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Achieving Advances and New Developments in Engineering and Technological Education

Colin U. Chisholm
School of Engineering, Science and Design, Glasgow Caledonian University
Cowcaddens Road, Glasgow G4 0BA, Scotland, United Kingdom

Consideration is given to a number of educational developments to which the author has contributed during his career in academia. For each particular development, the role played by the author is reviewed, and consideration is given to the contribution made to engineering and technological education, as well as to his continuing work with Glasgow Caledonian University in Glasgow, Scotland, UK, and with the UNESCO International Centre for Engineering Education (UICEE), based at Monash University, Melbourne, Australia.

INTRODUCTION

The author began his career with the Glacier Metal Co. Ltd, spending seven years working in the research and development centres at Kilmarnock and London. It was during this period that he developed an interest in materials engineering and technology education. This early career involved lectureships at Wolverhampton and Staffordshire College of Technology (now Wolverhampton University) and Dundee College of Technology (now Abertay University).

He was then appointed as a senior lecturer at Robert Gordon's Institute of Technology (now Robert Gordon's University) where he became involved in the development of offshore engineering education. This was followed by a decade as Associate Head of the Department of Mechanical and Industrial Engineering at Paisley College of Technology (now Paisley University). During this time, he became involved in a range of engineering educational developments and was the course leader for the industrial engineering degrees during that period.

In 1985, the author became Head of the School of Engineering at Glasgow College of Technology (now Glasgow Caledonian University) where he was awarded a professorship. It was at this stage in his career that the author became heavily involved in the innovative programme development of engineering at the undergraduate, postgraduate and post-experience levels. He was appointed the Dean of the Faculty of Science and Technology at Glasgow Caledonian University (GCU) and led the Faculty through a rapid period of growth in student numbers in engineering and technology education. It was during this period that contact was made with the UNESCO International Centre for Engineering Education (UICEE) at the *1st UICEE Annual Conference on Engineering Education*, held in Melbourne, Australia, and it was at that conference that the author proposed that the GCU would become a Partner institution of the UICEE and take forward the first satellite centre of the UICEE, which was designated the *Caledonian Centre for Engineering Education*.

It was also during this time as Dean that he became involved in 1995 with the major development of an engineering college in Muscat, Oman, and he was involved in the college development until his retirement in 2003. The University conferred on the author the title of Emeritus Professor and, at that point, he returned to the University to research and contribute to projects in the School of Engineering, Science and Design and in General Academic and Professional Studies, including the *Scottish Centre for Work-based Learning*. In this article, the author presents his contributions to engineering education and describes his continuing work with the GCU and UICEE.

ACHIEVEMENTS RELATED TO RESEARCH AND SCHOLARLY ACTIVITIES

In his role as Associate Head of Engineering at

Paisley College of Technology, the author took forward a major development in the form of a new and novel honours degree programme in industrial engineering. At that time, there was an acute shortage of quality industrial engineers needed to take engineering forward in the UK. The author developed the programme over a two-year period, completing research in the USA, where industrial engineering had emerged as a strong and popular discipline. This was the first course of its kind set up in Scotland to educate engineers through a blend of disciplines related to men, money, machines, materials and related management.

The author led the development of this new course, including the development of a suite of specialist laboratories to support the learning, including laboratories to support the study of ergonomics and industrial psychology.

The course was open to students in 1977 and was led by the author until leaving Paisley in 1985. During that time, he established this type of engineering education with both students and industry, providing professional practitioners to revitalise the manufacturing sector. In order to assure that school leavers were aware of this novel course, the author worked closely with career advisors to facilitate an understanding of the value of this form of engineering education. He set up the basic philosophy for the course to provide an in-depth understanding for students that industrial/business problems are multi-dimensional, with the technological answer only developing against a background of economics, sociology and decision making abilities. It was for this reason that the author designed the course to include periods of training in industry and businesses to provide the essential multidisciplinary environment that would support problem solving. He also introduced real world casework and built up a library of caseworks drawn and developed from industry as a key and essential novel component of the course [1][2].

While Head of School of Engineering in Glasgow, the author completed research into engineering education by analysing those factors that relate to effective staff development methodologies for engineering educators. He examined how each factor affected the establishment of effective staff development. He identified a number of novel ways available to engineering departments to achieve formalised staff development of their engineering educators and these approaches were successfully evaluated in the School in Glasgow. Of particular interest was a mentor scheme to facilitate the development of competences in research methodologies and competences in using the real world environment of industry to educate students. The results were shown to have transferability to other engineering schools and departments, and the work was finally published in a European journal [3].

In 1986, the author contributed to a European Economic Communities study conducted in Portugal to critically examine the developing role of vocational education and training related to small to medium enterprises [4]. The resulting report provided a valuable contribution to achieving greater integration between education, and small to medium-sized enterprises and models already operating successfully in the UK were suggested as a way forward to achieving more effective vocational education.

As part of his duties while Head of the School of Engineering in Glasgow, the author conducted developments in engineering education with a view to establish flexible entry routes for students to degree education; the examination of team teaching of engineering subjects to provide higher student motivation and consequently to reduce reported failure rates for engineering courses. He evolved a useful expected course level index (ECL), which was allocated to each student at entry to a composite course involving higher diploma degree and honours degree. At the end of each study year, the ECL index was reviewed against student performance, thus allowing a student to complete the course most appropriate. So a student, who initially entered with an index supporting study of the honours course, could, after analysis of performance, find they had their ECL index changed such that they would complete the higher diploma course.

This research was directly implemented within the School and, using the combination of team teaching and an ECL index system with the composite course programme, failure rates were significantly reduced and higher levels of student motivation were noted. This model for diploma/degree education involving flexible entry routes was published so that other educators could test the model [5].

In 1975, the UK Teaching Company Scheme was launched jointly by the then Department of Industry and Science Research Council. This scheme was designed for UK universities with engineering departments to take forward as postgraduate training integrated with industry. Young honours graduates, termed associates, were able to spend a period of two years in industry delivering real time projects while also achieving learning at the postgraduate level. In time, the Teaching Company Scheme proved to be one of the most successful postgraduate developments ever introduced in the UK. It is significant that the Scheme is still effectively operating now in 2006 under the

modified title of Knowledge Transfer Partnerships (KTP). The author had a keen interest in seeing the development of teaching companies in Scotland, as he could see the value of having access to real live *laboratories* in industry to take forward postgraduate engineering education.

He was awarded his first grant of many to develop his first Teaching Company Scheme in 1979 while at Paisley College of Technology. This involved four associates being trained over a three-year period; for the author, it provided the evidence of the value of the Scheme to engineering educators [6]. For the rest of his career to date, the author has been involved with the Scheme and, when he became the Head of the School of Engineering in Glasgow in 1985, he made it part of the vision of the School to develop and implement teaching companies with companies in Scotland. This led to a number of such developments and, later as Dean of the Faculty of Science and Technology, he actively encouraged the other technology-based departments to adopt the Scheme as part of their postgraduate education.

Now retired and back in the University as an emeritus professor with the new School of Engineering, Science and Design, he led in 2005 the successful development of a Knowledge Transfer Partnership with a local company to operate over a three-year period from 2006. Thus, the author has contributed to this innovative scheme for postgraduate training for a period of 25 years.

While Head of the School in Glasgow, the author realised that product liability was a neglected subject area in the engineering curriculum. In collaboration with Dr M.H. Chisholm, a barrister and senior lecturer in law, he researched what was required in terms of introducing engineers to strict product liability. With engineering courses already filled with many subject disciplines considered essential, a solution was sought that presented the essential requirements for engineers. The work was promoted by the implementation of the European directive in 1988 relating to strict product liability for engineering products.

In order to introduce it to the engineering curriculum effectively, a team development involving engineers and lawyers was found to be the best approach. A main significant result identified was that differences in culture, legislation, interpretation of legislation, language and the structure of industry across Europe would need careful and detailed study if a transferable curriculum common to engineers was to be acceptable. The results of this development was finally presented where a team-teaching approach, which involved engineers and lawyers, was found to be the optimum approach, and where the essentials formed the basis of the teaching with differences across Europe being considered through relevant casework [7].

In collaboration with Dr M.H. Chisholm, the author also developed continuous professional development programmes for strict product liability that were presented within a range of Scottish companies over a period of several years. This allowed engineers in industry to update in this important subject matter that affected design and manufacture.

The author, while at Glasgow, was awarded major grants to develop and research the establishment of a model of association between industry and academia to provide work-based learning as an integral part of engineering degree education. The author led a team of staff who were involved over a period of several years in delivering models that were then tested, reviewed, and an improved model evolved. Underlying the study was the search to find models that were cost effective in terms of the academic course in the real world environment of industry in a formal and structured manner so that value assessment could be made.

Successful models were put in place so as to facilitate structured industrial practice studies (SIPS) and, in particular, the models were shown to be highly cost effective as academia was able to access high cost equipment in industry, thus avoiding the high costs of such capital equipment being required in university laboratories [8]. For the author, this proved to be a highly stimulating and rewarding period of development with the results being of immediate value to engineering educational programmes [9]. For the author, it also established his interest in what could be achieved in the work-based environment and later led him to become involved over the past 15 years in the development of work-based learning, where he has been able to make highly significant contributions to this now rapidly developing form of education.

Throughout his career, the author has significantly contributed to the research education and training of graduate engineers through his supervision of students at the MPhil, MSc and PhD levels. To facilitate this training, the author created leading edge research in materials engineering involving both research into the processes for the production of the materials, and into the properties and structure of the resulting materials.

Since 1970, he has supervised successfully over 60 research students from various parts of the world. In delivering this training, he set up a collaboration with staff at the Eotvos Lorand University, Budapest, Hungary, in 1984/1985, and this collaboration has been sustained and is still operating in 2006. The research students have their training enhanced by spending a

period in the laboratories at the Eotvos Lorand University. The results of this continuing research form the basis of over 120 papers in international conferences and journals.

DEVELOPMENT OF ENGINEERING PROGRAMMES AND THEIR IMPACT

For the author, engineering programme development has been a major focus throughout his career. The following details his more major contributions to the design, development and implementation of undergraduate, postgraduate and research training programmes:

- He helped to develop materials engineering courses with specific relevance to civil, mechanical, electrical, electronic and manufacturing degrees. These courses, while containing the same theoretical understanding of materials, were designed to have application-specific relevance to each engineering discipline. The results were highly effective, with students enjoying much higher motivation due to the courses being application-specific and relevant to the type of engineering being studied. This work was completed while at Dundee in 1965/1970 (now Abertay University). This work was shown to be easily transferable and was implemented by the author for engineering courses at Robert Gordon's Institute of Technology, Aberdeen (now Robert Gordon's University), including offshore materials engineering over the period 1971/1974.
- While at Robert Gordon's Institute of Technology, the author made significant contributions to the development of a new applied aspect of engineering – offshore engineering. The Institute and the School of Mechanical and Offshore Engineering responded rapidly to an essential requirement to educate and train personnel for offshore engineering with the rapid expansion of oil production taking place in the adjacent North Sea. This involved intensive research into the discipline area, visits to the USA to examine engineering courses and visits offshore to understand the working environment.

  Over a very short period of a year, a post-diploma in offshore engineering was developed to suit a wide and flexible entry of engineers and other associated disciplines to prepare them for a career in offshore engineering. Alongside this development, the existing engineering programmes were reviewed and offshore engineering included as a subject within the overall programmes. All this work led progressively to the establishment of a suite of undergraduate and postgraduate programmes related to offshore engineering.
- While at Paisley College of Technology, the author initiated a major development in the form of a new degree with honours in Industrial Engineering (this is detailed elsewhere in the article).

  Another significant contribution was made by the author in the form of introducing the study of offshore materials into the Honours degree in Mechanical Engineering. This was based on earlier research and consultancy completed at Robert Gordon's Institute of Technology. Students were allowed to elect to complete the degree by selecting an optional route named offshore materials engineering, and those students who selected the option also completed their final year dissertation in offshore materials. As the growth of the offshore industry was rapid, this became a popular option with students. Novel to the course was casework developed from real consultancy problems in materials that had involved the author.

  With rapid developments relating to information technology, the author also led the development of a new postgraduate diploma in Information Technology (IT), which was designed to facilitate the entry of students from various engineering disciplines.

  While at Paisley, the author also made a major contribution to continuous engineering education in corrosion technology. During that period, there were various government initiatives developed to tackle the problem of corrosion in engineering, including the need for education. The author developed a suite of corrosion education programmes as post-experience courses, either taught in-company or on-campus. Where the courses were taught in-company, the author introduced the novel concept of problem-solving workshops, where the participants looked at existing corrosion problems that the company had still to address. This approach was found to be highly popular with both participants and company management. These programmes were sustained over the period 1978-1985.

  Within the existing degree programmes, the author also introduced corrosion studies where a particularly innovative approach was taken by teaching students how to design to prevent corrosion through effective engineering design. This proved to be a highly effective approach, as students were able to see how rational design

engineering could control corrosion and effectively design it out of an engineering product.

- The author arrived in Glasgow College of Technology (now Glasgow Caledonian University) during 1985 with a view to creating a new School of Engineering under a Scottish Education Department initiative, *Switch to Engineering*. This initiative was taken forward at that time due to the significant shortage of graduate engineers. With the establishment of the School, the author took forward the development of a new honours degree programme that was designed for both full-time and part-time students. The degree was developed after research into what was needed from future graduates. Research also suggested that often students wished to change disciplines, but traditional courses were not designed to facilitate this. So the author and his team developed an integrated degree where the subject matter of the earlier years of the programme was common to all students, followed by the students choosing a route based on manufacturing engineering, mechanical-electronic systems, microelectronics, building services engineering and power engineering. This approach proved to be highly popular and a rapid growth of student numbers took place over the next few years. At a later stage, students were also able to spend a year in industry that, if successfully completed, led to the award of a Diploma in Industrial Practice in addition to the degree.

  Another innovative development was taken forward by the author in the form of a new degree scheme that combined an understanding of business with manufacturing systems. The author made a successful bid to the Scottish Office Education Department under a *Manufacturing Systems Engineering Initiative* to develop a course in Glasgow. This development involved departments across the College cooperating with the School of Engineering to put the new degree in place. Once implemented, this programme attracted much interest from both business and career guidance teachers.

  The author also developed the first MSc programme within the institution. He was successful in being awarded a major grant from the High Technology National Training initiative to develop an MSc/Postgraduate Diploma in Energy and Environmental Systems. This programme proved highly popular with students and has been sustained within the School's current suite of MSc programmes.

  The author also led the development of an MSc programme related to maintenance engineering and maintenance systems, which also proved to be popular and has also been sustained within the School's current suite of MSc programmes.

- Within Glasgow Caledonian University, the author, while Executive Dean, took forward a major piece of development relating to a new postgraduate work-based learning framework. At the time, this development was regarded as highly innovative and at the leading edge of educational learning ideas. He researched the idea over the period from 1990 to 1992 and, in 1992, the first MSc framework for work-based learning study was approved. Thereafter, the author was highly involved in the implementation of the framework in engineering companies, the examination of the results obtained, followed by modifications to the framework and its reapproval by the University. The framework was also combined with the postgraduate teaching companies, thus allowing the associates within the company to complete an MSc by work-based learning based on their teaching company activities. This proved to be a highly successful innovation as the work-based learning approach had direct empathy with the work of the teaching company associates. After further research, the author introduced the idea of extending work-based learning to the doctorate level and, in 2000, the University approved the establishment of a ProfD. This facilitates participants completing work-based study at the leading edge of professional practice. The author has now successfully supervised the first ProfD awarded by the University in 2005. At present, the author continues to research into work-based learning and is supervising several participants both locally and as far away as in Kigali, Rwanda.

ACHIEVEMENTS RELATED TO ENGINEERING EDUCATION

In 1988, the author was appointed by the Scottish Office of Government as a Director on the Board of the Engineering Industry Training Board (EITB) for the UK. He served on the Board for a period of three years and, during that time, gave significant contributions to the debates on strategy and policy relating to engineering training. During this time, he also took forward a major UK project as Chairman of the Technology Standards Committee to deliver professional level (5) occupational competences for UK industry. He led this development through consultants and managers from industry using 12 development

sub-committees. The author made a significant contribution to the future development of engineering competence-based education in the UK during that period.

Following his period with the EITB, the author was appointed as Chairman of the Standing Conference for Engineering Manufacture (SCEM) in 1991, supported by the professional institutions, lead bodies and industry through the Government Employment Department. The remit was to continue to deliver standards and competences at the professional engineering level (5) for the UK and Ireland. As chair of the SCEM, the author was appointed as a Director of the Engineering Occupational Standards Group. With this remit, the author made a significant contribution to the establishment of standards and professional level competences in engineering.

The author made a major contribution to UK engineering over the period 1975-1991 by contributing his expertise to various developments with the Council for National Academic Awards, London (CNAA). At that time, this body was responsible for the formal accreditation of degree-level education within the polytechnic sector of higher education. He initially served as a member of the Mechanical and Production Engineering Board, which involved chairing working parties, and chairing or being present as a team member on validation and approval visits to polytechnic establishments throughout the UK. This was vitally important work, as it involved verifying the standards of engineering degrees as appropriate and, on this basis, validating the degree or alternatively withholding validation on the basis that standards had not been achieved. The same process was also used for approved degrees where reapproval visits were made at appropriate intervals. Thereafter, the author also became a member of the research sub-committee for engineering relating to the validation of MPhil and PhD. He also joined a special working party looking at the development of enhanced engineering degrees. During this period, CNAA degrees in the polytechnic sector gained a high reputation for standards and quality that ultimately led to the merging of the CNAA sector with the universities to create a one university system in 1992. During validation events, team members had to become experts on all aspects relating to an engineering course, including a critical analysis of laboratories, teaching methods and research underpinning. This usually involved long hours of preparation and then, during the visit, being able to reach a sensible decision that sometimes involved either withdrawing approval from an existing course or withholding validation of a new course until certain criteria were satisfied. The author believes it was a tough but fair process that made a major contribution to achieving and maintaining the standards of UK engineering degrees.

The author also contributed to establishing the standards of engineering degrees in the polytechnic sector in Hong Kong. He was first involved in validation visits with the CNAA, UK, which had been invited to carry out the validation work. Later, the author was appointed as a member of the Hong Kong Council for Academic Accreditation when they assumed responsibility for the polytechnic sector.

The author also contributed to the standards of engineering in Ireland over the period 1979-1989 when he was a member of the Council for Educational Awards (NCEA). This involved similar processes to the CNAA work with validation visits being made to the non-university sector.

Through British Council Grants of four years duration, the author, in the early 1990s, was able to develop collaborative work with engineering departments at the Technical University in Budapest, Hungary, and with the Prague Technical University in Prague, Czech Republic. During this period, help was provided to these engineering departments as they entered the free economy system of the West. In particular, developments relating to energy, environment and maintenance engineering were taken forward. Exchange visits were put in place and staff from the Prague Technical University qualified at the MSc level through the Learning Contract Framework at Glasgow, and thereafter began the development of a similar system in Prague.

A TEMPUS grant obtained by the author led to the development of maintenance engineering at the Technical University of Radom , Poland, in 1984. This led to ongoing developments between Glasgow and Radom over a ten-year period. The author was pleased to note that the maintenance systems engineering was sustained; this was important as, at that time, maintenance engineers were important for the further development of the Polish infrastructure.

Work at Glasgow also led to the author reporting innovative developments with Prague Technical University where staff from the Technical University developed skills to implement learning contract training programmes in Czech industry that proved to be successful [10].

COLLABORATION WITH THE UICEE

In February 1998, the author negotiated the signing of a Memorandum of Understanding between the UNESCO International Centre for Engineering Education (UICEE), based at Monash University, Melbourne, Australia, and the Faculty of Science and Technology of Glasgow Caledonian University (GCU),

Glasgow, Scotland, UK, to establish the first UICEE satellite centre, which was named the *Caledonian Centre for Engineering Education* (CCEE). This Memorandum was signed by the author on behalf of the Faculty while in attendance at the *1st UICEE Annual Conference on Engineering Education*, held at Monash University in mid-February 1998.

As Dean of the Faculty, the author was particularly attracted to the collaboration, as the UICEE is the world's first and only centre of its kind in engineering education with, as its centrepiece, human resource development on a global scale within engineering education.

The desire to address UNESCO's Constitution, which states that *...since wars began in the minds of men, it is in the minds of men that the defences of peace must be constructed*, was a prime mover in attracting the author and the Faculty of Science and Technology to become a partner of the UICEE by the establishment of the CCEE as a satellite centre. The globalisation and building of international cooperation is also in sympathy with the strategic aims and objectives of the GCU.

At the time of signing the Memorandum, part of the vision was to see a number of satellite centres established on a global basis so that an international network could be established with the UICEE as the quintessential pivot of the global operation. Within the time span of eight years, this vision has been accomplished, with the establishment of about 20 satellite centres strategically positioned geographically to synergise the sustainability of the UICEE [11][12].

The author is particularly pleased to see this rapid growth towards the vision, which was discussed when the Centre was initiated. The basis has now been well established to enhance engineering and technological education through effective global communications and to see the transfer of expertise in engineering and technology to developing nations.

CALEDONIAN CENTRE FOR ENGINEERING EDUCATION

When the CCEE was established, it was agreed with the UICEE that it would provide a focus for the development of academic and research-related activities in engineering education in the UK and Europe, and that it would work closely with the UICEE to realise the progressive globalisation of engineering education. This would be accomplished by establishing the range of activities of the UICEE, which have been already well documented [13][14].

The author also agreed that the CCEE would participate with the UICEE in taking forward seminars, workshops and conferences. Since 1998 the author has worked with the UICEE, having an active membership in the organising committees, such as the *Global Congress on Engineering Education* held at Kraków, Poland, in 1998, the *2nd Global Congress on Engineering Education* in Wismar, Germany, in 2000, and the *2nd, 3rd and 4th UICEE Annual Conference on Engineering Education* in held in Auckland, New Zealand; Hobart, Australia; and Bangkok, Thailand, respectively.

At these conferences, the author presented workshops relating to various aspects of work-based learning. At the outset, the author agreed that the satellite centre would facilitate the transfer of work-based learning on a global basis, as well as provide the focus for academic and research activities related to workplace/work-based learning.

The author provided the leadership for the growth of work-based learning and workplace learning and this became a major driving force within the Centre such that in 2000, the satellite centre was repositioned as the University was restructured. The new centre was named the *Scottish Centre for Work-Based Learning*.

1ST CCEE CONFERENCE ON LIFE-LONG LEARNING FOR ENGINEERS

The author organised a conference with support from the UICEE under the theme of work-based learning and continuous development for engineers. This theme was considered to be particularly relevant as research by the author had indicated that off-campus learning would be a major area of growth over the next decade, with work-based learning increasingly becoming the norm for the professional development of engineers [15]. The Conference was highly successful and was one of a number of regional conferences supported by the UICEE. The author presented findings that showed that the process of taking technological education off-campus into the workplace environment provided an important basis for a change in the mindset needed to stimulate life-long learning and CPD through an off-campus work-based model.

A set of Conference Proceedings was provided in the form of refereed papers selected for publication in a special edition of the *Global Journal of Engineering Education* (GJEE), Vol.3, No.3 [15]. The author acted as a Guest Editor.

ACTIVITIES AND DEVELOPMENTS THROUGH THE CCEE

The UICEE has a particular interest in the establishment

of a global curriculum for engineering education, particularly taking into account the needs of development of advanced technological processes and IT-related technologies. The author assisted the UICEE in taking forward the debate about achieving a global curriculum, and assisted the UICEE in hosting a workshop debate on the way forward at one of its international conferences. The UICEE took forward the development in the form of a global postgraduate range of qualifications up to the MSc level. The author played a role in this development, contributing to a workshop for this qualification, which was held prior to the *3rd UICEE Annual Conference on Engineering Education* in Hobart, Australia, in February 2000.

The author continues to work with the UICEE to resolve the complex issues surrounding the establishment of a globally suitable undergraduate curriculum, which is compatible with the conflicting requirements of advanced and developing nations.

The author contributed during the strategic planning period of the University to have a commitment to the delivery of life-long learning, particularly through the development of widened access and through flexible learning models based on workplace/work-based learning [16]. Again, working in collaboration with the Professor of Entrepreneurship, a model was put forward for the development of a thematic work-based learning contract in technopreneurship to provide a new mindset for technologists in creativity and innovation in high technology [17][18]. A model for a part-time foundation learning contract for employees returning to learning with no formal qualification was taken forward by the author. The basis of this development was to provide the return to learning through the workplace environment as a transition to combining on-campus learning and work-based learning.

The author supported the student experience by continually reviewing leading edge publications relevant to improving the delivery of the programmes by updating the teaching and learning methods, and then disseminating this information to relevant areas of the Faculty portfolio.

He also led the development of the University Postgraduate Learning Contract framework and took forward the extension of this framework to deliver a doctorate in Professional Practice (ProfD) [19][20]. He was awarded a Continuous Professional Development Grant to advance this postgraduate framework across the GCU by providing staff development for supervisors, and progressing the internal/external marketing of the framework.

Since 1998, the author has participated as a member of the UICEE's Academic Advisory Committee (AAC), being also appointed a Deputy Chairman of the AAC, as a member of the International Liaison Group for Engineering Education (ILG-EE), and he has actively worked with the UICEE to support the development of a network of similar satellite centres.

A number of keynote addresses were made at several UICEE conferences and congresses, reporting on key factors that have been investigated regarding workplace learning at the undergraduate and postgraduate levels, and the internationalisation of such programmes [21][22].

The importance of workplace/work-based learning in the development of life-long learning for engineers was also taken forward through an action research project. This has been reported elsewhere [15].

The author identified that workplace/work-based learning generated new challenges for achieving quality assurance. This aspect formed a main project and the results were published and incorporated into the extension of the GCU Postgraduate Leaving Contract Framework for the professional doctorate level [23][24]. Due to the complex issues surrounding the quality assurance of off-campus work-based learning, this project is ongoing.

The developments in work-based learning at the University by the author were recognised and praised at the government level by the Education Secretary, David Blunkett [25][26]. This was in addition to an invitation for him to present a paper on recent developments in work-based learning to the UK Deans of Science Group [27]. He also presented the results of action research and a workshop on the online supervision of work-based learning at an ICEE-sponsored conference in the Czech Republic [28].

In order to gain further experience in online techniques, the author participated in a Virtual International Conference hosted from Hawaii, attended virtual paper sessions, took part in the synchronous discussion sessions, attended various virtual social events and presented a paper [29].

When the GCU was established with a full university charter in 1993, the author made a major contribution to the establishment of a new Faculty of Science and Technology.

When the University took a decision to replace the Faculties with Schools, the author, as Dean, played a major role in replacing the Faculty of Science and Technology by three Schools, which operated from 2002. At that time, the opportunity was taken to review the role of the CCEE, and the author decided to restructure and take forward the satellite link through a Centre designated the *Scottish Centre for Work-Based Learning*. It was situated within the newly created Learning Services under General Academic and Professional Studies.

The author structured the centre so that it has a *hub and spoke* relationship with the Schools in relation to ongoing developments associated with work-based learning related to engineering and technological education.

The author led the launch of the new satellite centre in May 2002 with over 200 people attending the event from industry and business. Since retirement in 2003, the author has continued to contribute to the satellite centre as an emeritus professor. In this role, he has continued to develop innovative programmes and research related to engineering education, alongside continuing to publish in the field of technological education.

DEVELOPING THE *SCOTTISH CENTRE FOR WORK-BASED LEARNING* (SCWBL)

The author developed the mission of *Scottish Centre for Work-Based Learning (SCWBL)* as follows:

> *Innovative in programmes, learning and research, inclusive al all society and responsive to the needs of the individual.*

Research by the author showed that with all the pressures of modern life on the individual, finding the time to study while holding down a job, raising a family, etc, can be very difficult. He then developed an innovative method of gaining accredited degree qualifications, both postgraduate and undergraduate, while remaining in work and with no loss of income. These engineering programmes involved learning contracts: that is gaining credit towards a degree based on agreed projects/learning goals carried out by the candidate in the workplace under academic and mentor supervision. In this way, the author made a major contribution to the professional developmental needs of the individual in the context of their employers' business aims being of paramount importance.

He set the objectives for a work-based learning degree to create a synergy between knowledge, work and learning, and the application of that knowledge in the practical work situation. The intention was to provide genuine benefits to the employer as well. This exciting and fully flexible route to a wide range of qualifications, from the bachelors' degree to the professional doctorate, is growing exponentially in popularity based on the innovative research and development of the author. In this respect, he has made a significant and sustainable contribution to engineering education in the form of work-based programmes.

In particular, he set out the following:

- To establish a clear identity as the centre of expertise and excellence in relation to work-based learning on a global basis;
- To design and deliver work-based learning programmes that are specifically related to professional development;
- To consolidate and expand the Postgraduate Learning Contract Frameworks;
- To expand the undergraduate Caledonian degree framework.

The main research and scholarly activities taken forward by the author were as follows:

- Extending work-based learning into lifeplace learning so as to include measured and credited learning in the home (family), the community and by use of the workplace;
- Understanding the nature of tacit knowledge and its role in work-based learning;
- Understanding the role of the workplace environment in relation to the development of advanced knowledge skills associated with emotional intelligence (EQ-i);
- The role of work-based learning in CPD development;
- The development of problem-based, work-based learning and controlling factors;
- Methodologies for negotiated learning systems involving mode 1 and mode 2 learning.

He also has arranged for the SCWBL to make available documentation that reflects the latest advances and thinking on knowledge, work and learning.

Publications, some of which reveal the latest advances and thinking on learning issues, are facilitated through the close association with the National Work-Based Learning Network, UK (UACE). It should also be noted that the author has produced a set of definitive work-based reports on relevant *good practice*.

The author has developed work-based learning as a sub-set of workplace learning. It refers specifically to the achievement of *planned learning outcomes* that are derived from the experience of performing the work role function. In addition, it is normal practice to complement the experience with directed reading, research or group work so as to ensure that the learning is taken forward within the context of current theory or practice. Such experiential learning must be evidenced and assessed before it can be recognised by the University. The author chose this approach so that the work-based learning is underpinned by rigorous quality assurance.

Further research by the author was completed on the assessment of *competence*, which has increased in importance over the last decade, particularly for engineering and technological practice. In the context of higher education, the author's view is that competence is more than the ability to perform tasks; it includes capability and the author noted:

- Assimilate underpinning knowledge and understanding;
- Acquire and utilise core skills;
- Develop the cognitive processes needed to apply the knowledge and understanding to workplace issues.

The author sees his role to help design and deliver a range of vocational work-based learning to extend and widen participation in engineering education. This provision can be delivered off-campus and is flexible to the needs of those already in employment who wish to develop their knowledge, skills and learning. In this respect, the author has provided a consistent and coherent approach to new programme development in collaboration with staff in the schools and other relevant academic units.

In addition, he provides for the delivery of specific work-based learning consultancy services and has membership of the steering group for the UACE in the UK.

He is prepared to work with clients on a global basis to provide expert support in the establishment of off-campus learning and is currently taking forward developments in Rwanda, China and with various European countries. In particular, he has contributed to the establishment of the first work-based franchise between education consultants and the University, and this programme is now operating in several leading European companies from the postgraduate certificate to MSc level in leadership capability.

In particular, the value of further developing the number of satellite centres so as to strengthen the global network is recognised as a key target by the author and he will continue to support the UICEE in moving forward in this direction. This is alongside continuing to provide the transfer of workplace off-campus learning to other interested UICEE-linked institutions on a global basis.

The author is committed to widened access through articulation, the increased part-time provision of life-long learning and addressing the issues of social inclusion [30]. He believes workplace/work-based learning is an ideal vehicle through which all of these issues can be addressed, and project work will be continued on already-published work on the economic and social issues of work-based learning and the client-server approach [31][32]. By supporting such off-campus developments, he will be able to play a key role in contributing to the delivery of these University strategic objectives.

He will also continue to work with other UICEE satellite centres to facilitate potential students and staff being able to complete a postgraduate learning contract leading to an MSc or ProfD. The advantage for staff/students is that of being able to complete the qualification while continuing to deliver in their own workplace. Work has already started in this respect, with work-based learning opportunities being presented at various centres.

The author also offers a workshop that describes work-based learning in the UK and how programmes have developed in the shape of learning contract frameworks, and will be of interest to all concerned with the integration of knowledge, work and learning in engineering education.

3RD GLOBAL CONGRESS ON ENGINEERING EDUCATION (2002)

As Dean of the Faculty of Science and Technology, the author spearheaded the development in the GCU leading to the *3rd Global Congress on Engineering Education* in July 2002. This was sponsored and organised by the UICEE with the GCU as the host, principal co-sponsor and co-organiser. The Congress provided a venue to continue the debate relating to the effects of globalisation on engineering and technological education. Over 100 papers from 30 countries worldwide stimulated useful debates and facilitated the identification of critical issues. The Congress was an academically exceptionally fruitful event with the majority of papers being of a very high academic standard.

A Special Edition of the *Global Journal of Engineering Education* (GJEE), Vol.7, No.1 (2003), was published dedicated to the Congress. It reflected the global trends of engineering and technology education that need to be taken into account by engineering educators. This edition contained a Guest Editorial by the author, the former Dean of the Faculty of Science and Technology and an introductory address. He also presented papers at the Congress relating to ongoing research on the future sustainability of engineering education and aspects relating to emotional intelligence (EQ-I) and work-based learning [33][34].

The author has taken forward developmental work to revise the existing framework for work-based learning so as to increase the flexibility of negotiated

learning by making available a wide range of off-campus and on-campus learning constructed according to the requirements of students. In this respect, he initiated the novel Caledonian degree, which provides students with the facility to negotiate those modules that they wished to complete each year [35].

As part of extending negotiated learning, the author modified the degree to facilitate students negotiating to complete some of their studies through completing work-based learning modules in their place of work. Those modules are being made available for students to complete during a third semester over the summer period. More recently, the author initiated a pilot study whereby students can negotiate to complete lifeplace learning modules in the home or community.

He also modified the undergraduate framework to provide a pathway for holders of higher national diplomas or their equivalent – such that students are able to undertake a top-up work-based learning BA/BSc degree, providing yet another innovative engineering programme.

As was indicated earlier, the author took forward the establishment of the first franchise with an external organisation in 2003. Much of the developmental work was associated with the establishment of secure quality assurance for the operation of the franchise. The University held an accreditation event to approve the external organisation as being able to deliver a thematic pathway on leadership capability at the postgraduate level.

This franchise is now ongoing with leading European companies, with students being supervised in various workplaces across Europe. Each student is able to progressively complete the Leadership Capability Thematic Learning Contract from the postgraduate certificate to MSc levels.

The author believes this development is of fundamental importance for future development and expansion of the Postgraduate Learning Contract Framework, which is currently limited by the available supervision in the University. The author is actively engaged in the identification of external institutions to deliver Thematic Learning Contracts. He believes these elements offer a route for considerable expansion.

More recently, the author has taken forward work-based learning into China and Taiwan. Discussions to date have shown that there is serious interest in China for students to complete work-based postgraduate degrees. He is exploring models of collaboration with various Chinese universities, including the progressive development of an appropriate franchise model with interested universities. He believes that the successful development of an appropriate franchise model will have global transferability and hence facilitate considerable expansion for the GCU.

In Taiwan, the author had discussions with the two UICEE satellite centres located at the National Changhua University of Education (NCUE), Changhua, and the Chinese Culture University (CCU), Taipei, respectively.

At the NCUE, the author signed two Memoranda of Understanding with the College of Engineering and the College of Technology. Ongoing discussions are now taking place to reach a Memorandum of Agreement relating to engineering programmes in the College of Engineering, which are a close match to the programmes offered in the School at the GCU. The author has put in place a model such that where a close match is established, students from the College of Engineering will be able to articulate to the third or final year of the corresponding programme at the GCU and then, continue with an MSc programme. With the College of Technology, similar considerations are taking place and the possibility of creating joint research studies is being considered at the doctorate level. Thus, the author has succeeded in developing a successful collaborative model for engineering students.

The author has also established formal collaboration with the African satellite centre at Kigali Institute of Science, Technology and Management (KIST), Kigali, Rwanda. The author initiated the signing of a Memorandum of Agreement with the GCU at a ceremony conducted at the *3rd Global Congress on Engineering Education*, held at Glasgow Caledonian University in July 2002. At the same ceremony, a Memorandum of Agreement was signed between the UICEE and the KIST to establish a satellite centre at the KIST. Ongoing developments have involved staff from the KIST developing work-based projects for consideration as potential study areas at the postgraduate level using the postgraduate framework at the GCU. Staff at the KIST and the author are working together to establish a number of postgraduate learning contracts at the MSc and ProfD levels, and already projects for ProfD are ongoing. The KIST has taken a keen interest in the methodologies of work-based learning and, in the longer term, the author hopes to establish work-based learning programmes at the KIST.

The author is also involved in an examination of the engineering programmes at the KIST to determine whether a close match can be found with programmes at the GCU so as to facilitate Rwandan students completing a degree in the School in Glasgow. In this respect, the author hopes that this will contribute to a global-based widening of student

participation in engineering.

He is also taking forward ongoing studies with the satellite centre at Aalborg University in Aalborg, Denmark. The basis of this collaboration is the bringing together of expertise in problem-based and work-based learning. To take forward this collaboration, applications have been made to the European Union (EU) for supporting grants and, on the basis of this collaborative work, is now being taken forward to develop models for CPD learning using problem-based and work-based learning methodologies. As CPD supports career planning and development, the author is concerned with identifying the role of tacit knowledge alongside explicit knowledge as a model for new and innovative continuous engineering education.

He has developed a highly innovative toolkit to support CPD studies that will facilitate the integration of requisite tacit knowledge with the required explicit knowledge. He has chosen workplace learning methodologies as the way forward as tacit knowledge is integral to the workplace environment and the organisation involved. Much of the project work is concerned with how to identify the relevant tacit knowledge and integrate it with explicit knowledge so that the tacit knowledge becomes explicit codified knowledge. A fundamental part of the work is to examine what aspects of tacit knowledge are suitable for conversion to codified knowledge. This initiative by the author has led to a new operational paradigm for CPD.

He is also taking forward developments relating to work-based and problem-based learning with further EU applications in preparation. In particular, an application is being prepared to extend the concepts of problem-based and work-based learning to the home (family) environment and the community environment. This new development is described as lifeplace learning, a concept initiated by the author.

The author continues collaboration through a Memorandum of Agreement with the satellite centre at Hochschule Wismar - University of Technology, Business and Design in Wismar, Germany. This has involved joint participation in applications to the EU for grants. Still ongoing is the potential development of a European Master's degree in engineering, the establishment of work-based learning at Wismar and joint-venture collaboration in relation to surface engineering. In this respect, the author has brought together research teams working in the area of deposition of thin films to establish collaborative and joint research in the specialist area of engineering, and to facilitate postgraduate education through problem-based applied research.

The author has also given support to the successful establishment of projects with the *Central Asia Centre for Engineering Education,* a UICEE satellite centre based at Tomsk Polytechnic University (TPU), Tomsk, Russia, and there are now regular visits by GCU staff to the TPU in order to take forward collaborative developments relating to engineering education.

The author continues to publish the results of his developments, scholarly activity and research at conferences and in journals related to both the UICEE and other organisations. Further work relating to the development of entrepreneurship and its role in the engineering curriculum was presented at the *5th Baltic Region Seminar on Engineering Education* in Gdynia, Poland (2001) [36]. An article relating to work on entrepreneurship was published in the inaugural issue of the *World Transactions on Engineering and Technology Education* (2002) [37].

Important developments relating to an undergraduate-negotiated learning model for the facilitation of broad-based engineering and technological education was presented at the *6th Baltic Region Seminar on Engineering Education* held in Wismar/Warnemünde, Germany (2002) [38]. The programme is now operating within the GCU.

More fundamental work on new models and modes of work-based learning involving a study of the role of tacit knowledge was presented at the *6th UICEE Annual Conference on Engineering Education* staged in Cairns, Australia (2003) [39][40]. Additionally, a paper relating to research into work-based learning methodologies was published in the GJEE (2003) [41].

More recently, the author has taken forward curriculum development and assessment for knowledge-based engineering graduates and more fundamental work relating to extending learning from the workplace to the home and community in terms of lifeplace learning was presented at the *7th Baltic Region Seminar on Engineering Education* in St Petersburg, Russia (2003) [42][43]. The author has also provided an invited keynote paper presentation on negotiated learning methodologies as a way forward for engineering at the *1st North-East Asia International Conference on Engineering and Technology Education* at the NCUE in Changhua, Taiwan (2003) [44].

In November 2003, the author attended the *1st International Conference of the UACE Work-Based Learning Network* in Cyprus. Presentations were made relating to major developments and research on the extension of work-based learning to lifeplace learning for the formalisation of learning in the community and in the family (home), as well as on research into the integration and transfer of tacit knowledge to

explicit knowledge [45][46].

The author, through his relationship with the UACE work-based learning network in the UK, has presented continuing research and development work relating to work-based learning at the UK annual conferences and in the journal, *New Capability* [47][48].

He also attended the *4th UICEE Annual Conference on Engineering Education* in Bangkok, Thailand, where leading edge developments relating to the role of generic descriptors for work-based professional doctorates were presented [49]. Results were reported at the same Conference relating to the role of structured workplace studies in undergraduate and postgraduate engineering programmes [50].

Studies relating to models for lifeplace learning and the potential for this to widen considerably entry to off-campus learning were presented at an *International Conference on Life-Long Learning* held at the GCU in July 2003 [51].

Although unable to attend the *8th UICEE Annual Conference on Engineering Education* in Kingston, Jamaica, the author made a major contribution in the form of three collaborative papers with staff from the GCU and the University of Wales Institute, Cardiff, who, with key GCU staff, form the Celtic Scholarly Activity Group. Recent work on the development of a model for the professional development of engineers was reported where the model provided a new paradigm approach for the global professional development of engineers [52]. This is now available as a CPD work-based qualification at the postgraduate level.

Research on the analysis and value of different learning environments for engineers was also reported by the author, who is now leading an in-depth study into off-campus learning environments [53]. The results reported in the paper showed that better engineering education could be achieved by the integration of various learning environments. This is now being successfully delivered at the GCU, but the model has global transferability. Work was also reported on the need for knowledge skills alongside engineering knowledge and professional development in programmes and ideas were put forward as to how to achieve this through the undergraduate curriculum [54]. Further research studies were reported on this development in the form of a paper published in the UICEE's *Global Journal of Engineering Education* [55].

This group now collaborates together on a number of research projects. Recent developments were reported at the *9th UICEE Annual Conference on Engineering Education*, held in Muscat, Oman, where four papers were presented. The author was a co-author of three papers [56-58]. He was also author of a paper as an opening address that detailed recent leading edge research through a Leonardo-supported EU project on the development of engineering competences in a global information society [59].

GLOBAL COLLABORATION WITH ENGINEERING PROGRAMMES AT THE GCU

In his role as Dean, the author established successful articulation to later years of a number of the Faculty programmes, and this success has been continued by the new School of Engineering, Science and Design. The author is now offering this facility to UICEE satellite centres as appropriate, thereby facilitating engineering students with the possibility to complete an engineering degree at the GCU.

He is also intending to take this articulation forward alongside other joint ventures involving postgraduate degrees. This type of development is already ongoing with three UICEE satellite centres alongside other universities globally.

At the undergraduate level, he has been involved with other institutions in determining whether or not the programmes they offer are a close match to a GCU programme. Where such a seamless match can be verified, students from that institution will be able to enter the corresponding programme in the School by articulating into the third or final year of a degree. This means that a student can complete two/three years at their own institution and then complete a degree in the School in Glasgow. The author sees this as a highly innovative scheme that allows students to gain a valuable new experience without having to spend the full four years of study in the School at the GCU. Research by the author has shown that this type of articulation can only be achieved through a close association and agreement between the institution and the GCU School in order to achieve a seamless match of programmes. He believes the institution needs to make available complete details of its programmes in order to determine whether a matching programme is available.

With this scheme operating successfully, the author is willing to cooperate with other UICEE satellite centres in order to facilitate students being able to come from overseas to enjoy a new experience and complete their degree in the School at the GCU. The process of determining articulation to later years of a programme is ongoing.

The author also has developments continuing to extend and develop collaboration at the postgraduate level. Previously, the earlier CCEE offered staff from other satellite centres the opportunity to study for a

PhD on a part-time basis. This was successfully taken up by a staff member from another UICEE satellite centre.

On the basis of previous success, the author is interested in extending this development and is willing to consider a joint MSc with a suitable institution where an overseas student could complete the lecture studies in the School and then return to his/her home institution to complete the project/dissertation. With regard to PhD study, he also suggests a willingness to collaborate with institutions where the student/staff could spend up to one year full-time at the GCU, followed by a return to his/her home institution to complete the PhD on a part-time basis. In each case, the collaboration would be based on a Memorandum of Agreement. The author is now also considering developments relating to ProfM and ProfD by work-based learning, where the staff/student can study in his/her own workplace. The author will welcome any interest in a collaborative development from any of the UICEE satellite centres.

THE OMAN COLLEGE OF ENGINEERING, MUSCAT

During 1995, in line with its strategic plan to support developing countries, the GCU proceeded with the establishment of an engineering college in the Sultanate of Oman [60]. This development was led by the author as Dean of the Faculty and represents a major contribution to engineering educational developments. In 1995, no engineering colleges existed in Oman awarding UK diplomas/degrees, and the author provided key leadership for the establishment of the College and, thereafter, as Dean of Faculty at the GCU was responsible for the continuing development until his retirement, which saw the establishment of honours degrees at the College. He contributed to the development of the academic infrastructure in its totality, leading initially to the establishment of four university diploma programmes in engineering discipline areas relevant to the developing workforce in Oman.

The author was present when the Caledonian College of Engineering in Oman was opened after intensive development in September 1996, and when it enrolled its first main group of students in 1997. The programmes were set up on the articulation model developed by the author so that students who successfully completed a diploma were able to articulate to the third year of a corresponding programme at the GCU, thus allowing students from Oman to gain a UK experience of engineering.

The author saw this development as facilitating the growth of engineering education through action research and other scholarly activity, thereby supporting the staff in the effective delivery of the range of engineering programmes.

After much collaborative development, which involved the author in the development of vigorous quality assurance procedures for the College, it was recognised in 2002 as an accredited university college. It was approved by the GCU to deliver a range of honours degrees in engineering and the built environment.

The author encouraged the College to sign an agreement to become a UICEE partner member and established a satellite centre. This was completed at a ceremony held during the *3rd Global Congress on Engineering Education,* hosted by the GCU in mid-2003.

AWARDS

The author gained the following awards, many related to his period of collaboration with the UICEE:

- Westinghouse Prize of the Institute of Metal Finishing for the best paper published in the Transactions, 1988/89.
- Westinghouse Prize of the Institute of Metal Finishing for the best paper published in the Transactions, 1995/96.
- American Electroplaters Society prize for the best paper presented at *American Electroplaters' International Conference*, 1971 and 1981.
- Best paper award for a paper entitled *Go Ask the Old Timer* at the *EISTA International Conference on Education and Information Systems: Technologies and Applications*, Florida, USA, 2004.
- The UICEE Gold Badge of Honour award for *...distinguished contributions to engineering education, outstanding achievements in the globalisation of engineering education through the activities of the Centre and, in particular, for remarkable service to the UICEE;* in 2000.
- The UICEE Silver Badge of Honour award in 1999.
- A Diamond Best Paper Award for a paper on quality assurance issues relating to the delivery of work-based learning programmes, selected by the participants at the *3rd UICEE Annual Conference on Engineering Education,* held in Hobart, Australia in 2000 [13].
- A special UICEE Director's Award for distinguished contribution was accorded for a paper on the assessment of how work-based

learning methodologies may contribute tot he development of engineering education in the 21st Century. This was presented at the *6th UICEE Annual Conference on Engineering Education* in Cairns, Australia.

- The UICEE Bronze (Fifth Place) Award for a distinguished contribution was accorded for a paper relating to the development of professional engineers in a knowledge organisation, selected by the participants at the *8th UICEE Annual Conference on Engineering Education* in Kingston, Jamaica, 2005.
- Awarded the title of Emeritus Professor by Glasgow Caledonian University in 2003.
- Awarded the inaugural *UICEE Order for Excellence in Engineering Education* at the *9th UICEE Annual Conference on Engineering Education* in Muscat, Oman (2006).

The author has extended his work on work-based learning over the period from 2003 to the present with the setting up of a team to research the extension of the concept of work-based learning by examining four specific areas that are ongoing as future work, namely:

- The concept of accredited learning in a person's lifeplaces (the home, community, workplace);
- The role of tacit knowledge and its interaction and integration with explicit knowledge;
- Theories and methodologies relating to defining a work-based learning environment;
- Accreditation and awards based on 100% prior learning.

Already work has been successfully completed relating to the delivery of awards based on 100% prior learning, where a model has been published that facilitates the completion of a reflective portfolio underpinned by assessment and quality assurance [61][62].

A new operational paradigm for lifeplace learning has been successfully tested by over 40 students completing modules within the Caledonian degree by negotiated learning at the GCU [63][64].

A major continuous engineering education project has resulted in the delivery of a CPD by work-based learning toolkit, which integrates tacit knowledge with explicit knowledge learning. Experimental testing has already shown that the toolkit is an effective mechanism for engineers to achieve life-long learning [65].

Work has already been completed on looking at the theoretical base of learning through a work-based environment and factors affecting the effectiveness of the work-based environment.

EMERITUS PROFESSORSHIP

After his retirement in 2003, the University conferred the title of Emeritus Professor on the author and he has continued to work in the University to date with the School of Engineering, Science and Design, as well as with the General Academic and Professional Studies Unit in Learning Services.

He continues to work closely with the UICEE, and to research and publish in engineering and education. He has also sustained his long-established global research collaborations and, more recently, has established a number of new European and international collaborations related to materials science, engineering and work-based education.

CONCLUSIONS

- Resulting from the established expertise in workplace lifeplace and work-based learning, the author will continue to take a lead role in research and consulting, alongside supporting and contributing to seminars, workshops and conferences/publications sponsored by the UICEE to underpin the continuing global development of off-campus life-long learning as the future focus for engineering and technological education [66].
- The author will continue to support new developments through action research, such as exploring the mindset needed to support the growth of new high technology workplace and lifeplace developments and the change in mindset of society in relation to the contribution of engineers, scientists and technologists to global society.
- The author has made a significant contribution to advances in materials engineering in terms of both processes for the delivery of new materials, and the understanding of the structure and properties of these new materials. In doing so, he has made a significant contribution to the research training of engineers and technologists at the doctorate level.
- In his career, the author has made significant contributions to a number of key areas of engineering education in the UK, Europe and on a global basis.
- The author will continue to consolidate and build new links with other satellite centres as one of his continuing activities as emeritus professor at Glasgow Caledonian University.

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BIOGRAPHY

Colin Urquhart Chisholm graduated with a BSc Hons in Metallurgy from Strathclyde University and with a Doctor of Philosophy from St Andrews/Dundee University in 1962 and 1968, respectively.

Prof. Chisholm is an acknowledged international

researcher in the field of electrodeposition of alloys and heads collaboration as Chairman of Surface Technology International, which involves a group of European universities. Since 1985, he has maintained a major collaboration with a team of researchers at Eotvos Lorand University in Budapest, Hungary.

For the last decade, he has led action research and development relating to work-based learning and, at Glasgow Caledonian University (GCU), has developed an innovative Postgraduate Learning Contract Framework for work-based learning, which has been operational since 1992.

In 1998, he negotiated on behalf of the GCU with the UNESCO International Centre for Engineering Education (UICEE), leading to the establishment of the first satellite centre of the UICEE, named the *Caledonian Centre for Engineering Education* (CCEE) at the GCU.

Prof. Chisholm is also a Deputy Chairman of the UICEE Academic Advisory Committee.

He was awarded the UICEE Silver Badge of Honour for distinguished contributions to engineering education in 1998. At the *2nd Global Congress on Engineering Education* in Wismar, Germany, in 2000, he was also awarded the UICEE Gold Badge of Honour. He is the recipient of the inaugural *UICEE Order for Excellence in Engineering Education*, which was presented to him on 14 February 2006 at the *9th UICEE Annual Conference on Engineering Education*, held in Muscat, Sultanate of Oman.

He has published about 300 scientific papers in refereed journals and conference proceedings and supervised over 45 PhD/ProfD students. Prof. Chisholm, in collaboration with the team for Surface Technology International, published the first paper regarding the successful deposition of tin-chromium, tin-zinc chromium, and tin-cobalt-iron alloys. Prof. Chisholm has also received a number of awards for published papers presented at international conferences.

Prof. Chisholm is now emeritus professor at the GCU, where he continues collaboration, research, publications and other projects. He can be contacted at: cuch@gcal.ac.uk