SHARING CONCRETE KNOWLEDGE GLOBALLY

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ABSTRACT. The communication of information and data is increasing in sophistication and complexity at a rate faster than ever before. Where construction projects were previously run by local design teams and publishing opportunities in journals and at conferences may have been limited in the distant past, the mechanisms are now bewilderingly manifold for sharing concrete knowledge globally in professional practice and in academia. Undergraduate and postgraduate students study internationally, international committees and organisations abound, intercontinental academic collaborations proliferate and a plethora of conference and journal outlets are extant for research output. This paper presents a personal view on some aspects of sharing concrete knowledge globally based on observations over many years working as an academic in Ireland and internationally and, more recently, teaching and researching in India. Supported by successfully employed concrete innovations in teaching and recent surveys, this paper illustrates some of the impediments to a successful career as a communicator of concrete knowledge, while identifying also some ideas on how to cope with emerging challenges when knowledge sharing globally.

Keywords: Concrete, Education, Research, E-learning

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INTRODUCTION

The task of presenting an opening address to an audience with a deep-rooted interest in things concrete is one which engenders trepidation. The range of sub-themes on sharing concrete knowledge globally, from artisan courses to doctoral research and the whole gamut of educational opportunities for life-long learning in a rapidly changing world stage, merits a multi-volume textbook, not a short paper. Indeed whether during private conversations or at meetings, an adversary is likely to whip out an i-phone and produce, chapter and verse, a view contrary to one's own on some esoteric concrete detail, but without the succor of knowing the source of this "expertise", which is probably without the benefit of peer-review. Concrete knowledge is already bewilderingly global, shared and accessible. The emergence of agreed European concrete design and product standards is testament to how continental collaboration and knowledge sharing can be technically and commercially successful, notwithstanding the calamitous and evolving Brexit debacle. Intercontinental knowledge sharing is now the norm. Nonetheless, as someone who has had the privilege of teaching and researching in many jurisdictions in the world, through Europe to Africa, Asia, on to Australia and the Americas, observations, perspectives and personal opinions based on some of my experiences over a long career as an academic might perhaps provide the ingredients for some new insights onto this rapidly changing facet of daily life in academia and in practice.

However, this paper will not consider the myriad of technological advancements in communications which enable knowledge exchange, but will focus on some practical local, national and international innovations in sharing concrete knowledge based on the author's experiences.

For example, in engineering and architectural consultant practices of any size or in any location the world over, one is just as likely to be working in a multi-national design consortium as in a local team. For example, not far from Jalandhar, in Patiala, Thapar Institute of Engineering and Technology (TIET) is completing the construction of five large construction projects on campus instigated over the last three years using collaborating Irish and Indian architects (see Figure 1), such as the award-winning (Royal Institution of Architects of Ireland International Award 2018) student residence on campus. On projects such as these, the sharing of a concrete vision and expert knowledge combined with an appreciation for local culture, traditions and conditions are all vital for a successful outcome.

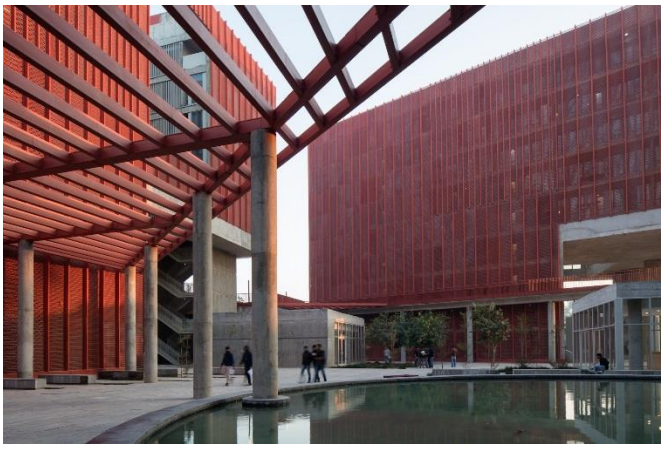
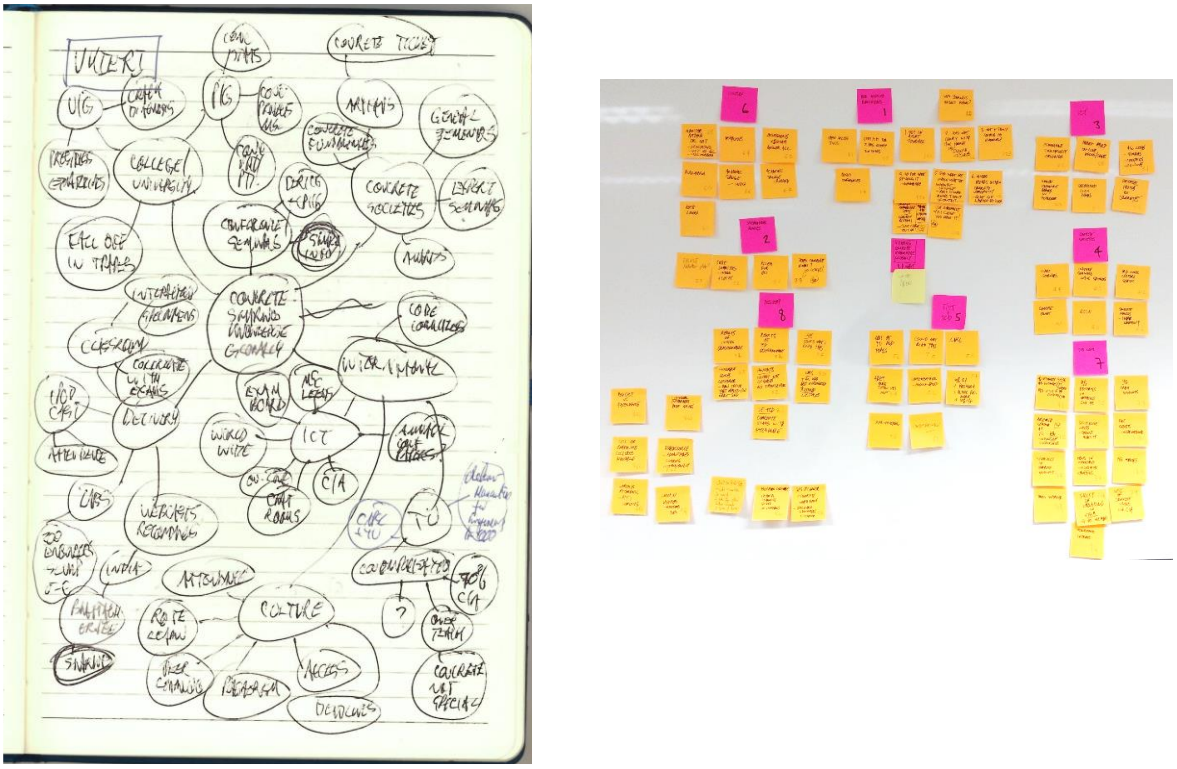


Figure 1 Thapar University Student Accommodation, designed by Irish Architects McCullagh Mulvin, Dublin with DPA, New Delhi

To share views on this complex topic, for this paper, a so-called brain storm ensued on the issuance of the invitation, followed by reflections on long-haul flights and the like, providing the methodology for this paper's gestation. An ordered technique for crystalising one's occasionally chaotic, random but organic thoughts into something which is hopefully cogent, comprehensible and worthwhile, involved the sketching of a mind-map (Figure 2(a)), followed by a more disciplined patchwork of post-its in a flow chart form (Figure 2(b)). The outcome of this oft-used method for sharing knowledge is a sequencing of themes and sub-themes into



(a) (b)

Figure 2 (a) Mind-map and (b) post-its leading to a flow chart for the topics covered in this paper

what one aspires to be a series of reasoned arguments and insights. In this way, logical and clear systematic thinking leads to improvements, through reflective practice, in an understanding of the quality and quantity of the opportunities expanding before us as we share knowledge of concrete globally.

PEER-ASSESSED PUBLICATIONS

What better place to start than the obvious universal mechanism for sharing concrete knowledge globally, namely through learned publications, principally books, journals and international conferences.

While the impact factor of journals is a good guide as to their standing, the almost annual emergence of new journal titles, and especially open-access journals, has made publishing somewhat easier, but the world's best, such as Cement and Concrete Research, Magazine of Concrete Research, ACI Materials, Materials and Structures, Cement and Concrete Composites, Advances in Cement Research etc., all have large numbers of aspiring paper submissions while rejection rates can be as high as 90%. In particular, the emergence of

publishing threshold requirements for PhD thesis submission and postdoctoral and faculty appointments in respect of publishing in Scopus-indexed journals has encouraged novice authors to make multiple submissions to the world's top concrete journals.

An interesting corollary, which may be of interest to fledgling researchers, is to examine some of the potential causes of rejection of journal papers. A better understanding of these factors may assist in being more successful with submissions and thus improve the knowledge sharing opportunities. A personal view suggests the following non-exhaustive causes and cures may assist in improving the acceptance rates of submitted journal papers:

(i) Not sent to the appropriate journal – always read the journal descriptions and pre-review previously published papers in that journal

(ii) Does not comply with the journal format – the formatting rules are all clearly laid out in the on-line instructions and tick-boxes for compliance should be generated. However, the use of poor English, the de facto international language it would appear, is unlikely to encourage engagement by a paper reviewer.

(iii) Not a significant contribution to knowledge – a key criterion for publication is to provide something novel which may appeal to the majority of readers - this should be uncompromisingly spelt out in the paper.

(iv) Not of sufficient practical interest – an identified gap in existing knowledge is not sufficient to justify its investigation – there has to be a practical need to investigate the proposed research.

(v) Lack of critical analysis of data outcomes – too often researchers only describe what they can visually observe in the graphs of their experimental work, but credible explanations of unexpected or novel trends are essential, reinforced by independent tests or previous publications.

(vi) Inference of significance where none exists – if the trends being described are relatively weak, then the test equipment or operator variability in the data must be known in order to evaluate the significance of the trends, if any. For example, calculation of a coefficient of variation or a t-test based on the entire set of data can assist in reaching firmer conclusions.

(vii) Inclusions of irrelevant test results – just because certain specialised equipment is available for use locally does not mean its use is merited. Design every experiment to develop the primary data, supplemented by secondary data which corroborates the main conclusions.

In respect of conference publications, peer review is not always as rigorous as it should be, but the draw of internationally renowned widely published speakers still provides excellent opportunities for networking and sharing knowledge globally, especially at conferences with a narrow focus in its themes. Caution is advised in signing up for some conferences which have financial success as their core mission and a preview of the organiser's track record beforehand would be worthwhile, given the almost weekly announcement of concrete conferences worldwide.

INTERNATIONAL BODIES

In relation to the dissemination of state-of-the-art knowledge of concrete globally, there are several excellent international bodies which issue valuable documents on various topics of

current interest. Such bodies as RILEM, FIP, ACI or Concrete Societies produce guidance documents based on an accumulation of international advice and expertise over time. Indeed, being a member of those committees, which invariably compile these documents on a largely voluntary capacity, is an excellent way to be exposed to and contribute to international collaborations. Even the development of Codes of Practice or Standards, which can often take decades (as in the case of the Eurocodes), with the need for local annexes to allow for country specific conditions, is an enriching experience of collaboration, compromise and information exchange between experts from many different countries, often with a legacy of conflicting concrete practices. Indeed, when an agreement is reached on, say, an equation to describe some aspect of concrete's mechanical behaviour, one might wonder does concrete itself know it has to obey that formulation and does it know in which country it will be expected to do that particular job? For example [1], Equation 1 describes generically the development of the elastic modulus (E_{cm}) of concrete with time, t, depending on concrete 28 day compressive strength (f_{cm}). In this, none of the "constants" (α, s, n and p) have universal values but depend on the aggregate type (α) temperature regime (s), cement type (n and p) and accelerator/retarder use (s). Local values and experimental calibration are needed, despite the monumental efforts over many years in having many countries agree technically on the mathematical form of the equation.

$$E_{cm}(t) = 22\times\alpha\times((f_{cm}\times\exp(s(1-(\frac{28}{t})^n)\ )/10)^{(0.3+0.081p)} \qquad \text{(Eqn. 1)}$$

With technical collaboration within India, given its size, vast States and large populations, it could be argued that the development of the Indian concrete standards is no less an achievement than that of the 28 European countries developing the Eurocodes.

INSTITUTE OF CONCRETE TECHNOLOGY

One organisation which is truly global, with concrete at its heart, is the Institute of Concrete Technology (ICT), a UK-based organisation. Different grades of membership are normally conferred on those who pass, in various stages, an assessment process, a testing blend of practice and theory at an increasingly advanced level. Ultimately this leads to a professional qualification (MICT) and a Master degree if taken though Leeds University, the global provider of the requisite course provisions, under the guidance of Prof Muhammed Basheer (Figure 3). It is interesting to note that in the last four years, candidates from 17 countries have enrolled on this on-line course, from Europe, Africa, the Middle and Far East and New Zealand/Australia. Course delivery in the past has been largely residential, but laterally, is now taken on-line with a heavy reliance on self-directed learning, with local exam and course centres but one examination process. Within the course structure, focussed on on-going and regular problem-based learning, the prescribed lecture material, in a 3-volume book format, guides the candidates through the material relevant to this series of scenarios. In this way, an

Figure 3 The unique ICT international Masters course on Advanced Concrete Technology is directed by Prof Basheer of Leeds University

understanding of the concrete technology problem and subsequent solutions is teased out in chat rooms on the web, led by a rotating student project manager within their multinational groups, communicating and collaborating across the continents in a blended approach to learning.

One of the pedagogical difficulties with group work is apportioning credit for work done – in this scenario, a declaration of participation and the evidence of exchanges of the monitored on-line activity allows confidence in the degree of candidate participation and, subsequently, mark allotment. Also, in this context, self- and peer-assessment may be helpful because they promote metacognitive skills.

Examinations on practice and theory have been used as the final test of competence on the ACT course, however, imagine the complexity associated with organising an examination to be held simultaneously across the globe with widely differing time zones. Indeed, the setting of exam questions which have to be de-localised to ensure that only universal truths about concrete are examined, is particularly challenging.

On gaining full membership, on-going advanced level continuing professional development is catered for through joint seminars with the UK and other local Concrete Societies around the globe, complemented by an annual convention in the UK featuring high-profile international speakers whose papers are published in the ICT yearbook (Figure 4). This institution is surely an exemplar of sharing concrete knowledge globally.

CONCRETE SOCIETIES

Many countries have their own concrete societies, including the UK, Ireland and India, which are generally charged with promoting concrete in all its forms with all and any parties who engage with concrete, not just designers, contractors and concrete suppliers, but also undergraduate and postgraduate students and even concrete sculptors.
For example, for several years the Irish Concrete Society has been training the trades people and artisans who work with concrete, leading to a “Concrete Ticket” (Figure 5) which gives

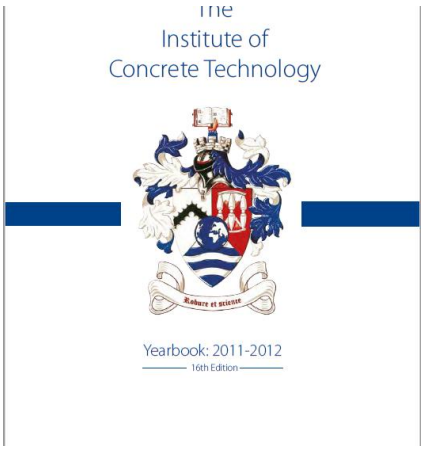


Figure 4 An ICT Yearbook containing annual state-of-the-art papers

Figure 5 The Irish Concrete Society's "Concrete Ticket" for on-site concrete training

them a passport for working with concrete on site. With increasing pressure on school leavers to register on an undergraduate degree course at a college, the shortage of apprentices and trades people in concrete and related disciplines will inevitable affect knowledge transfer from generation to generation and a recognition of this knowledge gap is important.

Education continues into third level colleges and universities where, apart from the normal materials modules, a purpose-designed certificate course was commissioned and launched in Ireland to encourage graduates to be concrete-ready on graduation.

Furthermore, as part of continuing professional development, a concrete modular series for practising designers, site staff and suppliers has been successfully run by the Irish Concrete Society for many years and, with the fluidity of mobility of workers in Europe, the participants on many of these courses are multinationals, keen to learn local practice.

Subsequently, regular expert seminars on concrete topics of the day, usually with invited international speakers, keep the industry apprised of recent developments and opportunities in concrete.

With no boundaries on the design and supply of concrete services and products internationally in Europe under the Products Directive, the annual awards of the Irish Concrete Society has a special category for international work, promoting and rewarding the sharing of concrete knowledge throughout the globe.

This high degree of activity is replicated throughout Europe through collaboration within the European Concrete Societies Network (ECSN) where views on best practice internationally, in their respective concrete society roles, are exchanged and reviewed.

Finally, in Ireland for over 20 years a biennial national research conference has been held to provide a forum for academics and practitioners to present and discuss their work. On an island with just 8 academic institutions active in concrete research, it is interesting to note that over 600 papers on concrete were published in the decade from 2005 to 2015 [2], with a further 160 in the subsequent 3 years [3]. Designed originally as a mechanism for new blood researchers to cut their teeth on technical presentations at the dais, it has evolved into a significant national research event.

And all of this activity is supported by the largely voluntary effort of actors in the concrete industry in Ireland serving a population of just some 5 million people. This is an exemplar of widespread sharing of concrete knowledge nationally.

CONTEMPORISATION

All highly ranked universities have strong international collaboration profiles. As an example of collaboration in education, leading to better knowledge sharing to the benefit of both parties, Trinity College Dublin (TCD) in Ireland has been in partnership with TIET in India for some four years to assist TIET in the contemporisation of their engineering courses. This involves a root-and-branch review of all academic, administrative and governance matters but the educational matters are what are of concern here – the re-structuring of all undergraduate courses to modify curricula, syllabi and learning outcomes, to introduce problem-based research-led learning throughout the degree programs, to inculcate self-directed and peer-to-peer learning. This paradigm shift in educational philosophy has been achieved without compromising the significant historical accomplishments of preparing graduates for the rigours of effective work on graduating while enhancing the capacity for life-long learning in the concrete and many other industries.

Over a 3-year intensive Centre for Academic Practice and Student Learning (CAPSL) programme provided largely on-line by Trinity, all faculty at TIET will have qualified with a certificate in postgraduate education, promoting a better understanding of pedagogical issues through the introduction of communities of practice and developing techniques for deep learning within large class teaching. Challenges for faculty include changing mind-sets and promoting student-centred, active rather than didactic approaches. The extent to which this is prescriptive (top-down) rather than organic (bottom up) is a key change management decision. In facilitating a sustainable cultural shift, the problem of bringing the students into the new paradigm of learning is that on the one hand they want to be more independent and self-regulating but on the other hand they are locked into educational and cultural norms.

One consequence of this contemporisation process is TIET's recently successful accreditation of all undergraduate engineering courses by the American-based ABET system. This onerous process requires, amongst other factors, the attainment of module and course learning outcomes to be validated by demonstrable high student performance in specific questions on tests and exams related directly to the claimed learning outcomes. Nonetheless, as is the case in many engineering course world-wide, there is a tendency to over-teach and over-examine and only when these matters are addressed will there be more quality time for research and, therefore, higher research output, more research-led teaching and better knowledge sharing. This is a laudable medium term aspiration of the contemporisation process at TIET.

CULTURE AND KNOWLEDGE SHARING

It is instructive to compare the learning philosophies and practices in two distinctively different jurisdictions because knowledge sharing must take into account the extant practices and customs if it is to be successful. For the purposes of this paper, the author conducted a small survey of Irish/Indian staff teaching and students studying in Ireland and India. Table 1 indicates some sharp differences in the respective environments which may suggest differing degrees of receptiveness to knowledge capture. The good performance of almost 100 TIET International Engineering Program (IEP) students over the last 4 years in the 3rd year examinations process in Trinity College demonstrates the adaptability of Indian students to a new learning environment. The IEP is a 2 + 2 international engineering degree programme, with Bachelor's degrees being conferred by TCD, while performance of all engineering students in 1st and 2nd year in TIET is monitored by an External Examiner from TCD.

Some clarifications on Table 1 may be useful:

To operate an exclusion system based on a prescribed minimum attendance, as observed in some Indian institutions (but no Irish ones), means that an attendance roll must always be taken, which is not practical for very large classes, as they tend to be in the early years of the Bachelor programmes. Yet a high degree of fidelity is needed to be certain, legally, of the attendance record if errant students are prevented from sitting exams. There are emerging technology solutions to this registration overhead at every lecture. However, one advantage of this roll call is that poor attenders can be identified and supported to bring them back to regular attendance. On the other hand, in the Irish system, there is a freedom attached to the absence of attendance monitoring and with that comes a responsibility which some find challenging. Undoubtedly, it is more efficient and more enabling to attend lectures compared to effort involved in catching up afterwards, assuming always that attendance adds value!

Irish students mostly do not live on campus, so the proximity of student peers when studying at night in Indian institutions means that the opportunity for plagiarism is greater. However, with a clearer definition of the boundaries on copying other's work and the strict and consistent adherence thereto, the incidence of plagiarism can be substantially reduced or even eliminated, although plagiarism can occur anywhere anytime with the advent of social media. Self-assessment could also help to minimise the incidence of plagiarism because students have to reflect on and justify their work.

Table 1 Comparison of approaches to Irish and Indian teaching and learning based on limited case studies (EST = End of Semester Test (exam))

FEATURE	TYPICAL INDIAN SYSTEM	TYPICAL IRISH SYSTEM
Learning style	Rote and recall in some exams	Understanding in all exams
Lecture attendance	Compulsory, monitored with minimum imposed for progression	Not compulsory, not monitored
Deadlines	Flexible but manifold	Inflexible, timetabled
Plagiarism	Can be a feature for sessional work	Consistently not tolerated leading ultimately to exclusion
Exam papers	Challenging questions, no difficulty gradation, lot of recall, answer all questions	Parts of questions increasingly difficult, unseen problem solving, question choice
Summative examination	Low weighting for EST (30-40%), very low performance in EST can still result in pass (> 33%) overall, flexible grade boundaries	High weighting (80-90%) and high pass mark (> 40% Bachelors, 50% Masters), fixed grade boundaries
Script viewing/ feedback	All students have automatic access with challenge possible immediately face-to-face	Rare and with permission and no challenge (except for errors) is possible without a formal appeal

If high achievement in heavily weighted sessional and Mid Semester Tests (MST) is attained in India (there are no formal MST assessments in Ireland, regrettably), then the supposed flagship of the course, the End of Semester Test (EST), can become irrelevant for some because the module has already been passed before sitting the EST. A candidate, knowing that a challenging EST exam has been very poorly attempted, can still attain a pass mark due to the high weighting (60 – 70%) of the MST/sessional marks. Thus the link between ability, hard-work, understanding and a successful outcome can be lost on some students in this system.

Apart from the importance of understanding the local conditions if invited as a visiting lecturer/speaker, when exchanging knowledge with professionals on international committees, reviewing submitted papers for conferences and journals, working on international research or construction projects, it is important to accommodate and facilitate different cultural backgrounds and to understand the education and research systems at play in other countries, thereby making this process of working collaboratively easier.

For example, for this paper, the author conducted a limited survey of the typical workload and work composition in an Irish and Indian academic institution in order to understand and explain work pressures. In the last two decades, in Irish institutions, the role of the academic has shifted away significantly from one of strictly teaching, researching and limited administration/management. With the introduction of best practice in almost every area, new legislation, cut-backs in administrative support, student-orientated delivery (in which the student is now the customer not a client), the plethora of subsidiary tasks to which an academic is now exposed and must excel is excessive. If an academic can be likened to a sponge which absorbs new tasks without question (Figure 6(a)), the drip-drip of new roles

over the recent years, each worthy in their own right but all under-funded, has led to a saturated "academic sponge" involving non-teaching and non-research work. i-expenses, data protection, health and safety, alumni interactions, exam quality control, appeals, accreditation, etc. all have been professionally reviewed by administrators and "optimised" by allocating the execution of the work to academics. Regularly handling 50-60 e-mails a day, each necessarily dealt with with legal precision (given the history of conflicts between academics and students), is a significant daily overhead, mostly involving non-productive work. But academics can excel at all of these things but not everything simultaneously!

On the other hand, in India there tends to be significantly higher teaching loads with much larger student cohorts, more module administration (for example, maintaining module folders with extensive tutorial, quiz, laboratory and attendance data) and, commensurately, less time will inevitably be available for research (Figure 6(b)).

Neither of the cited Irish nor Indian scenarios can be hugely attractive to younger researchers wishing to devote energy to developing their research profiles in order to be seen and heard on the international stage, in sharing their hard-gained knowledge. But all of these matters impinge on time available for research, a primary role – meaningful research work should not start at 6pm after a busy day!

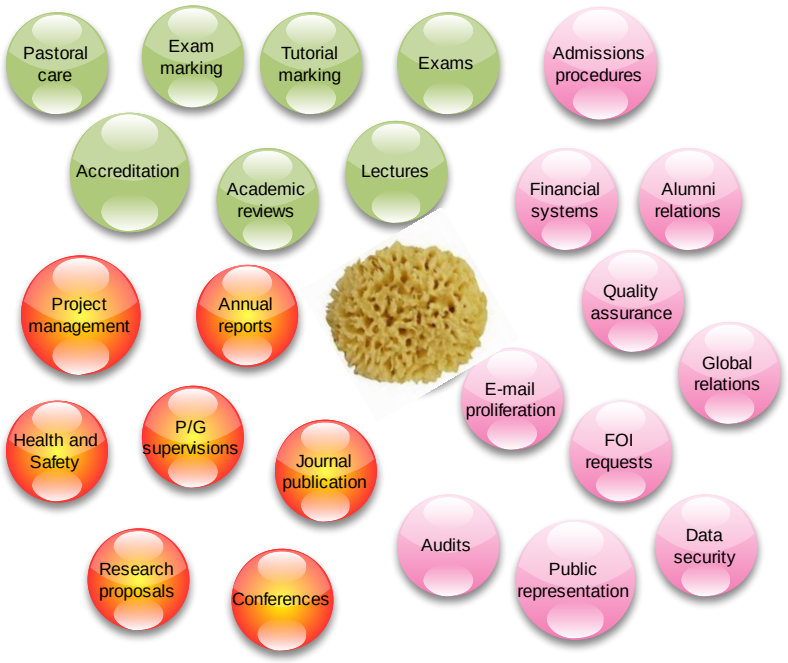
SHARING CONCRETE KNOWLEDGE – 3RD LEVEL EDUCATION AND RESEARCH

Having been a regular visitor to India for the last 8 years, developing teaching and research collaborations with TIET, BITS Pilani and IIT Delhi, the author has learnt much about better ways to teach and conduct research internationally. Some examples of teaching and research initiatives follow, from which it is hoped that the reader can cross-pollinate his/her own experience in subsequent interactions with international players.

Teaching

In teaching on a classical 1st or 2nd year materials engineering module, concrete has a part to play because, apart from its ubiquity, it is such a complex material displaying many of the mechanical characteristics which one would wish to illustrate – indeed, the example of production of pre-cast concrete slabs conveniently demonstrates stress-strain and load-deflection relationships, elastic shortening, flexural cracking, brittle behaviour, shrinkage, creep and thermal movement, with significant challenges in using supplementary cements in relation to very early age strength development. Further, with carefully planning, hundreds of students can receive personalised stress-strain curves for their own concrete cubes tested in compression, thereby developing an appreciation for the variability of the material when comparing results peer-to-peer.

On more advanced undergraduate modules, when exposing the students to the concepts of non-structural cracking for example, a site visit around any campus would reveal any number of cracks in concrete, on which one can elicit the student's written advice as to evidence for the likely cause and the need for action or not.



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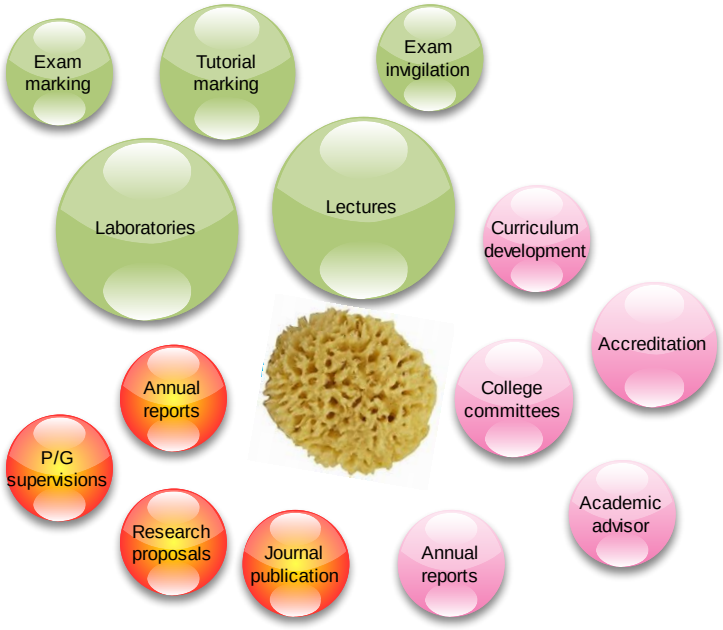

(b)

Figure 6 (a) Typical Irish academic work profile (b) Typical Indian academic work profile in the "academic sponge"

At postgraduate level, on Trinity's MSc stream in Geotechnical and Structural Engineering, modules on advanced concrete technology may well have a more international cohort and so the lecture content should be de-localised in order to improve the graduate's later mobility. These modules also give rise to opportunities to explore more creative teaching methods: For example, the unpopular but essential topic of statistics can be applied in concrete technology by focussing not on the standard statistical techniques, with which the students should be familiar from undergraduate modules, but by lecturing on the multifarious case histories of

the misuse and abuse of statistics in concrete technology [4]. By allocating one of, say, 14 suitable statistical topics to each student (see Figure 7), students are given a brief to describe and illustrate the concept, prescribing that they give an example in the concrete arena of its proper use, but then novelly citing examples where the technique has been misused. The entries are corrected, edited and bound into a volume to which all the class have contributed – the take-away for their individual contributions is satisfaction in contributing to a guide on statistics in concrete which they can bring with them into industry on graduation. By taking part in this process, the communal nature of the effort ensures that most students submit better "chapters" for the statistics booklet. The following year, this guide is issued to the incoming students who are given the opportunity to improve on the previous entries and thus become the new author of their "chapter". The innovative nature of this process both engages the student and is transportable across boundaries [5] – the students of TIET in India will be competing with Irish students for entries in the booklet in 2019.

Furthermore, this concept for improving knowledge sharing amongst students internationally is being expanded to include booklets involving one-page fact sheets on concrete types, workability, mechanical and durability characteristics. Some typical well-established material options for structural design, which should be on every structural engineer's horizon, are listed in Table 2.Without necessarily being an expert or knowing the details in each case, the existence of these concrete technologies as potential solutions to engineering problems should be in every structural engineering graduate's toolbox of knowledge. The participatory nature of the genesis of such a booklet gives graduates pride in this resource.

In relation to continuing professional development, for over 40 years TCD has been running postgraduate diploma courses for mature professionals in the construction industry – currently some 150 multidisciplinary postgraduate students attend 8 different courses every Friday night and Saturday morning (to suit their work commitments) for a full academic year. Included in these eight, for example, is a Diploma in Applied Building Repair and Conservation in which concrete features heavily – its durability, deterioration and repair. Many of the lecturers are industry experts not academics, to whom the students are exposed and have access, particularly during the research for their dissertations. Since Ireland's construction industry attracts workers from all over Europe, the participants on these courses are multinational and the networking opportunities for exchanging knowledge and information enhances the learning experience and the course's reputation.

In relation to postgraduate examinations, several years ago a two- sided A4 page of dense and complex equations, individually hand-written by every student and verified by the academic, was allowed to be brought into examinations of a module on elasticity, plates, dynamics and finite elements [6]. This enabled more discerning and realistic exam questions to be set, not relying on the student's ability to recall complex equations, but testing the aptitude to suitably select and manipulate the relevant equations, undertake calculations and interpret the output - in short, more challenging and practical questions were set and answered. Now this concept is being expanded so that the chemical formulae (Figure 8) inherent in all principal concrete constituent materials (such as for, say, tricalcium silicate) and concrete processes (such as, say, sulphate attack) can be listed for reference, as appropriate, in examinations in both TCD and TIET.

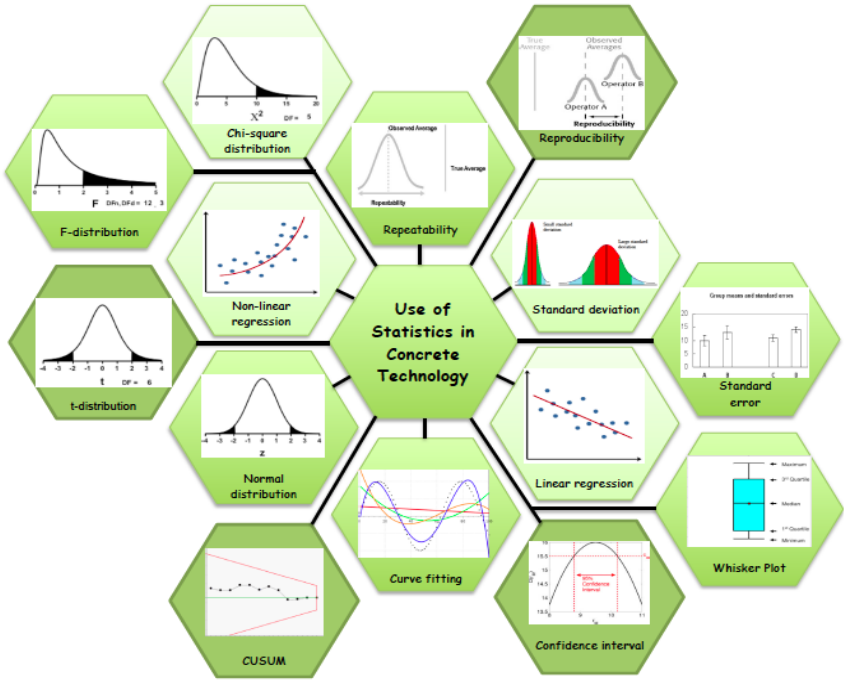

Figure 7 The front cover of the module booklet on the use of statistics in concrete technology, co-authored by Irish and Indian academics [5]

Table 2 Special concrete types for particular circumstances

SHOTCRETE	ULTRA HIGH PERFORMANCE	FIBRE REINFORCED	FOAMED	POLYMER	GEOPOLYMER
Lean	Controlled low strength	Recycled aggregate	Lightweight	Microbial	Air-entrained
Roller compacted	No fines	Phase change	Pervious	Self-healing	Hemp-lime

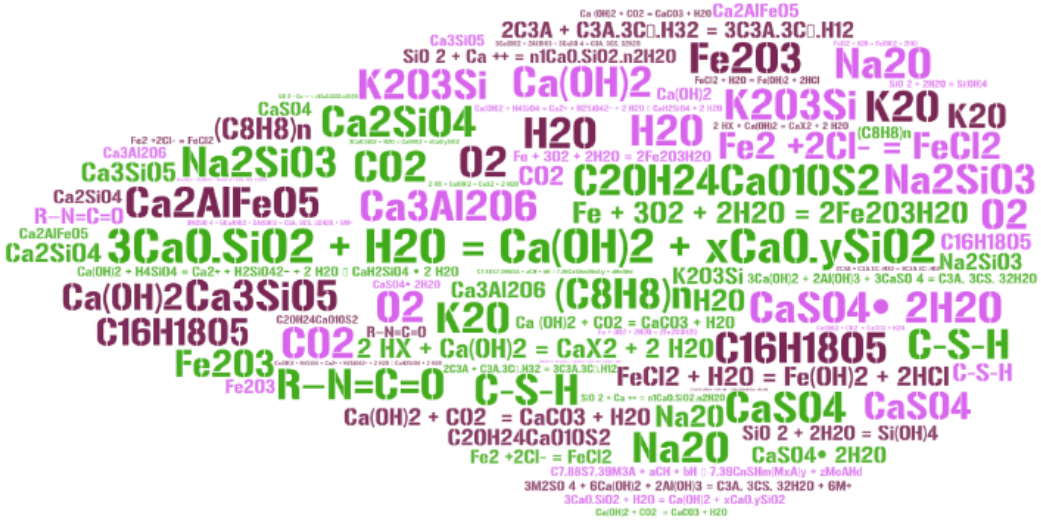

Figure 8 Chemical formulae for the principal materials and processes in concrete

Research

Regarding research links, developing strong relationships internationally takes time and considerable effort, but it can be very enriching for both parties. Often, co-supervision of internship students visiting either host institution can be a cost effective way of starting links. Similarly, joint supervision of Master's research thesis is not expensive as the student or academic travel, but salaries do not need not be found for either. The longer duration visits of co-supervised PhD students, with access to laboratory equipment, material and technical staff usually need substantial sponsorship, but is more likely to lead to Scopus publications. Staff exchanges are often funded by the home institution and so is more manageable financially. The author has been fortunate to have arranged short term staff exchanges and one year long sabbaticals into TCD, and has himself spent three months in each of TIET, IITD and BITS Pilani on research sabbaticals. Inevitably this leads to surprisingly close common interests, where individuals have been working independently in areas, where synergy could exist.

For example, on a recent lengthy visit to TIET, the author convened 12 research seminars with the PhD students working in the area of concrete under the supervision of six TIET academics. A comparison of the areas of research interest with 4 corresponding members of staff in TCD may be seen in Table 3. In this it may be observed that there are as many as 8 areas of mutual interest for collaboration. The sharing of experiences in these areas was beneficial to both parties and, invariably, technical discussions identified new perspectives for all involved on the work in hand. Arising from this, a jointly funded internship in TCD for three months for one of these PhD students will be offered in 2019. The postgraduate students were also give advice individually on their research projects including the information above on how to avoid some of the pitfalls when submitted papers to journals for publication.

Furthermore, arising from existing collaborations with the three Indian institutions, 15 joint papers have been co-authored between this author and 5 Indian academics in the last three years [2, 3]. This is again a good example of sharing concrete knowledge internationally.

DELIVERY

The mode of delivery of knowledge to the masses has changed immeasurably, having evolved within one generation from "chalk and talk" to presentation projection to on-line to podcasts, leading to instantaneous information exchange. However, it can also lead to information overload, reduced discernment, cessation of active learning, poor bonding in networks and widespread absenteeism. With hours to fill, the padding of lecture time with transcription of theory from the screen condemns the student to boredom and disengagement. Prior uploading of these notes to the web with access during the lecture to annotate the text ensures that the mind is active and engaged *in-situ*.

An overreliance on the relevant chapters of books stymies creative examples and anecdotes during lectures, though one needs confidence and an ability to focus on the principles while staying on point, which is not a common attribute of lecturers. Doodles, sketches and examples can all be recorded electronically (even using iphone or ipads during lectures) for reflection afterwards. Interestingly, in a recent survey of Indian students by the author, most said they did

Table 3 Current concrete research interests in TIET and TCD

TOPIC	TIET INTEREST	TCD INTEREST
Accelerated GGBS strength for precast		X
Carbonation	X	X
Controlled low strength materials	X	X
Copper slag as aggregate	X	
Corrosion inhibitors	X	
Ferrocement		X
Formwork constructability	X	X
FRP rebars	X	X
Headed rebar anchorage	X	
Hemp lime		X
Incinerator biomedical ash	X	
No-fines concrete	X	X
Microbial concrete	X	
Phase change materials		X
Polymer concrete	X	X
Precast sandwich panels	X	X
Ultra high performance concrete	X	X
Waste Marble	X	

not reflect deeply on previous lectures before the next, in the passive hope that the mists would clear unaided and a point would eventually sink in. This is not good enough and occasionally leads one to ask when correcting submitted material – "how could the student have so misunderstood what I thought I had said when explaining that particular point". On way to avoid such surprises is to use the concept of "think pair share" in which break-out time during lectures allows students to discuss and reflect in small groups. This social constructivist approach moves beyond behaviourism and empiricism and the students become co-creators of knowledge. However, realistically, the use of this technique is limited in a crowded syllabus.

Engendering an understanding of and a passion for concrete is possible through face-to-face contact with motivational professors, allowing patient and non-patronising answering of questions after formal lectures in the classroom. The live feedback derived therefrom allows the lecturer to re-evaluate how to approach the class differently next time around to overcome these often simple misinterpretations of established concrete knowledge.

The rapidly evolving technology for on-line delivery has allowed a lecturer to observe, on a screen in front of him/her, as many as 100 students simultaneously "attending" during a lecture. This mode of delivery falls short when subliminally employing that innate sense of whether or not a class is with you intellectually at any point in an argument.

Worse still, some might argue that thinking of students as customers means it is at their convenience that they can log in to pick up previously broadcast pod-casts, allowing them to de-prioritise study, enhance convenience over commitment, avoid making spontaneous contributions and absolving them from peer-to-peer learning. Attendance numbers drop infectiously and the atmosphere and enlightenment engendered in a dynamic lecture is lost. However, others will argue that web-casting of lectures opens up knowledge sharing to those who have to spend time in paid employment, balancing life and work, and it is a more

measured approach to learning which widens the net of opportunity. From the learner's viewpoint, it is much easier to multi-task during playback in the privacy of one's own study space than it is to avoid eye contact in a lecture theatre!

In this context, a recent research study by the author investigated the consequences of attending lectures on exam performance. In an environment in which there is over-reliance on established text books, Powerpoint overhead notes are seldom adequate to evoke the essence of the material being explored in the lecture, with intonations, anecdotes, and throw-away comments all adding to the lecturing experience which, in the absence of audience presence and/or response, will be lost to the non-attendee. By mapping specific lecture attendances to particular parts of exam questions for each of 175 students over a 12 lecture series on concrete technology in second year undergraduate engineering, it was possible to establish the broad correlation between attendance and marks obtained, albeit with a wide spread in the data. (Figure 9). Perhaps reassuringly the figures suggest that the more one attends the lectures, the higher the probability of obtaining a higher mark in this module on average (over 20% in this case). This does not mean one is guaranteed to pass simply by attending or that one is certain of failing if one does not attend any lectures. Nonetheless, the statistics were sufficiently compelling to encourage the class to improve its attendance markedly when this data was presented to them.

With the pervasive focus on the measurement of the quality of teaching in the classroom worldwide, how much more difficult is it to be a naturally good presenter when being videoed or during pod-casting than to be one of the very many excellent more traditional lecturers. Delivering an engaging "performance" to an anonymous and non-responsive audience beyond a camera is a honed skill not given to all. While training will help (how many of us have been surprised at our own peculiar traits when presenting, as revealed by a screen audition?), no amount of preparation will overcome the deficiencies of some who fail to convert to this new and often unwelcome and ineffective medium for communicating knowledge, albeit globally accessible.

Despite this pessimism on the efficacy of these more convenient learning techniques, there is an excellent modern example of an effective way to communicate concrete knowledge globally, sourced here in India through support from the Government of India – the National Programme on Technology Enhanced Learning is a multi-faceted tool for e-learning with the strap line "Knowledge is free" or "Anyone, anytime, anywhere". With over 700 engineering colleges in India, it would be impossible for all colleges to have the requisite expertise to deliver research-informed lectures on concrete technology (or any other sub-discipline of any other discipline, as the wealth and scope of the available on-line lectures exemplifies). Prof Bishwajit Bhatacherjee of IIT Delhi is the very able presenter of 14 modules in concrete technology amounting to about 14 hours of illustrated lectures (Figure 10 and Table 4). These are indeed available globally and this author has used targeted lectures to supplement knowledge sharing with TCD students, particularly for those students who are new to the topic in hand or who struggle with the subject matter. The accessibility of this material is truly a sharing of concrete knowledge globally, keeping closely to universal truths about concrete with only a modicum of local inflexion.

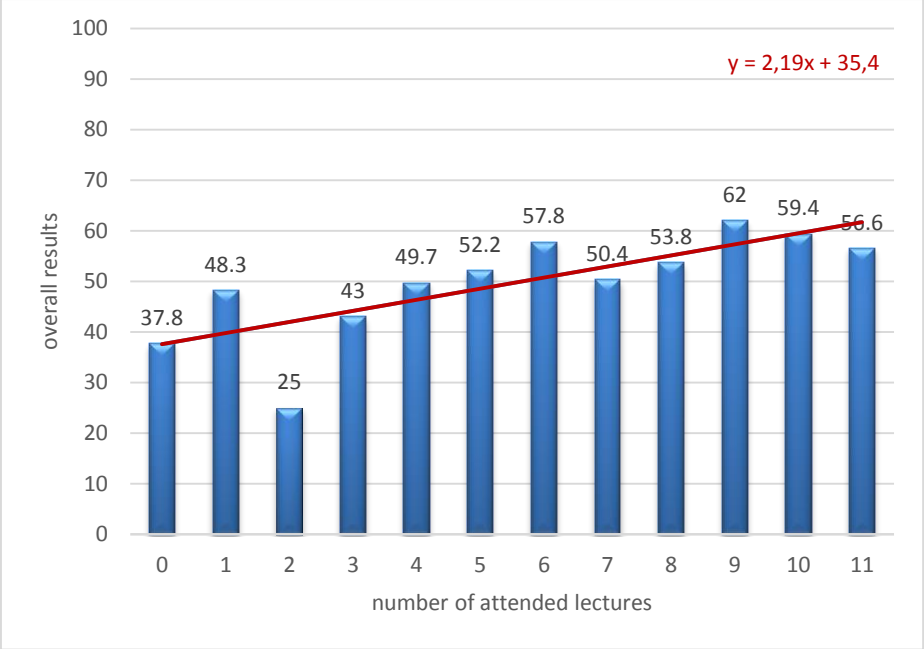

Figure 9 Correlation between attendance and overall material module exam results for individuals in TCD

Figure 10 On-line NPTEL lectures on concrete which is universally accessible

Table 4 Concrete and other material modules on the NPTEL e-learning course

CEMENT	FRESH	STRENGTH	DURABILITY	MIXES	MASONRY	REBAR
Hydration	Mix	Properties	Mechanisms	Design	Materials	Types
Alternatives	Admixtures	NDT		IS	Walls	Corrosion
	Segregation			BS	Defects	

Finally, one should remember that in sharing concrete knowledge globally, the subtleties in the nature of culture in different countries should be accounted for. For example, a specific survey of Indian students studying concrete in Ireland undertaken by the author for this paper revealed a higher respect for authority, excellent attendance, a penchant to engage in negotiations of marks awarded for assessments and exams and an awareness of the need to make content universally applicable. Conversely, comments solicited from Irish students

studying in India convey a sense of surprise at the absence of good note taking, the different views on what constitutes plagiarism, the enhanced peer-to-peer learning (due in part to living in close proximity in hostels on campus with heavy schedules of assessment, which is not a feature in Ireland) and the preponderance of large contact hours.

CONCLUSIONS

It is difficult to do justice in a single paper to the topic of sharing concrete knowledge globally, with its wide scope and rapidly changing environment of knowledge exchange. One could interpret the paper title in many ways, such as: how to encourage expert research collaboration; undergraduate and postgraduate internships; the pressure on obtaining certified continuing professional development experience; the expanding opportunities for new conference topics and new open access journal publication with all the attendant risks therefrom. Or one could examine which medium one chooses to employ to deliver concrete knowledge on a global stage in which location, time and cost are becoming less of an impediment. The advantage of giving an opening address is that a multitude of facets can be referred to, as in this paper, where others who follow may deal with some in more depth. Ultimately, the opportunities for gaining and sharing authoritative expert knowledge on most concrete technology topics are expanding at a bewildering pace, where even the fledgling undergraduate can instantly verify your stated "facts" on an iphone.

Cited examples of successful local, national and international mechanisms for sharing concrete knowledge have been described in this paper, identifying new pedagogical paradigms for sharing this knowledge.

But there is still no substitute for the deep innate informed intuition which experience brings and it is our responsibility and privilege to take every opportunity in life to share this concrete knowledge globally by every means possible.

ACKNOWLEDGEMENTS

The author would like to thank Prof Pat Shiel and Dr Michael Wride from Ireland and Prof Maneek Kumar and Dr Chaaruchandra Korde from India for their insightful comments on early drafts of this paper.

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