



PLEA 2017 EDINBURGH

Design to Thrive

Bridging the gap: A framework for a robust sustainable design process

Sarah O'Dwyer¹ and Vivienne Brophy²

¹ School of Architecture, University College Dublin, Ireland. vivienne.brophy@ucd.ie;

² Welsh School of Architecture, Cardiff University, United Kingdom. odwyers@cardiff.ac.uk.

Abstract: There is an ongoing deficiency in the application of sustainability theory through design by many construction professionals including architects. While sustainability knowledge has grown, importance should not be placed solely on its existence, but rather improving knowledge through its application and adoption in order to lessen performance gaps. While there are existing techniques to assist in meeting these challenges (e.g. design process guidance, environmental assessment guidance and software tools) research conducted by the author through a design charrette revealed limitations to this guidance in its current form. These findings indicated that of the guidance available, an integrated and informed design process has the most potential to be successfully developed to more effectively implement well-performing sustainable design. The author recommends a framework for the form, content and application this sustainable design process guidance should take, and suggests it would help give a bottom-up approach to how sustainability should be defined and implemented in practice; helping to move the current design process paradigm towards a sustainable design process one. Such guidance would be a practical tool that is universally accessible and capable of responding to changes in context in order to enable practitioners to create and deliver buildings that perform as intended.

Keywords: Sustainable design process, sustainable design guidance, inexperienced sustainable designers, performance gap, sustainability implementation

Introduction

Building professionals require the knowledge, skills and tools to understand and implement sustainable design in practice; not solely to respond to a top-down legislative agenda but additionally to improve the user experience of buildings and respond to sustainability issues from the bottom-up. Architects are key professionals within this process as the building consultant with the earliest influence on the design, and the need for architects to possess the sustainable design skills to support this role is crucial for future sustainable development. Whilst there appears to be a reasonable understanding of concepts and theory surrounding sustainable design currently within design practice, there is an ongoing deficiency in the *adoption and application* of this theory through design. This deficiency manifests itself in continued high levels of building energy use and oil dependency (Eurostat, 2016), in building performance gaps (Bordass and Leaman, 2013), in the lack of sustainable buildings which go beyond tepid 'greening' (Irish Green Building Council, 2012) and in the lack of robust sustainability confidence in architects (NBS, 2012).

This paper suggests therefore that importance should not be placed solely on architects gaining *possession* of sustainability knowledge, but rather improving their skills in the *application and adoption* of it within the design process. The focus of this paper is therefore the review of available sustainable design guidance in the form of processes,

methods or tools and the effective implementation of same by architects. It examines to what extent guidance might better support a more successful realisation of sustainable design. The focus stage is early stage design guidance - as these early stages are most influential, and the focus consultant is inexperienced sustainable design architects in Ireland who are interested in these issues but unclear how and when to implement them.

Therefore, this paper seeks to firstly briefly summarise through literature review what current guidance is available. These broad findings are further discussed and verified by the findings of a design charrette conducted by the author which evaluated how current guidance is being utilised, and offers suggestions on how sustainable design guidance should be offered in the future in terms of a guidance framework which would enable architects to not only develop sustainable design skills and ability but to implement same.

Existing Design Guidance

A literature review was undertaken to examine the effectiveness of current sustainable design guidance in the Irish early design context. There is currently sustainable design guidance available in the form of processes, (e.g. RIBA overlay) [environmental assessment] methods (e.g. LEED) and tools (software and manual). This guidance is an attempt to give some structure to a problem and to organise decision making sequences to help reduce design waste (Magent et al., 2009).

Current design **process** guidance does not address definition, realisation or sequencing of sustainable design ideas and standards. Instead, it offers a design process in which sustainability, where pursued, is added as an additional aspect to existing linear processes, manifesting in a 'DESIGN PROCESS plus SUSTAINABILITY' whereas what is called for is a SUSTAINABLE DESIGN PROCESS which incorporates sustainability within the design process. Current **method** guidance helps to set the [aspirational] goals of sustainable design - the definition - but not the means to achieve them - the realisation and sequencing is not addressed. They are primarily intended as assessment methods, and as such are unable to guide design (Cole, 2012). Current **tools** guidance are of some use in realisation of sustainability. Essentially, tools are useful to measure progress and though early design tools are available, tools appear to be of more value at a later design stage - the 'early' sequencing is therefore not fully addressed by tools, or these tools are in the wrong format. Most tools are of a technical nature and relate to outcomes that can be clearly measured, meaning many tools are used to assess not to inform decisions (Schweber, 2013).

It seems that while the body of knowledge on the theory of 'sustainable development/building/design' is growing - along with an associated increase in software, internet tools, methods and publications to act as design guidance in manipulating this theory - there still remains a consistent dearth of sustainable building both globally and specific to Ireland at present, and robust green building practices are yet to develop (Korkmaz et al., 2010). The technologies, products and guidance for sustainable building are available, but they are not successfully exploited in design (Häkkinen and Belloni, 2011). The current guidance interface is not meeting this need fully as guidance rarely addresses sequencing issues, and often issues are divided by topic or profession, and interdependencies between issues or professions are not highlighted (Lombardi, 2011). It is further suggested by the literature that as a support for sustainable design, existing sustainable design guidance such as methods and tools are useful and equally as important as process guidance but which are structured to be used at a later stage in the design process for a much more developed design, and as such process guidance is best poised to offer most assistance to inexperienced

sustainable design architects in early stage sustainable design. This calls for existing sustainable design process guidance to be questioned and perhaps enlivened to deal with the practicalities of delivering sustainable buildings.

Design Charrette

The next phase was a design charrette, which was constructed as a “small scale experiment” involving a single test with a small number of groups (Cash et al, 2012 cited in Vallet et al., 2012); with both quantitative and qualitative aspects in its design and analysis of results. It provided an opportunity to observe design process in practice (Austin et al., 2001) and to test the applicability and validity of existing design guidance in from of process, methods and tools. It could be analogous of actual practice and process (Edwards, 2009) in order to enable characterisation of participants in relation to larger population (Vallet et al., 2012).

30 participants took part in design charrettes held over two days. Two of these participants were experienced sustainable designers recruited from an earlier interview research phase and the remaining participants were selected through an advertised open call for architects inexperienced in sustainable design. In the main participants worked on a variety of projects, were from small practices and had less than fourteen years’ experience. The participants were split into 5 groups and were given the same small group design task. Each group was given additional guidance in the form of either process, method and tool guidance, with one control and one inexperienced group given no guidance - Table 1.

Table 1. Charrette participant detail

GROUP	NO. IN GROUP	EXPERIENCE	GUIDANCE PROVIDED	FORMAT PROVIDED
Control (C)	7	Inexperienced	None	N/A
Tools (T)	6	Inexperienced	Variety of 8 software tools appropriate for early stage design regarding site ('climate consultant'), fabric (u value calculator, materials ('BEES'), comfort ('freerunner', 'designadvisor' and daylight factor calculator), energy ('design advisor')— all freely available and advertised as not requiring previous experience.	On 2 laptops with internet access, with instructions
Process (P)	7	Inexperienced	RIBA Green Overlay .This relates to UK design stages, and are mainly similar to the Irish RIAI stages. It gives sus issues to consider at each design stage.	Paper format, with instructions
Method (M)	8	Inexperienced	BREEAM 2008 for Offices - a sustainability accreditation checklist of sustainable topics and issues to consider in checklist format.	Paper and digital format, with instructions
Experts (E)	2	Experienced	None	N/A

Two surveys recorded the attitudes of participant’s pre and post design task, and were compared to annotated observations made by the author during the task. It is recognised for increased confidence in the generalizability of these findings a larger sample size would be required, however the sample size was deemed to be in line with previous studies of a similar nature (Cash et al., 2013) and appropriate for the investigative nature of this research.

The limitations to studying in this way all the design processes undergone be an architect are acknowledged; it is still a “synthetic experiment that does not carry weight equivalent to a natural experiment” (Clayton et al., 1998). However it is an approximation of process which to reveals elements of real world practice which can inform and direct current sustainable design guidance and future research in these areas.

Participants were asked questions on the particular design guidance used by their group in terms of: 1) how useful it was to aid knowledge and understanding and meet sustainability targets 2) how effective it was to help to direct the design process, 3) practically how useable and understandable it was and 4) how likely participants are to use the guidance in the future. The main conclusions are summarised below.

Knowledge and understanding and sustainability targets

It should be noted that pre-task the majority of the participants expressed generally that their knowledge and skill level to be ‘average’ or ‘below average’. Participants found the process

guidance most useful and the tools least useful in terms of the ability of the guidance to aid understanding and consideration of the design targets/brief. Post-task participants expressed their knowledge of sustainable design had improved, signifying that when a design process is framed with a sustainable design brief and approached from this viewpoint that sustainable design knowledge of participants can be enhanced. These findings correlate with literature findings in terms of the need for improvement in sustainable design knowledge and suggests that when the knowledge is there it can remain dormant and requires additional activation to bridge the gap between theory and its implementation in the design process.

Directing the design process and effect of guidance on design process

Participants found the tools guidance least successful at aiding integration of sustainability into the design process and in aiding coordination of design activity – Figure 1. The process and method guidance are observed to be of equal success in this regard.

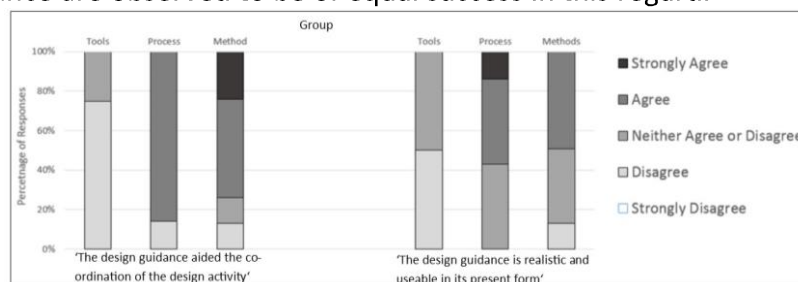


Figure 1. Responses of relevant charrette groups to given statements

Whilst on the whole the inexperienced groups P,T and M showed no major differences in terms of design activities engaged with or time spent on each design activity, there were some differences – particularly in relation to engagement with design activities (Table 2) which suggests this is in part linked to the guidance each group used, and that therefore perhaps the process guidance was more successful in eliciting a better design process response from participants than either of the Tools or Method guidance.

Table 2. Total percentage of design activities engaged with per charrette group

Group	Total % design activities engaged with (as indicated by participants)
C	62%
M	66%
T	70%
P	81%
E	95%

Practically useful or understandable

The tools guidance was least understood with similar proportions understanding both the method and process guidance. Tools and method guidance is found to be the least straightforward to use by participants. Tools guidance is found to be least useable and realistic, and Process the most - Figure 1. Tools guidance is least successful in directing the design process and least relatable to existing design processes, with method and process similar.

Potential Future Use

Participants were willing to use all guidance on a future project, with participants most willing to use the method guidance, then the process guidance, and then the tools. Participants expressed more strongly that the process guidance would be implemented more easily than the method, followed by the tools guidance. However, participants expressed they still required additional guidance on how to implement sustainable design into their process. This indicates that although the design guidance used was useful in improving knowledge and skills, none of the given guidance was completely effective to enable successful implementation of

sustainability and there is still the capacity and the need for a more developed or different form of sustainable design guidance for architects of this demographic in terms of *applying* sustainable design theory.

Where participants received no guidance

In terms of the participants who *did not receive any additional guidance*, the Expert Group E is ambiguous in their attitudes to potential additional guidance though they are in clear agreement in their willingness to use additional guidance. The Control Group C participants agree that potential additional guidance would be useful. Both of these findings indicates an openness and readiness that could be found amongst all participants to use and integrate sustainable design guidance into working design processes – either by inexperienced sustainable designers to enable a more effective sustainable design process or, to a lesser extent by experienced designers to advance their existing sustainable design processes.

Summary of design charrette findings

In terms of the participants who *used some form of design guidance* during the task, the tools guidance was the least successful in all aspects as expressed by participants. Whilst there are a few aspects where method guidance is more successful than the process guidance these aspects are mainly related to design process management and administration issues. The process guidance is more successful than method guidance with regard to: considering design targets, effective team working, being useable, realistic and straightforward and ease of future implementation in practice; and marginally more successful in terms of understanding the guidance, having the potential to be clearer if the participants had had more time to use it and improving the process of sustainable design undertaken by architects. As such in this study it can be seen that the process guidance is most successful overall, particularly for aspects which have more weight in terms of enabling an effective sustainable design process (e.g. knowledge, understanding and practical use).

Proposed Process Guidance Framework

From the research findings, the author proposes the form, content, structure, sequencing and use of guidance – Table 3. This is an initial framework to what guidance should respond to and contain and provides a basis for further research, testing and refinement. Table 3 shows an example of the framework for stage 1 of the design process 'inception'. It gives design criteria gathered from four sources for two headline issues (water and management). Please note this is a snapshot as the framework currently exists as interactive spreadsheet which covers expanded issues and design stages.

Table 3. Proposed guidance framework Stage 1; simplified

Sustainable Design Factors Headline Issues	Sustainable Design Factors Sub-Headline Issues	Design Process Stages (From RIAI workstages)			
		1. INCEPTION AND GENERAL SERVICES			
		Sources for detail of sustainable design criteria			
		Openhouse indicators	Established and published literature and guidance for the Irish context	Interviews	RIBA Green overlay
WATER	Water efficiency		WATER: 1. Assess if the client will consider water-saving sanitary fittings - cisterns, controls and taps 2. Discuss the levels of water re-use possible - 'green', 'grey', and 'black' water.		
	Rain Water Harvesting				
MANAGEMENT	Management				Client to consider formal adoption of soft landings approach to the project

Proposed form and structure of Guidance Framework

The author suggests the proposed sustainable design guidance should take the form of a framework which is based on a known process model structure (e.g. for Irish context - the RIAI workstages) which has a familiar structure and known context to inexperienced sustainable design architects and which could potentially be easily adjusted to other European design stages which are largely similar. Often existing guidance has been created with the transfer to industry expected to function as a self-evident automation. However, the use of the framework within or alongside a familiar structure would help to enable the assimilation of the new knowledge rather than it being an adjunct to the existing process; looking to make existing processes more sustainable instead of developing a new process (Heiskanen and Jalas, 2003 in Coley and Lemon, 2009).

The charrette findings suggest basing a guidance framework on a process model has the most potential to be successful. Using process workstages as the guidance framework basis has the potential to succeed as many practitioners refer to these workstages within their everyday design process. The purpose of the framework is therefore not to introduce new ideas but to improve and refine existing processes. Design processes evolve and change over time and a guidance framework related to the existing design process could be a trigger for this change in helping to integrate sustainable design into mainstream design process.

Proposed Content and sequencing of Guidance Framework

It is suggested the framework guidance should map the *whole* spectrum of potential sustainability goals. It is proposed this map is derived, compared and assimilated both from previous research (e.g. Openhouse indicators) and from published literature and guidance for the Irish context- Table 3. In this way many facets of sustainability could be assimilated into one area which relates very specifically to the Irish context but which would also be capable of being related easily to others. As such it would represent a more robust and holistic definition of sustainability than currently exists and enable a wider range of factors to be considered from the beginning –avoiding abortive work. The framework would ask designers and stakeholders to define and discuss project sustainability goals to help make clear any value judgements, worldviews, or ways of thinking (Wahl and Baxter, 2008) about sustainability that might otherwise go unheard and negatively influence the design process.

The charrette findings indicate that the current interface of existing processes, methods and tools guidance rarely addresses sequencing of issues, and often issues are divided by topic or profession; and therefore interdependencies between issues or professions are not highlighted; as various facets of sustainability can be affected by one design aspect; these interrelationships should be made evident (Lombardi, 2011).

Firstly sequencing of the issues should be mapped by relating the issues to *when* they should be considered in a design process (based on workstages as above) and secondly relationships between issues should be addressed by indicating which issues affect and influence other issues. In this way the framework would help a designer to translate a design process to a sustainable design process through specific actions and sequencing. As such the proposed guidance framework is intended be both comprehensive and practical to use (Schweber, 2013).

Proposed use of Guidance Framework

The framework is intended to form a guide to a better pattern of activities, not to prescribe a sequence of activities which must be performed. It is not intended as a ‘one size fits all’ – it

must be aligned to user and client needs and assembled by the designer for that particular project. By default the proposed guidance framework would indicate all the potential sustainable design factors to be considered at all stages which the design team could then refine. This is particularly useful in increasingly interdisciplinary design processes as the guidance framework can give a defined approach to enable teams to work successfully together towards shared goals which can be nurtured from the bottom up. This also reinforces the difference between this proposed guidance framework and other existing guidance interfaces in that it does not force a strict procedure, but can be adapted to suit a particular team and/or project. As the framework is directed at inexperienced sustainable designer it is expected these designers would use it only when experience is not sufficient to design a satisfying solution. Indeed, as the charrette findings have shown once architects move from inexperienced to experienced sustainable designers, i.e. towards a *sustainable* design process their need for a framework, such as this, diminishes.

The proposed framework is not intended as an assessment tool but to be a kick-start for sustainable design – an early design decision support tool to help to bridge gap between theory and practice (Magent et al., 2009). It enables architects to address a barrier in their individual control instead of waiting for bigger picture barriers to catch up (Figure 3). Even in integrated design processes, known to be best in delivering sustainability, a supportive framework could be of benefit to enable more sustainable solutions (Coley and Lemon, 2009).

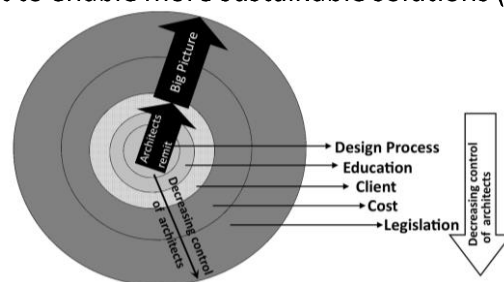


Figure 3. Levels of barriers to sustainable design implementation

Conclusion

The aim of this paper was to explore current sustainable design guidance and propose the form it should take to enable more successful implementation of sustainable design. The intention of this study is to move the discussion forward with a focus on the *application* of sustainable design by architects in the Irish context, with a focus on early stage design.

Literature findings revealed limitations to the existing guidance available which was further established by the charrette findings. The charrette studied the importance of understanding how to *apply* sustainable design knowledge to working design practice and revealed existing guidance is not absolutely successful in achieving this - post-task participants expressed they still required additional guidance on how to implement sustainable design into their process. This indicates existing sustainable design guidance is not completely effective in its current form to enable successful implementation of sustainability within early stage design by inexperienced sustainable design architects. It was found there is still the need for sustainable design guidance for architects of this demographic which could apply to the greater population of inexperienced designers.

Notwithstanding this, charrette findings suggested the process guidance was most useful guidance overall, particularly for aspects related to knowledge, understanding and practical use and that overall, of the guidance available, design process guidance has the most potential to be successfully developed to more effectively implement sustainable design.

From this a guidance framework is proposed with the intention to assist in moving the design process of inexperienced sustainable designers towards a sustainable design process, and its proposed form, content, structure and use is based on the findings of literature and the charrette research phases. As such it is intended to respond to deficiencies highlighted within current sustainable design guidance to enable more effective implementation of sustainable design. As such it is hoped these findings will not only serve as a reference to practitioners but will aid the development of further understanding of the nature of this gap between theory and practice, and that the recommended guidance framework can give improved understanding and act as a stimulus to a more effective, useable and relevant form of sustainable design guidance for inexperienced sustainable designers than currently exists.

Future Work

The proposed framework exists currently as a spreadsheet and requires further development and refinement to test its usefulness and appropriateness. Additionally the charrette findings could be further tested on larger numbers of the desired sample population.

References

- Austin, S., Steele, J., Macmillan, S., Kirby, P. & Spence, R. (2001). Mapping the conceptual design activity of interdisciplinary teams. *Design studies*, 22, 211-232.
- Bordass, B. & Leaman, A. (2013). A new professionalism: remedy or fantasy? *Building Research & Information*, 41, 1-7
- Cash, P. J., Hicks, B. J. & Culley, S. J. (2013). A comparison of designer activity using core design situations in the laboratory and practice. *Design Studies*.
- Clayton, M., Kunz, J. & Fischer, M. (1998). The Charrette Test Method. Available: <http://cife.stanford.edu/sites/default/files/TR120.pdf> [Accessed 13th March 2013].
- Cole, R. J. (2012). Regenerative design and development: current theory and practice. *Building Research & Information*, 40, 1-6.
- Coley, F. J. S. & Lemon, M. (2009). Exploring the design and perceived benefit of sustainable solutions: a review. *Journal of Engineering Design*, 20, 543-554.
- Edwards, R.L., (2009). October. Design charrettes as pedagogical method in a multimedia design course. In *Proceedings of the 27th ACM international conference on Design of communication* (pp. 181-186).
- Eurostat. (2016). Energy Trends. Available: <https://ec.europa.eu/energy/en/topics/energy-efficiency/buildings>.
- Korkmaz, S., Riley, D. & Horman, M. (2010). Piloting evaluation metrics for sustainable high-performance building project delivery. *Journal of Construction Engineering and Management*, 136, 877-885.
- Hoffman, A. J. & Henn, R. (2008). Overcoming the Social and Psychological Barriers to Green Building. *Organization & Environment*, 21, 390-419.
- Häkkinen, T. & Belloni, K. (2011). Barriers and drivers for sustainable building. *Building Research & Information*, 39, 239-255.
- Irish Green Building Council. (2012). Building Environmental Assessment for Ireland. Available: <http://www.igbc.ie/c5/projects/>.
- Lombardi, D. R. (2011). Elucidating sustainability sequencing, tensions, and trade-offs in development decision making. *Environment and planning B, planning & design*, 38, 1105-1121.
- Magent, C., Korkmaz, S., Klotz, L. & Riley, D. (2009). A design process evaluation method for sustainable buildings. *Architectural engineering and design management*, 5, 62-74.
- NBS. 2012. Sustainability Survey 2012. Available: <http://www.thenbs.com/topics/Environment/articles/nbsSustainabilitySurvey2012.asp/>
- Schweber, L. (2013). The effect of BREEAM on clients and construction professionals. *Building Research & Information*, 41, 129-145.
- Vallet, F., Eynard, B., Millet, D., Mahut, S. G., Tyl, B. & Bertolucci, G. (2012). Using eco-design tools: An overview of experts' practices. *Design Studies*.
- Wahl, D. C. & Baxter, S. 2008. The Designer's Role in Facilitating Sustainable Solutions. *Design Issues*, 24, 72-83.