart has contributed to more than 120 publications including co-authoring a major text book, ‘Close Range Photogrammetry: Principles, Techniques and Applications’. For the MSc Surveying programme he contributes to the module on Principles and Practice of Surveying and leads the Terrestrial and Aerial Data Acquisition modules.
8 Programme review and accreditation

In common with other geomatics MSc programmes in the department, the MSc in Surveying is recognised by the Royal Institution of Chartered Surveyors (RICS). This means that passing at MSc level affords an entry route into that institution for graduates of the programme. In order to gain this accreditation, details of the syllabus are supplied to the RICS, and then on an annual basis further information is supplied on qualifications of entrants, destinations of graduates, and so on. There is also an annual “partnership” meeting between the RICS and university representatives, with invited attendees from industry.

The programme, the department itself, and UCL more widely, are subject to a hierarchy of quality control procedures. These start at the level of the individual modules, with a consideration of the marks awarded and any problems encountered, and then work their way up through a consideration of the programme as a whole, the department, and finally UCL itself being subject to external review of its quality control apparatus.

Student feedback into these procedures takes several forms, including questionnaires and round table discussions, but as with any surveying course the experience of working together on field courses means there are many opportunities for students to comment on the programme.

Separately to all of this process there is a system of external examiners to ensure that the academic standards of the degree match the national and international norms. Thus, all exam papers are sent to the external examiner for review before being signed off, they have access to all student work and review the marking, and they are present at the final examiners’ meeting at which degrees are awarded.

9 Entry Requirements

The minimum entry requirement for the MSc in Surveying is an upper second class honours degree in a cognate subject at undergraduate level (generally a BSc). Entrants should also have an appropriate level of background mathematical knowledge.

Examples of cognate degrees would include geography, civil engineering, mathematics, marine sciences, physics, archaeology and geology. The essential point is that before embarking on the MSc in Surveying students should already have followed a programme of study that prepares them for scientific analysis, report writing, the statistical analysis of data, and so on.

The UCL Registry has extensive knowledge and experience of overseas institutions and their marking schemes, and is able to provide an assessment for any applicant of how they compare against UK university standards.

Preparatory reading for entrants

For the appropriate level of mathematics, the advice given to students is that a British “A Level” in mathematics would certainly be sufficient preparation for the course. However, given that not all applicants are likely to have this, more specific specifications are available about the level of background knowledge and the subjects that should be revised before embarking on the course. Essentially,
these advise the students that they are expected to have a basic familiarity with algebra (manipulation of equations, solution of simultaneous equations, quadratic equations, etc.); geometry (properties of circles, concepts of angular measure); trigonometry (definitions and applications of basic functions, expansions of compound angles, application of sine and cosine rules for plane triangles); calculus (differential calculus including application to standard functions); matrices (definitions, simple algebraic functions such as addition, subtraction and multiplication, inversion of small matrices). Students are advised to prepare themselves for the programme by studying these subjects as much as possible before arrival; it is then possible to give a fairly rapid summary of these subjects before immediately proceeding to apply them in practice. An example of a comprehensive mathematics text book to revise from would be:

“Engineering Mathematics” (paperback) by Stroud

Other text books are available if the above is not available locally. Another option would be:

“Maths for Map Makers” (paperback) by Arthur Allan

Average age of students on this MSc

It is worth pointing out that although the minimum age for enrolling on the MSc is 21 (this being the effective minimum for a graduate of a British undergraduate degree) in practice the average age is generally a bit older than this. Some graduates have come to us either with a few years of general experience of work – for example in the IT industry – or have more specific experience of working in surveying and are coming back to university for further study of specialist areas. However, there are plenty of others who have come straight onto the course without any previous experience.

10 Assessment

At the programme level, the minimum standards required are:

MSc Pass:

- 50% weighted course average in ALL taught modules
- No more than 30 credit points at less than 50% (‘condoned fail’ grades may be granted between 40-49% at Board of Examiners’ discretion). No marks below 40% are allowed
- 50% (minimum) in Dissertation

MSc Merit

- 60% credit-weighted average over ALL modules (including Dissertation)
- 65% (minimum) in Dissertation
- No marks below 50%, no condoned fails, no re-sits, and all marks are based on first attempts.
**MSc Distinction:**

- 70% credit-weighted average over ALL modules (including dissertation)
- 70% (minimum) in Dissertation
- No marks below 50%, no condoned fails, no re-sits, and all marks are based on first attempts

*N.B* The taught modules have a weight of 120 credit points. The Dissertation has a weight of 60 credit points.

Individual modules may be assessed either by coursework or by an unseen written examination or by a combination of the two.

A summary of the method of assessment of each module, together with details of the nature of the examination (where assessed by a written exam) or of how many pieces of coursework need to be submitted and what their credit value is (where assessed by coursework) is given in the table below.

<table>
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<tr>
<th>Module Title</th>
<th>Credit value</th>
<th>Assessment</th>
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<tbody>
<tr>
<td><strong>First Term</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GIS Principles &amp; Technology</td>
<td>15</td>
<td>100% Coursework</td>
</tr>
<tr>
<td>Mapping Science</td>
<td>15</td>
<td>100% Exam</td>
</tr>
<tr>
<td>Data Analysis</td>
<td>15</td>
<td>100% Coursework</td>
</tr>
<tr>
<td>Principles &amp; Practice of Surveying</td>
<td>15</td>
<td>50% Exam and 50% Coursework</td>
</tr>
<tr>
<td><strong>Second Term (Compulsory)</strong></td>
<td></td>
<td></td>
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<tr>
<td>Positioning</td>
<td>15</td>
<td>50% Exam and 50% Coursework</td>
</tr>
<tr>
<td>Management/Group Project</td>
<td>15</td>
<td>50% Exam and 50% Coursework</td>
</tr>
<tr>
<td><strong>Options</strong></td>
<td></td>
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</tr>
<tr>
<td>Ocean and Coastal Zone Management</td>
<td>15</td>
<td>60% Exam and 40% Coursework</td>
</tr>
<tr>
<td>Hydrographic Applications</td>
<td>15</td>
<td>60% Exam and 40% Coursework</td>
</tr>
<tr>
<td>Airborne Data Analysis</td>
<td>15</td>
<td>100% Coursework</td>
</tr>
<tr>
<td>Geographic Information System Design</td>
<td>15</td>
<td>100% Coursework</td>
</tr>
<tr>
<td>Research Methods</td>
<td>15</td>
<td>100% Coursework</td>
</tr>
<tr>
<td>Terrestrial Data Acquisition</td>
<td>15</td>
<td>100% Coursework</td>
</tr>
</tbody>
</table>
### 11 Examples of individual MSc projects

Some examples of MSc projects that have been carried out by students on the MSc in Surveying are given below.

<table>
<thead>
<tr>
<th>Name</th>
<th>Project Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benjamin Skelton</td>
<td>Multipath Mitigation using a Dual Polarisation Antenna.</td>
</tr>
<tr>
<td>Nelson Munyamba</td>
<td>Derivation of a Solar Radiation Pressure model of the latest GLONASS satellite.</td>
</tr>
<tr>
<td>Patrick Foster</td>
<td>The integration of satellite positioning and inertial navigation systems in the railway environment.</td>
</tr>
<tr>
<td>Stephen Hudson</td>
<td>Performance Characteristics of SnakeGrid.</td>
</tr>
<tr>
<td>George Lock</td>
<td>Estimation of Post-Glacial rebound rates from Satellite Altimetry and Tide Gauge data.</td>
</tr>
<tr>
<td>Naomi Nazi-Angileh</td>
<td>Evaluating the application of geomatics techniques in crime scene reconstruction.</td>
</tr>
<tr>
<td>Gareth Beddoe</td>
<td>Numerical modelling of tsunami waves.</td>
</tr>
<tr>
<td>Timothy Thwaites</td>
<td>Static GPS validation of improved multibeam positioning using OSNet.</td>
</tr>
<tr>
<td>Christopher Miller</td>
<td>An Assessment of highly elliptical orbits as a platform for improving the availability of EGNOS corrections in urban environments.</td>
</tr>
<tr>
<td>Tom King</td>
<td>Non-contact monitoring of the UCL Hospitals phase three site: a comparison between reflectorless EDM, close-range photogrammetry and laser scanning.</td>
</tr>
<tr>
<td>Vikki Lynch</td>
<td>Terrestrial Laser Scanning for deformation monitoring.</td>
</tr>
<tr>
<td>Gruffudd Roberts</td>
<td>Comparison of four geoid models across mainland UK.</td>
</tr>
<tr>
<td>Peter Hall</td>
<td>Validating sea level change trends in Indonesia</td>
</tr>
<tr>
<td>Daniel Binney</td>
<td>Performance Evaluation of the PrimeSense IR Projected Pattern Depth Sensor</td>
</tr>
<tr>
<td>Yang Song</td>
<td>UCL Navigation App - Indoor Modelling and Augmented Reality</td>
</tr>
<tr>
<td>Hannah Corcoran</td>
<td>A Comparative Study of a Robotic Total Station, Laser Tracker and Terrestrial Laser Scanner for Deformation Monitoring of Points on a Structure</td>
</tr>
</tbody>
</table>
12 Careers and Student Profiles

In this section you can get an idea of the opportunities that are available upon graduating from the MSc in Surveying by looking at the career profiles of some of our past students.

Below are just a few of our graduates from the last twenty years or so. You’ll see that they are working in sectors that include private survey companies, research, rail companies, the construction industry, the oil and gas industry, satellite data companies, and so on. Others work for national mapping agencies, or universities, or have gone on to other careers that make use of the generic skills they have acquired on the course. You’ll also see that they are working not just in the UK but all over the world, and so get an idea of the international reputation of the course.


I had a great time during my MSc in surveying during 92-93; it led me to a career in survey and currently I am the Operations Director of a medium sized Land and Building Surveying business, MSA (Marshall Survey Associates Ltd).

We have about 18 staff and work mainly in London and the South East, with some of the biggest firms dealing with survey in all its forms. We work with the likes of Zaha Hadid, Knight Frank, TilfenLand Land Securities, Amanda Levete Architects, Miller Hare, Ian Ritchie Architects, Westminster City Council amongst many others and we run a RIBA accredited CPD about Laser Scanning to introduce these new technologies to architects

We produce all types of survey covering measured building plans, architectural elevations, 3D models, Rights to Light surveys, View Verification Survey and utilise the latest equipment including an HDS6100 Laser scanner and a C10 laser scanner, Digital Levels, GPS, Total Stations and High accuracy Prism Sets.

The team works well together and all surveyors see their projects through covering both site work, cad work and office work. There is a good level of camaraderie and it is a pleasure to go to work where we continually push the limits of what survey means.


I attended the UCL Masters in 2001-2002 having previously worked on construction projects in Latin America. I was seeking a qualification which would allow me to build a focussed career in the construction industry. The UCL Masters was one of the most challenging and rewarding years of my life and it set me up for the challenging projects that have followed.
Upon graduation I began working for the Severn Partnership in Shrewsbury, and I started work on the railway within the first month. I progressed through the ranks gaining invaluable experience eventually becoming Principal Surveyor. This role then evolved into the current job description of Project Manager; which includes tendering, planning all aspects of the project and liaison with a variety of clients.

I was fortunate to be involved at the start of the Severn Partnership drive to develop laser scanning and have been responsible for the development and management of this area of our business. Numerous projects include Brighton Royal Sussex County Hospital, Sheffield to St Pancras Line Speed Improvement – 70 miles of railway survey and 100 miles of geodetic control.

The Masters provides a solid foundation of the basic principles of surveying and business management which form a platform upon which a successful career can be built.


I completed the MSc in Surveying in 2007-8 following a BA in Geography from the University of Nottingham.

After finishing the course, I joined Jacobs Engineering UK as a Graduate Surveyor based on the Kent Highways Contract. My work involved producing high-order control and detail surveys for major new highway designs. In 2010 I transferred to a different team in Jacobs working as a Surveyor on a variety of Rail, Energy and Environment projects. Whilst in this team I became the lead Rail Surveyor, managing all the Rail work which we completed.

I am currently seconded into the Rail Engineering team as a Construction Manager working to support the Project Managers in the successful running of projects. In addition I am currently awaiting my final RICS chartership interview.

The MSc in Surveying at UCL provided me with a great foundation in both the technical and professional skills required to work in the Engineering industry.

**Stephen Hudson (2008 – 2009)**

Following my degree, I began working for Plowman Craven Ltd, as part of their measured building survey team. Typically, a measured building project will require detailed floorplans, elevations, and sections to be created. Capturing the necessary data is done through a variety of methods and techniques, which are constantly evolving as new developments within the industry are made.
It is the variety in the type of buildings surveyed that ensures there are always new challenges and obstacles that need to be overcome. Projects have varied from a small two bedroom mews house through to a modern city centre shopping mall. Although much of the work is based in and around London, projects I have completed include a survey in Edinburgh, and also Jersey. Exposure to various concepts on the UCL course has ensured I have been in a strong position to determine the most appropriate approach and methods for successful outcomes. The course has also given me a strong grounding in the principles behind many of the commercial survey software packages I use on a regular basis.

Chris Miller (2006 – 2007)

Prior to studying the MSc Surveying course at UCL I was a site surveyor who would only be given a limited amount of responsibility and was battling against numerous other candidates for promotion. The course gave me a fantastic knowledge base and made me stand out from the crowd. In the 4 years since completing the course I have been the lead surveyor on the £200M DLR Capacity Enhancement Project and the £700M Victoria Station Upgrade Project. I recently took up a new role with Plowman Craven as a project manager, overseeing a wide variety of survey work for a broad range of clients.


Having completed my MSc in 2005 I went to work for The Severn Partnership Ltd as a junior land surveyor. I spent the first 3 years travelling around the country surveying railway lines from Somerset to the Scottish Highlands gaining experience in everything from laser scanning tunnels to large scale GNSS survey control networks, installing a few hundred concrete PGM’s along the way!

In between railways I have laser scanned the Valhalla golf course in Kentucky for the 2008 Ryder Cup (which we lost..), laser scanned a quarry on the Isle of Jersey for redevelopment, and carried out numerous surveys of major accident scenes for government organisations.

I am now a project manager for the Severn Partnership with responsibilities ranging from marketing, project tendering and in-house training through to line managing. Stand out projects along the way include managing a survey and aerial photo control network from Dublin to Cork, some 267km, and control...
validation surveys for the Thameslink and Crossrail programmes. These projects have required a sound understanding of Geodesy, Survey Grids, Datums and Map Projections, all of which I can thank the UCL MSc Surveying course for.

**Sook Yee Loh (2006 – 2007)**

In my part of the world, it's not so common to find a woman who wants to do an MSc in Surveying. Looking back, I'm very glad I have chosen this off beaten track because it has opened up many doors for me.

I joined the MSc in Surveying in 2006-2007 under the sponsorship of my previous employer, Singapore Land Authority. I worked in Singapore Land Authority for 3 years on GIS and cadastral surveying area before I started this course. Upon graduation, I took on a bigger role in SLA developing the National Spatial Data Infrastructure before I joined DigitalGlobe in the middle of 2011 working as a Client Services Manager working on projects in the South East Asia, Australia and New Zealand.

The MSc in Surveying in UCL has a very comprehensive and rigorous curriculum. Whilst it focuses on various surveying technologies, it also covers a good breadth of related geomatic engineering topics such as GIS, Remote Sensing and Management, where I have the flexibility to choose the electives that interest me the most.

There is a balanced mix of theories and practical sessions including projects, assignments and field work. It was an enriching experience interacting with course mates who came with diverse background and culture. The academic staff are very knowledgeable on the subject matter and they always give good guidance.

I would highly encourage anyone who wants to build a strong foundation on Geomatic Engineering to take up this course. You will definitely learn a great deal and have an enjoyable time living in central London for a year!


I completed the MSc in 2000. I have worked for three different survey companies since then. Immediately after finishing the MSc I went to work for Capital Surveys based near St Albans. The work load was quite varied from small topographical surveys to large river cross section surveys. After being with Capital for about five years I went to work in Vancouver Canada for a company called McElhanney. The work there was also quite varied. I was involved in some high profile jobs, I was in charge of the survey QC of the ski jump for the 2010 winter Olympics, I was also involved in setting the primary control and QC for the bobsleigh run. During my time in Vancouver I worked for about 18 months on an underground train line that was being built. My role involved setting primary control, setting out and
managing three other survey teams. With three years abroad under my belt I decided to come back to the UK and have been working for the Severn Partnership since then. We work mainly on railways but also do a lot with scanning and 3d modelling.

The MSc course helped me immensely as it gave me the base knowledge that my career has been built on. Experience is very useful but I think you need the academic background to fully understand what you are doing and make a good career in surveying. On a personal note, the course was very good for me as I met my wife whilst doing it.

**Alex Parkins (2004 – 2005)**

I found my MSc project, in which I analysed methods to improve GPS positioning on the railway, enjoyable and rewarding. So much so that immediately after the completion of my MSc, I started a PhD with the same supervisor. My PhD was sponsored by the General Lighthouse Authorities, and I investigated different GPS positioning techniques for the various phases of marine navigation, as well as the potential benefit of the forthcoming European satellite positioning system Galileo. After the completion of my PhD I moved to a post-doc position, also at UCL. In this role I am working with scientists from several other universities as part of the Centre for the Observation and Modelling of Earthquakes, Volcanoes and Tectonics (COMET+). I am currently working with two PhD students to investigate the integration of precise GPS positioning and seismometry for earthquake and tsunami early warning.


I completed my MSc September 2009, and started working for an Engineering Surveyor’s in North Wales later that month. It was a small firm but it had a very good reputation in many different industries. Working there really opened my eyes to the different aspects of design and installation engineering that survey techniques can be used as a solution for. The work was varied - one week I could be monitoring dams in North Wales and the next I could have been erecting steel work at the Olympic Stadiums in London or surveying pipelines on an Oil Rig.

After 18months I chose to gain additional experience in the Oil and Gas industry and moved to a company based in Aberdeen: the Surveying I carry out now is mainly pipeline surveys offshore on Oil and Gas platforms and some onshore work in Oil and Gas terminals.
Timothy Thwaites (2006 – 2007)

After graduating from UCL I returned home to Jamaica and began work as a land surveyor in the private sector. I immediately started to realize the advantages of the strong theoretical and practical experience I received in the Surveying MSc. The understanding of the fundamental principles of spatial data and the methods used to acquire it has allowed me to take on tasks at all levels of accuracy and in a wide range of environments. Ranging from G.P.S. mapping for G.I.S. database population, survey accuracy GPS observations for control surveys, topographical and cadastral surveys with total station, and near-shore hydrographic surveys, my skill set has afforded me the confidence to take on any data acquisition project. It has also allowed me to travel the Caribbean to work on a wide range of projects. The UCL Surveying MSc. has set me a cut above the rest, and would be recommended for anyone who wants to gain a distinct advantage in the surveying world.


I was the first ever student to complete a part-time MSc in Surveying at UCL, while working as a Senior Geomatics Officer with the Museum of London Archaeology Service (see picture), and graduating in 2002. I had such a great time on the course that I stayed on to complete a PhD and post-doc, researching the art and science of producing high accuracy satellite orbits. In 2008, largely because of networking opportunities afforded to me during my time at UCL, I started working as a Senior Systems Engineer for NASA's Jet Propulsion Laboratory in Pasadena, California. I am now part of a team responsible for producing JPL's GPS-based orbit solutions, both for the GPS constellation itself, and low Earth orbiting satellites that have GPS antennae. These solutions are used by an international community of scientists for high-precision geodetic purposes, such as monitoring global sea-level and plate boundary motion.


I was one of the handful part-time students who completed a 2-year Surveying MSc (1 year if studying full time) at UCL in 2010. I took out the course as a stepping stone into acquiring a Survey Management role. The invaluable support I got from staff and fellow students helped me to successfully complete the course and to strike the balance between working as a Setting Out Engineer in London and being a Postgraduate student.
After finishing the course I got a role in the Middle East (Bahrain) with an Oil & Gas consultancy Company as a Junior Survey Manager. The company is a specialist engineering consultancy focusing on 3D Laser Scanning, Process Automation and Mechanical Piping within the oil/gas, petro-chemical and power plant industries Gulf wide. Apart from office work, I am also involved in 3D data capture and data processing from time to time. Our current methods of data capture / acquisition include GPS RTK, Static and Mobile Scanning. Currently I am working on an 80km pipeline project in Iraq, where Map Projection, Datum transformation & Combined/Scale Factor are common terms that remind me of my great time at UCL.

My Surveying knowledge base that I have widened by studying at UCL has enabled me to confidently lead, supervise survey teams and to deal with the client directly.

**Faith Osagie (2004 – 2005)**

I undertook the MSc course in 2004 - 2005. Afterwards I went to work for a London based measured building surveyors, where I undertook a variety of surveys and enrolled on the RICS APC scheme. I completed this and became a chartered surveyor in 2008. In April 2010 I changed jobs and commenced a role as a project coordinator at MSA. My job is to run and maintain projects from inception to completion. The work is diverse and interesting, creating 3D models and visualisations, as well as more traditional 2D survey work. The MSc in land surveying equipped me with a great deal of knowledge integral to my role. It was tough, but is well respected in the industry and a great building block to start or consolidate a career in surveying.

**Barry Gleason (2003 – 2004)**

I undertook the MSc Surveying course at UCL in 2003-2004 after working for 10 years in the survey industry in Ireland. On finishing the course I took up a role as Senior Engineering Surveyor with a UK based company on a multinational construction project in China, travelling on to work in India, Germany, Romania and Mexico. I returned to UK in 2007 to join a UK wide multi-disciplinary survey consultancy to set up a land survey department in their Central London office.
In 2009 I joined Network Rail as the Survey Assurance Manager for the Thameslink Programme involving a £3.5 billion railway investment project.

Hardly a day goes by when I don’t think of something that was taught on the MSc course at UCL and I refuse to let go of my notes or handouts after nearly 10 years. Without doubt the course at UCL changed my career direction, and my life experiences. It has assisted greatly in my appreciation of the profession and its importance to the modern world at large. This is in no small part reflected by many of the academics who taught me there, past and present, and students who studied there, with many being leading figures in the Geomatics world today.

13 Final Remarks

The UCL MSc Surveying programme has been running for over sixty years and has produced hundreds of well-trained graduates, who have gone on to have fulfilling careers and extraordinary experiences. You’ll find them all over the world – helping to construct roads and railways, running national survey offices, surveying the land, working in research and development or running their own company. Wherever they are, their UCL degree is respected and valued: this is as true today as it’s always been, and we’re investing in the equipment and appointing the staff to make sure it stays that way into the future.

We have tried in this brochure to give as much information as is feasible about the scope of the course, its particular strengths, the staff who contribute, and the facilities available. If you do need to know more, then have a look at our web site or do feel free to contact us.

Otherwise, if you are thinking of applying to do the course, or if you have employees that you are planning to send here for further training, or if you are looking for well-trained graduates to join your organisation – then we look forward to hearing from you.