1. THE TRANSLATIONAL DESIGN OF LEARNING ENVIRONMENTS

EVIDENCE-BASED DESIGN PRACTICE

The transformation of design thinking through evidence-based design in health facilities planning is based on the medical model of clinical research. These studies ensure that the resultant evidence is sufficiently valid, replicable and double blinded to ensure the safety of a procedure under test for ultimate commercial use with patients.

Also known as translational (clinical) research, the method has been adopted and adapted by health facility planners with qualitative and quantitative studies measuring, for example, the rate of healing of patients in different physical environments and in varying therapeutic regimes. The use of a scholarly evaluation rigour drawn from such methodologies and applied in developing new clinical procedures results in convincing evidence of the impact of the physical environment on human behaviour (Ulrich et al., 2004). Such an evidence-based approach is becoming essential in learning space design as the early 21stC sees the rapid emergence of wireless broadband and mobile communications devices that are inexorably changing the way people communicate, collaborate, create and transfer knowledge.

The vast majority of our learning environments were designed in the 19th and 20th centuries. Now, in the 21stC, new learning environments are being reengineered to meet these new and emerging technologies. They are also being designed to support new knowledge production, learning and work practices. However, these developments have not been thoroughly evaluated to assess if they actually work and whether should be scaled-up widely across school systems.

THE ORIGINS OF TRANSLATIONAL RESEARCH

Derived from medicinal sciences, and formerly known as clinical and medical science, translational research (ANU, 2009) can be defined as follows:

> To improve human health, scientific discoveries must be translated into practical applications. Such discoveries typically begin at 'the bench' with basic research in which scientists study disease at a molecular or cellular level then progress to the clinical level, or the patient's 'bedside'. Scientists are increasingly aware that this bench-to-bedside approach to translational research is really a two-way street. Basic scientists provide clinicians with new tools for use with

> patients and for assessment of their impact, and clinical researchers make novel observations about the nature and progression of diseases that often stimulate basic investigations. Translational research has proven to be a powerful process that drives the clinical research engine. (NIH, n.d.)

There is an emerging trend to leverage what is becoming known as 'transactional knowledge' into the knowledge partnership domain, refer Figure 1. This is evident at the Australian National University (ANU, n.d.) and also at North-Western University (Norman, 2010). In the latter, alternative terms have been explored such as 'translational science' and 'translational engineering' due the 'gap' between research and practice.

> Research is research, and practice is practice, and never the twain shall meet,… The gap between these two communities is real and frustrating. (Norman, 2010)

In some cases it is argued that this gap is deliberate, where, on the one hand, researchers traditionally find it 'uninteresting' to commercialise intellectual property whilst conversely many practitioners are not interested in research findings.

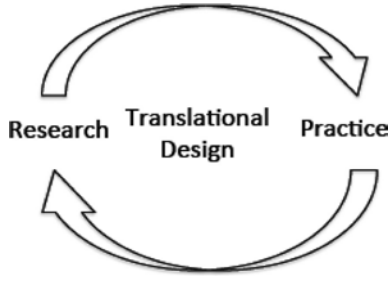

Figure 1. The inter-relationship between research and practice

Further many practitioners say that the research is not applied enough and not useful in practice. Norman also argues that sometimes the gap is a result of misunderstandings on both sides around goals and requirements. Some researchers believe their ideas are not applied correctly whilst some practitioners argue that the research results cannot be readily translated into workable applications.

Norman specifically critiques the discipline of design, arguing that 'design is still an art, taught by apprenticeship, with many myths and strong beliefs, but incredibly little evidence. We do not know the best way to design something. The real problem is that we believe we do. Beliefs are based more on faith than on data' (op. cit.). Indeed he argues that the evidence, such as it is, is based on so-called 'best practice' and that there has been no rigorous analysis of practice, in part because it is so difficult to control or fix a wide range of variables in practice.

In urging that similar methodologies should be used in the architectural profession, he urges a 'use-inspired' basic form of research, such as Pasteur used in

developing antibiotics, as illustrated in Figure 2. In this context a problem is isolated and research carried out to solve the problem. Whereas Thomas Edison (Figure 2) was more interested in using relevant knowledge to solve an applied problem, he was less concerned with trying to extend the general understanding of phenomena of the material that would improve the already existing light bulb.

Thus, according to Norman, he did not advance our understanding of science or engineering significantly. Edison was more 'consumed with making sure his inventions were practical and useful'. Norman suggests that Edison may have read the scientific literature but didn't add to it.

A third quadrant is inhabited with what Norman calls 'tinkerers' who produce inventions that neither adds to fundamental understanding nor have any use. The fourth and most significant quadrant is reflected by Pasteur, which does not resonate with the interest of the pure scientist as is illustrated by Bohr in the remaining quadrant.

Use-inspired researchers are interested in a quest for fundamental knowledge within a specific use context where the biggest payoffs lie, for example, with a smallpox vaccine. Pasteur started with a real, practical problem and understood that fundamental scientific insights were needed before it could be solved. He then 'did the science and then applied it back to the problem'.

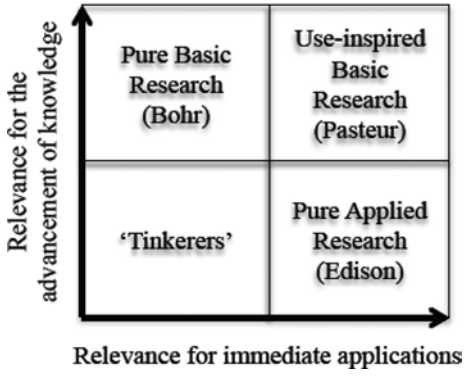

Figure 2. The research relevance dilemma
Source: openeducationresearch.org

Such research is done in search of solutions to real problems, or what Stokes (1997) calls 'use-inspired basic research'. However, Normal suggests yet another model, that of translational development:

> Between research and practice a new, third discipline must be inserted, one that can translate between the abstractions of research and the practicalities of practice. We need a discipline of *translational development*. Medicine, biology, and the health sciences have been the first to recognise the need for

> this intermediary step through the funding and development of centres for translational science. This intermediate field is needed in all arenas of research. It is of special importance to our community. We need translational developers who can act as the intermediary, translating research findings into the language of practical development and business while also translating the needs of business into issues that researchers can address. Notice that the need for translation goes in both directions: from research to practice and from practice to research. (Norman, 2010, op. cit.)

In stating that there is a huge gap between research and practice Norman argues that we need a new typology of practitioner known as *the translational developer*. They can work between the two 'sides' and understand the insights of researchers and translate them to practical outcomes. Conversely, they can translate the problems and concerns of practice into the clear, need-based statements that can drive researchers to develop new insights.

Such a model requires the transfer of intellectual property between researchers and practitioners and vice-versa. Researchers and companies could take a 'bench to bed' or 'lab to leader' approach in expanding the knowledge partnerships (University of Melbourne, 2014) model.

RECIPROCAL KNOWLEDGE TRANSFER

To a certain extent, knowledge transfer already occurs in many research and corporate institutions, but it might be focused even more using some of the concepts embedded in translational research. Alternative concepts could be considered in disciplines other than medicine such as, for example, translational engineering, translational science or translational design in architecture,

The University of Melbourne has adopted a knowledge transfer model although it acknowledges that this term could be construed as 'one way traffic' and prefers the term knowledge partnerships (University of Melbourne, 2014b) thus overcoming a weakness identified in Norman's analysis – it is two-way traffic, not just one-way. A taskforce on knowledge transfer observed that the university could be viewed as an 'arrogant institution' if knowledge was just one-way. The task force also noted that knowledge exchange – as a two-way process – is a narrower term than the process of community engagement that forms the third strand of the triple helix (research, application and community).

Knowledge transfer supports knowledge partnerships by 'advancing knowledge through the sharing of information and skills between the University and its external partners; is mutually beneficial to the University and its external partner; links into the University's teaching, learning and research; prepares students to be global citizens; increases the participation of economically disadvantaged students and contributes to the social, economic, environmental and cultural life of the wider community' (University of Melbourne, 2012).

Activities within knowledge transfer can range from partnerships with external organisations, the commercial development of research and appearances in the media and at public forums. It is intrinsically connected to research and teaching and can be a component of both. When teaching and learning activities include the input or involvement of an external partner or collaborator then they contain an element of knowledge transfer and this will involve a mutual exchange of intellectual knowledge. For example, many courses in architecture have visiting lecturers from industry, as do business and commerce. We also know that the teaching of medicine has for centuries relied on clinical practitioners to teach doctors their profession in teaching hospitals.

Student engagement with industry may include subjects and projects which involve external partners volunteering in training seminars, workshops and volunteer service research opportunities that offer engagement with business, government and community organisations internships. I now turn to how these concepts can be applied to the design of knowledge environments.

HYBRID KNOWLEDGE ENVIRONMENTS

21stC blended and hybrid knowledge models – simultaneous online and face-to-face – seriously call into question the efficacy of the still pervasive industrial-age classroom-based models of knowledge construction. The following explores learning environments, health environments and workplace environments – arguably all coming under the rubric of knowledge environments.

During a Queensland University of Technology Workshop in 2005 in conjunction with this writer, William Mitchell (see Figure 3) noted that we now have a true synchronous /asynchronous and virtual/physical matrix of knowledge opportunities for which our existing local/synchronous knowledge environment infrastructure is not well suited.

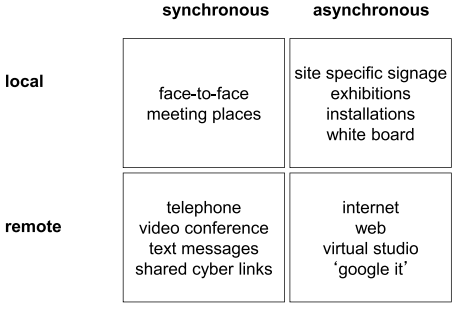

Figure 3. The physical virtual matrix
Source: Mitchell (2005)

As a response to these developments, many innovative knowledge environments are being tested. This includes an increasing focus on so-called 'third-spaces' to

support social forms of interaction. We therefore need to rethink the nature of a 21stC learning environment. These developments are blurring the boundaries between what has traditionally been seen as the built learning environment and the associated information and communications technologies that inhabit those spaces.

Three environments are explored below to illustrate how translational design can influence the relationship between the virtual and the physical in practical applications – these are the *healing environment*; the *office workplace*; and the *learning environment*.

HEALING ENVIRONMENTS

A large and growing body of evidence supports the notion that the physical environment impacts patient stress, patient and staff safety, staff effectiveness and the quality of care provided in healthcare environments. As a consequence evidence-based design is increasingly being used to guide health environment planning and to inform design decisions to improve patient, staff and health care outcomes.

Evidence based design is a process for applying research findings about the physical environment to improving the design (The Nurture Report, 2007, p. 1). Links between the natural world and healing through *quantitative* data collection has steadily grown, for example a view through a window may influence recovery from surgery (Ulrich, 2008). Ulrich's work has since guided the study of links between physical and architectural characteristics with human wellbeing through the 'common denominator' of stress reduction (Malkin, 2008, p. 26). Evidence-based design follows an 8-step process (Figure 4):

- Define evidence-based goals and objectives.
- Find sources for relevant evidence.
- Critically interpret relevant evidence.
- Create and innovate evidence-based design concepts.
- Develop a hypothesis.
- Collect baseline performance measures.
- Monitor implementation of design and construction.
- Measure post-occupancy performance results.

Research methodologies vary from casual observation through systematic observation and cognitive interviews to focus groups and surveys (Picker Institute, 1999). The activity of interviews and focus groups has to be carefully managed and in some cases can be combined into one category called 'focused interviews' which may be individual and group. They are flexible, appropriate for various populations, and provide first-hand patient insight (Cama, 2009).

Systematic observation requires monitoring environments and subjects in an environment while recording similarities or dissimilarities (Zeisel, 2006). Although this method might be cost-effective and relatively unobtrusive, such observations

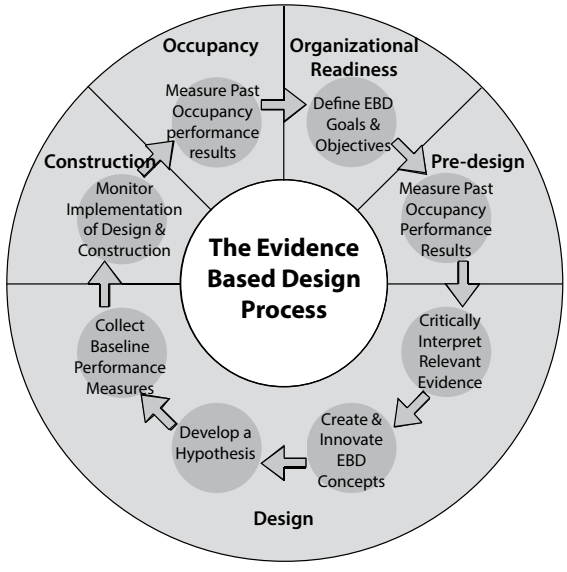

Figure 4. The evidence-based design process
Source: www.healthdesign.org/chd

may permit human error, as it is open to misinterpretation. The resulting observational data is more detailed while less generalisable (Cama, 2009).

Depending on the analysis, interviews afford both *quantitative and qualitative* data; conversely, they are time-consuming intensive and make comparison and generalisation difficult (Cama, 2009). Surveys (including questionnaires) allow easy comparison of specific data and offer control and efficiency of collection of data (Zeisel, 2006). However they are inappropriate for answering complex issues and are highly intrusive (Cama, 2006; Zeisel, 2006).

Possible performance measures fall into a number of categories including a) *overall organisational performance* – financial and economic measures (including average cost per patient day); clinical measures (including average length of stay [ALOS], stress measures, medication errors, nosocomial infection rate, fall rate, and mortality); satisfaction measures (including patient satisfaction, family satisfaction, staff satisfaction, physician satisfaction, market share, and community perception); b) *social and cultural interventions* – environment supportive of family and social connections; environment supportive of the staff; philosophy of organisational culture; c) *commitment to safety* – aspects of patient safety; safety for the staff; continuous improvement model.

Other factors include d) *healing environments* – stress reduction; access to nature; attention to the senses; wayfinding; positive distractions; e) *performance improvement* – efficiency; systems initiatives; f) *technology usage/leverage* – medical

technologies; computer technologies; labour-saving technologies; and g) *sustainable design* – greenstar; materials selection; water conservation and site planning. Effectively understanding and applying this range of performance measures, and using them to evaluate the performance of the facility, is becoming increasingly complex. As now occurs for Greenstar Professionals, health professionals – at least in the United States – can choose to become certified evidence-based health planners through EDAC (EDAC, nd.).

Accordingly, the Centre for Health Design's internationally recognized EDAC program awards credentials to individuals who demonstrate a thorough understanding of how to apply an evidence-based process to the design and development of healthcare settings, including measuring and reporting results. Its mission is to develop a community of *certified industry professionals* through education and assessment of an evidence-based design process.

Its vision is that all healthcare environments are created using an evidence-based design (EBD) process. EBD bases decisions about the built environment on *credible research* to achieve the best possible outcomes. Effectively, the fully accredited evidence-based practitioner could be seen as a translational developer or designer as they have achieved the highest level of research impact, which includes doctoral study and/or academic journal peer-reviewed articles outlining their evidence.

Evidence-based design was most recently endorsed in the design profession with the St Vincent's O'Brien Centre. This is a centre for adolescent patients suffering mental health problems and it is designed to remove the stigma from such diagnoses. From an evidence based perspective, Huffcutt (2010) has suggested that incorporating holistic healing programs should consider the impact of the physical environment on the mental, emotional, and physical states of patients. He notes that understanding how the physical environmental affects patients undergoing psychological rehabilitation has been 'less studied'.

In the mid-1800's Kirkbridge (1984) argued that the design of psychiatric facilities should incorporate a cheerful and comfortable appearance while discarding 'everything repulsive and prisonlike' (Kirkbridge, 1984, p. 624). However, the latter authors suggest that it is not possible to determine what the impact of the environment might be in the treatment of patients 'nor what good effects may result' (op. cit.). Subsequently guidelines have been developed to improve the lot of psychiatric patients.

Such guides suggest that all behavioural health facilities and units should be designed to appear 'comfortable, attractive…and [avoiding] an institutional look' (Sine & Hunt, 2010, p. 8). They further state that adolescence 'is a difficult developmental period of rapid physical, mental, and emotional change which complicates the recognition of mental illness in adolescents'.

Not surprisingly there are links between health and education with linkages for advancing appropriate mental health partnerships with schools (LAAMPS, 2014). The literature on adolescent mental health suggests that changes in identity,

biological development, and peer interaction may result in behaviours that generate mistrust by adults (Willis, 1992).

Further, 'adults generally dislike and mistrust adolescents more than any other age group' (Rice, 1992, p. 3). Other findings include the need for privacy (see Figure 8), access to nature, choice and control, and social support. Issues of control can be addressed through access to communication and opportunities for privacy. Other aspects to consider include spaces for social support from visitors and peers and 'positive distractions' such as entertainment and art. Views to nature promote visual connections to the outside world whilst community grounding and promoting rehabilitation into society are also considered essential.

From a practitioner viewpoint adolescent mental health facilities need opportunities for individual 'calm down' spaces relating to adolescent needs for privacy and the inclusion of murals drawn to a realistic, detailed imagery. It has been found that murals and artwork offer opportunity for mental escape and are a source of positive distraction (Hathorn & Nanda, 2008). Cool colours, such as varying hues of blue and purple, are preferred and numerous studies and articles have found an association of cool colours (green, purple, and blue) to feelings of calm (Figure 8) and relaxation suggesting residents' needs for calming spaces. Residents disliked imagery with strong primary colours, child's toys, and small-scale furniture whilst there is a strong desire for natural lighting.

Many of these concepts were designed into Sydney's St Vincent O'Brien's Adolescent Medical Health Centre. St Vincent's is focused on helping to prevent mentally ill youth being admitted to adult facilities. It is intended that this facility will massively improve the level of care for younger patients between the ages of 16 to 30, as it allows for a far more caring environment to heal and repair the young people's minds. The facilities also aim to provide much more support for the families.

Recently awarded the first prize in an international health facilities design competition the jury stated that the design integrates vibrant colours and a flowing layout creating a true sense of community. The 'evocative interiors' and the 'warmth

Figures 5 and 6. The O'Brien centre
Source: Woods Bagot

of colour and texture to the interior spaces' is an excellent example of patient-based design.

The jurors noted that a small project was picked this year (2012) as 'the true test in the healthcare sector is not only based on efficiency but on the personal experience of the patient', so the winning design had to design its rooms to be 'not only based on the patient but the patient's family'.

It also noted that the crucial healthcare challenges lay in the fact that each scheme requires hugely varying complexity to resolve its programmatic needs. For example, a small clinic does not require much complexity in its layout but may be a stunning piece of architecture. In contrast to this large, multi-purpose hospitals will show highly resolved, extremely complex floor plan layouts but sitting within uninspiring architecture.

Figures 7 and 8. The O'Brien centre
Source: Woods Bagot

The jury also noted that great thought was put into creating flexible, well-lit spaces that create a sense of community and encouraging a social aspect to the healing process is essential (Figure 7). In this project the jury commented that the designers exceeded brief in terms of the level of detail applied, to the level of designing window seating that encourages the patient to sit there (Figures 5 & 6) and the integration of natural light and nature as a key way to alleviate stress.

Mental health facilities in the past – as noted above – have been very clinical and restrained which the jury notes share similarities to prisons, whereas 'this design is a world apart'. Redefining how we see mental health within society, embracing it and creating a comfortable rather than imposing environment for the patients to live in is fundamental to a successful health outcome.

The role of the translational designer in such a process is critical so that evidence is brought to bear on the design process, rather than designing blind or on instinct.

THE OFFICE WORKPLACE

Translational design and evidence-based design is more difficult to establish in this domain as there has been little peer reviewed academic research on the topic.

Whilst there are a number of qualitative academic journal articles that consider issues around power relations in the workplace, there had been little peer reviewed quantitative evaluation work done using rigorous research methods.

Consultants in this field present many planning and design tools but these are usually kept internally within those consulting agencies as a means of maintaining a competitive advantage. Thus it is hard to point to translational developers or designers in the field of workspace design.

Useful writers in the qualitative domain however do include Fayer and Weeks (2007) who explore proximity, privacy and permission both within the virtual and physical thirdspace; Matthew et al. (2011) covering the evaluation of open plan offices, change and organisational management; Humphrey (2011) and Berger (2004) looking at personalising, nesting, the virtual/physical nexus, and the apparent failure of the hoteling concept; Bennet, Pitt, and Owers (2008) on social networking in offices; Baldry and Barnes (2009) critiquing the open-plan academy and the issues of space, control and the undermining of professional identity; Pinder et al. (2009) putting the case for a new academic workspace; and Nenonen (2004) who explores the intangible benefits of the workplace including a theory of knowledge management developed in organisations.

This is not a comprehensive literature survey by any means and it remains perhaps the domain of a translational developer who might aspire to the top level of the EDAC accreditation stages to carry out such a study as part of a doctoral project. It has to be noted, however, that there are a myriad of publicly available papers that are not rigorously methodologically based or peer reviewed available.

They illustrate little evidence which can be used to inform the translational design of knowledge environments covering workplaces. Note that Duffy (1997) has been excluded as I don't see any evidence for his assertions and theories, although they are still extensively used today more than 25 years after their development. This testifies to the lack of any translational development in this field.

However, if we do take the research/practice dialogue as illustrated earlier, then maybe we should be looking more closely at the assertions made by practitioners as to the efficacy of their proposals and consider whether these actually do provide a form of evidence, despite the apparent lack of rigour. The idea of translational design as noted above is reciprocal, so if practitioners are seeking some deeper evidence to test concepts, then researchers should respond.

Practitioners like to use case studies to illustrate their practice and sometimes methodology so I will use a recently awarded project, the Shelley St office fitout for Macquarie Bank.

Organisational change within Macquarie 'drove' this design and it has to be said that many 'innovative' workplace designs are often driven by an organisation's wish to transform work practices in their workforce.

Macquarie sought a more team-based approach to its operations for a variety of reasons. So individuals had to come out of their silos (see Figure 9) and collaborate more.

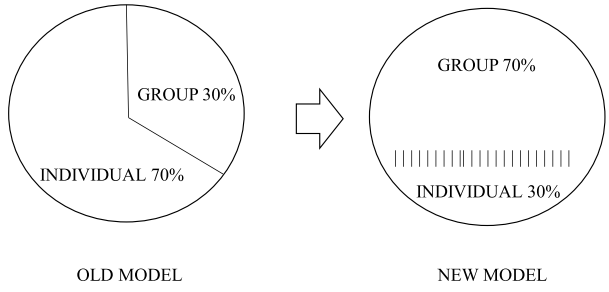

Figure 9. Group vs individual spaces
Source: Wilkinson (n.d.)

This meant a shift from 70% individual offices and workstations down to 30% and vice versa for collaborative or meeting spaces. The traditional single floor of meeting rooms- which I have seen in many merchant banks – had to become distributed for teams to access (Figure 10).

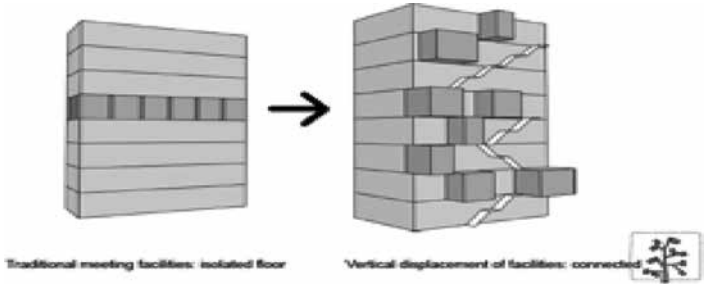

Figure 10. Distributed meeting rooms
Source: Wilkinson (n.d.)

Changing leadership aspirations included the impact of information technology, increasing competition for staff, downward pressure on costs, the realisation that office space is often highly under-utilised and the consequent development of new ways of working (Baldwin, n.d.).

Macquarie suggest the workplace is measured in three key ways – *efficiency* i.e., making economic use of real estate and driving down occupancy costs; *effectiveness* i.e., using space to support the way that people work, improving output and quality and; finally, *expression* i.e., communicating messages both to the inhabitants of the building and to those who visit it, to influence the way they think about the organisation – getting the most from the brand (ibid).

In supporting the negative views of open plan office space design, Macquarie felt that the concept doesn't encourage communication and collaboration (people

still work in silos), that people need places to concentrate, that interruptions were costly (in that staff still needed at least 15 minutes of 'immersion time' before returning to optimal levels of concentration following an interruption) and that people typically spend less than 50% of their time at their desk in their business of merchant banking.

Macquarie states that the lessons learnt from research into activity based working 'is that a variety of work settings should be available based on the activity undertaken by each individual and team, balancing the need for concentration and communication' (CABE, 2005). It also suggests that a definition of activity based working (ABW) includes no allocated desks (people choose a working setting appropriate to their task); wireless network coverage – everybody has a laptop computer and a mobile telephone; teams have a home base (anchor point) for team storage and personal storage in a locker; follow-me printing allows people to access print/copy facilities anywhere in the building, and finally projection screens in all meeting spaces to discourage paper usage.

Critical to the process was a change management programme made up of the following elements (Baldwin, n.d.): communication, communication, communication, communication (sic), project structure, business engagement and consultation, change champions, intranet site, regular emails, pilot floor, blogs, e-learning, face to face change program for leaders and people, follow-up one-day workshops, technology training, signage, communications – reinforcement of behaviour change, leader workshop and induction.

The concept also provided some challenges for client visits and confidentiality, so these meeting rooms were located in the public zone of the public-invited-private areas of the operational floors, as can be seen in Figure 11, which is largely identified by the publicly accessible 'tree' otherwise known as the atrium.

Activity based workplaces for individual and group work are satisfied by a range of 'affordances' comprising a number of settings (Figure 12). These are arrayed over the floorplate in a variety of combinations depending on the type of work activities that a particular team is carrying out, whether it be auditing, pitching for a project developing a prospectus or other (Figure 13). The dilemma begins to appear when we examine the 'evidence' of how successful the design concept has been. Some of the measures included:

- Engagement was up 35%
- 50% less energy used
- 60% of occupants believe they are more effective
- 70% less use of paper
- Long term business benefits
- 93% would not go back to desk ownership.

There some 'wins' but, in other projects – especially in universities, for example – additional individual personal and confidential interviews have elicited very unhappy office workers, with many wearing headphones to develop a sense of privacy for

Figure 11. The tree of meeting and social spaces
Source: Wilkinson (n.d.)

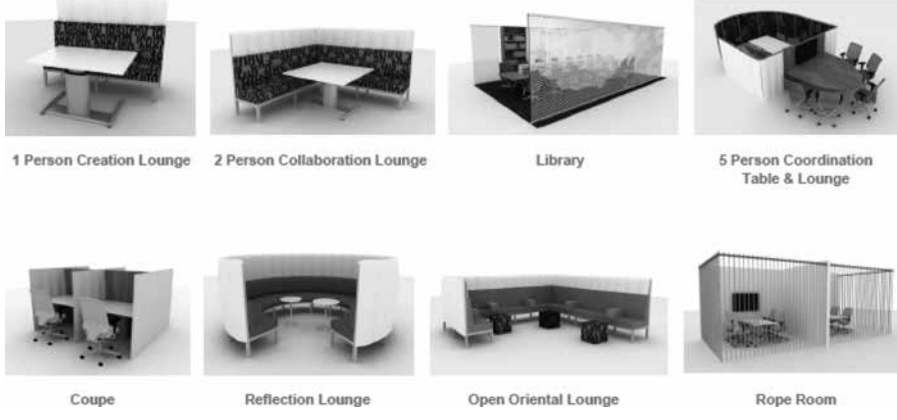

Figure 12. The activity settings matching work practices
Source: Wilkinson (n.d.)

some of their work. Organisations are not keen to share their research methodologies and so it is difficult to critique this case study.

Nevertheless, using the performance measures noted above – and it is excellent to see these established before the project was designed, not after – the published

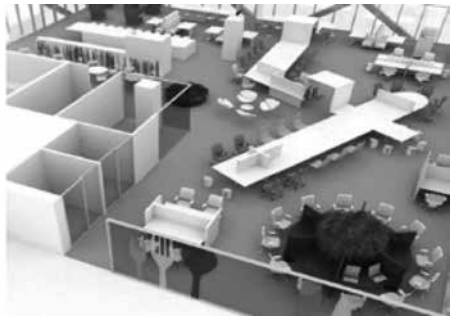

Figure 13. Team space
Source: Wilkinson (n.d.)

evaluation (Baldwin, n.d.) found that in terms of *efficiency* the AWB approach increased the capacity of the building from 2,850 people to 3,500 people.

Savings due to lack of churn were estimated as $3.1 million, savings due to environmental design initiatives – $870,000. With regard to *effectiveness* over 90% of staff surveyed post move said they wouldn't go back to the old way of working, 59% said they were 'more effective' at work because of the new way of working, 98% supported the cultural change embodied in the new workplace. Furthermore, service level performance metrics of the staff in the client contact centre have improved on previous productivity benchmarks. The evaluation also notes that 'research shows that the workplace is responsible for 24% of job satisfaction which affects staff performance by 5% for individuals and – because of the benefits of improved interaction – by 11% for teams'.

Concerning *expression*, there were 37,286 visitors to the building in the 1st year, over 40 articles published in popular, industry and the design press globally, there were over 20 industry awards for the building, the workplace and the sustainability initiatives, tours requested for CEO's from Qantas, Credit Suisse, CBA, Lend Lease, Suncorp, Westpac, Westfield and Telstra, 60% of the building occupants invited family or friends to see the new workplace in the 1st 3 months and the Group Head for Business Financial Services talks about brand cohesion – the building enables BFS to 'walk the talk'.

The workplace area of knowledge environment design is ripe for a translational developer to dig deeply into a methodologically robust research project in partnership with a practitioner and willing client to develop some true evidence on the effectiveness of activity based work-settings. But for such a solution to be truly evidence-based, the research project would have to be trialled many times and arguably in a double-blinded manner before it could be truly cited as a principal source on which to design such settings. Such projects are difficult to find funding for, and so the domain remains a little bereft of sufficient evidence to support such initiatives, other than in innovations.

Another knowledge environment domain that is beginning to replicate research projects is that of learning environments, to which I now turn. Indeed both the health and AWB office examples illustrated above form a strong basis for understanding how EBD might be applied in learning environments.

THE LEARNING ENVIRONMENT

Many of innovative spatial developments in formal and informal learning environments are being instigated primarily through initiatives led by information communication and technologies (ICT) departments, particularly in universities (Marmot & haa Design, 2004). In parallel with the reengineering of these formal spaces is a profusion of informal learning commons, learning hubs and learning centres to encourage students to spend longer hours on campus with their peers.

Educause (2014), a non-profit association whose mission is to advance higher education by promoting the intelligent use of information technology, notes that we also need to incorporate the extraordinarily rapid advances in social networking, such as Twitter, Facebook and so on, which can all be used in learning frameworks. Relatively rigid physical learning spaces must adapt to meet the emerging needs of a wide range of workplace pedagogies for a variety of professional disciplines.

But 'good teaching' must still have a role to play; the role of the mentor will remain critical, whether the mentor be virtual or physical. Whilst there is still a resistance to the use of the virtual, for example in trade training, it is without doubt that the use of simulation will become the norm as the Australian National Broadband Network unfolds over coming years. Good teaching understands how learners learn, and that learners are multi-modal, multi-skilled and multi-tasking in the way that they learn. There are myriad learning styles as illustrated in Figure 14 and it is difficult to see how all of those learning style options can be utilised in the standard classroom.

Putting 25–30 students in one classroom – whether it is 7 year olds or 17 year olds or older students in post secondary environments – limits the opportunity to differentiate teaching and support a range of learning styles. Classroom dimensions are of the order of 60 square metres for approximately 30 students, or variations of 2 m^2 per student. The alternative layouts for students with this area rating only allows for students facing the front, and groups cannot be formed. Studies by this writer have determined that a minimum of 2.7 m^2 per student is needed to allow for collaborative configurations, and preferably 3 m^2 per student. If wheelchair access is required more area is needed

There are a wide range of cognitive and neuroscience-based styles of learning for which social construction of learning must be accommodated. Clearly such an approach requires a wide range of learning spaces other than the 19thC outdated classroom. Although pedagogy is still critical in the early years of learning, some of the concepts in Figure 14 are increasingly being taught to students at young ages (Hase & Kenyon, 2010).

Generic and other constitutionally based factors

- Gregorc's Mind Styles Model and Style Delineator
- The Dunn and Dunn model and instruments of learning styles

The cognitive structure family

- Riding's model of cognitive style and his Cognitive Styles Analysis (CSA) stable personality type
- The Myers-Briggs Type Indicator (MBTI)
- Apter's reversal theory of motivational styles, the Motivational Style Profile (MSP) and related assessment tools
- Jackson's Learning Styles Profiler (LSP)

Flexibly stable learning preferences

- Kolb's Learning Style Inventory (LSI)
- Honey and Mumford's Learning Styles Questionnaire (LSQ)
- The Herrmann 'whole brain' model and the Herrmann Brain Dominance Instrument (HBDI)
- Allinson and Hayes' Cognitive Style Index (CSI)

Learning approaches and strategies

- Entwistle's Approaches and Study Skills Inventory for Students (ASSIST)
- Vermunt's framework for classifying learning styles and his Inventory of Learning Styles (ILS)
- Sternberg's theory of thinking styles and his Thinking Styles Inventory (TSI)

Figure 14. Post secondary learning styles
Source: Adapted from Coffield et al. (2004)

When these students become secondary school learners they are expected to have some attributes of adult learning, although it is noted that skills development is critical and that in many instances training or explicit instruction is still needed for some students at some stages (Figure 15).

Ultimately, though, as we move through life changing jobs – it has been argued, eight times in our working lives – we need to be autonomous learners able to re-skill into our new working domains. The rapidly emerging models of technologically-enhanced learning and learning environments or TEAL – first introduced under that term at the Massachusetts Institute of Technology (MIT) in 2000 – emphasise the role that acoustics, furniture, lighting (both natural and artificial), mobility, flexibility, air temperature and security play in supporting the new and emerging learning technologies designed for those spaces. But this is insufficient evidence to suggest we proliferate these designs.

Now there are a number of TEAL evaluations (Fisher, 2010) emerging that can support the further development of this model of learning and learning environment. For example the Experience 1 Future Learning Space was introduced to meet the pedagogical and student engagement needs, outlined above, around the teaching of engineering at UniSA (University of South Australia). There has been an evaluation covering a range of key areas (Smith et al., 2011) examining issues such as the

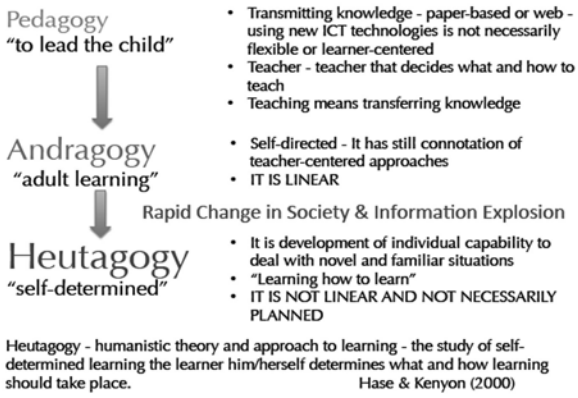

Figure 15. Transitions in teaching and learning practice
Source: Adapted from Arbab (2012)

aesthetics of the space and what messages students were receiving, (e.g., did they feel safe, positive, student satisfaction); the *function* of the space to determine how the students were using the environment and if the infrastructure (e.g., computers, appliances) was supporting them in their learning and socialising; measuring the *flexibility* of the space; and, indirectly, the *impact* on the student experience and learning outcomes.

A range of research tools was used for the evaluation. A survey of all first-year engineering students was conducted two months after students were first allowed access to the space. This survey reviewed many aspects of first-year experience and had several items that specifically drew information about the Experience 1 Studio.

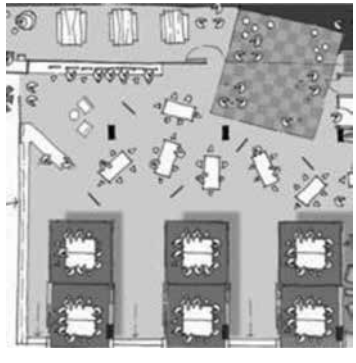

Figure 16. Experience 1 studio floor plan
Source: Woods Bagot

Figure 17. Experience 1 studio agile seminar room
Source: Woods Bagot

A similar anonymous survey was repeated towards the end of the year of occupation. Student focus groups were also organised to more deeply explore the issues raised in the surveys and to allow investigation into other issues. Students were asked to map their typical travels within the first year experience of the space (Figure 16).

A study on how the walls within the Experience 1 Studio were adjusted to create different spaces was conducted over one week (Figure 17).

To facilitate meta-cognitive talk (discussion of thoughts and thinking) a selection of visual methods were used in a photo-elucidation activity. Random focus group participants were provided with disposable cameras and asked to capture what the first year engineering space meant to them. These images were used to facilitate discussions about meaning in subsequent focus groups.

A comparison of grade outcomes was made for the four first semester courses before and after student access to the Experience 1 Studio. In summary the key outcomes were: a positive influence on student learning that in some cases has translated to better learning and social outcomes; student retention has also improved – although it is considered that this is hard to measure accurately as there are many other factors that impact upon retention; the student creation of a new club (the Amalgamated Engineering Recreational Organization – AERO), that spans the civil, mechanical and electrical engineering students (previously each program had their own club); students enjoyed interacting with their peers in other engineering programs as significant improvements to learning outcomes emerge in adopting this approach.

A crucial outcome included a much clearer understanding of the complex elements which impact on the design of a learning environment, as illustrated in Figure 18. Additional findings are reinforcing the need for teachers and lecturers to be supported as they move into new learning spaces (OLT, 2012). It is not enough to provide new, technologically connected learning spaces without giving teachers and lecturers the time, space and guidance to build collaborative teams of students, teachers and tutors.

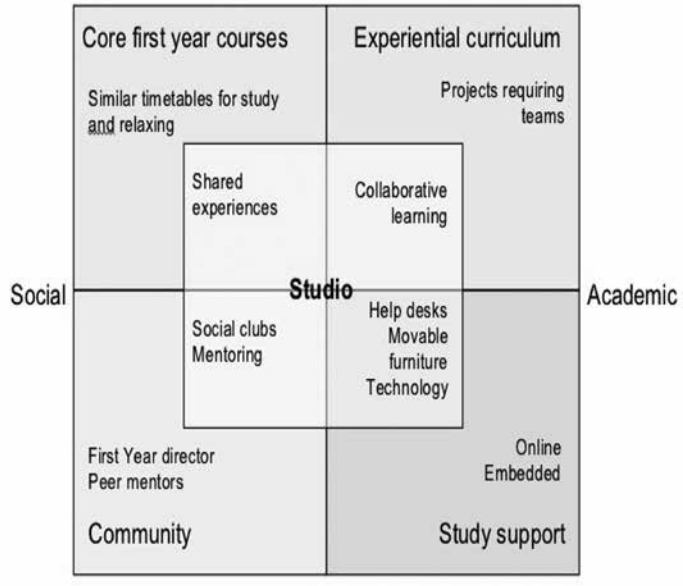

Figure 18. The experience 1 pedagogical framework
Source: UNISA

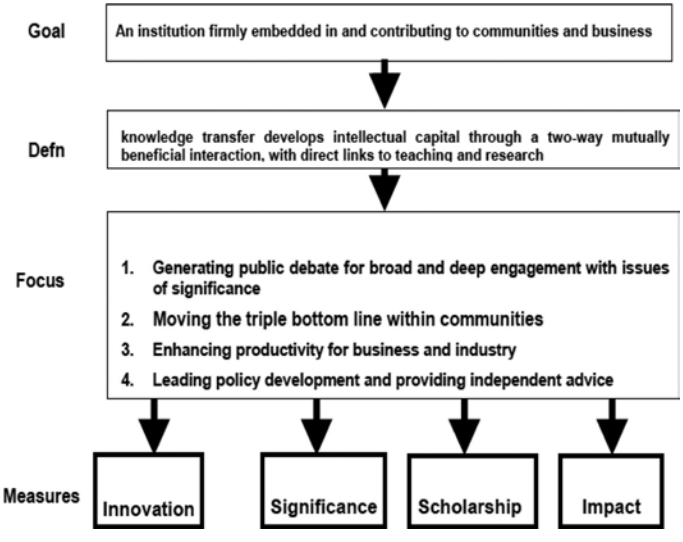

Figure 19. Knowledge partnerships model
Source: University of Melbourne

CONCLUSIONS

What will the future hold for the evidence-based design of learning environments? We are told that the university might well take a completely different form (Ernst & Young, 2012) in a decade or two and that heutagogy may well be the dominant mode of post-secondary learning and knowledge construction (Hase & Kenyon, 2000).

It may be that universities will move 'forward to the past' and emulate where the university and the community become almost indistinguishable such as was (and still is) the case at Oxford and Cambridge centuries ago. Increasingly as educational institutions evolve they are likely to be more engaged with the community so that transformative development will become more common (Figure 19). We will all need and prefer to construct knowledge collaboratively (Gibbons et al., 1994) both face-to-face and virtually.

As noted at the beginning of this chapter, the transformation of design thinking is being heralded through the evidence-based design approach in health facilities planning which itself is based on the medical model of clinical translational research trials.

We now need to look at *transforming design thinking* to support a rapidly changing psycho-socio cultural environment through the idea of *translational developers* where educational planners apply the practice of *translational design* using evidence to shape our future learning environments.

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