

## “OFF-PISTE PEDAGOGY”: CONSTRUCTION SITE VISITS FOR UNDERGRADUATE CIVIL ENGINEERS

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**Abstract:** Undertaking construction site visits with undergraduate civil engineers can assist students to acclimatise to the realities of construction contracting practice. Construction site visits allow students to meet project personnel and observe the construction technology whilst benefiting from additional learning associated with risk and commercial issues in real-time. Whilst the provision of construction site visits can present various logistical problems related to the site and university custom, they do provide a number of educational benefits. The data collection required students to complete post visit questionnaires designed to elicit both positive and negative attributes associated with each visit. This paper provides an analysis of the questionnaires returned by the students enrolled on a civil engineering course. Recommendations are made for academics and practitioners on what may be done to ensure a successful site visit and the authors discuss opportunities for contextual learning before, during and after construction site visits are undertaken.

*Keywords: Civil Engineering; University Education; Student involvement*

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### 1. INTRODUCTION

Formal lectures and small group tutorial work continue to be the mainstay for the majority of construction and civil engineering programmes. However a blended approach to teaching and learning including guest lectures, student mentoring, and construction site visits enriches the student learning experience. For undergraduate (UG) students studying civil engineering, the construction site represents the transformation of theory into practice. This typically ‘VIP’, ‘access all areas’ site visit represents an inimitable and multi-sensory experience. Wolf (1980) cited in Gunhan (2014, p.2) suggests that students ‘see, hear and smell in an organizational practical context’ whilst Chrisp (1998, p.99) reiterates this, stating construction visits allow ‘guests’ to ‘watch, feel and smell civil engineering at its best - a real piece of theatre’.

This paper presents the results from a survey of UG students who visited construction sites during their first year of studies whilst enrolled in the department of civil and environmental engineering at a Scottish university. The paper is presented in six sections. Following the introduction, section two examines the educational benefits attributed to site visits. Section three provides a brief account of the institutional barriers to undertaking visits. Section four examines the research methodology and data collection methods employed and section five provides an analysis and discussion of the case study data. The conclusion (section six) comments on the

enduring educational value of construction site visits and highlights the need for new guidance on site visits for both university academics and industry hosts.

## **2. EDUCATIONAL BENEFITS OF SITE VISITS**

The Joint Board of Moderators (JBM, 2009a), the body responsible (under license for the Engineering Council) for approving academic institutions to deliver civil engineering courses in the UK, consider regular site visits to be of importance and can assist tutors to ‘thread’ the practice of health and safety (JBM 2011, 2) and sustainable construction (JBM 2013, 2) through examining contemporary design and construction practice. The educational benefits of site visits are arguably twofold. Firstly, they offer students an opportunity to witness first-hand the ‘nuts and bolts’, ‘messiness’ (Anderson et al. 2010), spectacle (Glaser, 2004) and ‘theatre’ (Chrisp, 1998) of a ‘live’ construction site. The ‘visual and physical impact of the surroundings bring the theory to life’ (Fry et al., 2003, p.140). According to Wankat and Oreovicz (2015, p.174) site visits ‘are visually and kinesthetically rewarding’. Secondly, the students have an opportunity to question project participants on design & construction aspects including the resolution of problems. This brief social exchange contributes to the notion of ‘legitimate peripheral participation’ as espoused by Lave and Wenger (1991). They provide an opportunity for students to be temporarily immersed (albeit as observers) within a community of engineers. The UG (newcomers) are exposed to ‘old-timers, and about activities, identities, artefacts and communities of knowledge and practice’ (Lave and Wenger 1991, p.29) that bring civil engineering to life.

Despite repeated endorsement, formal assessment of student learning based on site visits appears to be a moot point with a paucity of empirical evidence albeit Thomas (2010) discusses visits to house-building sites incorporating assessments. Moreover, whether formally assessed or otherwise, Creasy (2013) found that UG civil engineering students at the University of Leeds considered site visits to be an important contribution to their career development. Indeed, at the university under study, students regularly praise the opportunity to visit sites through the provision of written responses in module evaluation questionnaires (MEQ’s) and the annual National Student Survey (NSS free response questions). However, in contrast with the practice shared by Thomas (2010), the students were not required to complete any assessments on completion of each visit.

## **3. CONTEMPORARY BARRIERS TO UNDERTAKING SITE VISITS**

Whilst the specific operational barriers to undertaking a successful site visit tends to be linked to logistical issues a more omnipresent problem in universities is that of reward and recognition for coordinating and accompanying students on visits. In research intensive universities, promoting industrial visits mean that most academics have to take time out from research (Nyampfene, 2012). Time spent on ‘teaching, doing it, conceptualizing it, developing it, has been considered unprofessional’ (Light and Cox 2001, p.36). Moreover, recent research examining the 2014 Research Excellence Framework (REF) submission process found concerns amongst academics that teaching and pedagogical research may suffer given it has not received parity with disciplinary research in regards to what counts as ‘impact’ (Manville et-al 2015). Such evidence confronts the actual production of this conference paper. However, civil engineering academics should be reminded that students appreciate teachers who demonstrate (and share with students)

a genuine interest and verve for the planning, design and construction of ‘real’ buildings, structures and infrastructure. Moreover, as Wilson and Chrisp (2003, p.6) argued, academics need to ‘see the value of it, [site visits] not just for the students but also for themselves’. This is perhaps ironic given that ‘the majority of students studying in higher education will not enter the same community of practice as the academic staff who teach them’ (Ashwin et al., 2015, p.25).

#### 4. RESEARCH METHODOLOGY AND DATA COLLECTION METHOD

The nature of the topic under study suggests that a case study approach (Yin, 2003) offers a suitable approach for drawing analytic generalisations, to enhance learning and teaching (Case and Light, 2011) from the primary data. The research question, “what attributes do UG civil engineering students deem necessary for a successful construction project site visit” positions the students as the primary unit of analysis and their voice is conveyed to the reader in the following sections of the paper.

The twelve case study projects and associated companies have been given anonymity. All projects (Table 1) were visited within the past six years, predominantly at substructure or shell & core / structures stage. After each site visit the students were issued a questionnaire requiring responses to a 5-point Likert scale (five questions shown in Table 1) and an opportunity to provide qualitative free text. The quantitative data was tabulated (Table 1) and the written responses were typed up and collated as one document. This document was scrutinised (coded) and read on several occasions (iteration) as a means to detect words and short phrases to help provide meaning and patterns that would disclose students feelings about the site visits. Subsequently, the themes were divided into two distinct typologies encapsulating positive (Table 2) and negative (Table 3) attributes. The verbatim shown in each table is representative of text allocated to each theme and is considered to be ‘vivid and compelling’ (Braun and Clarke, 2006) and tells the story of the data set and facilitates the development of generalisations. No attempt has been made to interpret and attribute the data based on demographic categories. From a total of 450 questionnaires issued, 361 questionnaires were returned. This represents approximately an 80% response rate from each student group who attended each site visit.

CS Project	Description	Likert Scale					No of Questionnaires
		Q1	Q2	Q3	Q4	Q5	
1	Motorway 1	4.39	3.80	4.03	2.30	3.99	79
2	Motorway 2	3.67	3.38	3.50	2.29	3.75	28
3	Tram (Depot)	2.97	2.55	2.87	2.19	2.82	38
4	Dockyard refurbishment	4.74	4.39	4.58	2.24	4.34	40
5	Arena (substructure)	4.16	3.65	3.74	2.35	4.13	32
6	Mixed commercial (urban)	3.66	3.17	3.31	2.79	3.62	32
7	Supermarket (urban)	4.25	3.75	3.88	2.21	4.08	28
8	Gallery refurbishment	4.29	3.88	3.82	2.12	4.00	21
9	Swimming pool	4.24	4.06	4.13	2.35	4.24	21
10	Regeneration site (urban)	4.36	4.00	4.10	2.57	4.26	19
11	University building (urban)	4.77	4.22	4.22	2.11	4.11	9
12	Health care complex	4.92	4.35	4.78	2.01	4.35	14
							361
	Max Values	4.92	4.39	4.78	2.79	4.35	
	Average Values	4.20	3.77	3.91	2.29	3.97	
	Minimum Values	2.97	2.55	2.87	2.01	2.82	
Questions	(1) I found the visit interesting? (2) I found the visit inspirational? (3) The visit has helped confirm my intentions to become a civil? (4) The site manager / engineer used too many technical words that I did not understand? (5) The visit was useful in showing me the design & technological aspects of civil engineering?						

**Table 1: Case study projects and Likert questionnaire result**

## 5. DISCUSSION

### 4.1 Things that matter – what is needed for a successful site visit?

The quantitative data in Table 2 shows (see average scores for questions 1, 2, 3 in Table 1) that the students were overwhelmingly positive about their site visits and found them interesting (4.20) and to a large extent inspirational (3.77). The visits have also assisted the students to develop positive views of a career in civil engineering (3.91). This is noteworthy given that:

.....from the first day that students enrol on an accredited programme of study they have commenced on their career as a professional engineer (JBM 2009b, p.1).

<b>Seeing local sites:</b> <i>It was interesting as I had walked past it a couple of times and wondered what it was being built.</i>	<b>Pre site tour presentation:</b> <i>The site was really good as we got a PowerPoint presentation also which helped us understand more about the project.</i>	<b>Literature:</b> <i>We were given technical drawings to take away with us.</i>
<b>Senior engineers:</b> <i>Having the head of the office speaking during the tour was also good as it showed that they had a genuine interest in the students.</i>	<b>Host engineers were enthusiastic:</b> <i>Everyone who talked to us gave the impression that they actually wanted to talk to us and showed genuine enthusiasm for the project they were working on.</i>	<b>Project team perspectives:</b> <i>We got to hear from contractor, consultant and client's rep all at once: this helped me to visualise what each person's job was and how they fit together.</i>
<b>Alumni as role models:</b> <i>It was nice to be taken around by a Strathclyde graduate and get his opinion on how his career has progressed throughout the years.</i>	<b>Theory into practice:</b> <i>The visit was very interesting. Finally I could see how the theory I am learning at the University may be applied in reality.</i>	<b>Getting close up:</b> <i>The project was extremely interesting and it was good to get up close to the piles and even go down into the dock basin itself to get a look about.</i>
<b>Problem solving:</b> <i>Hearing about the problems that have been encountered on the project was so interesting and how these problems have been overcome really caught my attention.</i>	<b>Careers:</b> <i>I found the site visit most enjoyable, interesting and informative. It confirmed to me that once I graduate, I do want to work as a site engineer.</i>	<b>Innovative practice:</b> <i>This section of the trip gave me a new appreciation of just how innovative contracting work can be. I was of a naive opinion that contracting work was straight forward.</i>

**Table 2: Things that matter – what is needed for a good site visit?**

The qualitative feedback reveals that the students appreciated visiting local projects where they could continue to take interest in the works after the initial visit. In addition to locality, students found great comfort in talking to alumni who have adopted the status of role model(s) (guides on the side as opposed to the sage on the stage) to the students and can readily articulate where they have turned 'classroom theory into practice'. Being able to explore and question this transition from student to graduate employee is particularly telling. The students also appeared to have a high regard and respect for senior engineers who 'took time out' to speak to them. Despite the attention that routinely comes with site visits, it was interesting to note that students were able to detect where the hosts were enthusiastic about their role and responsibilities on site. It is also clear that the students wish to be considered different from that of public visitors. Whilst the site management team is slightly constrained by corporate health and safety policy, the pre-tour presentation should explore opportunities to extend the scope of the health & safety induction and introduce key aspects of construction technology that will be viewed on the tour and support meaningful learning opportunities. Whilst issues dealing with procurement and contractual issues

are of general interest, the majority of students enjoyed hearing about how engineers undertook problem solving related to technical issues.

The students also appreciate the opportunity to take home project documentation and as Preece et al. (1998, p.150) noted, visitors should ‘never leave the site empty-handed irrespective of profile or age group’. One project (case study no.12) provided the students with an innovative tour guide complete with site map and accompanying pictorial and text information explaining what they were viewing at each carefully prearranged stop on the tour. On return to the university the students were encouraged to consult *Barry’s Advanced Construction of Buildings* (Emmitt & Gorse, 2010) and *The New Penguin Dictionary of Civil Engineering* (Blockley, 2005) to consolidate their learning regarding specific technology observed. The reading of the publication *New Civil Engineer* is also encouraged and Murray and Tennant (2014) argue that published case study projects are suitable for conveying inspirational and contextualised learning to students.

In relation to technical issues, the students appreciated getting close to the ‘coal face’ to view the works in progress. This appears to be problematic for the more risk adverse contractors, however students feel excited to be ‘in a tunnel’ or ‘behind a cofferdam’ as opposed to looking at them from a distance. Consequently, careful consideration should be given to provide some limited provision / access. Indeed Table 1 discloses that students considered projects to be interesting (Q.1) and inspirational (Q.2) where they perceived the visits to offer them guidance about design and technological aspects of civil engineering (Q.5). Case study projects no. 4 (dockyard refurbishment) and case study no. 12 (new hospital) demonstrate this relationship. Moreover, there is a clear linkage to how these two project visits assisted the students to confirm their intentions to become civil engineers (Q.3) dockyard (4.58) and new hospital (4.78). Whilst on the tour, a combination of contractor, design team, client and operative perspectives can provide the students with a broad and stimulating perspective of operations on site.

#### 4.2 What should be avoided for a successful site visit?

Case study no. 3 received the lowest scores across questions 1 (interesting-2.97); 2 (inspirational-2.55); 3 (confirm intentions-2.87) and 5 (design & technology-2.82). The visit was hosted by the project client and the student group were not introduced to the main contractor responsible for building the depot. Unfortunately, the overall project delivery had attracted significant negative media coverage and was mired in delay, cost escalation and disputes. Whilst the depot project appeared to be largely independent of these problems, the students were able to sense an atmosphere of tension on site. As Buchler (2008, p.44) asserts, ‘building sites are constructions most effective calling card and that they immediately reveal the business culture of the firm involved’. The results for this project and the verbatim below speak for themselves: *This wasn’t enjoyable as they didn’t show us a lot, said very little and tried to avoid difficult questions. The visit didn’t last too long and was a real disappointment.* (1<sup>st</sup> year student)

<p><b>Visiting too soon:</b> <i>There wasn't enough construction yet so you had to visualise it.</i></p> <p><i>It would have been better to see a project further on in its development.</i></p>	<p><b>Difficulty hearing:</b> <i>I found everything that was going on in the site really interesting, the only thing I didn't like was the noise from the crane hammering in the piles, as at some points I struggled to hear what was being said.</i></p>	<p><b>Difficulty Understanding:</b> <i>It felt like the contractors speaking to us didn't realize we were in 1st year and used too many technical words/descriptions.</i></p>
<p><b>Insufficient time on site:</b> <i>I believe the visit could have been improved by having longer on the construction site rather than in the office and having him discuss more about parts of the building while being showing us around.</i></p>	<p><b>Group size:</b> <i>The trip could have been made better if we were taken in smaller groups we could have asked more questions.</i></p> <p><i>The only thing that I would change would be to split the group into smaller ones as I think it would be more personal.</i></p>	<p><b>Too little Engineering context :</b> <i>I felt that their tour was more heavily biased towards a PR talk for the general public that anyone could understand rather than giving us trainee engineers something to go away and think about.</i></p>

**Table 3: Things that matter – what should be avoided to ensure a good site visit?**

Reviewing feedback from all case study visits highlighted a number of common issues raised by the students; namely, construction noise, technical language, (linguistic noise) large groups, disconnection from the ‘action’ and witnessing site activities that provided few opportunities for learning. Other concerns included visiting the site too soon when the substructure works did not have sufficient and/or varied technology to view, or spending insufficient time on site, perhaps after an overly long pre-tour presentation. It is clear that despite the majority of the first year students having little knowledge of construction technology they felt somewhat ‘short changed’ when they did not receive sufficient engineering context from their visit. This may be avoided by the host engineers carefully planning the route through the site to show particular themes previously covered in a pre-tour talk. Students will remember the symbolic and iconic aspects of their visit and these memories are likely to inform and shape the stories (Preece et al., 1998) they tell to friends and relatives about their site experience site. While the average for question 4 (2.29) suggests that the students did not find too much difficulty with unfamiliar terms used by the site hosts some undergraduates did: *I would have liked to have understood more of what the engineer was talking about so it would have been good if he didn't use so many technical words.* (1<sup>st</sup> year student).

## 6. CONCLUSION

This paper has presented constructive evidence that demonstrates how site visits can interest and inspire students through inductive learning, visualising and sensing. Exposing students to engineering through witnessing an authentic ‘problem solving’ environment and culture can help foster their personal curiosity and promote ‘engineering habits of mind’ (Lucas et al., 2014). Exposure to these ‘real’ workplace environments can assist students to develop an identity as an engineer and to witness the repertoires of engineering practice (Johri and Olds, 2011). Ideally visits to sites that should demonstrate the core technological subjects across the civil engineering syllabus (structures, geotechnics, materials, hydraulics) and incorporate parallel topics of importance such as health & safety, environmental engineering and project management Given current guidance on organising site visits appears to be limited to the JBM document; *Organising construction site visits for university students* (2009), it is recommended that the findings presented in this paper could act as a pilot study towards a more extensive empirical

investigation that would inform new guidance documentation for the JBM. Such guidance would incorporate guidance for faculty, students and industry and may be developed and structured around the overarching themes / texts shown in Table 4.

<p><b>Faculty:</b> Site visits should be incorporated into the formal curriculum to allow students to integrate and reflect on new knowledge that bridges all topics studied. Teaching and learning committees should discuss the pedagogical aspects related to the outcome of visits. The concept of 'legitimate peripheral participation' (Lave and Wenger 1991) would be worthy of examination a means to frame the student experience before, during and after undertaking visits.</p>	<p><b>Students:</b> Research on the company / project should be undertaken prior to a visit. Site visits are active learning opportunities and students should be curious in disposition and be receptive to acquiring new knowledge and understanding through exposure to industry practice. Consolidation of the learning acquired through participation in a visit should be undertaken through the completion of a reflective report. The reflective report should contribute to an ongoing Personal Development Plan (PDP) and uploaded on their e-portfolio.</p>	<p><b>Industry:</b> Students are 'VIP' participants in an engineering community of practice and potential future employees. Visits should be planned to showcase different disciplines within the design team and contractor company. A 'route map' type guide document should be produced with photographs (annotated) and descriptive text highlighting the key design and construction aspects to be viewed on site. This guide should be discussed with the students before departing on the site tour. The guide should provide a dictionary definition (glossary) of technical narrative.</p>
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**Table 4: Suggested site visit Guidance**

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