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New Civil Engineer: Introducing Undergraduate Civil Engineers to Construction Technology

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Abstract

Undergraduate (UG) civil engineering students should graduate from university with knowledge that links their computational competence in structural engineering and mechanics to construction technology principles, processes and practice. However, there appears to be a paucity of evidence to suggest that UG civil engineering students receive sufficient instruction in construction technology throughout their degree studies. This paper presents evidence from a study employing the weekly *New Civil Engineer* (NCE) publication as a vehicle for introducing construction technology to first year students. The results reveal that students found this publication interesting and inspirational.

Whilst this innovative approach to teaching construction technology would be best 'blended' throughout the UG course, its introduction, application and success arguably requires a multi-disciplinary and carefully 'engineered' approach. Given the diversity of academic staff, individual motivation and the professional demands of a contemporary mass higher education system, the prospective benefits from 'blended' learning in UG construction technology studies will in all probability remain unfulfilled.

Keywords: Education & training; trade magazines; piles & foundations

1. Introduction

The complex character of the construction industry together with global business pressures, regulatory demands and increasing client expectations require highly educated and skilled civil engineering graduates (Love *et al* 2001). Consequently, sound knowledge and meaningful understanding of construction technology, 'it's means and methods' is fundamental to the performance requirements of a civil engineer (Kuennen and Pocock 2003).

Unlike alternative academic programmes such as mathematics, the science disciplines (physics, chemistry and biology) and languages, the subject of civil engineering and by extension construction technology are largely absent from secondary education. As a result, the majority of first year undergraduates enrolling on civil engineering programmes exhibit little or no basic appreciation of construction technology. This absence of prior knowledge and understanding raises unique challenges for first year undergraduate (UG) students and construction technology lecturers alike.

Astonishingly, at the end of the second year over half of the undergraduates who can invert matrices, analyse beam stresses and even plot Mohr's circle cannot draw the basic components of a suspension bridge or a water supply system or a building or the different types of foundations and where they might be used....They do not understand the difference between a tunnel and a pipe, a valve and pump, an excavator and a bulldozer and so on. (Constructionarium 2013)

Construction technology is neither static nor executed in a vacuum. Constant innovation and development in science and application arguably requires an emergent student culture of engineering curiosity and a capacity to reason and communicate visually (Ferguson, 1992). Thus, it is imperative that construction technology is delivered in a manner that not only encourages engagement but also provides a sound intellectual foundation upon which students can refine their wider interests and understanding of the civil engineering profession. Connecting the

theory of construction technology with industrial realism is widely thought to enhance student understanding (Bather 2011).

More importantly, the relevance and role of construction technology in the career of a civil engineer begins to become imbedded. This paper aims to explore the impact of a first year coursework designed to stimulate student interest in construction technology and promote on-going student engagement with a specialist, current affairs civil engineering publication. Impact on student expectations of a career in civil engineering is also reviewed.

The paper is organized in a traditional format. The introduction identified the unique challenges facing both UG students and lecturer in the delivery of construction technology. Section two and three examines the introduction and teaching of construction technology within civil engineering courses. This is followed by a terse description of popular construction and civil engineering publications. Section five provides a more detailed introduction to the NCEpublication. The following section outlines the methodology and method adopted in this study of introducing UG civil engineers to construction technology. The findings and subsequent discussion are explored in section seven. The conclusion reinforces the importance of connecting theory with educational practice and offers new insights in the delivery of construction technology on civil engineering undergraduate courses.

2. Introducing Construction Technology

UG students are known to appreciate lecturers who use of real-world examples in their teaching (Collins & Davies 2009) and case studies of technology (Pan 2010). Indeed, Anderson et al (2010) argue that engineering ‘students need more real-world experiences from the very first day’ so as to understand the ‘messiness in real-world engineering problem solving’; this requires the interplay of practice-generated knowledge. In relation to UG civil engineers, the Joint Board of Moderators (JBM 2009: 2-3) recommends that students are exposed to:

The design of “realistic projects” such as railways, airports, hydropower schemes, bridges, skyscrapers, water treatment works, highways or the like

and that students should understand how the construction method, issues of safety and legislation, and the concepts of buildability can drive design.

Indeed, the Royal Academy of Engineering (RAE 2007) report, *Educating Engineers for the 21st Century*, notes the need for universities to strive to improve their courses in terms of technical content as well as motivation and inspiring students to become engineers on graduation.

In addition to formal lectures and design projects that feature construction technology, UG students are frequently exposed to construction practice through site visits (UOS 2013a) and graduate mentoring (UOS 2013b) activities. Despite the unique challenges often associated with integrating site visits within the curriculum (see Bather 2013), the narrative below suggests that these activities leave a personal legacy:

I was fascinated by the scale of the project. I would have definitely loved to work on such a project. I was impressed by the construction technologies. Now I see the point of that NCE Construction Technology assignment. (1st year student)

The feature which I feel I gained most knowledge on over the project was the construction of the concrete frame. Previously I didn't actually know what many technical terms, such as "slipforming" or "precast", really meant. However being on site, and actually watching the processes as they were carried out, was probably the best possible way to learn. (3^d year student)

3. Teaching Construction Technology

There are a variety of ways to introduce and teach construction technology studies to full-time undergraduates. Formal lectures supported by small group tutorials and recommended text books are the mainstay for the majority of construction and civil engineering courses. However, 'critical thinking' and 'contextual engagement' with the topic arguably requires a holistic teaching strategy. This may include frequent

site visits, guest lectures, small group work, graduate mentoring and/or contextual learning via carefully designed continuous assessment coursework.

Alternative strategies for teaching construction technology have received academic interest (Pan 2010), most notably the educational value, benefit and challenges of construction site visits (Bather 2013). In stark contrast, the scholarly value and academic utility of construction / civil engineering journals has been largely ignored. This is surprising; many mainstream construction / civil engineering journals arguably provide a convenient and readily accessible conduit between the fundamental principles of construction technology (the theory) and 'live' and 'innovative' applications (the practice).

Nowadays, holistic teaching strategies and encouraging on-going student engagement arguably extends beyond the basic principles, processes and practice of construction technology per se. In addition to the 'technological fit', there is also consideration of a 'social-fit'. Introducing and persuading students to read and engage with mainstream construction / civil engineering publications would arguably assist with the process of 'anticipatory socialization' (Sang *et al* 2009). This would include familiarization with the language, customs, traditions and wider institutional norms that would later support industry integration, personal affinity and critical thinking. In short, construction / civil engineering journals provide readers with an insight in to the culture and context of industry 'membership'. Interestingly, the notion of anticipatory socialization is frequently overlooked in traditional educational frameworks but is becoming increasingly acknowledged as an integral, albeit largely intangible, facet of excellence in Higher Education.

4. Construction and Civil Engineering Publications

There is a comprehensive range of monthly and weekly 'magazine' style publications dedicated to the construction and civil engineering sector. A representative selection of the most popular publications of interest to civil engineers includes the following:

- Building -*Building* magazine is the arguably the most established weekly publication dedicated to the construction industry. In contrast to alternative publications, Building has a diverse readership including, contractors, clients, design specialist consultants and house-builders (Building 2014). Building is published by UBM Built Environment
- Construction News -*Construction news* is a weekly publication reporting on a diverse range of construction related news items including business intelligence, tender shortlists, contracts and employment opportunities (Construction News 2014). Construction News is part of the EMAP publishing group.
- New Civil Engineer -*New Civil Engineer* (NCE) is a weekly publication, with a targeted readership of construction engineers and the wider civil engineering community and made available to ICE Members (New Civil Engineer 2014). The NCE is published by EMAP.
- The Structural Engineer - *The Structural Engineer* is a monthly publication made available to IStructE members (including students). The magazine publishes different types of articles, across seven primary sections. It differs from the other three publications in that it also features research papers (The Structural Engineer 2014)

It should be noted that these publications are neither definitive nor exhaustive. They are however symbolic of mainstream construction / civil engineering magazines currently available within the UK.

Despite discrete differences in their professional emphasis and projected readership, these publications routinely report on topical developments within the wider construction and civil engineering sector. Their remit is typically diverse. Each publication identified routinely addresses a broad spectrum of topical (social, political, economic, environmental and technological) news stories. In addition to current affairs, the publications frequently provide dedicated articles and case

studies reporting on 'live' national and international construction and civil engineering projects.

Given the frequency of publication (monthly and weekly) and the characteristically tabloid style of production, their editorial purpose is largely informative, as opposed to educational in the traditional, summative sense. The publications readily acknowledge this potential disparity. It is not atypical to come across editorials that connect with a more formal educational format by combining themed commentaries with self-assessment questionnaires. Indeed, responding to these self-assessment questionnaires may be used and accepted by various professional institutions as evidence of continued professional development (CPD). However, critical appraisal of construction technology remains rare.

After careful deliberation and taking note of the specialist links between the undergraduates elected course of study (civil engineering), prospective professional affiliation (The Institution of Civil Engineers), early career prospects (site / design engineering), frequency of publication (weekly) and accessibility (University library - including a comprehensive back catalogue of journal titles), the New Civil Engineer (NCE) was considered the most appropriate publication for introducing undergraduate civil engineers to construction technology.

The authors are acutely aware that journal selection may be interpreted as selecting the 'best' publication. This assertion would be incorrect. Each of the publications cited unquestionably have their merits and under differing circumstances may have been identified as the preferred option. Nonetheless in this context, the NCE arguably provides the most appropriate technological and social fit between student needs, course ambitions, the civil engineering profession and the prerequisite for contextual learning.

5. New Civil Engineer

The inaugural NCE magazine, published in 1972 was intended to bridge the gap between the *ICE Proceedings*, characterised by in-depth technical papers, and the need to provide civil engineers with regular news, whilst providing a forum for

discussion. Reflecting on the publication's 40th birthday, Oliver (2012) cited original text suggesting that the goal of the NCE was "to convey the excitement of an idea rather than the mathematical detail of technicalities". Despite the publication's success it has attracted both praise and criticism. Geddes (1980) claimed that it 'can be provocative and irritating at times but it can never be ignored' and Hambly (1994) concluded that it was one of several magazines 'highly valued by readers for reliable technical news'. It's suitability as a vehicle for introducing construction technology appears to be supported by Oakland and Aldridge (1995) whose review of industry-based literature included the NCE; they observed that 'the literature featured seemed to be characterized by a strong technical bias'.

There appears scant evidence to suggest that the NCE is used by civil engineering academics for pedagogical impact. However, the lead author has advocated its use to students for some years. In a recent exercise, students were encouraged to read and take cuttings from the magazine as part of a festive fun art competition (see Oliver 2010) Moreover, the magazine regularly features reports on regional projects where our students have attended site visits (i.e. Rosyth Docks Refurbishment (NCE 2010a); M74 JV (NCE 2010b); Forth Replacement Crossing (NCE 2013). These site visits combined with targeted reading, arguably help the students to establish an affinity with civil engineering within their local community.

6. Research Strategy: Methodology and Method

The research methodology adopts a distinctly qualitative approach. The objective of this study is to collect, collate and communicate UG experience and opinion in relation to an innovative construction technology coursework. Given the large class size(s), questionnaires were considered the most appropriate method of data gathering. For session 2011-2012, 70 questionnaires were distributed, 40 questionnaires were returned resulting in a 57% response rate. For session 2012-2013, 75 questionnaires were distributed and 60 questionnaires returned giving an 80% response rate. For the most recent session 2013-2014, 85 questionnaires were distributed with a response rate of 62% (53 questionnaires). Figures for the three year study period (2011-2014) reveal that in total 230 questionnaires have been

distributed with an approximate response rate of 66% (153 questionnaires). For this method of data gathering, an average response rate of 66% is highly satisfactory (Fellows and Liu, 2003).

It should be noted that for academic sessions 2011-12 and 2012-13, the class at the centre of this survey (Construction and the Environment) was an elective. Unfortunately, those students (around 15% of each session cohort) who did not undertake this class received no similar substitute to provide foundation knowledge related to construction technology. For session 2013-14 this class / module was made compulsory for all 1st year civil engineering students

6.1 The Coursework

Using one or more hard copy editions of the magazine available in the university library, and following guidance regarding the definition of construction technology, the students were required to select 6 technological themes from any section (news, projects, adverts etc.) of the magazine. They were required to produce 6 drawings / sketches on either A3 or A4 paper and annotate each sketch and provide further notes indicating research. The students were shown typical resources that would be of assistance including textbooks such as *Barry's Advanced Construction of Building* (Emmitt & Gorse 2010) and *The New Penguin Dictionary of Civil Engineering* (Blockley 2005); periodicals such as the *Proceedings of the ICE- Civil Engineering* and the *Structural Engineer* and a range of product & manufacturers Webpages.

On submission of the coursework the students were required to complete a questionnaire. The format of the three part questionnaire was carefully structured to encourage participation, clarity and validity. Section one, 'technology themes' asked students' to identify the main civil engineering topics they elected to review. Section two explored current student membership of relevant professional bodies and student enthusiasm and access to the NCE magazine. Section three, 'value' adopted a Likert scale to enable respondents to evaluate the 'usefulness' and 'contribution' of the NCE in their understanding and application of construction technology studies. Fully completed questionnaires were returned from 153 students. From this sample, 123 students had student memberships of the ICE; 51 students had membership of

the Institution of Structural Engineers (IStructE) and 6 students had subscriptions to NCE.

6.2 Limitations

Despite the positive figures, it is important to acknowledge that there are a number of parameters, limitations and assumptions with the study. Given the limited population sample (one class / module; conducted over a three year period), the views and opinions expressed reflect a unique and largely private learning experience at the lead author's university. Whilst the data accurately captures UG experience and opinion, generalizing the outcome across comparable Higher Education establishments requires careful interpretation. Notwithstanding this requirement for context, the data analysis, findings and following discussion offer insight and understanding that not only enhance the delivery and understanding of construction technology but also explores student motivation.

7. Discussion and Summary of the Findings

7.1 Construction Themes

The use of the NCE as a catalyst for developing knowledge and understanding of construction technology highlighted the diversity and complexity of construction technology in the 'real world'. By reading the NCE, undergraduates quickly become exposed to a range of technological themes as well as their specific application. Despite the impressive array of construction technology themes examined by the students, it is interesting to note that traditional 'heavy' civil engineering topics such as foundations, plant / equipment and tunnelling dominated students' interest:

Finding out about common technologies such as piling and underpinning made me feel as if I was actually learning something really useful. Its information that will help me understand exactly how engineering projects work. I feel more like an engineer now.

This coursework was very useful, it has introduced me to construction technologies that I never knew before and has created an interest for me to

keep an eye out for more construction technology the next time I read the NCE.

From a total of 492 construction technology articles (including adverts) independently reviewed by the students, ninety-nine (20%) featured construction plant and one hundred and sixteen (23%), relate to traditional 'heavy' (piles/ foundations/ tunnels) civil engineering activities. Whilst it is readily acknowledged that some of the themes identified (see figure 2) may overlap, for example tunnels and geotechnics; the list is envisaged as an indicative guide to the civil engineering themes popular with first year students. In contrast and despite growing interest within the wider civil engineering community, student interest in off-site construction technology and prefabrication techniques (Design for manufacture and assembly / Dfma) accounted for only one article (0.2%) selected, see Figure 1. Despite the significant number of construction technology themes explored, some students expressed difficulty in finding appropriate articles to review:

Personally when trying to find articles I found it difficult to decide if they met the brief. It would have been easier to decide on what type of article was suitable if the brief had been more definitive as to what "construction technology" is. I wasn't sure if they all had to be new designs and ideas or existing designs being adapted or even just existing methods and how they're done.

The NCE magazine I read was more political making it slightly difficult to find articles related to construction technology.

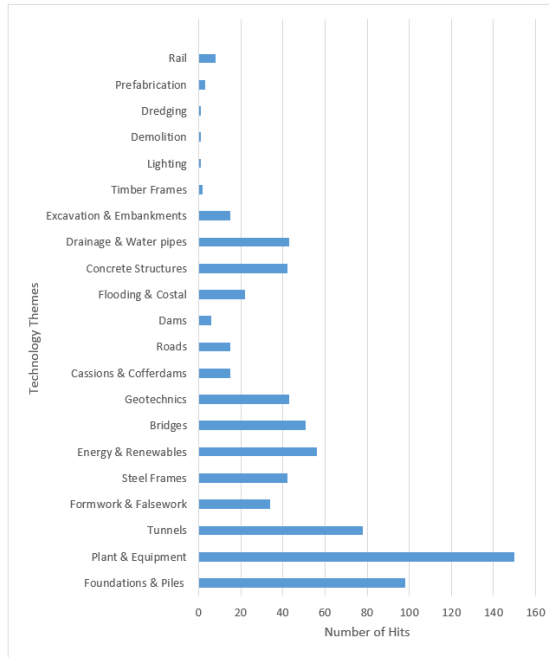


Figure1. Technology themes examined by students

7.2 Drawings & Sketches

Commentary on the drawing & sketching ability of UG civil engineers has received regular attention for decades. Coates (1979) raised his concerns about the lack of time undergraduates spend on engineering and their inability to articulate their technical ideas. Carrato and Kellogg (2004) observed that the use of CAD could discourage students from sketching and argued that ‘the ability to pull out a pen, grab a cocktail napkin, and sketch up a concept that can save a client two weeks off a construction schedule is a skill that remains timeless’. Indeed, Rose (2005) called for civil engineering educators to provide students meaningful opportunities to develop and practice hand sketching techniques. Moreover, the Joint Board of Moderators (2009) recommends that civil engineering students should be able to show evidence of clear communication through sketching and drawing.

Whilst over the course of their studies, the students do receive instruction in hand and computer assisted drawing, for this coursework, the students were not instructed in technical drawing or sketching etiquette. However a few students had successfully completed graphical communications examinations, including the use of CAD, at

secondary school. It was expected that the students would submit 'neat and tidy' illustrations and exemplars were displayed for examination. However, the key aim of the coursework was to encourage and develop student curiosity, research and observation skills. Indeed, Rolt (1989) argues that it was a habit of drawing that gave both Marc and his son, Isambard Kingdom Brunel 'such extraordinary acute power of observation'. The responses from a number of students suggest this broader aim was achieved:

I've learned many new civil engineering words, sketching helped look at parts that I didn't notice before, reading the magazine made me inspired and interested [in my studies].

I thought it was quite useful as it allowed me to have a look at different types of construction technology and helped with my technical drawing skills.

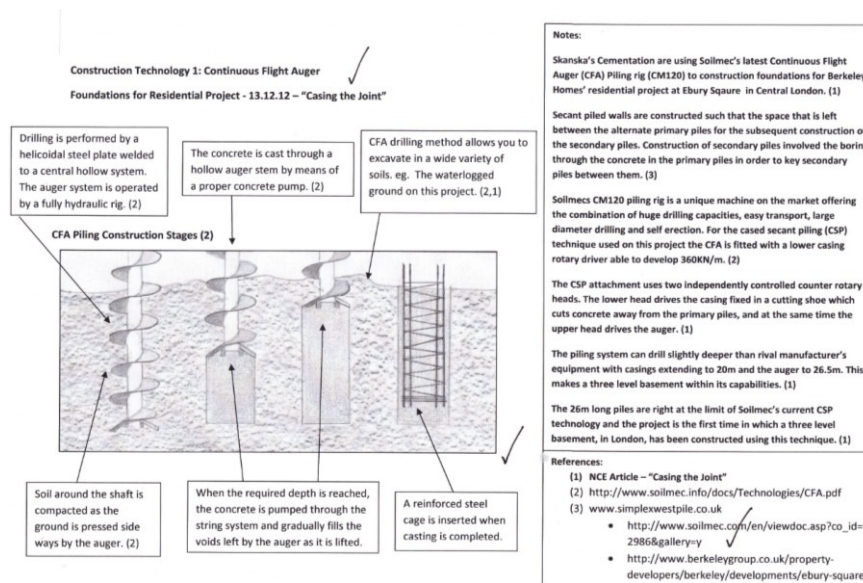


Figure 2. Example sketch

7.3 A Catalyst for Curiosity

Whilst the NCE coursework had the objective of introducing construction technology, an overarching legacy whereby the students develop a heightened curiosity with their civil engineering studies was also envisaged. Given that the students were all

new entrants to Higher Education (HE), helping them to establish an understanding that 'learning how to learn' holds great value, and that the acquisition of new knowledge and skills can be a fun and enjoyable experience was paramount. Indeed, Vorster (2011) recommended that 'students must be scuba divers in the sea of knowledge' whilst McCuen *et al* (2011) emphasised the need for civil engineers to have a questioning attitude and be curious to learn new things that will assist them in problem solving. Several responses reflected this behaviour:

The coursework was helpful as it encouraged me to read NCE magazines. I am now more interested in reading them in my spare time as I have realised how helpful they can be for my general knowledge of the civil engineering industry.

I found it useful, I've obtained more knowledge by reading through the NCE but also reading papers on the ICE virtual library on my chosen technology, but it also encouraged me to read through other articles on technology that I was considering covering.

I found the coursework useful as I learned things I didn't previously know and it intrigued me and encouraged me enough to go and find out more!

7.4 Use of References

Whilst it is encouraging that students engage with referencing protocol and readily access manufacturer's web pages at an early stage in their academic studies, the challenge is to ensure that students can critically appraise the quality and robustness of the information they are citing.

Examination of reference sources used by UG students demonstrate a growing and potentially disquieting trend for citing web pages. The practice of citing web pages itself is not the primary cause for concern, it is the increasing use of unverified web sources that may ultimately undermine the quality of the student learning experience. Analysis of the additional references cited by students reveal 'other' web pages accounted for nearly seventy (37%) of the one hundred and eighty-nine references cited by students. Including the citing of manufacturer's web pages significantly

increases the use of web-based sourcing of construction technology information from 37% to 63% (120), see Figure 3.

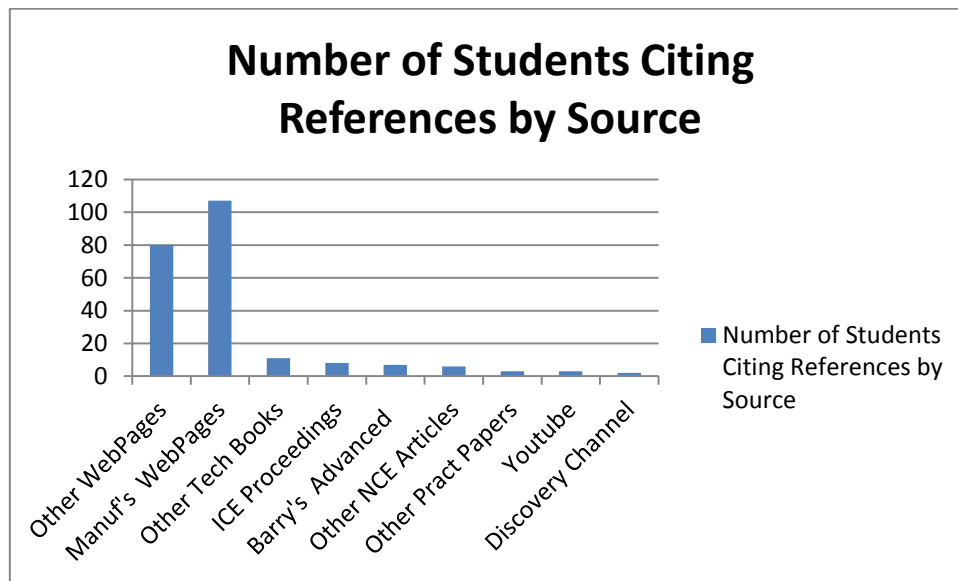


Figure 3. Source of additional references cited by students

7.5 NCE Subscription

Addressing the cost of annual NCE subscription, the findings disclose that from the 2011-2013 cohort (n=100) responses:

- 21% would like to receive NCE free of charge
- 45 % would pay £20
- 20 % would pay £30
- 11% would pay £40
- 3% would pay £50

Despite the encouraging responses cited below, UG students overwhelmingly rejected the student subscription fee of £50, set in 2013. This is perhaps representative of the wider student body as Lynch (2012) found that in 2011, only 378 student members of the ICE, opted to subscribe to the magazine. Given that the Higher Education Statistics Agency (2013) reported that 26,915 students were undertaking civil engineering studies (from foundation degree to post graduate and

including part time studies) during 2011-12, it can be seen that the vast majority of students are not subscribers. However, it may be that this points to an argument being made on a point of principle, rather than affordability. That said, it can be seen from the results in Table 1 and in the verbatim below that exposure to the magazine can have a positive impact and should be actively encouraged:

The coursework was useful in getting me to read the NCE and think about the articles written. I definitely think it has inspired me to get a subscription in the near future as it allows me to gain extra background information about civil engineering that my lectures will not provide and helps me to keep up to date with all of the relevant and new projects happening in the civil engineering world.

It was very useful. I have discovered a lot of new concepts through reading the magazine and it portrayed the magnitude of the industry to me. It has forced me to go and read the NCE magazines and has convinced me that I should take out a subscription.

Figures on actual readership of the NCE will of course be higher as copies of the magazine are readily available in university libraries and this often includes partial electronic access. However despite the recent evolution of NCE's iPad app, and student familiarity with electronic media, Table 1 shows that 68% of the students either disagreed / strongly disagreed when asked if they would have preferred to read the NCE in electronic format (n=100). Given that from January 2014 it has been decided to give ICE student members free access to the website (nce.co.uk) and a iPad / Android app (ICE 2013) it would interesting to track any development in ICE student memberships and seek to establish usage patterns of the electronic version of NCE by students.

Statements' about the New Civil Engineer	Strongly disagree	disagree	neutral	agree	Strongly agree
S1. I have found the NCE magazine I have read interesting?	0%	3%	4%	58%	35%
S2. I found the NCE magazine I have read exciting?	1%	11%	39%	43%	6%
S3. I found the NCE magazine I have read inspirational?	0%	7%	23%	55%	15%
S4. Reading the NCE Has helped confirm my intentions to become a civil engineer?	0%	4%	23%	50%	23%
S5. I would have preferred to have read an electronic(online) copy?	26%	42%	13%	8%	11%
S6. I found it easy to find 6 articles with a technology theme to allow me to complete my coursework?	15%	35%	26%	19%	5%

Table 1 Student feedback on the New Civil Engineer (n=153, S5 n=100)

Table 1. Student feedback on the New Civil Engineer (n= 153, s5:n=100)

7.6 Value

Student responses to questions in section three, value; disclose predominately positive comments. In combination, 93% of students either strongly agreed or agreed that the NCE was interesting reading material, see Table 1. Additional comments provided by the students suggest the NCE was useful, enjoyable and provided encouragement to search for alternative sources of information.

I feel it was the most interesting piece of coursework we have been given, as it allowed us to investigate the methods what are used in construction and gain some knowledge how these operate

Reading through the NCE articles has greatly increased my knowledge and interest in construction technology. It has also heightened my appreciation for civil engineering, and the NCE magazine.

Endorsing these comments, half of respondents (49%) either strongly agreed or agreed that the NCE was exciting to read. A further 70% of students indicated that the NCE was inspirational. In response to whether reading the NCE had confirmed their intentions to become a civil engineer, 73% strongly agreed or agreed, whilst 23% neither disagreed nor agreed:

The coursework given was quite useful because it gives you an insight into the many different things that civil engineers build and do in their day to day job. Also, it has clarified my intentions to become a civil engineer.

It was useful to find out more about construction, it gives an insight as to how a future in civil engineering would be, and it reaffirms my conviction to become a civil engineer

7.7 Prize Award

As a means to show the students that the coursework has external industry relevance and to provide a degree of novelty, contact was established with the chief editor of the NCE to secure a prize award of a one year subscription for the top five scoring coursework's. To uphold a degree of impartiality, the coursework's are sent (without the student's names and academic author's % grades) to the editor who undertakes his own assessment based on the overall quality. Interestingly, the top five scoring students for session 2012-13 were all female. From observing behaviour and coursework submissions over more than a decade, anecdotal evidence suggests that the fresher female UG students have a heightened awareness regarding acting on coursework guidance and the importance of the overall presentation & structure of coursework submissions. Although beyond the scope of this paper, the performance of female civil engineering UG students and by extension gender issues concerning preferred learning styles provides a potentially rich avenue for future research activity.

8. Conclusion

It may be argued that by using the NCE as the original source of the learning experience, student judgment of alternative sources of information, both electronic and text may be enhanced. Additional information collated by the student, regardless of source may be evaluated against the benchmark of the NCE. In many ways, using the NCE as an introductory educational standard for quality and accuracy provides the student with a construction technology 'litmus test'.

The irony of the research findings and discussion is that notwithstanding the potential benefits of introducing fresher civil engineers to construction technology, a growing number of first and second year undergraduate civil engineering courses are now part of a common faculty of engineering. Under these generic 'engineering' frameworks, scientific principles are often taught by academics who are largely without civil engineering industrial experience (i.e. see Barr 2008: 20 Graham 2012: 60 Clarke 2012: 203). Compounding this, such academics are less likely to hold ICE / IStructE membership, be unaccustomed to reading NCE or similar publications and perhaps reinforce, a self-fulfilling stereotype (as perhaps with mathematics and physics schoolteachers) that the profession of civil engineering is only accessible and dominated by computational competence. This, despite evidence that school pupils are often drawn to the wonder, innovation and ingenuity of buildings and civil engineering structures through the context of television programmes (for example: grand designs and mega-structure documentaries) and listening to inspirational stories from family relatives or young graduate engineers. Similar content to that found in NCE!

In conclusion, our UG civil engineers must be provided an opportunity to embed and 'blend' basic principles of construction technology in their 'everyday' evaluation and assessment of civil engineering issues. If not, then universities and their civil engineering departments miss out on the initial enthusiasm and personal motivation that UG students bring to their formative university days. As a consequence, the construction industry potentially misses out on future civil engineering graduates who

are highly educated, competent and comfortable with issues pertaining to construction technology and management.

References

- Anderson, K. J. B. Courter, S. S, McGlamery, T Nathans-Kelly T.M & Nicometo, C. G. (2010) Understanding engineering work and identity: a cross-case analysis of engineers within six firms, *Engineering Studies* **2** (3), 153-174. DOI:10.1080/19378629.2010.519772.
- Barr, B. (2008) UK civil engineering education in the twenty-first century, *Proceedings of the Institution of Civil Engineers, Management, Procurement and Law* **161** (1), 17-23. DOI: 10.1680/mpal.2008.161.1.17.
- Bather, M.(2011) Students' views on their education and the future. *Proceedings of the Institution of Civil Engineers, Municipal Engineer* **164** (4), 209-219. DOI: 10.1680/muen.2011.164.4.209.
- Bather M (2013) Civil Engineering Students; What Stops Them Engaging: Motivation, Work or Family? *Journal for Education in the Built Environment* **8**(1), 1-15. DOI: 10.11120/jebe.2013.00006.
- Blockley, D. (2005) *The New Penguin Dictionary of Civil Engineering*. London: Penguin.
- Building (2104) About Us. Available at <http://www.building.co.uk/about-us/> (accessed 6th January 2014).
- Carrato, P and Kellogg, G. C. (2004) Scared to sketch? The lost art of drawing. Available at http://www.gostructural.com/magazine-article-gostructural.com-11-2004-scared_to_sketch__the_lost_art_of_drawing-4160.html (accessed 20th August 2013).
- Clarke, B. (2012) The 2011 James Forrest Lecture – engineering education – a historical perspective of the future, *Civil Engineering and Environmental Systems* **29** (3), 191-212. DOI:10.1080/10286608.2013.835192
- Coates, R.C. (1979) Presidential Address 1978-79, *Proceedings of the Institution of Civil Engineers: Civil Engineering* **66** (1), 1-15. DOI: 10.1680/iicep.1979.2262
- Constructionarium (2013) What is Constructionarium. Available at <http://www.constructionarium.co.uk/pages/why-constructionarium.php> (accessed 15 August 2013).
- Construction News (2014) Home Page. Available at <http://www.cnplus.co.uk/> (accessed 6th January 2014).

Collins, K. and Davies, J. (2009) Feedback through student essay competitions: what makes a good engineering lecturer? *Engineering Education* **4** (1), 8-15. DOI: 10.11120/ened.2009.04010008.

Emmitt, S. and Gorse, C. (2010) *Barry's Advanced Construction of Building, (2nd Edit)*:Chichester. Wiley-Blackwell.

Fellows, R. and Liu, A. (2003). *Research Methods for Construction*, Oxford, Blackwell Publishing.

Ferguson, E. S. (1992). *Engineering and the Mind's Eye*, London, The MIT Press.

Geddes, W.G.N. (1980) Presidential Address 1979-80, *Proceedings of the Institution of Civil Engineers: Civil Engineering* **68** (1), 1-11. DOI: 10.1680/iicep.1980.2501.

Graham, R. (2012) *Achieving excellence in engineering education; the ingredients of successful change*, The Royal Academy of Engineering, London.

Hambly, E. (1994) Presidential Address 1994-95, *Proceedings of the Institution of Civil Engineers: Civil Engineering* **102** (4), 142-144. DOI: 10.1680/icien.1994.27247.

Higher Education Statistics Agency (2013) Students by subject of study, first year indicator, mode of study and level of study 2011/12. Available at <http://www.hesa.ac.uk/content/view/1897/239/> (accessed 20 August 2013).

JBM (2009) Annex B- Design in Degree Programmes. Available at http://www.jbm.org.uk/uploads/JBM122_AnnexBDesign.pdf (accessed 20th September 2012).

Kuennen, S. and Pocock, J. (2003) Bringing Construction Experience into the Classroom, *Construction Research Congress: Wind of Change: Integration and Innovation*, March 19-21, pp 1-8.

Lynch, D. (2012) Students told they must pay 25% more to receive NCE, New Civil Engineer, 15th March. Available at <http://www.nce.co.uk/students-told-they-must-pay-25-more-to-receive-nce/8627754.article> (accessed 20 September 2012).

Love, P.E.D, Haynes, N.S and Irani, Z (2001) Construction managers' expectations and observations of Graduates, *Journal of Managerial Psychology*, **16** (8), 579-593, Available at, <http://dx.doi.org/10.1108/EUM0000000006301>

McCuen, R. H. Ezzell, E. Z. and Wong, M.K. (2011) *Fundamentals of Civil Engineering: An Introduction to the ACE Body of Knowledge*, Florida, CRC Press.

NCE (2010a) Making an entrance: The Rosyth Shipyard refurbishment. Available at <http://www.nce.co.uk/features/water/making-an-entrance-the-rosyth-shipyard-refurbishment/8600312.article27>, by Paul Thompson (accessed 2nd October 2012).

NCE (2010b) New bridge to carry M74 over the River Clyde. Available at <http://www.nce.co.uk/news/transport/new-bridge-to-carry-m74-over-the-river-clyde/8601460.article>, by NCE Editorial (accessed 2nd October 2012).

NCE (2013) Marine: Forth Replacement Crossing, by David Hayward, 30/05/2013, pp 14-18.

NCE (2014) Home Page. Available at <http://www.nce.co.uk/> (accessed 6th January 2014).

Oakland, J. S. and Aldridge, A. J. (1995) Quality management in civil and structural engineering consulting, *International Journal of Quality & Reliability Management* **12** (3), 32-48.

Oliver, A. (2010) Students celebrate NCE with festive posters, *New Civil Engineer*. Available at <http://www.nce.co.uk/news/business/students-celebrate-nce-with-festive-posters/5212873.article> (accessed 20 September 2012).

Pan, W. (2010) Learning of Construction Technology Appraisal in Higher Education: A Case Study Enquiry, *Journal for Education in the Built Environment* **5** (1), 77-97.

Rolt, L. T. C. (1989) *Isambard Kingdom Brunel*. London: Penguin Books.

Royal Academy of Engineers (2007) Educating Engineers for the 21st Century. Available at http://www.raeng.org.uk/news/releases/pdf/Educating_Engineers.pdf (accessed 20th September 2012).

Rose, A. T. (2005) Graphical Communication Using Hand-Drawn Sketches in Civil Engineering, *Journal of Professional Issues in Engineering Education and Practice*, **131** (4), 238-247. Permalink: [http://dx.doi.org/10.1061/\(ASCE\)1052-3928\(2005\)131:4\(238\)](http://dx.doi.org/10.1061/(ASCE)1052-3928(2005)131:4(238))

Sang, K., Ison, S., Dainty, A. R. J. & Powell, A. (2009) Anticipatory socialisation amongst architects: a qualitative examination. *Education + Training* **51**, 309 – 321. DOI. 10.1108/00400910910964584.

The Institution of Civil Engineers (2013) Free access to NCE website and app for ICE student members. Available at <http://www.ice.org.uk/News-Public-Affairs/ICE-News/free-access-to-New-Civil-Engineer-website-and-app-> (accessed 4th January 2014).

The Institution of Structural Engineers (2014) The Structural Engineer, <http://www.istructe.org/thestructuralengineer/guidetocontributors> (accessed 29/04/2014).

University of Strathclyde (2013a) Civil & Environmental Engineering, Why Site Visits as part of your undergraduate course? Available at <http://www.strath.ac.uk/civeng/ug/sitevisits/> (accessed 20th June 2013).

University of Strathclyde (2013b) Civil & Environmental Engineering, Undergraduate Mentoring, Available at <http://www.strath.ac.uk/civeng/ug/mentoring/> (accessed 20th June 2013).

Vorster, M. (2011). Teaching and Learning: The Critical Balance in Effective Education, *ASCE Journal of Construction Engineering and Management*, **137** (10), 916-922 , Available at [http://dx.doi.org/10.1061/\(ASCE\)CO.1943-7862.0000295](http://dx.doi.org/10.1061/(ASCE)CO.1943-7862.0000295)