

Thinking While Doing:

Explorations in Educational Design/Build

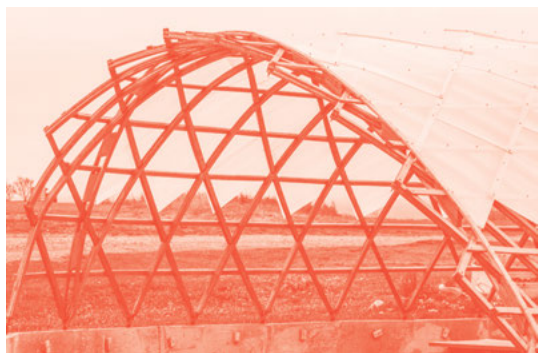
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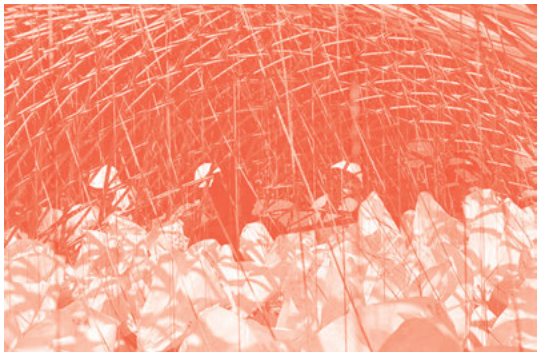
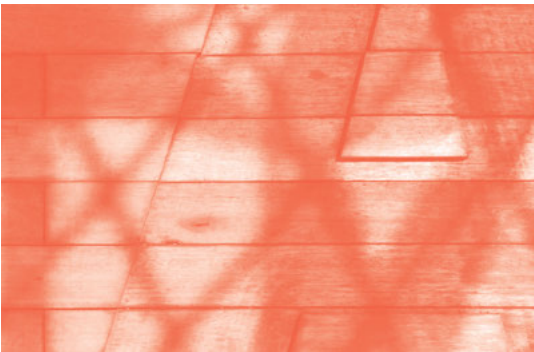
*For every student who has worked on
a design/build project while in
architecture school*

Table of Contents

Foreword	7	
Richard Harris		
Acknowledgements	13	
1 Introduction	17	
Ted Cavanagh, Stephen Verderber and Arlene Oak		
2 Territories of Educational Design/Build	29	
Stephen Verderber		
3 History and Theory of Gridshell Architecture	47	
Ramsey K. Leung		
4 The Chéticamp Farmers' Market	73	
Ted Cavanagh		
5 Care Ethics in Educational Design/Build	101	
Kaitlin Sibbald and Melanie Frappier		
6 The Social Epistemology of Thinking While Making Architecture	111	
Letitia Meynell		
7 The Lafayette Strong Pavilion: An Unhurried Building	129	
W. Geoff Gjertson		



8	Interdisciplinary Engagement Through Design/Build Education Arlene Oak	161	
9	Building as Social Medium: Anthropological Perspectives in Design/Build Claire Nicholas	177	
10	Student Perspectives in Educational Design/Build Stephen Verderber	193	
11	The Sonoran Pentapus Pavilion at the University of Arizona Christopher Trumble	217	
			12 The Design/Build Exchange as Knowledge Transference Patrick Harrop, Simon Doucet and Stephen Verderber
			13 Engineering Considerations in Design/Build Education Stephen Verderber Interview with Anthony Spick and Christopher Trumble
			14 Theory-Practice Hybrids: The Cape Breton Highlands Gridshell Ted Cavanagh



15	Reflections—A Conversation Arlene Oak and Stephen Verderber	327
	Afterword, Part I Thomas J. Mouton	343
	Afterword, Part II W. Geoff Gjertson	349
	List of Contributors	357
	Illustration Credits	363
	Index	369

Foreword

The creative process begins with idea formulation, followed by an ability to transform ideas into a finished project. Thus, for any creative endeavour, a combination of imagination and practical skills is essential. In building design, where it is virtually impossible for a single individual to perform the entire operation of design and construction, this combination of skills is highly complex, requiring an ability to communicate in a specialised, sophisticated way.

To study (and teach) design in architecture, a clear understanding of the design process is a prerequisite. However, construction practitioners themselves do not always fully understand the social and personal underpinnings of architectural creativity. For example, in structural engineering there can be much misunderstanding of what constitutes architectural design. Sometimes it is taken to be only the process of sizing structural members. However, for success, it becomes essential that the structural engineer recognise that the design process is about far more—including choosing an appropriate structural system, coordinating with specialists in architecture and environmental design, choosing appropriate materials of construction and identifying the best construction methods. As little as 15% of the structural engineer's responsibility is analysis, and then merely setting down a satisfactory justification in numbers. This job requires creating a design that meets the needs of the functional brief while working within a multifaceted team to deliver specialist skills alongside others in achieving a successful outcome. Thus, the design process functions as a highly fertile area of study for anthropologists, sociologists, historians and philosophers.

7

Those who teach courses in construction science have a responsibility to provide skills often associated with vocational training. However, education in structural design must be focused on moving beyond the development of practical skills in calculation, drawing and modelling to also instill confidence by means of communicating an awareness of the broader design context. This level of knowledge can then help to drive the entire creative process with the aim of providing effective solutions to complex, multidisciplinary problems. These solutions must not only be buildable and affordable but also provide a physical, visible template on which the occupants of the completed building can impose their own uses. A successful building is one that opens up new opportunities, opportunities invariably not foreseen by those who initially commissioned the structure or even by those who designed the built project. Design creativity that is fully reflective of local cultural traditions and local materiality is the catalyst for ultimate success.

Much of the learning that occurs in an architecture design course involves the student's immersion in the design process in a studio environment. To successfully move across a sequence of studio courses over multiple academic years requires students to demonstrate an ability to work with increasingly demanding functional briefs as they proceed through the curriculum. Ideally, all architectural professional education curricula should include a Design and Make or a design/build element, but the requisite instructional and faculty resources are rarely earmarked to enable this. In most mainstream undergraduate

curricula, the time required to make this type of experience available for every student makes it nearly impossible to incorporate full-scale design/build projects into the coursework. Thus, the full understanding of the design and construction process is invariably delivered to the young graduate by means of tutelage under experienced practitioners, post-university.

For a fortunate small number of students in architectural education, there are a handful of institutions in the world that specialise in design/build courses.

At the Rural Studio at Auburn University in Alabama, final-year architecture students take two academic terms to design and build a project for communities located in Hale County, Alabama. The Rural Studio was founded by Samuel Mockbee, D. K. Ruth and Andrew Freear, who is originally from Yorkshire, England. It is he who has directed it since 2002. This remarkable curriculum delivers its course to fifth-year undergraduate students, who are immersed in designing/making real projects for real people. The built projects' successes and failures are apparent for all to see—some of the projects are well cared for, and subsequently thrive, while those that do not meet the needs of the people they are intended for become unused and derelict.

At Hooke Park in England, Andrew Freear advised his alma mater, the Architectural Association, on the establishment of their Design and Make Masters Course at their Woodland Campus. In these courses, graduate students develop designs for extending the facilities of that campus.

In Finland, Professor Pekka Heikkinen at Aalto University offers a one-year intensive programme focusing on wood and wooden architecture. His Wood Program is a unique and challenging course, designed to attract graduate-level students (as well as recent graduate architects with some professional practice experience). The course deals with topics such as ecology of forests and wood; technical properties of wood; wood as a building material; centuries-old traditions in wood building design and construction; maintenance and renovation of wooden buildings; and modern wood-based architecture.

Only the Rural Studio, year after year, delivers large-scale design/build courses to undergraduates, and the scale of these projects requires time and resources beyond the constraints of a typical undergraduate course. Months are required to achieve the construction of a full-size building structure, and yet only days are often available to achieve such an outcome in a normal course timeframe. To enable aspects of design/build to be incorporated into a more typical undergraduate programme, the process of design needs to be more rigorously studied so that it can be better understood in this learning context.

Given how few large-scale design/build courses exist in the world, the success of the multi-year *Thinking While Doing* (TWD) project is both remarkable and laudable. The recording of what was achieved, in this book, enables others to understand this process far better so they too will be able to structure multi-year studio-based curricula well positioned for the assessment of learning outcomes at the core of the design/build learning experience.

A successful work of architecture requires that the structure reflect its local conditions, climatically, materially and socio-culturally. By utilising a multidisciplinary approach to the study of this process, the

TWD research project captured these parameters in its fundamental concept. The TWD project has been large, as it was a collaboration between 10 universities in Canada and the United States. It has been a long project, running from 2013 to 2019, and it maintained momentum only achievable due to the commitment, dedication and determination of everyone involved. It is a remarkable achievement.

By structuring the project to include the Design/Build Group (dbG), the Design/Build Exchange (dbX) and the Insight Group (IG), there has been a clear and rational division between the design/construction activities and the interdisciplinary study of the fundamental learning. The dbG was led by the professors who coordinated the design and construction of the series of gridshell pavilion structures presented in this book. The interdisciplinary IG team of scholars was drawn from the social sciences and humanities as well as architecture, and brought together a sociologist, anthropologist, philosopher and historian.

Building design is a complex process. Successful buildings address the social and material circumstances that form the context of their geographic locale. As described by Arlene Oak in her introduction to the TWD project, in Chapter 1, the research reported here reflects numerous field studies and analyses on topics that include the craft expertise, technical skill development, cross-disciplinary collaboration between academic institutions, the nuances of conversational negotiation and the inner workings of knowledge transference.

In good research, the first task is to define the typology at hand. Without this, too many random variables will needlessly blur the results and make coherent interpretation next to impossible. To allow the TWD interdisciplinary research-based team to carry out their studies in a consistent, comparable manner, all of the built structures were held constant to a single typology, and correctly, this decision was made early on.

The ambitious scope of this project called for a building type that allowed for creative expression while being of a scale and construction method attainable within the specifics of the individual briefs. The choice of gridshell pavilions met these criteria. The five studios reported are CS1 (Chéticamp), CS2 (Lafayette), CS3 (Arizona), CS4 (Charlotte) and CS5 (Cape Breton Highlands). Of these, four projects were constructed, two in Canada and two in the United States. Chéticamp Farmers' Market (2014–2016) is the first project and is described in Chapter 4. The Lafayette Strong Pavilion is presented in Chapter 7, the Sonoran Pentapus Pavilion in Tucson at the University of Arizona in Chapter 11, and the Highlands Pavilion in Cape Breton National Park (2016–2019) in Chapter 14.

In the first project, CS1, through the simple handling of materials, model making and close collaboration with the structural engineers, the team of students and their teacher were able to establish an understanding of constraints as well as have the member sizes and materials of construction fully endorsed. Although the building span is small, the complexity of the process of design and construction would be revealed by means of the essential knowledge and skill sets acquired through practical experience. The team for this project was small, yet it crystallised a body of expertise ready to be used to seed the following larger projects.

In Chapter 7, the second project, CS2, subtitled “An Unhurried Building,” was expressed as a small, highly detailed artefact. What a

wonderful opportunity – to allow the proper time to maximise community involvement and develop a site-specific project to satisfy a wide range of objectives. This project was created by a team based at the University of Louisiana at Lafayette. The initial project schedule of four months eventually extended to 18, reinforcing the need to allow sufficient time to take in the larger process – providing the students with an understanding that design and construction is about more than a linear sequence of tasks. It consists of a complex web of connections and communications, generating a wide range of emotional responses from optimism to despair and back again.

The third project, CS3, departed from the others in that it was built in steel, a material chosen in response to the harsh, arid Arizona climate. This built project represents a significantly different design process, providing the humanities-based researchers with an understanding of how the design and construction process in design/build can lead to such different building solutions.

The fourth project built, CS5, the Highlands Pavilion in Cape Breton National Park, was the second gridshell pavilion designed by the Dalhousie University-based team, in Halifax, Nova Scotia, with much assistance from the US-based TWD faculty studio directors. The level of ambition was raised, with the outcome a sophisticated building carefully situated in its landscape. It also provides its users with a resource supportive of a wide range of activities. Together, the built TWD structures represent an upward knowledge trajectory insofar as the confidence of prior success fueled ambitions for increasingly larger, more sophisticated buildings.

It is unfortunate that CS3, the third building in this series, intended for a site in Charlotte, North Carolina, remains unbuilt at this writing due to circumstances beyond the control of the TWD project team. However, there was also something to learn from this, that not all studio-based projects proceed to a successful built outcome. Regardless, much was learned by everyone who worked on this project.

The consistencies achieved by employing a single structural typology made it possible to apply at each successive construction site lessons learned from the previous case studies. Similarly, this pre-validated and reaffirmed the structural type as viable in a wide variety of site and climatic contexts. The systematic accumulation of deeper understandings and skills required to work with this structural typology is well documented in this book. This fueled the increasingly progressive upward ambitions of each built project.

Forms were chosen that were capable of delivering the requirements particular to each site and building use. Studies conducted in each case enabled the students to acquire an understanding of how their building would sit in its landscape and the structural system that would best resist wind forces, which, for lightweight structures, is invariably the most severe loading condition. The design process progressed through studies of material palettes most appropriate to the locality, and the most appropriate details of construction. Physical scale models were built to acquire an understanding of the engineering principles at work. Once the design was formulated, construction logistics were studied, materials procured, personnel mobilised and construction undertaken.

The same procedure was replicated by each university-based student team on each of the constructed projects. As this occurred,

the humanities and social science-based researchers observed and documented this process at each of the five institutions, capturing the actions and thoughts of participants as the five project teams variously created progressively more complex building forms. The relevance of this research reaches beyond the immediate architectural teaching/learning environment into the realm of allowing the layperson a deeper understanding of the design process more generally. Through these multidisciplinary investigations of the live process, the complexity of design itself is revealed and set down in this book. The results will be of benefit to both teachers of design and also practitioners.

In the contemporary world of competitive design bids and constant pressures to cut costs, there is a tendency for design to be taken for granted as a mere series of tasks to be optimised as a means to reduce construction costs. As a matter of fact, however, the complexities of the creative process require adequate time and opportunity to succeed—with time provided to allow thoughts to build and be set down, and opportunities for interdisciplinary interactions to occur in order for solutions to mature. This book provides the reader with insight into the design and construction process and the way in which the design/build approach informs the university-level learning experience, while simultaneously providing a detailed account of an evolving architectural/structural type.

This book is an excellent account of a remarkable project.

Richard Harris
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An interdisciplinary project of this scope and duration requires the collaborative contributions of many. In the case of the *Thinking While Doing* (TWD) experience, over 200 individuals have contributed to the overall effort, spanning two countries. I would like to thank everyone involved; perhaps this book will provide some context to frame the larger multi-year project of which you were an important part. I dedicate this book to you all.

First, the impetus for the TWD project was the straightforward and highly effective external governmental support provided by the Social Sciences and Humanities Research Council of Canada (SSHRC), based in Ottawa. There, research is always a priority. SSHRC's straightforward reporting procedures between the TWD team leadership and home institution (Dalhousie) allowed us to concentrate on the architectural work at hand; this was an indispensable aid from start to finish. We thank the president of SSHRC, Ted Hewitt. We also thank the many people at SSHRC who consistently worked in support of our project and in particular our main contact people: Anna Torgerson, Gianni Rossi and Adam Yates. The partners in the project were Arlene Oak at the University of Alberta, Robert Miller and Chris Trumble at the University of Arizona, Ken Lambla at the University of North Carolina–Charlotte, Geoff Gjertson at the University of Louisiana–Lafayette, Ursula Hartig at Technische Universität Berlin and Blair Pardy at Parks Canada. Important collaborators on the team are Greg Snyder, Letitia Meynell, Melanie Frappier, Stephen Verderber, Patrick Harrop, Claire Nicholas and Johanna Beth Amos.

Over the last six years, the TWD project was coordinated out of Dalhousie University with the help of Alex Morier, Philippa Keri Ovonji-odida, Jessica Wyss, Johanna Beth Amos, Matthew Timmons, Christina MacNeil and Queena Crooker-Smith. Additionally, thanks go out to Christine Macy, Dean of Architecture and Planning, and Diogo Burnay, Director of the School of Architecture.

The Chéticamp Farmers' Market: the Dalhousie University TWD design/build team included Xan Hawes, Evan Hoyles, Nina Hitzler, Noah Jacobson, Amanda Kemeny, Kaitlyn Labrecque, Katelyn Latham, Megan Lloyd, John Marshall, Elijah Montez, Fraser Plaxton, Abbey Smith, Daniel Smith and Julia Weir. The hosts at Le Conseil des Arts included Paul Gallant, Joeleen Larade, Clarence LeLièvre, and Stephane Sogne. The University of Louisiana at Lafayette TWD student team consisted of Olivia Almeida, Nouf Alalushi, Richard Arcuri, Joseph Artall, Kelly Bergeron, Jolee Bonneval, Caleb Boulet, Erika Flowers, Joshua Floyd, Patrick Flynn, Emily Girlinghouse, Breanna Hinton, Lavell Johnson, Khoa Le, Brooke Leblanc, Katie Leleaux, Wendy Meche, Benjamin Magallon, Thomas Mouton, Tran Nguyen, Michael Perry, Robert Poche, Jessica Prejean, Daniel Richard, Christopher Rush, Sarah Simar and Adam Traweek.

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The Cape Breton Highlands Gridshell: the TWD design/build team included 115 people from many different universities. The project was initiated in 2015 with the help of Alex Moirier, Lawrence Freisen, Tracey Bendrien, Stephane Sogne, Cassie Burhoe, Lydia Lovett-Dietrich, and Jessica Wyss. The design/build work that began in 2016 included: from Dalhousie University—Alex Moirier, Philippa Keri Ovonji-odida, Cristien Murphy, Abbey Smith, Cassie Burhoe, Emily Cassidy, Jane Casson, Jasper Crace, Laura Day, Sarah Dede, Karl Gruenewald, Andre Kott, Lydia Lovett-Dietrich, Josh Nieves, Andrew Nocente, Thomas Schreiber-Costa, Xinran Tang, Valerie Chang, Yen Pang (Jim) Chou, Connor Clark, James DeMartini, Robin Ellis, John Mella, Jody Miller, Isaac Neufeld, Ellen Penner, Mahta Safavi-Khalifeh-Soltani, Kyle Smith-Windsor, Adam Sparkes, Mallory Swing, Bardia Tajik, Bingyu Sun, Jinjing Wang, Ning Xu, Jie (Amy) Zhou, James DeMartini, Ben Harrison, and Lachlan MacDonald;

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from the University of North Carolina at Charlotte—Matt Allen, Calum Dodson, Alex Shuey and Nate White.

The design/build work continued in 2017 and included: from Dalhousie University—Philippa Keri Ovonji-odida, Alix Lanyon-Taylor, John Marshall, Abbey Smith, Jessica Wyss, Kristina Bookall, Megan Burt, Shaili Chauhan, Liam Healy, Lucien Landry, Ruth Vandergeest, Paryse M. Beatty, Alex Caskey, Matthew A. Gillingham, Andrew Secco, Sumaiya B. Taher, Ning Xu, Abdullah Akram and Kimberley Hoimyr; from the University of Arizona—Marco Contreras, Jerrick Tsosie, Michael Hernandez, and Moshe Wilke; from the University of North Carolina Charlotte—Alicia Foreman, Constanza Gonzalez and Drue Stroud.

The design/build work continued in 2018 and included: from Dalhousie University—Liam Healey, Hannah Newton, SuetYing (Julie) Leung, Zewei Zhang, Michael Maclean, Paulette Cameron, Kaley Doleman, Shane Hauser, Chelsea Kinnee, Bea Casiano, Natalie Steele, Kaling Zhang and Andrew Gilmour; from the University of Arizona—Cameron Behning, Jerrick Tsosie, and Ellie Franzen; from the University of Hertfordshire—Sam Healy and Ilona Hay; from the University of Toronto—Esther Bogorov, Peter Dowhaniuk, Oussama El-Assir, Jeremy Keyzer, Aseel Sadat, Lucas Siemucha, Joshua Silver, Anton Skorishchenko, Martin Drozdowski (2017), Timothy Bool and Ramsey Leung (2016).

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1 Introduction

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The Thinking While Doing (TWD) initiative was a comprehensive, unprecedented investigation (2013–2019 and ongoing) that focused on the relationship between the rapidly expanding curricular area of design/build education in schools of architecture in North America, and the broad-based implications of this curricular area as a cultural and social activity. Cultural and societal ramifications of the design/build experience were examined from the perspective of the social sciences and humanities, with attention directed to ethics, meaning, communication, understanding and performance in the context of creative practice. The TWD initiative was international in focus, functioning as a consortium of seven universities in Canada and the United States that worked collaboratively to sponsor, design, document, construct and evaluate a series of experimental structures, with each built structure expressing local climatic determinants, social and cultural traditions and indigenous material palettes. The TWD initiative was supported by grants totaling \$2.5M (CAD) in support of research in this specialised area of architectural education. Three principal aims were achieved *vis-à-vis* this grant. First, the establishment of an open-source design/build exchange database/ontology. This interactive, fluid ontology facilitates the documentation and collegial sharing of precedents in the form of completed and ongoing design/build activities throughout North America. The second major aim of the grant was to support new avenues of inquiry on the interdisciplinary nature of educational design/build (e-d/b) from the perspectives of the humanities and the social sciences. The third major aim was to design and construct a series of experimental structures, representing original contributions to the state of the art in design, engineering and fabrication of open-air gridshell pavilion architecture.

The geographic scope of the effort was far-reaching, with faculty members, students and staff at 10 universities collaborating on the TWD initiative from the fall of 2013 to the spring of 2019, led by the home institution, Dalhousie University, located in Halifax, Nova Scotia. The two Dalhousie-based e-d/b studios and built structures were the Chéticamp Farmers' Market (2014–2016) and the Cape Breton Highlands Pavilion (2016–2019). Other participating Canadian universities were Laurentian University, the University of Toronto, the University of Alberta and the University of Montreal. Participating universities in the United States were the University of Arizona (e-d/b studio and built structure, 2015–2017), University of Nebraska at Lincoln, the University of Louisiana at Lafayette (e-d/b studio and built structure, 2015–2016), New Jersey Institute of Technology and the University of North Carolina at Charlotte (e-d/b studio, 2015–2016). The work of this international team of institutions, educators/researchers and practitioners has been presented at numerous professional and academic conferences and events and is documented throughout the various chapters in this book. The authors whose contributions are represented here wish to express their gratitude for this rare opportunity to

collaborate on what has been a most interesting and challenging undertaking—a once-in-a-lifetime opportunity to explore and document an important facet of university-level education while contributing to its knowledge-base, and the transference of this new knowledge. This introductory chapter is presented in three parts, each describing a co-editor's (presented alphabetically based on last names) motivations and aims with regards to the *Thinking While Doing* research-based design experience.

Ted Cavanagh: I first became enamored with design/build education while an undergraduate architecture student at McGill University in Montreal in the 1970s where, at the time, there were no studios offered on the topic. We took it on as an extra-curricular activity on our own, completely outside of our classes. Working in a small team, we had as our first projects a series of five ferroconcrete playground structures built at schools and parks in various neighbourhoods across the city. I worked on four of them. No professors at McGill at the time were involved in any way whatsoever. However, one classmate, Peter Sijpkens, later became a professor in architecture at McGill. Peter has over the years gone on to design and build many structures with his students, including ice structures. Those of us who worked on these projects bonded closely because they were completely *ours*—of our own initiative. We built these structures on campus, then transported them to their sites for installation. In a way, it was a laboratory-based experiment and few students elsewhere in North America were doing anything like it, especially completely on their own. It was an unauthorised, guerrilla-like design activity.

I conducted my first undergraduate design/build studio as an educator soon after I arrived at Dalhousie University in Halifax more than a decade after those early structures I had helped to design and build in Montreal. The students built a full-scale section of a building. It was called the Building Studio. Currently at Dalhousie, the students in the design/build studios are typically first-year, first-term graduate students. During that first year, in the last two weeks of July, the whole school at Dalhousie shuts down and everybody goes out and engages in design-build studios simultaneously.

Ten to 12 design/build studio options are offered concurrently each summer for our approximately 140 students. I started this curricular tradition in 1991 and called it Free Lab. Free Lab would be a way to expose each and every Dalhousie architecture student to the freedom and personal empowerment opportunities I had experienced myself as a student. In its current incarnation it runs for 17 days as a three-credit course and has become firmly enmeshed in the cultural fabric of the architecture school, respected by both students and faculty. While Free Lab is interesting in many ways, only so much can be achieved in a mere two weeks because of the many inherent limitations in designing and building a structure in such a short time-frame. The aim pedagogically is to take on an imminently buildable project. So, in a way, it represents a continuation of the guerrilla studio projects of my past. Free Lab structures tend to be relatively easy to design and construct. Nonetheless, for a faculty member directing one of these short studios, it can take three or four months of background work to establish the context and find a sponsor/client for what is to be built, how it is to be constructed, choose the material palette and the location of deployment/construction. The majority of the Free Lab studio builds have been constructed in the Halifax metropolitan area.

When we first conceived the transdisciplinary *Thinking While Doing* project in 2012, we were not necessarily aiming to build four or five similar projects, typologically. We had assumed we would design and build a more varied series of structural forms, even considering things like beginning with gridshell forms and moving on to cable-net structures, then perhaps into another structural type, or even a dymaxion grid structure. Why are all the structures gridshell pavilions? My interest in this type of structure actually evolved over a number of years. The lamella configurations of the 1960s and earlier were essentially simple structural vaults, a barrel vault where virtually everything is repetitive. Brick vaults are essentially catenary vaults with everything in compression so the next step was to move beyond such historical precedents. These precedents dated from the 1920s and slightly before, as in the case of the catenary shell, the basic brick vaulted shell form, dating

from the late 19th Century work of Antoni Gaudí and later Gaudinists in North America, in Boston. These historical precursors inspired us to move progressively into more complex forms while remaining within a single architectural typology.

The *Thinking While Doing* grant our research-based design team was awarded from the Social Science and Humanities Research Council of Canada (SSHRC) was the most recent in a series of grants I had received in the past decade on the topic of studio-based design/build in architecture. The first grant I received in design/build from the SSHRC was titled Research Creation in the Fine Arts. Soon thereafter, SSHRC ended this program. In the interim, I decided to up the ante, encouraged by the fact I previously had received two modest grants from SSHRC of about \$200,000 (CAD) each, and as this research was being featured on the SSHRC homepage I was concurrently being invited to sit on review panels for other SSHRC grant submittals. I saw this as a strong indication the agency would be receptive to our scaled-up ambitions in the realm of humanities-based research on design/build education in architecture.

Although my students at Dalhousie had designed and built a lamella vault and a series of single-vaulted structures, it was decided from the outset, here, to be more ambitious. This led to my seeking out collaborations with other schools of architecture based on the assumption this would further enhance the educational experience for our students at Dalhousie University and place more of a spotlight on the pedagogical merits of inter-institutional collaboration in design/build education. Beyond this, I sought to push the tectonic and formal parameters of the structures we would design and build. The goal was to probe how innovation actually occurs both in the studio setting as well as on the construction site, in the pursuit of better understanding the *process* of creating architecture. Learning about this process would require collaboration with specialists in the humanities who could observe, document and interpret the socio-cultural, ethical and philosophical ramifications of architecture as cultural expression.

This is why the *Thinking While Doing* initiative was not conceived as solely a Canadian project. How did it become a joint

Canadian-American project? First, there are not many design-build-oriented architecture schools in Canada. Dalhousie is among the leading advocates of this aspect of architectural education in Canada and in North America. This called for a search for architecture schools known for their prior interest, experience and commitment to design/build education in architecture. This led me to approach the University of Arizona (Robert Miller and Christopher Trumble), the University of Louisiana at Lafayette (Geoff Gjertson), where the Acadian-Cajun historical and cultural connection resulted in a unique learning experience for the students of both universities, and the University of North Carolina at Charlotte (Greg Snyder).

This cultural-academic exchange between the United States and Canada has been tremendous. For instance, the students in the Louisiana design/build studio traveled to Nova Scotia while they were actually designing their own structure that same term in Louisiana. They learned firsthand about the structure we were then constructing at the Chéticamp Farmers' Market and drew from this experience in the design and construction of their structure in Lafayette (the Strong Pavilion). They learned about our design process, the construction process, the built project and pitfalls to avoid. By this point, the Chéticamp gridshell was virtually complete. They brought with them their design schematics and assessed their assumptions and structural calculation software against what actually occurred in the Chéticamp experience. At about this same time I was traveling annually with teams of Dalhousie students down to Louisiana. For four years in a row I took the students across the southeastern US, and we would spend considerable time in Lafayette. The largest group I brought there was 15, and we spent a few weeks working with the local students on their construction site in brutal Louisiana midsummer heat and humidity.

With the \$2.5M (CAD) SSHRC grant, the initial intent was to design and build the TWD structures in Nova Scotia in close collaboration with the three American architecture schools, beginning with the University of Arizona, then in successive collaboration with the University of Louisiana at Lafayette, followed by the University of North Carolina at Charlotte. The aim was to bring to Canada the

other schools' students, faculty and expertise, with the collaborations occurring on Canadian soil, but the first test of this format did not go particularly well. The project became too large and complex too fast, and there was no easy way to effectively coordinate the design/construction timeline required within the limits of the Dalhousie academic year schedule, together with the University of Arizona academic year schedule. The Arizona academic year started weeks earlier than Dalhousie's, and we therefore lost nearly an entire term of productivity early on due to scheduling problems. While the prospect of sequencing the involvement of three American universities on Canadian soil remained attractive in theory, it proved too complicated to effectively implement.

We realised early that if we were to jump from one building type to another we would encounter a very steep learning curve, a learning curve that could slow down or potentially completely derail the *entire* initiative. Type-jumping would require us all to learn completely new types—continually—and the grant as structured was framed largely to examine and learn from how one design-build team learns and then passes its acquired knowledge to the next team. This process of knowledge transference was fundamental to why we received SSHRC's support in the first place because, as previously mentioned, our aim was to link the design/build experience with the humanities to the fullest extent. So we struck the initial goal of typological diversity in favour of sticking entirely with variants of open-air pavilion structures. Now the goal would be to push the boundaries of a sole building type. In deciding all five structures would be variants within a single typology, we allowed the interdisciplinary team new opportunities to advance the state of the art in ways otherwise unattainable.

The case study chapters appear in this book chronologically, based on when they began. Moving from one design/build studio project to the next within a single building type allowed for comparing/contrasting geographies, climactic variations, socio-cultural variability, and local indigenous traditions with regards to what is built and why, together with individual and collective broader ramifications. The four universities where the design/build studios were based each agreed

to build a structure locally, then join forces on the final structure. This strategy resulted in the design-tectonic trajectory expressed in this book. I am grateful to everyone—and especially for the hard work and commitment put forth by each and every student.

Arlene Oak: The *Thinking While Doing* project is structured to include the Design/Build Group (dbG), the Design/Build Exchange (dbX) and the Insight Group (IG). The activities of the IG have been conducted through ongoing communication with the dbG (led by the professors who coordinated the design and construction of the gridshell structures). The IG is composed of scholars who work in the social sciences and humanities, with the group consisting of myself, a micro-sociologist who researches the conversations that happen during design; Claire Nicholas, an anthropologist whose research focuses on craft and design; Letitia Meynell, a philosopher who examines the modes of representation from sketches to technical drawings; and Melanie Frappier, a historian whose work focuses on the intersection of science and technology. While the IG also includes the architects Stephen Verderber and Patrick Harrop, the following comments are focused on those IG participants who are not practitioners of architecture but who, instead, bring the perspectives of the interpretive social sciences and humanities to the study of architectural education and the professional practice of architecture.

The research project *Thinking While Doing: Connecting Insight to Innovation in the Construction Sector* (its official title) was granted under the SSHRC project category Research-Creation. As a grant-project category, Research-Creation is important because it recognises the importance of combining modes of scholarship in the social sciences and humanities. In architecture, research-as-practice is typically undertaken autonomously rather than also as a topic of study by the social sciences and humanities, while most social science or humanities scholarship that studies architecture does so through the consideration of its practitioners or its finished products—buildings and other structures. It is fortuitous that SSHRC has Research-Creation as a funding category, although in reality we discovered through the TWD project that it is not always easy to

connect architectural practice to research in sociology, anthropology, philosophy and history. Despite difficulties of time, distance and different modes of working (discussed briefly in chapter 15), the TWD project did achieve this connection.

Within sociology, anthropology, philosophy and history, there is increasing recognition that phenomena such as drawing, materials selection and model making involve interesting and complex translations of information from one domain to another, such as from pencil sketch to computer model to a wood lattice structural form. The creation of a building is a combination of social and material circumstances that include craft expertise, technical skill, cross-disciplinary collaboration, conversational negotiation and knowledge transference. My own research examines the talk that occurs in and throughout design practice in professional and academic/educational contexts, such as when an architect speaks with a client, or when a design student presents their work for critique. Such conversations reveal on-the-ground debates, controversies and decisions that concern, for instance, building program, structure, materials and aesthetics. While the everyday talk of designing and building reveals interesting aspects of practice, it is usually somewhat difficult for researchers to gain access to the social situations where the 'real' activities of designing, building and educating are taking place. The TWD project provided opportunities to access these situations—from design reviews to construction sites—and so enabled the IG to collect a rich set of research materials, such as audio and visual recordings, photographs and field notes. These research materials have captured many moments in the moving 'flight'¹ of each gridshell, from sketch to finished form, and so will serve to inform future scholarship on architecture and design-build education.

Evolution of the Insight Group:

As noted above, the IG team members explore many of the ongoing practices of architecture, such as sketches (Meynell), and the diverse issues raised by those practices, such as ethics (Frappier). Yet, also as noted above, it can be difficult for scholars in the

1. Yaneva, Albena & Latour, Bruno (2008). Give Me a Gun and I Will Make All Buildings Move: An ANT's View of Architecture. In Reto Geiser (ed.). *Explorations in Architecture: Teaching, Design, Research*. Basel: Birkhäuser. pp. 80–89.

social sciences and humanities to gain access to those sites of creative production where, for instance, sketches are being sketched and ethical dilemmas are being considered. How did TWD's particular blend of interdisciplinarity occur? It was Ted Cavanagh's particular background that proved to be an important catalyst.

Ted Cavanagh has established a distinguished record in design/build education and is a historian-theorist of architecture in the field of science and technology studies (STS).² An interdisciplinary area of scholarship, STS encompasses work by anthropologists, sociologists, philosophers and historians. His research in the history of technology and practice led him to an article of mine in the journal *Design Studies*, where I discussed how, by investigating the mundane talk that occurs during design, we can arrive at a better understanding of the complex collaborations inherent in creative practice and production.³

Ted's initial proposal for TWD was clearly a rare opportunity to explore further the "live" activities of design and the process of construction through a range of scholarly approaches and theories. Although my work comes from a different academic/applied context than Ted's, my background, like his, encompasses elements of both design practice and scholarship, including studio-based education in textiles, clothing, furniture, products and graphic design, as well as post-graduate studies in history and the social sciences. In particular, my PhD research focused on the conversations that occur throughout design practice: particularly those occurring during design education, where the student as a novice designer learns the explicit and tacit "languages" of design.⁴ Design education involves acquiring technical skills but also the modes of explanation, discussion and presentation that are the hallmarks of a "real" professional designer. After completing my PhD I worked on projects centred on university-level design education, including urban planning, professional architects and engineers in practice, and research on the presentation of architecture and design through the medium of television. By the time I joined the TWD project, Ted had connected with a philosopher and a historian (Halifax-based Letitia Meynell and Melanie Frappier). After receiv-

ing the grant, the Insight Group took shape as a small, diverse team of scholars who would bring to TWD the reflective insights of (some of the) interpretive social sciences and humanities.

While enthused about the TWD initiative from the outset, I was not fully appreciative of its ambitious scope. This changed at the first meeting of the project team, in Halifax in September 2013, when the total group of participants from Canada and the US gathered together for three days. This was when I realised the logistical difficulties involved in following diverse groups working in diverse geographic locales. As a micro-sociologist who studies *talk* I needed to be personally present to audio-record the "live" interactions of various associated team members and working groups. Fortunately, Claire Nicholas arrived on the scene. I met Claire in 2011 at a conference where she spoke about her doctoral research on the practices of designers and craft artisans in Morocco.

As leader of the IG, I maintained contact with others in the TWD group and, along with Claire, undertook micro-sociological and ethnographic studies focused on the diverse groups of students, instructors, engineers and others involved with the design and construction of the various structures. Claire and I observed in the design studios and on the construction sites, taking notes, photographs and producing many hours of audio and video recordings. We listened, recorded and transcribed informal meetings, design reviews, presentations and conference calls. We are extremely grateful to all who allowed us access into their everyday lives, and it has been a privilege to witness the dedication and creativity of everyone involved. More recently, Claire and I, with Letitia Meynell, have disseminated our research findings at conferences, including those centred on architecture and architectural education, such as the conferences of the Association of Collegiate Schools of Architecture; those centred on the social sciences and humanities, such as the conferences of the American Anthropology Association; and those centred on both practice and theory, including the conferences of the Society for the Social Study of Science, and the Design Research Society. Members of the IG are also beginning to publish works associated with the TWD project in venues

that focus on architecture and its education, as well as on wider scholarship in the social sciences and humanities. By communicating this interdisciplinary work to diverse academic and professional audiences, we in the IG aim to continue the TWD project's lasting impact.

Stephen Verderber: On summer evenings after dinner my mother would open the back door to loudly call out my name, knowing full well I had spent hours pillaging lumber from the neighbourhood's construction sites after dusk. The postwar suburban neighbourhoods of Skokie, just north Chicago, still had a few unbuilt lots, and my block still had large triangular-shaped parcels at its centre. We 10-to 12-year-olds always called it the prairie. We competitively constructed elaborate structures in it, each trying to outdo the others. Next door to my house was a 12-foot hill that sloped downward into a second unbuilt parcel (where two split-level houses would later be built). I somehow managed to build a three-level structure at the uppermost edge of the slope, next to my parents' driveway. Using only pilfered materials *ad hoc* I designed and assembled it on my own. Featuring a ladder and tent-roof on the top level, it was my first design/build construction. Winter months did not go to waste, either, because I created igloo-like structures on the property.

Years later, while an undergraduate in architecture at the University of Wisconsin–Milwaukee, my design studio embarked on a three-day wilderness excursion to Rock Island, Wisconsin, a rural outpost on Lake Michigan at the farthest tip of Door County, accessible only by ferry, with no vehicles allowed. Ten four-person student teams designed/built a structure to live in on a cold, rainy late October weekend—the construction budget was only \$100. My team concocted a black, 10-foot-high tetrahedral structure consisting of three diagonal steel columns supported by interconnecting tension cables, with turnbuckles and sheathed in black plastic. Our unusually shaped structure worked as designed while most of the other structures proceeded to collapse in the rain while we were high and dry in hammocks slung from the columns. Later, in graduate school, in Joseph Valerio's design/build studio at Wisconsin, we designed/built a bright blue tent fabric structure that featured triangulated tensile columns sheathed in

2. Cavanagh, Ted (2008). *Diverse Designing: Sorting Out Function and Intention in Artifacts*. In Pieter de Vermaas, Pieter A. Kroes, Andrew Light, Steven A. Moore (eds.) *Philosophy and Design: From Engineering to Architecture*. New York: Springer. pp. 301–315.

3. Oak, Arlene (2011). What Can Talk Tell Us About Design? Analyzing Conversation to Understand Practice. *Design Studies*, 32. pp. 211–234.

4. Oak, Arlene (2001). *Identities in Practice: Configuring Design Activity and Social Identity Through Talk* (PhD dissertation), University of Cambridge, King's College.

neoprene double-curvature fabric we sewed ourselves (requiring multiple all-nighters toiling in a local garment factory). It served admirably as a main stage at that June's Summerfest music festival in Milwaukee.

When my son Alexander was age 10, (not coincidentally) I hosted his class at Tulane University where, on the patio immediately in front of the architecture building, teams of three to four children were each paired with a pair of architecture students. Supplied with piles of corrugated cardboard provided gratis by a local arts supply store, teams designed and built kid-scaled structures not atypical of an uptown New Orleans neighbourhood. Years later, six months before Hurricane Katrina, the chair of the board of the New Orleans Homeless Mission met with me to gauge my interest in helping them build a dormitory facility for single homeless mothers and their children. I agreed to take it on as a design/build studio project at the Tulane University School of Architecture.

24 That spring of 2005 the student team demolished a termite-infested structure on the site while six teams of two students developed a design proposal for a two-level facility with 32 beds on the upper level, with support spaces below. HomeAid, an NGO based in Newport Beach, California, had committed \$3.5M (USD) in October 2005 to its housing rebuilding initiative along the devastated Gulf Coast region. The New Orleans Mission was now benefactor of a \$1M (USD) grant to build this design/build studio project.

Against a chaotic post-disaster backdrop—an event that claimed the lives of 1,840 and destroyed 120,000 structures—we regrouped. Our engineers on the project, as well as the city's planning department, were in chaos. It was the Wild West. HomeAid ended up hiring a professional contractor to build key parts of the structure. Innumerable hurdles were encountered as we muddled through. The New Orleans Homeless Mission's women's shelter earned a First Design Award from the Louisiana Chapter of the American Institute of Architects and a Collaborative Practice Award from the Association of Collegiate Schools of Architecture (2007) and was certified LEED Silver (2007). It was the first LEED building completed in New Orleans post-Katrina.⁵ Many worked on that project, contributing time and energy under difficult conditions.⁶

I relocated to Clemson University in 2007, having left Tulane after 22 years in New Orleans, where I had raised a family. In 2012, Ted described to me a large grant proposal he was then developing, and referred to it as *Thinking While Doing*. He asked if I was interested in working on this grant as part of a cross-border collaboration with other universities with in an interdisciplinary team. He was assembling a number of American and Canadian universities to work together on the grant. He asked if I would be a part of the social science and humanities-based portion (IG) and on something he referred to as the design/build exchange (dbX). The dbX was to fill a void in the design/build educator discourse in North America. I would focus on constructing an evidence-based student experience assessment component, and on the dbX database.

Later in spring 2018, I assembled a team of eight University of Toronto architecture students to assist in the final construction phase of the Cape Breton Highlands pavilion. From the beginning of the TWD project, the students and my colleagues on this interdisciplinary team have been amazing to work with. This ambitious undertaking provided a once-in-a-career opportunity to collaborate with many creative people, including a social and materials culture specialist, an anthropologist, philosopher, the engineering team, an ethicist and the client-sponsors who hosted the four case-study builds.

Structure of This Book

Early on in the sprawling *Thinking While Doing* (TWD) project the team realised a book would be the best way to document everything. It could capture the breadth of the work in its fullest geographic dimensions. Unfortunately, the current status quo in design/build education in North America typically mandates that studio-based work in architecture be presented/published as one-off, autonomous statements with little to no effort to establish any connective thread with similar activities that may be occurring at any other architecture schools. We viewed this as a major missed opportunity in peer-to-peer learning. As exemplified by the renowned Rural Studio, founded by Samuel Mockbee and D. K. Ruth, based at Auburn University, independent

pursuits continue to prevail, with built outcomes presented only after the fact. By contrast, the TWD team set out to not merely establish an internal discourse within the team but to connect our evolving internal discourse with other, external, contemporaneous discourses occurring elsewhere, such as the Berlin-based design/build exchange initiative that operated from 2014 to 2017 and sought to bring together and coalesce parallel design-build endeavours throughout the EU. That said, this book is structured as a set of **context** chapters interspersed with a set of **build** chapters with each build chapter representing a case study, beginning with the first build and culminating with the Cape Breton Highlands gridshell pavilion. It is as much about *place* as process, and this represents the defining framework of the book, where each geographic locale was instrumental (Figure 1.1).

The **context** chapters function as a parallel, interconnected narrative to the **build** chapters. Together they draw insights, illuminating socio-cultural, ethical and philosophical ramifications while placing the TWD experience in its broader societal context. Collectively, context and case study become a broader interdisciplinary narrative when established together. As such, the five “build” teams and their allied documentarians worked closely, side by side throughout, with the aim of making sense of what educational design/build means in its broader cultural contexts. It has been about connecting dots, so to speak, about drawing new interconnections while consciously drawing upon precedent within this specialised realm of architectural education. In so doing, we hope the TWD initiative has advanced the cause from an advocacy perspective as much as from an aesthetic, technical, scholarly or professional practice standpoint. Our hope is for it to be seen as a contribution to the scholarly and professional discourse on the learning and making of architecture.

In Chapter 2, salient territories of educational design/build inquiry are outlined *vis-à-vis* 10 interrelated dimensions of activity, each expressed as a theorem of sorts. In Chapter 3, a brief history of gridshell structures is presented that draws from various key precedents built in the 19th century through the modern movement and up to the

5. Verderber, Stephen; Glazer, Breeze & Dionisio, Rodney (2011). LEED and the Design/Build Experience: A Shelter for Homeless Families Returning to Post-Katrina New Orleans. *International Journal of Architectural Research* (Archnet-IJAR), 5(1). pp. 55–72.

6. Breeze Glazer (M.Arch., Tulane University) has worked in Robin Guenther’s studio team at Perkins + Will in New York, and Emilie Taylor Welty (M.Arch., Tulane) is currently a Professor of Practice and Interim Director of the Small Center for Collaborative Practice at Tulane University. Rodney Dionisio (M.Arch., Tulane) is currently an Architect and Capitol Projects Coordinator for the City of New Orleans.



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present. In Chapter 4, the first of the four built case studies is documented (Chéticamp). In Chapters 5 and 6, ethical and philosophical considerations are explored. In Chapter 7, the second case study (Lafayette) is presented. In Chapters 8 and 9, social, psychological and anthropological dimensions of educational design/build are explored, and in Chapter 10, its engineering dimensions are examined. Chapter 11 consists of the third case study (Tucson), and Chapter 12 describes the genesis, development and structure of the design/build exchange (dbX) ontology. In Chapter 13, the first evidence-based investigation of the student experience in educational design/build is reported. In Chapter 14, the fourth case study narrative is presented (Cape Breton Highlands).

Editors' Note

The TWD initiative as originally conceived and funded by SSHRC was to consist of five case studies (built structures), although only four are presented in this book. The fifth of these and the third to have been built, chronologically (to have been constructed in Charlotte, North Carolina, and led by Professor Greg Snyder), remains unbuilt due to circumstances beyond the control of the TWD project team. Despite this, this design/build studio (based at UNC–Charlotte) provided an exceptional learning experience for the students involved and for the entire TWD project team. Professor Snyder also had a significant role in the design and construction of the Cape Breton Highlands project (Chapter 14).



2 Territories of Educational Design/Build

Stephen Verderber **Introduction**

Educational design/build (e-d/b) need no longer operate as an outsider within the academy. One major reason for its outsider status in the past has been a persistent lack of meaningful connections to broader scholarly discourses within the discipline and practice of architecture. It has thrived, despite the odds, often as a bona fide *movement* even though there have been remarkably few fiery manifestos to propel its advocates and practitioners. Its expansion and maturity have occurred over the past four decades more through a series of landmark events or *moments* in a more or less default condition; this condition continues to undercut a growing oeuvre of significant built work and pedagogical innovation. To its credit, the movement has prospered while continuing to operate in the margins more often than not, expressing an unusual degree of resilience, inspiration and freedom to experiment outside conventional curricular boundaries. Unfortunately, the full impact of this growing body of high-quality built work and the teaching/learning-by-doing it entails remains rather obscured by an insufficient examination of what it all means. To this end, 10 territories of educational design/

build activity are outlined below in an attempt to foster internal connectivity and to connect this emerging field to broader discourses both within and beyond architecture.

E-d/b, more often than not, operates in the margins of conventional architectural curricula. In the extreme, it operates in a curricular vacuum rather disassociated from the mainstream. This has, on the one hand, allowed for a degree of freedom and autonomy, although at times, this freedom and autonomy may run counter to the wishes of acquiescent administrators in our current litigious era.¹ With this said, if it is to ever evolve into a specialised area with its own rigorous scholarship, and connected to broader scholarly discourses within architecture and beyond, it cannot continue to operate as a stepchild.² One needless consequence of e-d/b's current default condition within the academy is that participating faculty continue to face hurdles in attaining tenure. Courses in this content area remain underdeveloped from a research and scholarship perspective, and implications of this become glaring from the standpoint of doctoral education, which for better or worse, remains the main pipeline for budding researchers, theorists and historians. The following discussion seeks to advance the growing international e-d/b movement.

Moreover, it makes some sense, here, to attempt to emulate what Alex Krieger accomplished with respect to his overview of urban design education and practice. His influential essay "Territories of Urban Design" provides a roadmap of sorts for the paradigmatic framework that follows.³ Krieger's essay consisted of 10 streams of inquiry that he viewed as informing both education and practice in the realm of urban design. In the case of e-d/b, the following discussion attempts to briefly encapsulate the rapidly expanding literature through case studies of programs from around the world. Ten territories of e-d/b are identified, each a dynamic, fluid stream of inquiry. Collectively they are interwoven, with each defined by means of examples drawn from one-off case studies as well as multi-year curricular initiatives globally. Evidence substantiating these streams of inquiry continues to expand and for this reason a fuller discussion lies beyond the scope of the present discussion. These foci are by no means mutually exclusive: specific programs and courses

are categorised, however, according to their primary pedagogical focus, with many examples crossing over into multiple territories (and in some cases most of the territories) of educational design/build (Figure 2.1). Virtually every studio project and/or curriculum on this subject addresses the following:

1. E-d/b as Reflective Pedagogy

The project/curriculum is a case study in reflective discourse on best teaching practices as much as the making of architecture and other built artefacts.

The roots of educational design-build run deep, dating from 19th-century post-secondary training initiatives. The aim has remained much the same for over a century: to conjoin design with the act of building what one has designed and to do so within a unified learning sequence. The act of designing-then-building is the overarching pedagogical objective. Its expression has since become bifurcated and diverse, expressed in small-scale furnishings to large-scale freestanding buildings of at times striking formal clarity and tectonic sophistication. For a variety of reasons e-d/b has continued to function in parallel to digitally driven design pedagogies common in most architectural design curricula today. Still, the underlying premise of e-d/b studios has remained constant—students' immersion in a real project with a real client. The largest and most well known programs do tend to dominate design pedagogy within their institutions. In the case of the top 10 North American programs, students elect to attend these institutions more often than not because of the institution's design-build curricular offerings. On the other hand, at institutions offering only episodic studios on this subject, or in cases where only a one-time studio is offered, perhaps never to be repeated, this is typically not the case.⁴

The Neighbourhood Design/Build Studio is an award-winning e-d/b studio offered by the Department of Architecture at the University of Washington. There, students design and build small community projects for Seattle-area NGOs. Architecture graduates and undergraduates in their final year gain experience with clients, public agencies, materials, assemblies and hands-on construction while

working to benefit community stakeholders.⁵ In Germany, at the Technische Universität Berlin, the module “Design and Building Construction” is considered a foundational subject in the undergraduate curriculum. Students there develop projects in the first semester in a workshop setting with high design valued as much as the ability for the student to integrate engineering concepts. In the second semester the “1:1 Laboratory” introduces first-year students to the complexity of architectural design and construction through working with real client-sponsors, engaging a tight construction schedule and budget limitations. With this “learning-by-doing” approach, students confront with real constraints, forcing them to devise multiple constructible solutions and selecting the most feasible option. Another course taught in Germany is the “Monolithisch Bauen” (Monolithic Construction) project done in collaboration with the Institut für Experimentelle Architektur and the Finger-Institut at the Bauhaus University in Weimar. These courses are premised on learning-by-doing.⁶ At the University of Stuttgart, the Institute for Computational Design and Construction has produced a number of built structures as the outgrowth of e-d/b studios, structures recognised for their technical sophistication and craftsmanship.⁷

In the US of the 1960s and '70s, Christopher Alexander's students at the University of California at Berkeley designed and built full-scale models using scaffolding and plastic sheeting on-site to test out their design concepts. At the Cranbrook Academy of Art in Michigan, students have periodically constructed 1:1 models and various full-scale site installations. Decades earlier, students who worked with Frank Lloyd Wright in the 1940s and '50s on the construction of Taliesin West in Arizona were also engaged in 1:1 construction projects on the grounds. Paolo Soleri's Arcosanti, also in Arizona, has existed for nearly 40 years as an experimental e-d/b outpost in the desert.⁸ In extending e-d/b into the humanities, engineering and environmental sciences, the student is able to become immersed in:

1. Badanes, Steve (2008). The Transformative Power of Architectural Education. In Bryan Bell and Katie Wakeford (eds.) *Expanding Architecture: Design as Activism*. New York: Metropolis Books. pp. 248–255.

2. Canizaro, Vincent B. (2012). Design-Build in Architectural Education: Motivations, Practices, Challenges, Successes and Failures. *International Journal of Architectural Research*, 6(3). pp. 20–36.

3. Kreiger, Alex (2009). Chapter 1: Territories of Urban Design. In Alex Krieger & William S. Saunders (eds.) *Urban Design*. Minneapolis: University of Minnesota Press. pp. 18–28.

4. Canizaro, Vincent B. (2012). Design-Build in Architectural Education: Motivations, Practices, Challenges, Successes and Failures. *International Journal of Architectural Research*, 6(3). pp. 20–36. “Service Learning” is a core aim of most one-off e-d/b studios and multi-term curricula although it is often not defined as such.

5. Badanes, Steve (2008). The Transformative Power of Architectural Education. In Bryan Bell & Katie Wakeford (eds.) *Expanding Architecture: Design as Activism*. New York: Metropolis Books. pp. 248–255.

6. Fioretti, Peter (2015). *Introductory Remarks*. Presented at the EU Design/Build Conference, Berlin, Germany.

7. Menges, Achim (2016). ICD ITKE Research Pavilion. Retrieved from <http://icd.uni-stuttgart.de/?p=11187.html>.

8. Carpenter, William (1997). *Learning by Building: Design and Construction in Architectural Education*. New York: Van Nostrand Reinhold.

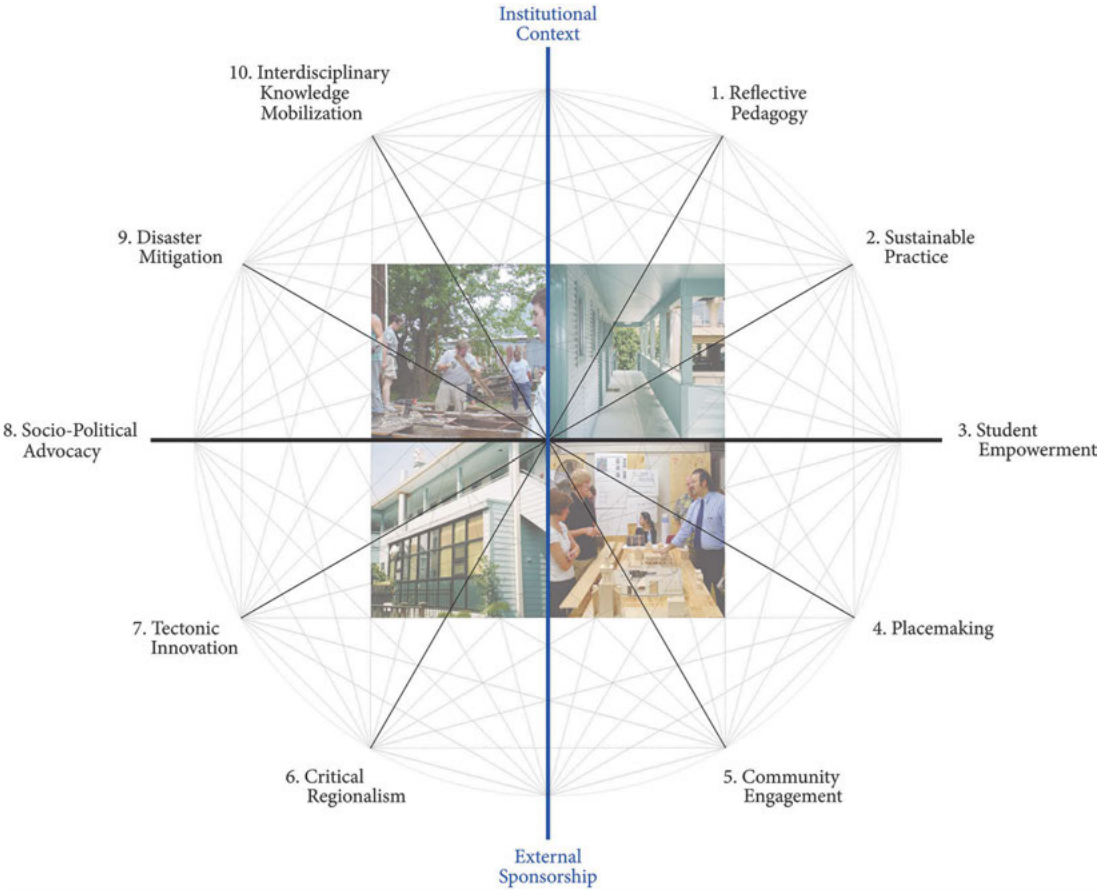


Figure 2.1
Territories of educational design/build – conceptual framework

2. E-d/b as Sustainable Practice

The project/curriculum advances the case for sustainable, resilient design and construction practices while invoking non-deleterious ecological consequences.

Sustainable design and building methods have been addressed in architectural education for more than 60 years.⁹ This work includes the geodesic domes built by Buckminster Fuller and his students at Southern Illinois University in the US, and earlier builds completed in New Zealand in the 1940s.¹⁰ Energy-efficient builds were later completed with faculty-student studio teams, often as collaborative efforts between a local university and the local storefront "Community Design Center" (similar to those in the 1960s and '70s in the United States).¹¹ Further advances were made after the 1973 Arab Oil Embargo, up to the current global sustainability movement.

Ecological design remains a primary driver and this manifests in projects that feature off-grid solar power, recyclables and off-site prefabrication. Eight students in a sculpture course at Pomona College in California designed and built furniture for that campus' new fine arts building, using repurposed detritus scavenged from the construction site.¹² This practice has been a hallmark of Auburn University's Rural Studio since its inception. In 1994, after securing a \$250,000 (USD) grant from the Alabama Power Foundation, the studio designed and built its first house in Mason's Bend, Alabama. Its unique feature: donated hay bales for walls. Since then, every Rural Studio build has made use of some type of recyclable—72,000 surplus carpet tiles were used in another house; worn-out tires were reused in the walls of a chapel; Chevy Caprice windshields were used for a roof in another.¹³ The Rural Studio has constructed more than 80 homes and civic buildings in Alabama, at this writing.

Also in the US, the North Studio, at Wesleyan University in Connecticut, is a contemporary variant on the traditional Beaux-Arts pedagogical model of architectural education. Focused on developing and constructing conceptually driven projects with nonprofit, public sector sponsor/collaborators, this studio is at once a locus for undergraduate design education within the context of a liberal arts

9. Ibid.

10. The Demonstration House (1948). *New Zealand Design Review* 1(4). pp. 8–9.

11. Hatch, C. Richard (1984). *The Scope of Social Architecture*. New York: Van Nostrand Reinhold.

12. Abraham, Sneha. (2014). Students Recycle Materials to Create Furniture for New Studio Art Building. Retrieved from <https://www.pomona.edu/academics/departments/art/news/posts/students-recycle-materials-create-furniture-new-studio-art-building>. Trumble, Christopher D. (2014). Interstitial Installation: Site Specific Furniture as an Architectural Microcosm. In John Stuart & Mabel Wilson (eds.) *Globalizing Architecture: Flows and Disruptions*. Paper presented at the 102nd Annual Meeting of the Association of Collegiate Schools of Architecture, Florida International University, Miami Beach.

13. Anon. (2014). Samuel Mockbee: History and Philosophy. Retrieved from <http://www.samuelmockbee.net/rural-studio/about-the-rural-studio>.

curriculum, and a multidisciplinary design workshop committed to seeing concepts carried through to construction. Situated in the Department of Art and Art History, this e-d/b studio was initiated in 2006. Exploring the relationship between architecture, landscape and sustainable design precepts, each project undertaken seeks to balance three objectives: the production of relevant design research, the real-world testing of ideas and the implementation of environmentally responsible built outcomes. Completed builds have won two national AIA (American Institute of Architects) awards and have been featured in professional publications.¹⁴

In Spain, the Endesa Pavilion, designed and constructed in 2011 by students at IAAC Barcelona, is a self-sufficient, solar-powered structure. Over a period of one calendar year it was used as a control room for the monitoring and testing of prototypes related to intelligent, renewable energy technologies.¹⁵ In the UK, the Waste House was built in 2014 at the University of Brighton's Faculty of Arts, in collaboration with BBM Architects. A total of 253 undergraduate students, apprentices and volunteers participated in the design and construction of this project for the recycling of reusable building materials. Designed as a live educational research lab, the Waste House collaboration tested new methods of green prefabrication techniques for on-site waste reduction.¹⁶ In these examples e-d/b provided a vehicle for the demonstration of how sustainable building methods can simultaneously contribute to:

3. E-d/b as Student Empowerment

The project/curriculum engages students' understanding and appreciation of the art and science of building, and hence, succeeds as a vehicle to empower the student.

The fundamental aim of e-d/b should be to heighten the student's skill levels, personal awareness and self-confidence, although unfortunately, this is not always how things turn out. If and when a disconnect occurs, it can be due to having miscalculated the scope of the task at hand. Or she or he may eagerly anticipate working on a real project yet may soon become disenchanted with its onerous technical chal-

lenges. Others may become overwhelmed by the project schedule and the sheer physical workload. Others may lack requisite skill sets and require some remedial training with tools. Perhaps the greatest challenge in the field is to get everyone to function as a unit and to work as a team.¹⁷ Self-empowerment can be inculcated through a culture that values teamwork, with the students deriving tangible benefits on a personal level that will serve them well as aspiring professionals. Small-scale projects tend to be more effective at instilling student confidence and empowerment while larger, more complex builds usually require more time, money and can harbour myriad logistical setbacks. Mentoring may be an effective vehicle, but one risk is that the student may be inadvertently relegated to a sideline role. The challenge is to carefully set and then adhere to a project's size and scope in relation to studio size, commitment of its members and then technical abilities.

This is what occurred in the Living Wall studio, which took place in 2010 and 2011 at the State University of New York at Buffalo, in the US. There, first-year architecture students acquire skill sets in designing, building and then living in their own creations.¹⁸ Similarly, in the UK, the Architectural Association's (AA) Design + Make studio was established in 2010 as a 16-month post-graduate design/build program based in Hooke Park, Dorset. There, students collaborate during design, on campus, and then proceed to live on the construction site while they build their structure.¹⁹ In Indonesia, in the case of the Singapore University of Technology's Design Library Pavilion construction project, their City Form Lab assisted in the pre-assembly of various component parts, then the contractor assisted in erecting the structure on-site.²⁰

Similarly, the Parsons' Design Workshop at the New School in New York City shares with many design-build programs the goal of providing a glimpse into post-academic architectural and building practice via its e-d/b studios.²¹ In Austria, the design.build studio at the Vienna University of Technology seeks to develop students' creativity, "against the constraints of the real world." Founded in 2000 at the university's Institute of Architecture and Design, the studio has completed numerous projects, including a day care centre for persons with developmental disabili-

ities in South Africa in the township Orange Farm, on the outskirts of Johannesburg. This build piloted a subsequent series of socially engaged builds, in collaboration with other architecture schools in South Africa. More than 40 projects, primarily kindergartens and elementary schools, have been designed and implemented by university-based student teams from Austria, Germany, Switzerland and Slovenia. Invited by Austrian NGO Caritas in 2007, the studio designed/built a multipurpose hall for an orphanage on the Indonesian island of Nias. From 2008 onwards, this studio has concentrated its activities in Austria, building permanent projects for social institutions including Parkbetreuung and Caritas. A recent project, the Mobile Urban Lab, was a portable structure for lectures, workshops and exhibitions, and was based on adapted ISO shipping containers.²²

In Scandinavia, the Norwegian University of Science and Technology (NTNU) Live Studio has a well-established tradition of e-d/b activity. Live Projects (the term used in the UK and Europe to describe e-d/b) there have included small, traditionally crafted Norwegian boathouses to larger-scale projects built in Latin America, Africa and Asia. Students work closely with local municipalities and with grassroots, community-based stakeholders.²³ This synchronization relates closely to:

4. E-d/b as Placemaking

The project/curriculum contributes in a positive manner to the establishment and reinforcement of locality, sense of place and cultural authenticity at multiple scales of inquiry.

A key to student satisfaction in e-d/b is the degree to which the built outcome addresses local as well as broader societal issues of concern. The term “placemaking” itself, however, is broadly defined and is often reduced to a marketing pitch.²⁴ New condo projects in places such as Vancouver, British Columbia, are advertised as creating an ersatz “Sense of Place.” Catchphrases, such as River Place or Prairie View Estates, are absurdly named when, in reality, no such sense of place is to be found anywhere in sight. The main question in the case of e-d/b is the degree to which the

14. Huge, Elijah (2016). North Studio. Retrieved from <http://ehuge.web.wesleyan.edu/northstudio>.

15. Rubio, Rodrigo & Guerrero, Miguel (2012). Endesa Pavilion/Institute for Advanced Architecture of Catalonia—IAAC. Retrieved from <http://www.archdaily.com/274900/endesa-pavilion-iaac>.

16. Kawayeh, Merlem (2014). Student Works: This House Made of Trash Teaches a Lesson in Green Housekeeping. Retrieved from <http://archinect.com/features/article/103711909/student-works-this-house-made-of-trash-teaches-a-lesson-in-green-housekeeping.html>.

17. Maturity and experience levels can (and frequently do) differ widely within a studio, a source of interpersonal tensions challenging overall team cohesiveness.

18. Nazarian, Shadi, Romano, Chris, Bruscia, Nick & Hume, Matthew (2011). The Living Wall. Retrieved from <http://thelivingwall.blogspot.ca>.

19. Introduction (2016). AA Design & Make. Retrieved from <http://designandmake.aaschool.ac.uk>.

20. Anon. (2013). Student Works: Singapore University of Technology and Design Library Pavilion. Retrieved from <http://archinect.com/features/article/75126636/student-works-singapore-university-of-technology-and-design-library-pavilion.html>.

21. Goldberger, Paul (2016). Excerpt from *Design Work-shop: 1998–2005*. Retrieved from <http://sce.parsons.edu/special-projects/design-workshop>.

22. Fattinger, Peter (2016). design.build studio. Retrieved from <http://www.dbxchange.eu/?q=node/387>.

23. Wellinger, Steffen (2016). NTNU Live Studio—Background. Retrieved from http://ntnulivestudio.org/?page_id=1860.html.

24. Verderber, Stephen (2012). *Sprawling Cities and Our Endangered Public Health*. London: Routledge.

studio experience is able to yield buildings and artefacts viewed as meaningful contributors in their surrounding physical and socio-cultural fabrics, and the degree to which the outcome reflects locality, i.e., local cultural traditions. Granted, in the confines of a one- or two-semester curricular sequence there is often insufficient time to fully examine the inner profundities of *place* and its broader ramifications (i.e., symbolism, infrastructural fabric, vernacular traditions and socio-cultural and political contexts), yet these dimensions of the built outcome remain meritorious.²⁵

With this said, the Winterlude Festival occurs each year in Ottawa, Canada. In 2015, Ryerson University Master of Architecture students designed and built a temporary bamboo pavilion with a user-responsive interior lighting system. As a site-specific installation, it proved popular as a gathering place within the city's Confederation Park.²⁶

In the US, the Detroit Collaborative Design Center (DCDC) is a multidisciplinary, nonprofit architecture and urban design conservancy at the University of Detroit Mercy School of Architecture. Since 1994, the DCDC has worked with over 80 Detroit-based NGOs, grassroots community groups and philanthropic foundations, in addition to the local government, private developers and local design professionals in the promotion of Detroit's stabilisation. Through the use of participatory design strategies, stakeholders engage in community planning, development and building design in each constructed project. To this end, the DCDC developed a nationally recognised Neighbourhood Engagement Workshop (NEW) process.²⁷

Also in the US, Spirit of Place/Spirit of Design was launched in 1993 at the Catholic University of America. Twenty-two builds have been completed in urban and rural locales in Peru, Canada, US, Ireland, Nepal, Italy and Finland. The studio experience is coordinated with the university's Cultural Studies and Sacred Space Curriculum.²⁸ In Japan, at the Koshirakura Landscape Workshop, a curricular extension of the London-based AA's Visiting School, students are challenged to respect and consider "local architectural character, heritage and ways of life." In 1996, the first iteration was held at the summer workshop in Koshirakura Village, Japan. It became an annual event and a part of Koshirakura's

traditional Maple Cutting Festival. Participants were drawn from the AA as well as many other schools. Intercultural exchange has been a significant part as students assist local residents. The festival begins with the selection and cutting of a sacred tree in the mountains, which is then carried down into the village for a night of singing and dancing. The following day the tree is carried from house to house to commemorate and celebrate significant events of the previous year—i.e., births, marriages, a special birthday, a new house built.²⁹ Place-making through e-d/b is closely aligned with:

5. E-d/b as Community Engagement

The project/curriculum succeeds in engaging client/sponsors, key socio-cultural stakeholders and broader constituencies in the community-at-large.

Most design/build programs partner with nonprofit organisations devoted to community service.³⁰ Often, a cold call or introduction through a mutual acquaintance is a first point of contact in seeking out this type of pro bono assistance. The Rural Studio, in the beginning, offered its services to whoever responded to its offer of help with small renovation projects.³¹ This led in time to what is arguably the most well known e-d/b curriculum in North America. Similarly, in the case of the New Orleans Women's Shelter Family Center, a Tulane University studio in 2005 and 2006 (led by this author) worked early on to gain the trust of the client-sponsor by volunteering as meal-time food servers and later volunteering collectively to demolish a dilapidated structure at the rear of what was to be the build site for a 35-bed LEED-Silver certified shelter for returning mothers and their children, in the aftermath of Hurricane Katrina in 2006.³²

A key precedent for the New Orleans build was Design Bridge, a student-run program based at the University of Oregon. Its focus is on projects accruing mutual benefit to design students and to the local community. Buckminster Fuller, a visiting critic in the 1950s and '60s, built plywood geodesic domes with the students. A related program, Oregon-BILDS (Building Integrated Livable Designs Sustainably), is an e-d/b studio program at the same university that draws architecture and

construction management students together to work on builds in the local community.³³

Since 1996, Miami University's Department of Architecture and Interior Design has collaborated closely with community organisations located in Cincinnati's Over-the-Rhine neighbourhood on a variety of projects *vis-à-vis* the university's Over-the-Rhine Design/Build Studio. This studio also provides schematic design for affordable housing and those eligible for tax credit financial assistance—through a federal program administered by the State of Ohio. Builds include the 2004 Cincinnati Freedom Summer Design Charrette for Social Justice, the Washington Park Housing Redevelopment Plan and a senior citizens' housing development in a neighbourhood then undergoing gentrification.³⁴ Community engagement is aligned with the practice of:

6. E-d/b as Critical Regionalism

The project/curriculum fuses indigenous building traditions, aesthetic vocabularies and building methods with progressive influences.

Design Build Bluff is a nonprofit organisation with a two-fold mission: to build energy-efficient and sustainable homes for the people of the Navajo Nation in southeastern Utah in the US while immersing students in local cultural traditions. Between 2003 and 2014, nine homes were built, all of ecologically sustainable, salvaged and recycled materials. Private fundraising and federal grants provided approximately \$50,000 (USD) in funding per build. Students spent the entire semester working out of the Bluff, Utah, basecamp. During the fall of 2010, 22 students built the Windcatcher House, having spent the preceding summer selecting the client (family) and the site, and being engaged in design. The dwelling was completed in 13 weeks.

Navajo culture inspired the endeavour, as did a severe yet spectacular desert site context. The private areas of this home are oriented to the east, in accord with Navajo tradition, which holds morning light as sacred. Rainwater is collected in a large cistern, and a trough provides drinking water for horses and irrigation. The focal point is the Windcatcher, a 30-foot-tall chimney at the

25. Bell, Bryan (2004). Finding Clients. In Bryan Bell (ed.) *Good Deeds, Good Design: Community Service Through Architecture*. Hudson: Princeton Architectural Press. pp. 26–28.

26. Bowen, Frank & Bica, Adrian (2015). Winterlude Wonderland. Retrieved from <http://www.ryerson.ca/graduate/news/newslistings/master-architecture-students-create-winterlude-pavilion.html>.

27. Pitera, Daniel (2016). Detroit Collaborative Design Center. Retrieved from <http://www.dcdcdm.org/about>.

28. Price, Travis (2016). Spirit of Place/Spirit of Design. Retrieved from <http://spiritofplacedesign.com/about-2/philosophy>. Also see Price, Travis (2015). *The Mythic Modern: Architectural Expeditions into the Spirit of Place*. San Francisco: ORO Books.

29. Canizaro, Vincent (2012). Design-Build in Architectural Education: Motivations, Practices, Challenges, Successes and Failures. *International Journal of Architectural Research*, 6(3). pp. 24. Also see Egashira, Shin (2016). Koshirakura Landscape Workshop. Retrieved from <http://www.koshirakura.org/about>.

30. Sokol, David (2008). Teaching by Example: Design-Build Educators Talk Pedagogy and Real Politick. *Architectural Record*, 10. p. 125.

31. Freear, Andrew, Barthel, Elena & Oppenheimer, Andrea Dean (2014). *Rural Studio at Twenty: Designing and Building in Hale County, Alabama*. Hudson: Princeton Architectural Press.

32. Verderber, Stephen, Glazer, Breeze & Dionsio, Rodney (2011). LEED and the Design/Build Experience: A Shelter for Homeless Families Returning to Post-Katrina New Orleans. *International Journal of Architectural Research* 5(1). pp. 55–72.

33. Canizaro, Vincent (2012). Design-Build in Architectural Education: Motivations, Practices, Challenges, Successes and Failures. *International Journal of Architectural Research*, 6(3). p. 24. Also see Thallon, Robert (2016) Oregon-BILDS. Retrieved from <https://oregonbilds.uoregon.edu>.

34. Sokol, David (2008). Teaching by Example: Design-Build Educators Talk Pedagogy and Real Politick. *Architectural Record*, 10. p. 125. Also see Dutton, Thomas A. (2016) Over-the-Rhine Design/Build Studio. Retrieved from <http://arts.muohio.edu/otr/about.html>.

centre of the *parti* that provides both cooling and heating. Since many Navajo live off-grid, this dwelling is completely self-sustaining.³⁵ Two other built projects were the Skow House (2013) and the Hozho House (2013). In each, local vernacular traditions and building methods were reinterpreted in a rural context.³⁶

The BaSiC Initiative is a collaboration of faculty and students from Portland State University and the University of Texas at Austin School of Architecture. Past e-d/b projects have addressed the affordable housing needs of Native Americans and migrant farm workers, offering students a variety of design/build opportunities. A program in Mexico occurs during the winter in squatter settlements in Morelos, whereas the Strawbale Program in Montana occurs during the summer at Native American reservations. This program has built elementary schools, clinics, a children's library, laundry facilities, houses, literacy centres, urban gardens, wells, cisterns, waste treatment facilities and solar panels.³⁷

The Women's Cooperative in NAXÍ, Mexico (2012), was built by architecture students from TU Berlin in Germany with Universidad Nacional Autonoma de Mexico (UNAM). This collaboration is called CoCoon. A jam factory was designed and built for the women's cooperative NAXÍ in Oaxaca. The factory was built primarily from clay bricks fabricated by local craftspeople from excavations at the building site.³⁸ This program began in 1998 and is an interdisciplinary course at TU Berlin that gives students of architecture, civil engineering, landscape design and other disciplines the opportunity to design and build a project during a fieldwork semester living in Mexico.³⁹ Similarly, in Australia, the Bower Studio, an e-d/b studio for graduate students at the University of Melbourne, has completed a dozen projects, including a shelter for an aboriginal family living in the Belyuen community in Australia's Northern Territory.⁴⁰ Similarly, the Scarcity and Creativity Studio at AHO, in Oslo, Norway, was established in 2012. To date, students have constructed projects in Norway and in Chile. Materials are sourced locally, and local craftspeople help to build responsiveness to local terrain, climate and cultural conditions.⁴¹ These activities can be effectively interwoven with:

7. E-d/b as Tectonic Innovation

The project/curriculum succeeds in showcasing innovative materiality, new applications of traditional materials and innovative construction methods.

Since 2004, the ecoMOD program at the University of Virginia has completed 12 housing units on eight sites. The intent has been to provide high-quality design for moderate-income families by means of off-site prefabricated modularity. Renovations and upgrades to existing historic residences have also been completed under the umbrella of this program. Five existing historic dwellings have been transformed. Both studios were an outgrowth of the university's 2002 Solar Decathlon Competition entry.⁴² The University of Arkansas' Design/Build Workshop (D/BW) shares a similar goal: the use of prefabricated components.⁴³

Other schools have explored common materials in uncommon ways. Explorations in tectonics and materiality have included lightweight gridshells fabricated in wood, which are also the focus of numerous studios at Dalhousie University in Canada.⁴⁴ The University of Kansas' Studio 804 is one of the most established programs in North America. Its recent Ecohawks Research Facility (2012–2013), built on the university campus in Lawrence, is designed for conducting research on the conversion of fossil fuel-powered vehicles into battery and solar-powered vehicles. The aluminum strips of the building's upper skin are interwoven with horizontal aluminum tubes, requiring precise hand-welding at every corner connection. The 20 students in this studio researched the alloy's properties to ensure every joined surface weathered equivalently, and to this end a series of welding training workshops were held. The *parti* consists of two enclosed volumes for working on electric vehicles and an open-air workspace. This was Studio 804's sixth LEED-Platinum certified project.⁴⁵

In London, the Architectural Association's Design + Make programme centres on student prototyping and subsequent 1:1 construction. Situated in the English countryside, it is based at Hooke Park, the AA's Dorset campus for research in timber and alternative rural architecture. Students use a studio and workshop/fabrication space, designing and build-

35. Meinhold, Bridgette (2013). *Windcatcher House. Urgent Architecture*. New York: W.W. Norton. pp. 237–241.

36. Anon. (2014). Skow Residence / Colorado Building Workshop+*DesignBuildBLUFF*. Retrieved from <http://www.archdaily.com/541436/skow-residence-colorado-building-workshop-designbuild-bluff/>. Also see Anon. (2014). Hozho House/Colorado Building Workshop +*DesignBuildBLUFF*. Retrieved from <http://www.archdaily.com/541420/hozhohouse-designbuildbluff-university-of-colorado-denver>.

37. Palleroni, Sergio (2016). *BaSiC Initiative—Building Sustainable Communities*. Retrieved from <http://basicinitiative.com/about>.

38. Hartig, Ursula (2016). Introduction to *CoCoon—Contextual Construction*. Retrieved from <http://edbkn.service.tu-berlin.de/edbkn/?q=node/365>.

39. Hartig, Ursula (2016). A Jam Manufactory for Naxii. Retrieved from <http://edbkn.service.tu-berlin.de/edbkn/?q=node/399>.

40. O'Brien, David (2016). Bower Studio—An Introduction. Retrieved from <http://bowerstudio.com.au>.

41. Anon. (2014). Building Day #26. Retrieved from <http://scl34.aho.no/building-day-26>.

42. Quale, John D. (2012). *Sustainable, Affordable, Prefab: The ecoMOD Project*. Charlottesville: University of Virginia Press.

43. Herman, Gregory (2008). Market Modular. In Brian Bell & Katie Wakeford (eds.) *Expanding Architecture: Design as Activism*. New York: Metropolis Books. pp. 193–198.

44. Cavanagh, Ted (2009). *Diverse Designing: Sorting Out Function and Intention in Artefacts*. In Pierer A. Vermaas, Peter Kroes, Andrew Light & Steven Moore (eds.) *Philosophy and Design: From Engineering to Architecture*. New York: Springer.

45. Gerfen, Katie (2013). Ecohawks Research Facility. Retrieved from <http://www.architectmagazine.com/design-build/eco-hawks-research-facility.aspx>.