Comparison of Naval Architecture Programs at U.K. and U.S. Institutions

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Abstract

This paper compares the educational training requirements of engineers to become professionals. In particular it compares the Naval Architecture courses at University College London and Stevens Institute of Technology. It considers the University entry requirements, course content, methods of assessment and the external influences such as Accreditation Board for Engineering and Technology, Engineering Council (UK) and the Washington accord. This paper is in part the result of the authors' effort to establish a student exchange between their institutions.

1. Introduction

University College London (UCL) and Stevens Institute of Technology (SIT) have come together as part of the 'The Atlantic Centre for the Innovative Design and Control of Small Ships (ACCeSS)'. This was formed as part of the US National Naval Responsibility for Naval Engineering sponsored by the US Office of Naval Research (ONR). The academic members presently consist of Stevens Institute of Technology, The US Naval Academy, University College London and Webb Institute. The industrial members are AMSEC LLC Group, Lockheed Martin Marine Systems, and VT Shipbuilding.

The mission of ACCeSS is establishing an international design environment where the disciplines associated with hull, machinery, weapon and control system design can be brought together within the context of the total ship system design, thereby facilitating the creative knowledge development, educational changes and discipline integration required for true innovation. Secondly, ACCeSS seeks to utilise this unique education and research environment in the recruiting, training and long-term career development of the best and brightest young engineers in the US (and UK). The latter initiative is expected to contribute to countering the continued downward trend in recruitment and retention in the marine industry being experienced in both countries.

1.1 Brief introduction to SIT and UCL.

Both universities have urban locations on prime real estate, one in Bloomsbury, central London and the other on the banks of the Hudson River overlooking Manhattan. Both have a long history of teaching engineering and conducting engineering research. Both were built on sites associated with pioneering railway steam engines.

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1.1.1 Stevens Institute of Technology

Stevens is named for a distinguished family who perpetuated a tradition in American engineering, dating back to the early days of the Industrial Revolution. John Stevens, a colonel in the Revolutionary War, purchased from the State of New Jersey in 1784 the land included in the present-day 55-acre campus of the college. Before 1800, Col. Stevens was a pioneer in the development of the steamboat, and by 1825 he had designed the first American-built steam locomotive. Robert Stevens, one of Col. John Stevens' sons, invented the T-rail, the form of railroad track in use today throughout the World. His brother, Edwin, was active in the design and construction of ironclad vessels for the U.S. Navy. With another brother, John Cox Stevens, who was the first commodore of the New York Yacht Club, Edwin joined in the syndicate that built and raced the yacht "America." In 1851, that vessel defeated all the English contenders to become the first winner of the famed trophy now known as the America's Cup.

When Edwin Stevens died in 1868, his will provided for the establishment of the college which bears his family name, through a generous contribution of land and funds for building and endowment. Stevens Institute of Technology opened its doors in 1870. The original trustees determined that Stevens should have a single, rigorous engineering curriculum leading to a baccalaureate degree they designated "Mechanical Engineer." The undergraduate program encompassed most of the then existing and emerging engineering disciplines and was firmly grounded in scientific principles. Over the years, the Institute evolved from a small four-year undergraduate college of engineering into a much larger multifaceted institution with considerable research activity and a variety of graduate and undergraduate programs stressing not only engineering, but also science and management. Instruction in Naval Architecture and Ocean Engineering at Stevens has for many years focused on post-graduate (ME, MS and PhD) education, beginning in 1929 with a joint graduate program with New York University in The Dynamics of Aircraft and Marine Craft and continuing through to present with graduate concentrations in Naval Architecture, Ocean Engineering, and Maritime Systems. Recently, the Naval Architecture program was expanded to include a full undergraduate degree in Naval Engineering.

1.1.2 University College London

UCL was founded in 1826, on a site which was then the edge of London. In 1808 the site hosted Richard Trevithick's "catch-me-who-can", the world's first fare paying steam railway. This only lasted for a few months, the adventure coming to an end when his steam engine fell off the track due to a broken rail. Nearly 200 years later, broken rails are still the bane of railway operators.

University College London (originally called the University of London) was formally founded on 11th February 1826, the first university to be established in England after Oxford and Cambridge. At that time they only admitted male members of the Church of England and taught a limited number of subjects which did not include engineering. A fundamental founding principle of UCL was that not only would students of all beliefs be allowed entry, but that no religious subjects would be taught. The established interests of Oxford, Cambridge and the Church prevented UCL receiving a royal charter, so it was set up as a joint stock company. The new University was vilified by the Church as "The Godless Institution of Gower Street", and by

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the Tory press as "The Cockney College", because of its aim to extend access to university education from the very rich to the growing new middle class.

The first academic sessions of the University started in October 1828. Chairs were established in several subjects which had not previously been taught in English universities, for instance modern foreign languages and English language and literature. The systematic university study of law began at UCL. Instruction at UCL was primarily by means of lectures and written examinations - reflection of practice in Scotland and Germany rather than Oxbridge. The teaching of engineering was pioneered at UCL, the first Professor of Mechanical Engineering was appointed in 1847. Also the first undergraduate teaching laboratories in physics and chemistry were established. In 1878 UCL was also the first university in the UK to welcome women on equal terms with men.

Naval Architecture came to UCL in 1967 when the UK Ministry of Defence (MoD) moved the training of its Royal Corps of Naval Constructors from Greenwich Royal Naval College to UCL. Research and training activity in Naval Architecture and Marine Engineering has been supported by the Royal Navy and UK MoD ever since. The chair of Naval Architecture and one other faculty position are filled by staff seconded from the MoD.

2. Entry standards to University

2.1 US / Stevens Institute of Technology

At Stevens, as in most US universities, applicants are judged on the basis of High School (grades 9 through 12) performance and a nationwide aptitude exam. There is no national entry system and each student applies as an individual to each institution. The admissions process at Stevens seeks to provide the Admissions Committee enough information to assess the student's potential for success. This information includes the following.

- High School Record: This varies depending upon the chosen major of study. For Engineering, the applicant's High School record should show high performance in the following areas: English (four years); mathematics (two years of algebra; one year of geometry; and one of pre-calculus) and three years of science (biology, chemistry and physics).
- College Entrance Examinations: The College Entrance Examinations test a different set of abilities and give a sense of the student's academic strengths. The required examinations include the Scholastic Aptitude Test (SAT) or American College Test (ACT). These are nationally administered and SAT and ACT are split geographically over the USA
- Personal Interview: A personal interview is required for those living within a 250-mile radius of the campus. Interviews are held in the Office of Undergraduate Admissions. If an applicant lives further than 250 miles from Stevens or cannot come to campus for an interview, an appointment is made with an alumnus in the applicant's area.
- English Language Requirement: English language competence is generally indicated by:
    - minimum score of 530 on the Test of English as a Foreign Language (TOEFL)

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    - minimum verbal SAT score of 530
    - minimum score of 5 on all parts of the language examination administered by the American Language Institute at New York University.
- Two Letters of Recommendation. Both letters should come from teachers, preferably at least one from a math or science teacher.
- Personal Statement. A brief essay of 300-500 words.

2.2 UK / University College London

In the UK (note that the Scottish the system is different, see below) the main discriminator for entry is currently the Advanced level examination (A level). Students usually study for three A levels for their last two years at school and then enter University at 18 years old. A small but significant and increasing proportion of the intake have qualifications other than A levels, the International Baccalaureate is the second most common qualification. Many students come from outside the UK and have their national equivalent to A levels. Note that students from all European Union countries count as "home" students and do not pay the much higher overseas fees.

Entry for undergraduates to UK universities is administered by a central system, the UCAS (University Central Admission System). Unlike the US students cannot apply directly to universities. Each student applies to no more than 6 degree courses and submits a personal statement. Offers of admission are made by universities on the strength of:

- Personal statement: 300 -500 words
- At least 17 years old on the start of the course.
- Confidential report: provided by their school, it may include a brief paragraph from each A level subject teacher.
- Predicted A level grades
- Personal Interview: UCL is one of the few UK Universities that holds an interview. At UCL these are conducted by a member of the faculty of the respective subject. All students from England and Wales are expected to come to UCL for an interview, other students are invited and may attend if they wish. No alternative arrangements for interviews exist.
- Meeting minimum requirement in English language and Mathematics. These are usually met by a pass at GCSE (GCSE is an exam usually taken at 16 years old, a pass is a grade C or better). A number of alternative results are accepted by the Engineering faculty including for English a TOEFL score 580 (paper version).

Once the offers are made, the student must accept one and nominate another as a reserve. Offers are usually conditional on achieving a set of A level grades. The A level results are published nationally in late August and students that fail to meet their offers are matched with unfilled course vacancies via a process of clearing run by UCAS.

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The A levels were originally created and administered by Universities and were seen not only as the entrance exams to universities but also as foundation courses for university degrees. Over the years, with the increasing participation in higher education, the role of A levels has changed. They are no longer administered by Universities but by a handful of profit-making bodies. They are now part of the general education system and have moved away from their original purpose. The whole role and nature of the A level is currently under discussion with the introduction of AS levels (where an AS is nominally half an A level) and most recently in February 2004 the Government instigated "Tomlinson Inquiry into 14-19 Educational Reform".

The subject requirement for entry into an Engineering degree includes A level Mathematics, A level Physics and a third appropriate A level. The third subject is often Further Mathematics, Chemistry or Design and Technology, but a Language or Geography are not uncommon.

Students apply for a specific course and it is unusual, if not impossible, to change subjects without starting again from scratch. The structure of UK degrees simply makes it impractical. This is true even for very similar courses such as Mechanical and Civil Engineering. Even a switch between Naval Architecture and Mechanical Engineering at the end the first year is very difficult despite the majority of the courses being common and all taught within the same department.

A different arrangement exists for postgraduate students.

2.3 Scotland

At Scottish Universities degrees are a year longer than in England because most students start at the age of 17 instead of 18. The Scottish educational system is slightly different, on completion of GCSE exams (age 16) students usually study five or six subjects for one year (known as Highers) before going to University at the age of 17. In their first year at University they cover basic engineering and mathematics, often taught as a common course faculty wide. Only in the second year do they split into the various Engineering disciplines. Students from England with good A level examination grades enter directly into the second year.

2.4 Comparison of entry requirements

Interestingly, there are many similarities in the entrance requirements of the two universities, in spite of the vastly different processes used in student selection. Both universities make use of the face-to-face interview, a requirement that is not common in the US or UK. Both require a detailed personal statement of interest, minimum standards of achievement in Mathematics and English, and confidential letters of recommendation/report from the applicant's teachers. Because of the rules governing tuition charges within the European Union (EU), it is likely that the UK receives undergraduate applications from more overseas students than does the US. This complicates the traditional UK reliance on a national pre-university curriculum, and may cause the UK and US processes to converge to a more similar system under which minimum standards can be achieved via different curricula. An additional problem in the UK for Engineering degrees is the modular nature of the Physics and especially Mathematics A levels. So despite there being a national curriculum the common core of material studied by the student cohort is surprisingly small as they will have studied different modules. There is a marked difference in

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the English language requirements between SIT and UCL with minimum TOEFL scores of 530 and 580 respectively.

3. Course structure

For the present paper, Naval Architecture is taken as the subject example. However, similar comparisons could be made with any engineering course. Here again, we aim to draw out the areas of similarity and difference, and try to identify why these occur.

3.1 Stevens Institute of Technology

The School of Engineering has a broad-based core curriculum of applied sciences, engineering sciences, design, management and the humanities coupled with a long-standing honour system. The curriculum is intended to provide for development of competencies that go beyond the purely technical. These competencies include: ability to analyze and provide creative solutions to problems, self reliance in approaching open-ended problems, effective teamwork and communication skills, an understanding of environmental issues, and knowledge of entrepreneurial concepts.

Stevens offers undergraduate programs of concentration in the following disciplines:

- Chemical Engineering
- Mechanical Engineering
- Civil Engineering
- Computer Engineering
- Electrical Engineering
- Engineering Management
- Environmental Engineering
- Biomedical Engineering (interdisciplinary)
- Naval Engineering (new)

These programs are all accredited by the American Accreditation Board for Engineering and Technology (ABET), the national accrediting organization for engineering education.
The Core Engineering Curriculum is the sequence of required courses that ALL students take regardless of the engineering discipline in which they choose to concentrate. In addition to the core requirements, concentration requirements are met by a sequence of technical electives which are chosen in consultation with a faculty advisor from that engineering program. The Core Curriculum provides a solid and broad-based foundation in the sciences and engineering sciences, together with an eight-semester sequence of humanities courses. There is also a physical education requirement. The core includes two electives that fall outside the concentration requirements and can be used by students to broaden their education with courses outside their field including those that contribute to a minor or to obtain credit for faculty-mentored research. Table 1 outlines the course sequence for the newly-introduced BE program in Naval Engineering. The academic year is based on a semester system. Each semester is 16 weeks long with 15 teaching weeks and one week for exams. Each course has typically 3 or 4

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hours of class meeting per week. The science classes - physics, chemistry - have an additional 3 hour lab each week. Fluid mechanics has a lab as well. The first two years are common to all engineering programmes at SIT.

3.2 University College London

To meet the UK Engineering Council's academic requirements to become a Chartered Engineer a candidate needs one of;

- M.Eng. (4 academic years, except Scotland)
- B.Eng. (3 academic years) plus an M.Sc. (1 calendar year) or appropriate further learning to Masters level (typically a company based training scheme)

All courses must be accredited by a professional engineering institution. There is a requirement for the training to include a significant component of project work, at least 25% and may be up to 50% of the last two years. This should include an individual project and a group project.

Table 2 shows the outline of the B.Eng and M.Eng courses in Naval Architecture at UCL. They have a common first and second year. Students may only continue onto the third year of the M.Eng. if they are demonstrating an upper second performance, (UK degrees are classified as first, upper second, lower second, third, pass or fail). Student who do not meet the academic requirement or who only want a three year degree take the B.Eng. The academic year is based on a trimester system with 26 teaching weeks. Two 11 or 12 week terms (depending where Easter falls) and a short 7 week third term which includes the main exam period. All courses, unless otherwise noted, extend over the full academic year. Each course has typically 2 of hours lectures or tutorials per week and most also have two or three laboratory classes which require a detailed report to be submitted. Exceptions include design which is more coursework orientated and maths courses with additional lectures in place of lab classes.

3.3 Comparison of programs

The primary difference between the UCL and SIT undergraduate programs in Naval Architecture is the degree of specialization, particularly in the early years of study. Whereas the SIT program retains the traditional 2-year core curriculum common to all engineering majors at Stevens, the UCL program provides for early exposure to the specialized science and engineering topics related directly to Naval Architecture. Over the 4 years, however, both programs provide students with a solid grounding in the applied sciences, design, and engineering management. One notable exception is Chemistry. This is covered in the first year at SIT to ensure a well balanced engineering core. By contrast at UCL not only is chemistry not taught, there is even no requirement to have studied it at school. This is offset by more extensive materials courses.

Significantly, both programs rely heavily on the design experience and team projects. The UCL program culminates in a comprehensive Group Design Project that represents approximately 40% of the student training during the 4th year. This project is an undergraduate version of the internationally-known UCL MSc Ship Design Exercise. The SIT program relies on a 3-semester design project that is smaller in terms of level-of-effort than the UCL project, but which is

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designed to encourage summer research in support of the design process. UCL students also conduct substantial individual projects in their third year which account for 25% of the year.

Notably both institutions provide their final year students with exposure to Masters degree courses. At UCL the undergraduate students work along side Masters students in many of the lectures of their final year, similarly with the Ship Design Project. While at SIT they have a number of electives which can be graduate courses.

There is no physical education requirement at UCL but students are encouraged to take part in the wide variety of clubs and societies. No lectures or labs are scheduled on Wednesday afternoon "sports afternoon". This is typical of most UK universities.

4. Degree Accreditation ABET v EC(UK)

4.1 Accreditation of Engineering programs at Stevens Institute of Technology

In the United States, accreditation is used to assure quality in educational institutions and programs. Accreditation is a voluntary, non-governmental process of peer review. It requires an educational institution or program to meet certain, defined standards or criteria. Accreditation is sometimes confused with certification. In general, institutions and programs are accredited, and individuals are certified.

Engineering programs in the U.S are accredited by the Accreditation Board for Engineering and Technology (ABET) through their Engineering Accreditation Commission (EAC).

There are two types of accreditation -- institutional and specialized. Institutional accreditors, such as those referred to as "regional" accreditors, examine the college or university as a whole educational institution. Specialized accreditors evaluate specific educational programs. Professional accreditors, such as those for medicine, law, architecture and engineering (ABET), fall into this category. Accreditation serves to notify parents and prospective students that a program has met minimum standards; faculty, deans and administrators of a program's strengths and weaknesses and of ways to improve the program; employers that graduates are prepared to begin professional practice; taxpayers that their funds are spent well; and the public that graduates are aware of public health and safety considerations.

State licensing boards and certification programs may require graduation from an ABET-accredited program as the first step in the registration or certification process for professional practice. In some instances, ABET accreditation may permit students to receive federal funds in the form of scholarships, loans and grants.

Engineering at Stevens has been accredited by ABET continuously since 1936. For most of this period the Stevens engineering curriculum was accredited under a single designation, Engineering. This was a reflection of the long standing Stevens tradition of providing a broad-based engineering education to all engineering students. This tradition remains, and is founded on the strong core requirement. The core is coupled with elective sequences in the various engineering fields to provide students with the necessary depth of knowledge to become an

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effective practitioner within their chosen engineering discipline. Stevens is one of only a few universities that award the degree of Bachelor of Engineering rather than Bachelor of Science for engineering majors.

Starting in 1986, engineering programs offering concentrations in specific fields within the engineering curriculum sought and received separate accreditation from ABET where such separate accreditation was available. The "Engineering" accreditation was retained for those programs for which separate accreditation by ABET was not available. The new BE program in Naval Engineering is accredited under the Engineering accreditation.

4.2 Accreditation of Engineering programs at University College London

The Engineering Council regulates the engineering profession in the UK and controls the Register of Chartered Engineers. It grants licenses to the engineering institutions that allow them to confer Chartered Engineer status. In their turn engineering institutions accredit degree courses to ensure that they meet their engineering requirements and standards. By successfully completing such a course a student meets in full or in part the educational requirements to becoming a Chartered Engineer. Once the educational requirements are satisfied there is no further requirement for examination. There is no UK equivalent to the State licensing board however candidates applying to become Chartered do have a professional review interview.

More recently all UK University degree courses have been assessed by a central government body under the TQA (Teaching Quality Assessment) to ensure a minimum teaching standard. Initially Departments were graded on a three point scale (excellent, satisfactory or unsatisfactory) later this changed to a 24 point scale. A separate national audit, the Research Assessment Exercise (RAE) deals with research. The results of the RAE are used to determine funding allocations to institutions. These audits are totally independent of engineering accreditation and for engineering departments there is considerable duplication of effort and still a little resentment of having the RAE and especially TQA imposed on them when they (unlike most other departments) already had an effective external audit process in place.

5. International agreements

The UK Engineering Council sees the world as being currently in two blocks. There are the countries whose education and engineer formation systems are built on a USA model and those mostly European countries and some ex-French colonies with a Napoleonic system of education and formation. The UK (and Ireland) bridge these two blocks and actively engage with both systems in order to reconcile differences and enhance mobility.

There are many bi-lateral agreements between Engineering Professional bodies so for example once one is a Chartered Engineer in the UK it is relatively easy to become a Member of a similar institution in the USA without having to go through the full admission procedure. For example a member of RINA (Royal Institute of Naval Architects, UK) can become a member of SNAME (Society of Naval Architects and Marine Engineers, US) by little more than providing personal details and paying the membership fee. They are deemed to have already met the membership requirements and do not need to go through the membership selection procedure.

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5.1 Washington Accord

The Washington Accord was signed in 1989. It is an agreement between the bodies responsible for accrediting professional engineering (undergraduate) degree programs in each of the signatory countries. It recognizes the substantial equivalency of programs accredited by those bodies, and recommends that graduates of accredited programs in any of the signatory countries be recognized by the other countries as having met the academic requirements for entry to the practice of engineering. Engineering technology and postgraduate-level programs are not covered by the Accord.

The signatory countries of the Washington Accord are Australia, Canada, Ireland, Hong Kong, New Zealand, South Africa, United Kingdom, and the United States. Japan, Germany, Malaysia, and Singapore have provisional membership status.

An important feature of the Washington accord is that each signatory has expressed its confidence in the Quality Assurance processes of the other signatories. By extension this leads to the effective mutual recognition of accredited Engineering Degree courses, and, generally, to exemption from the education requirement for becoming a Chartered Engineer (or equivalent) in each of the signatory countries. An anomaly here is that in the US, further state/subject exams are required after graduating to become a Professional Engineer, but not in the UK.

5.2 The Bologna Declaration

The Bologna Declaration was signed in June 1999 by the Education Ministers of 29 European countries including the UK. The Declaration has the aim of bringing the majority of European Engineering degrees to a common level. It aims essentially to create a European Higher Education area, through achieving the following six objectives:

1. Adoption of a system of easily readable and comparable degrees
2. Adoption of a system essentially based on two main cycles, undergraduate and graduate
    i. The first, or undergraduate, cycle must last at least three years. The degree awarded at the end of it must be relevant to the European labour market as an appropriate qualification.
    ii. The second cycle, which can lead to a masters and/or a doctorate, can only be accessed through successful completion of first cycle studies. No minimum length is specified.
3. Establishment of a system of credits
   The Declaration suggests the European Credit Transfer System (ECTS) as a possible basis for this. The ECTS can be equated to systems that are used in the UK, on the basis of one ECTS credit being equal to two UK credits, so that an academic year of study would normally lead to 60 ECTS credits. It has been designed to facilitate students spending parts of their courses within universities in different countries, and so is geared to credit transfer rather than to credit accumulation.
4. Promotion of mobility for students and staff
5. Promotion of European co-operation in quality assurance

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The Declaration does not envisage a common system of quality assurance throughout Europe. However, it stresses the necessity of close co-operation between national quality assurance systems.

6. Promotion of European dimensions in Higher Education

The problem with the Bologna Agreement is marrying up English and Continental educational standards. At present the latest UK Engineering Council's academic requirements require only a 4 year M.Eng or the B.Eng. + 1 option (see Section 3.2) to satisfy the academic requirements to become a Chartered Engineer.

This does not sit comfortably with the continental system where a 3 + 2 arrangement is more common and the UK requirement is viewed as too little especially via the M.Eng. route. There is pressure to move the UK system towards the continental system. However the latest requirements form the UK Engineering Council, published in December 2003, have shied away from this.

5.3 Implications for UK Engineering degrees

UK honours degrees at Bachelor level in engineering and technology should have no difficulty in being recognised as first cycle qualifications. The position for M.Eng. degrees is more problematic, for the following reasons:

- The MEng is at present a single qualification, and to be recognised as a second cycle qualification in Bologna terms would need to be preceded by a first cycle award
- It lasts only four years as a full time course. While there is no minimum time requirement for second cycle awards, a total of five years seems to be the norm in much of Europe, as many countries move to break their traditional five year courses into 3 + 2 or 4 + 1 structures, for first and second cycle awards, or develop new qualifications.

Conventional M.Sc. programmes avoid the first problem, but the duration issue is unclear. There have been suggestions that these should normally require 90 ECTS credits but elsewhere 75 ECTS are quoted for a calendar year (full time, 12 months). All sources are consistent that an academic year (UK typical three terms) is 60 ECTS.

6. Conclusions

In spite of the many differences in the university application and entry process between the two countries, and in the nature of licensure for engineering professionals, there are a remarkable number of similarities between the undergraduate Naval Architecture programs at University College London and Stevens Institute of Technology. Perhaps most striking is the emphasis of both programs on the design experience and team projects – educational elements that in the opinion of the authors are essential to success in today's complex, systems-based ship design process. The primary difference in the two programs is the early exposure to Naval Architecture theory and design at UCL, which stands in sharp contrast to the broad-based core curriculum in the first two years at SIT. Although the SIT core curriculum has long been viewed by the Stevens administration and alumni as a strength by virtue of its providing a base from which to pursue a career in many different fields of engineering, there are also problems related to

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retention and eventual specialization that are addressed by more focused training of the type represented by the UCL curriculum. The UCL approach necessitates a career decision by students at the age of 17 when they are applying for University. This is has been argued as far too young and many students do not understand what Engineering is, let alone the specialised field of Naval Architecture. The inflexibility of the UK system makes subsequent change very difficult.

The UK higher educational system has been seen as a bridge between the North American and the Continental systems. The Washington Accord is pulling together the engineering professional requirements of its signatories including the UK and US. There is a danger that the Bologna Declaration might pull in the opposite direction, taking the UK system away from the US system and towards the Continental model. Other European countries are already modifying their systems to satisfy the requirements of the Bologna Declaration.

The U.S. Office of Naval Research will sponsor an international workshop "Educating the Future Warship Designers" during the summer of 2004. This workshop will provide a unique opportunity to expand the analysis contained within this manuscript, and may pave the way for a more comprehensive, graduate performance-based review of various educational programs within the US, UK and across Europe.

7. Acknowledgments

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8. Sources of information

Engineering Council (UK)
http://www.engc.org.uk/international

10 Maltravers Street
London
WC2R 3ER
Tel: +44 (0)20 7240 7891
Fax: +44 (0)20 7379 5586
e-mail: staff@engc.org.uk

Washington Accord
http://www.washingtonaccord.org

Washington Accord Secretariat
ABET, Inc.
111 Market Pl., Suite 1050
Baltimore, MD 21202
(410) 347-7700
(410) 625-2238 (Fax)

Accreditation Board for Engineering and Technology
A full description of ABET and their activities is available at their website: http://www.abet.org.

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Table 1. Course summary of Naval Engineering BE at SIT

Fall Semester	Spring Semester
First Year	
Chemistry Math Physics Engineering Design Engineering Graphics Computer Science Humanities	Chemistry Math Physics Engineering Design Mechanics of Solids Humanities
Second Year	
Math (differential equations) Physics Thermodynamics Circuits Engineering Design Humanities	Math (multivariate calculus) Physics Electronics and Instruments Probability and Statistics Engineering Design Structural Analysis Humanities
Third Year	
Fluid Mechanics Laboratory in Naval Architecture Materials Introduction to Ship Design and Shipbuilding Engineering Design Humanities	Computer Aided Ship Design Engineering Economics Principles of Naval Architecture Ship Design Project, part 1 Marine Structures Humanities
Fourth Year	
Naval Engineering Elective[1] Naval Engineering Elective[1] General Elective[2] Engineering Economics Ship Design Project, part 2 Humanities	Underwater Acoustics or Adv. Hydrodynamics Total Ship System Design General Elective[2] Ship Design Project, part 3 Humanities
[1] chosen from Naval Architecture, Ocean Engineering and Maritime Systems graduate courses. [2] chosen from courses outside of the student's area of concentration, or research for credit	

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Table 2. Course summary of Naval Architecture B.Eng and M.Eng. at UCL

<table>
<tr><th colspan="2">First Year</th></tr>
<tr><td colspan="2">Applied Electricity
Applied Mechanics
Basic Naval Architecture
Computing
Design (1 term)
Engineering Drawing (1 term)
Materials & Manufacturing Technology (inc. basic workshop training)
Mechanics of Fluids
Modelling & Analysis I (= maths)</td></tr>
<tr><th colspan="2">Second Year</th></tr>
<tr><td colspan="2">Design
Dynamics & Control
Management for Engineers I
Materials & Design Studies
Mechanics of Marine Vehicles (includes fluids)
Modelling & Analysis II (= maths)
Stress Analysis
Thermodynamics</td></tr>
<tr><th>Third Year MEng</th><th>Third Year BEng</th></tr>
<tr><td>Principles of Marine Design & Production
Marine Hydrodynamics
Advanced Marine Structures
Management for Engineers II
Individual Project (counts as 2)
Plus two Third Year Options</td><td>Marine Design & Production* (counts as 2)
Marine Hydrodynamics
Advanced Marine Structures
Management for Engineers II
Individual Project (counts as 2)
Plus one Third Year Option</td></tr>
<tr><td colspan="2">Third year options</td></tr>
<tr><td colspan="2">Mathematics | Automatic Control | Thermal Power & the Environment | Composite Structures
Applied Mechanics | Applied Electricity & Instrumentation | Digital Business | Foreign Language</td></tr>
<tr><th colspan="2">Fourth Year M.Eng. only</th></tr>
<tr><td colspan="2">Project Management & Design (including Group Design Project 40% of year)
Ship Dynamics
Ship Hydrodynamics
Ship Structures</td></tr>
</table>

* Includes a group design project.

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