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The Engineering Pavilion – a learning space developing engineers for the global community

1) Gregory Tibbits, Strategic Partnerships, Brisbane, Australia

2) Jolanta Szymakowski, Curtin University, Perth, Australia

3) Nicoleta Maynard, Curtin University, Perth, Australia

Abstract - Of the many factors, formal and informal, that facilitate engineering students' skills development and engineering identity, interactions with fellow students, teachers and industry are key. The Engineering Pavilion at Curtin facilitates these interactions in a building dedicated to students, providing a 'home' throughout their studies, a base for industry to engage with students, and stimulating concept understanding in a live (instrumented) building and learning space.

To understand how students develop their learning, experience and behavior in this space, we need to understand the culture of the Pavilion. The theories of Pierre Bourdieu and the key concept of habitus, allow us to operationalize the concept of culture and understand the shifting mixtures of values and beliefs that underlie behavior. An ethnographic approach, studying a culture-shaping group at a single site, was employed.

The Pavilion, recently opened, already supports student interactions. In moving from a habitus of student to graduate engineer, students' perceptions and behavior are influenced by these interactions. The larger field of engineering education also changes through adoption or revaluing new forms of behavior through the curriculum. The Pavilion hosts the development of changing habitus and exemplifies how innovative learning spaces can influence the norms of long-established disciplines.

Keywords – Bourdieu; curriculum; habitus; learning spaces

I. INTRODUCTION

The last decade has seen many dedicated "learning spaces" constructed or refurbished from existing buildings, within Australian universities [1]. They tend to be flat-floored reconfigurable spaces rather than lecture halls or standard forward-facing classrooms. This trend is also reflected within the UK and US [2]. A number of practical concerns have driven this process including the increase in student numbers [3], the need to upgrade facilities and the advent of new technologies [2], [4].

These practical concerns have coincided with a critique of traditional university teaching methods. Current learning theory argues that students construct knowledge in social environments (constructivism) rather than absorbing knowledge passively [5]. Learning occurs within the student by their interaction with their environment and with others and is constructed upon prior knowledge and experience. Learning cannot be imposed on students by simply talking to them; it requires active involvement from the student.

4) Moses O. Tadé, Curtin University, Perth, Australia

5) Lesley Jolly, Strategic Partnerships, Brisbane, Australia

A number of principles have been proposed for developing new spaces [6]. All principles demand "flexibility" or "versatility" of the space, allowing different methods of teaching and different activities. These principles assume that by creating an alternative space which is very different to a traditional lecture theatre active learning occurs automatically. The space itself is of less importance than the behavior of people within it, that is, what the students are doing to learn and what the instructor is doing to facilitate that learning.

Dedicated learning spaces, with dedicated classes with a teacher and students are not the only space where learning can occur [7], [8]. Some research has focused on alternative learning spaces outside of classrooms, that is a space where no formal class takes place, a coffee shop for example ([9], [10]). Various authors have argued that campus spaces as a whole and not just classrooms, should be designed to foster and encourage learning [11]–[13]. We have set out to examine how learning spaces impact the learning process.

The learning space in question is the Engineering Pavilion at Curtin University. The Curtin Engineering Pavilion consists of two buildings, built in two stages. The first stage, Building 215, was completed in 2011 and provides a space for engineering undergraduates with three teaching rooms on the top floor. The second stage, Building 216, was completed in 2012, providing desks and offices for engineering postgraduates and staff. [14]. It is intended that the Stage 1 building "enhances (students) learning experience and facilitates the education of more and better engineers". The two stages have slightly different functions, but both demonstrate the shift to "learning spaces" within higher education buildings. Stage I has "Project rooms, self-learning studios and structured learning rooms" while stage II has "active learning workshop based classrooms". When students talk about "The Pavilion", they refer to Building 215, the engineering undergraduate building.

The working area of stage I is designed to "bring together students, academia and industry" and this reflects a constructivist understanding of learning. The working area structures interactions between these groups but also increases serendipitous encounters, increasing the opportunities for constructivist learning. The intention of the building was that "The internal layout of the building will encourage academics and students to interact outside the confines of formal teaching spaces" [15].

The complex is designed according to active learning pedagogical principals, the space is versatile and used for

things other than teaching, and there are dedicated “social” spaces. Different groups of people interact, formally and informally in the space reflecting constructivist learning principles.

The Pavilion (Building 215) consists of three floors. The ground floor has a lunch area, an events area and rooms for various clubs and societies. The second floor, where most data were gathered, is a mezzanine floor with one large room – the Clough Self-Learning Studio (named after Clough Engineering Ltd. , an industry sponsor). Within this self-learning studio is a large open area and four small rooms, each having whiteboards and projectors. The open area has seating and desks and a capacity 70 students. The third floor has three teaching rooms, with flexible furniture, videoconferencing, and the ability to link all three rooms.

Access to the Pavilion is by swipe card and is restricted to engineering students. Engineering staff are able to access the building at any time, but students are only able to access the building between 8 am and 11 pm, every day of the year.

First year engineering students have their own dedicated space (The First Year Studio) in an adjoining engineering building. While first years do have access to the Pavilion, they tend to work in the First Year Studio. Thus the students using the Pavilion tend to be second, third and fourth year students. Post graduate engineering students tend to remain within Building 213 next door.

Engineering at Curtin University is a four year degree. Assessment over the course of the degree is broadly; exams (20-80%, average 50) consisting of short answer and calculation questions, individual assignments, including lab work (0-100%, average 50) and group assignments (0-70%, average 35). Contact hours are approximately 20 per week each semester.

The Pavilion complex within the Curtin University creates a unique learning and social experience for engineering students. Both experiences are of equal importance. This is because, when considered using a social constructivist prism, learning is enculturation [16]. That is to say that as well as acquiring knowledge, students acquire the attitudes, beliefs and behaviors that are accepted as normal in their chosen profession. Therefore it is prudent to examine the Pavilion complex in terms of culture. Understanding the culture of the Pavilion complex will be important in understanding how and what learning occurs in the space.

The theories of Pierre Bourdieu [17]–[19] allow us to operationalise the concept of culture to allow us to get a firmer grasp of the shifting mixtures of values and beliefs that underlie behavior. His key concepts are field, capital and *habitus*. In this paper the focus will be on *habitus*.

Habitus is the acquired propensity to act in certain way, a disposition. It can be thought of as a template for action (practices) and thought (representations) and can include particular mental processes and also physical movements, such as characteristic ways of “standing, speaking, walking” [17, p. 70]. The *habitus* is a practical disposition; there is no “conscious aiming at ends” [17, p. 53]. This is to say that the *habitus* is not a template for success in a field, rather a template

constraining some and encouraging other actions. It is what individuals do (and think) and why they do (and think) it. It is a system of perceptions, apperceptions and behavior [20].

Habitus is a ‘feel for the game’ and football is often used by Bourdieu as an explanation. Football players can be differentiated by their “feel for the game”. An expert player will perceive opportunities on the field that a novice will not, for example the expert player is always in a position to receive the ball (perception). They will know how much such opportunities are worth in the current state of play, evaluating likely opportunities and threats (apperception) and will have the mental and physical skills to act appropriately (behavior). We argue that the Pavilion space influences *habitus* by exposing students to experiences they would not otherwise have (perception), in the company of adepts who demonstrate a particular set of evaluations of what is happening (apperception) and that by interaction and imitation they will learn how to act like an engineer.

Individuals within a field (the social space) will tend to have similar *habitus* as the space tends to shapes all individuals in much the same way [20]. This is particularly important for the examination of the *habitus* acquired by students in the Pavilion complex. The acquired *habitus* will be that of an engineering *habitus* but the question remains how social interactions affect the ‘flavor’ of the kind of engineers they become.

II. METHODS

Observations of 1-2 hours in length were used to capture naturalistic behavior. While intended to be unobtrusive, students were aware of some observations and may have modified their behaviors in response. In this research, multiple researchers collected data. This reduced the influence of any one researcher and meant multiple records of observation and interviews were made and could be compared. A total of over 30 hours of observations were conducted over a 15 week period. Table I lists the number of observations of the Pavilion space.

TABLE I. OBSERVATIONS

	Researcher 1	Researcher 2	Researcher 3
Floor 1	4	7	0
Floor 2	16	1	2
Floor 3	0	2	0

Three focus group discussions were held with students who used the Pavilion (Table II). The focus group interviews were part of the triangulation process to validate the observations, and three focus group interviews with 15 students using the space were conducted. While a small sample, this was a method used in conjunction with observations and both data were used throughout this pilot study. Focus groups were 20-30 minutes in length. The discussions were semi-structured beginning with how the students used and perceived the space. The conversations from the focus groups not only validated the observer’s notes, but enriched the understanding of how and why various aspects of the Pavilion space were used.

TABLE II. FOCUS GROUP COMPOSITION

	Students
Focus group 1	8: 2 female, mostly 2nd year ,range of disciplines
Focus group 2	2: Both male, 4th year, civil engineering
Focus group 3	3: 1 female, 3rd year, chemical engineering

III. RESULTS

The engineering curriculum, as detailed earlier, has many contact hours and a high workload including group and individual assessments. The curriculum creates a need for a space for engineering students where they can gather and complete their studies. The curriculum also encourages particular behaviors, such as long work hours, rote learning and socialization through group work. The Pavilion is one space which satisfies this need and facilitates these behaviors.

Students were observed performing a range of study behaviors including individual study and group study within the Pavilion.

During individual study, students predominately performed calculations and exercises from textbooks. In most cases textbooks were accessed via laptop computers, though a minority of students did use physical textbooks. Students practiced numerous exercises and this study was performed for exams. Students also accessed lecture material, either notes or recorded lectures individually.

Students were observed completing assessments individually, that is composing and writing assessment on laptop computers.

The most frequent activity engaged in by students was working on their laptop computers. Students only worked at tables, and were never seen sitting on the ground and working.

Many of these study behaviors were also noted among groups of students. A typical group session included students completing exercises and calculations with each other. The interaction between students in these situations ranged from one student asking another for the solution to X, to further explanations of the many steps required to find X. Sometimes these interactions would involve more than two students, and one student comfortable with the material would provide assistance or a "tutorial session" to a number of students simultaneously.

Students were also observed completing group work assignments. In these interactions students project managed, delegated, reported verbally and wrote in groups. Some groups did separate to perform various functions, but most stayed in proximity to do much of the work.

Group interactions involved people who already knew each other, students were not observed interacting with students that they did not know. Introductions were not observed, implying some familiarity between the parties.

Students were observed learning from each other in a number of ways. In some cases, students would ask each other for assistance during their studies. This happened often when students were completing calculation type questions. Students would demonstrate steps and solutions to each other using the

whiteboard, their own laptop or on paper. Students also learnt how to use the space from observing other students.

Interviewer: You guys said you use the whiteboard a bit. What do you do on the whiteboard?

M1: A lot of group organization goes in there... so when we get a group assignment, it doesn't necessarily mean group stuff; a lot of us have broken down our thesises (sic) through the whiteboard this semester as well. But basically get an assignment and analyze quite deeply and break it down on the whiteboard.

M2: It's a good way to visualize it, everything we need to do, so you don't miss parts and you can delegate it to certain people or have a good idea of what is required for the assignment.

Interviewer: Have you guys always done that sort of level of detail or is that something you picked up?

M1: Probably since the start of last year I think.

M2: Yeah once we realized we could use the whiteboards,

M1: Yeah I don't think we really even kind of noticed them much before that. (Focus group 2, 21 May 2014, M-male student; F-female student)

Another example of students observing and learning from other students was the construction of a stick bridge on the first floor. All first years are required to construct a bridge in groups for an assessment. Part of the ground floor of the Pavilion was reserved for this activity, with up to 10 groups working on their bridges at any one time. The project brief stated that only glue or string could be used to join the elements of the bridge. One mature student was observed by the others to use epoxy resin as the adhesive, which was unique, while other groups used PVA glue. The use of epoxy resin was admired "Wow! That's hell good!" Subsequent conversations among bystanders and passers-by discussed the relative merits of different types of adhesives.

A few students reported using all facilities in the aid of study, while others reported using only some. The facilities concerned are; whiteboards, wireless connections and projectors.

Projectors were reported being used by some students particularly when performing group study to demonstrate a particular concept. Other students reported that projectors were often faulty. It is unknown as to whether the projectors were faulty or if these students were unable to use the equipment due to a lack of knowledge or additional equipment such as AV cables

Whiteboards were reported as very important for study purposes, to give tutorials to fellow students. This is active collaborative learning as detailed in the following quotations.

M1: Yeah, definitely especially leading up to exams someone will be really good at a specific aspect and for an hour or so they will go crazy on the whiteboard and give you a tutorial on that specific aspect. It is invaluable it wouldn't be possible without it.

Interviewer: Does that happen a lot?

M1: For our group.

M2: I have seen other groups do it. (Focus group 2, 21 May 2014)

M2: ... I found for myself that the best way to study was in a group doing questions on the whiteboard, because if you try and do things yourself you get stuck and spend far too much time and get sidetracked trying to find something, but if you've four people doing one question, more minds make it easier and doing it on the whiteboard keeps you focused.

F: And everyone can see it.

M2: Exactly and everyone has got their pen and we all sit there and you see how other people do it and sort of come across the best way to do it. (Focus group 3, 23 May 2014)

M: We have had to do work where maybe one student actually grasps the concept better than the rest and it is easier to put it up on a board and explain it, and have that student teach the rest. (Focus group 1, 20 May 2014)

M: You learn better from students that you do teachers. You do.

F: You learn better by teaching others.

M: And learn better by teaching others. (Focus group 1, 20 May 2014)

Students respond to the curriculum by increasing their workload throughout their studies.

Interviewer: So there is a real industrious vibe in there? You see people working hard, or most people you obviously can't work hard for ten hours a day all day, but you see most of the people are working hard?

M1: Most people the proportion increases as you get to the higher years. The second years that come in here are still a bit, they don't quite understand. It's just a transition for them and that's the way it is, you can't really blame them for it, they are still learning really. (Focus group 2, 21 May 2014)

Interviewer: It sounds like though as they themselves get further on they will probably begin to do more work, but of course you get another group of second years come in. You've been there for a few years is that what it is like, the second years are a bit slacker a bit more relaxed it is a space where you can hangout and do a bit of work, is that what you have noticed?

M1: Generally a few people will kind of maintain it throughout their time. (Focus group 2, 21 May 2014)

Access to the Pavilion space is exclusively for engineering students. Student from other disciplines can be and are invited in, but the vast majority of students within the space at any one time are engineering students. This means that any interaction an engineering student has within the space is usually with another engineering student. These social interactions (as

opposed to study) are important for the reinforcement of *habitus*.

Engineers in this space reported various aspects of an engineering identity. In this space, "real" engineers are studious and work hard; a behavior of the engineering *habitus*.

Interviewer: How else do you know if someone is going to be a real engineer?

...

F: The ones that have learned that they actually need to do study to get by in this course.

M: That's it, definitely. (Focus Group 3, 23 May 2014)

M: If you look around right now, there is probably 70% actually working, actually working by themselves. (Focus group 2, 21 May 2014)

There is a real sense of engineering students being different and superior to other students. This is another aspect of the *habitus* in that it differentiates engineers from other students.

M: I feel dumber going to the business school and the library but in here..., when you got to the business school you go like wow huh. (Sarcasm)

M: And we have had friends that come in here and say they feel out of place.

M: Yeah all our friends who come in here from business feel out of place.

Interviewer: Why do they feel out of place?

M: Because everyone is smarter than them.

M2: Everyone is smarter than them

M: We have a sort of nerd factor (Focus group 1, 20 May 2014)

An important aspect of social interactions in the space is "engineering banter" demonstrating a particular way of perceiving the world.

Interviewer: Engineering banter? What is engineering banter?

M2: Sort of..

F: We will have conversations about the weirdest things and all look at it from an engineering standpoint (M2:Yeah) even if it is something like a really silly question yeah get all engineering on it.

M2: Have to get all analytical. (Focus group 3, 23 May 2014)

IV. DISCUSSION

As noted in the introduction the actual use of a learning space could differ from of the design and intended use of learning space. Active learning does not occur without appropriate instruction and assessment, that is, the curriculum of a course or even a degree. The use of the Pavilion by students is no exception. One stated goal of the space is to be a "working area to bring together students". This is a broad statement however our observation and focus groups

demonstrate that this occurs. But this occurs not because of the building; rather the engineering curriculum encourages this use.

The high workload, use of drill exercises and numerous group assessments mean that engineering students are on campus for many hours and need an appropriate space to complete their studies (i.e., working at a table) because it is impractical for many students to leave campus in between contact hours.

F: A lot of us are here twelve hours plus kind of thing, on a bad day.

M2: Yeah and if it needs to be done it needs to be done.

F: There are some people I know who have actually slept here because they have had so much work to do, they didn't bother going home. (Focus Group 3, 23 May 2014)

Due to the workload requirements of the curriculum students are often within the Pavilion, indeed it is full to capacity during parts of the day. In addition access to the space is exclusively for engineers, concentrating the population of engineers in the space.

This means there is a high volume of engineering students in the space and consequently many engineering student interactions. This results in the potential for similar *habitus* to be quickly acquired by students within the space. The particular *habitus* being strengthened in the Pavilion space is that inculcated by the engineering curriculum. It is the shared experiences of the curriculum, and the adoption of engineering perception, apperception and behavior that the curriculum teaches. Students perceive physical systems and consider them worthy of discussion. The behavior that results is an abstraction of the physical system, from an “engineering standpoint” and “all analytical”. This occurs for physical systems presented during their studies such fluid dynamics and mechanics and even when discussing ping pong

M: even then the banter comes into it where we start talking about how the putting spin on the ball is affecting and the wind. (Focus group 3, 23 May 2014)

Adopting an engineering *habitus* is essential to fit in within the Pavilion space for instance business students are thought to feel “out of place”. Therefore each interaction within the space will reinforce and strengthen the *habitus* acquired throughout the broader curriculum. This is evident in the examples of engineering banter given by one focus group, engineering thinking and concepts were applied during many interactions. This behavior and these interactions reinforce that way of seeing the world, they reinforce this particular *habitus*.

The Pavilion space reinforces particular perceptions, apperceptions and behaviors, it reinforces *habitus*. In this case the *habitus* is recognized as “engineering” by students within the space.

In the Pavilion there are a number of behaviors that demonstrate the engineering *habitus*. These are recognized by engineering students and they are comfortable within the space.

Whereas students who are not from engineering are reported by engineering students as feeling “out of place” Briefly some of these behaviors are, “nerdiness”, industriousness or studiousness, project management and analysis.

The frequent interaction of between students who share this *habitus* reinforces it, as does the performance and observation of these behaviors.

The Pavilion not only provides a space for students to complete their studies, it also provides a space for the reinforcement of a particular engineering culture. *Habitus* is not just thoughts, but also observable actions. It is not enough to think a particular way; an individual must demonstrate to others that they have a particular *habitus*.

V. CONCLUSIONS

Observation of the use of the pavilion space and talking with students who use the space highlight the importance of curriculum in determining how a space will be used. In this case the intended use of the Pavilion, the focus on active collaborative learning is achieved in its actual use. However, *the actual use of the pavilion is shaped, in part, by the engineering curriculum, not by the building in of itself*. This suggests that any space could be used as a learning centre for engineering students to do active collaborative learning if the engineering curriculum is also focused on active collaborative learning.

One intriguing aspect of the Pavilion is the exclusivity of access. This aspect is important in the reinforcement of *habitus*. This *habitus* deserves further investigation to describe it more clearly. This would be of interest to engineering practitioners to see how engineering curriculum shapes engineering *habitus*.

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