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Building Sustainable Architecture and Livelihoods in Indonesia: An International Education*

DAVID JAN COWAN
Purdue School of Engineering and Technology, Indiana University Purdue University Indianapolis 799 West Michigan Street ET 314G, Indianapolis Indiana, 46202, USA. E-mail: jancowa@iupui.edu

The paper addresses sustainability within the context of an undergraduate research project located outside Yogyakarta, Indonesia that involved students from the Purdue School of Engineering and Technology (IUPUI). The project focused on the architecture and sustainable building practices of this far eastern region of the world and in particular a shop house located in the art market. This paper discusses how the conceptual design of this shop house was created under the direction of sound, local, sustainable building practices that were obtained from survey data distributed to Indonesian designers.

Keywords: architecture; sustainable; international; architectural education; livelihoods; Indonesia

INTRODUCTION

SUSTAINABILITY IS DEFINED by the American Institute of Architects as: 'the ability of society to continue functioning into the future without being forced into decline through exhaustion or overloading of the key resources on which that system depends' [1]. Within this definition are two statements that are directly applicable to the project discussed herein. First, the notion of being able to function 'into the future' conjures up concerns for more than the physical aspects of sustainability and calls to mind the importance of a holistic view of sustainable issues, particularly with respect to sustainable livelihoods. Second, the mention of 'key resources' emphasizes the need to look at construction materials that will not exhaust or overload existing supplies. All of this is an applicable and important context to begin a discussion of an educational experience that focuses upon a sustainable building project in Indonesia.

This paper will review and discuss sustainable building practices within the context of an undergraduate architectural research design project located near Yogyakarta, Java Indonesia. The project involved the design of a small shop house located at the entryway to a communal, outdoor arts and craft market. The shop house (roughly 12 m by 3 m) was intended to house crafts persons and their wares. It would also serve as a temporary living quarters. The author seized this as an opportunity for students to become involved in the research and design process of an international project as well as an appropriate context to incorporate sustainable principles into the project and extend their education.

This paper will first focus upon the conceptual stages of this project, which addresses the following research questions and initial design concerns:

1. What is the current state and extent of sustainable building design practices in Indonesia?
2. How can sustainable design principles be applied to a collaborative educational design project located within this country?
3. What are some of the sustainable building materials and practices currently being used in Indonesian architectural design practice?

Sustainability in Indonesia

The International Institute for Energy Conservation speaks of Indonesia's 'extensive renewable energy resources and the vast potential for energy efficient improvements in all sectors of the economy' [2]. It also notes that 'progress in developing these resources has been slow'. More recently Gearing and Cheng proclaimed that: 'Environmental considerations rate pretty low on the agendas of most Asian developers. Attitudes are not much better among policy makers'. However, in a more positive manner they add that: 'tendrils of *green* [italics added] are beginning to poke through' [3].

The 'greening' of the Indonesian construction industry has recently been accelerated as this country reconstructs after the devastation of the 26 December 2004 tsunami. There are many that realize that this is a prime opportunity to embrace sustainable building practices. As of April, 2005 Indonesian officials endorsed a set of World Wild-

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life Foundation (herein WWF) recommendations for environmentally sensitive construction as the country moves to rebuild in the wake of the disaster [4].

These sentiments were restated by the Indonesian Minister of the Environment in September 2005 that 'present construction trends in tropical and subtropical regions still show little awareness about energy conservation' [5]. He also, in reference to the tsunami, noted that: 'In addition, the tsunami has raised environmental concerns that threaten human health. Moreover, the need for continuous livelihood became more urgent. These are the lessons (sic) learned and it would be irresponsible if they were not included in the total concept of an environmentally friendly architecture'.

Not surprisingly, with only a recent focus on the topic of sustainable building practices, we find a dearth of literature (particularly literature in English) that directly discusses these practices in Indonesia. There is research related to sustainability in the industrial and power sectors (e.g. International Institute for Energy Conservation and Yayasan Bina Usaha Lingkungan, 1997) but much less that is directly focused upon architecture.

The Indonesian people historically see sustainability mainly as healthy housing; as Larasati notes ' . . . common terms that are used in the context of housing projects and housing development in Indonesia are "health" and "cleanness", instead of "sustainability"' [6]. With the advent of the above stated WWF green building recommendations and policies implemented in Northwestern Indonesia these viewpoints are hopefully about to change.

Methodology: Key Informant Interviews

In order to first determine the current extent of interest in sustainable design practices in the midst of the post-tsunami focus upon sustainability, this study utilized key informant interviews with Indonesian architects, engineers and the academic community to determine the 'pulse' of the country's designers. This was done in the summer of 2005 before engaging in the design development stages of the project.

The preliminary stage of the design research process began with developing a questionnaire that was directed to Yogyakarta (herein Jogja) designers. This city was chosen as it coincided with contacts that the author had made on previous visits to the country and as Jogja is widely considered to be the intellectual capital of Indonesia and Javanese culture. It is a city of roughly 500,000 inhabitants that houses over 300,000 students in 120 state and private tertiary educational institutions [7]. The questionnaire was also distributed at a meeting of the Indonesian Architectural Society in Denpasar, Bali Indonesia where the author was invited to give a presentation on post-tsunami sustainable community-building approaches.

The questionnaire was developed by the author and students from Indonesia: Trisakti University (Jakarta) and Gadjah Mada University (Jogja). The students provided the translation of the material and also aided in the questionnaire distribution and location of the designers in Jogja and Bali under the careful guidance of professors from the School of Architecture and Planning at Gadjah Mada University and the staff at Popo Danes Architects in Denpasar. The questionnaire was based on Peterson's BRUSO criteria: B = Brief, R = relevant, U = Unambiguous, S = Specific, O = Objective and questions were kept to under 20 words [8].

Development of the Conceptual Design

Students from the Construction Technology Department at Indiana University Purdue University Indianapolis (IUPUI) were also engaged in the research portion of this project through support of a research grant that will eventually enable them to develop their findings within a directed studies research course. A journal of their activities plus a research paper will be the student outcomes. It is also hoped, that once travel warnings have been lifted from this country, that the students will be able to be involved in field and case studies. Currently, the two students who are actively engaged in this project have received Undergraduate Research Opportunities Programme (UROP) Grants from IUPUI, but had to postpone their field studies after the bombings in Bali, Indonesia.

The design process began with an initial meeting of the IUPUI students to determine tasks, set goals and objectives and a time line of activities. One student was assigned to researching vernacular Indonesian architecture and another was involved in researching local and sustainable building products. Both students collected information and made notes of what might be considered to be future case studies for the project, for example, recent projects that utilized sustainable building practices. A follow-up meeting was used to edit this information and to focus on what would be valuable to this specific project.

To date, the first conceptual design images have been completed by both the author and the students with some input from the questionnaires and literature search. All materials are tentative at this stage as the project sits in wait for final budget and development approval. Redesign will occur as the budget is approved and as more of the survey data are analysed (the survey took place after the conceptual design was due because of available travel times and impending deadlines for the conceptual stage). As well, to market the project (for funding), an IUPUI Computer Graphics Technology student completed an animated fly-over of the project.

The students in Indonesia also helped in the formative design stages for they provided names

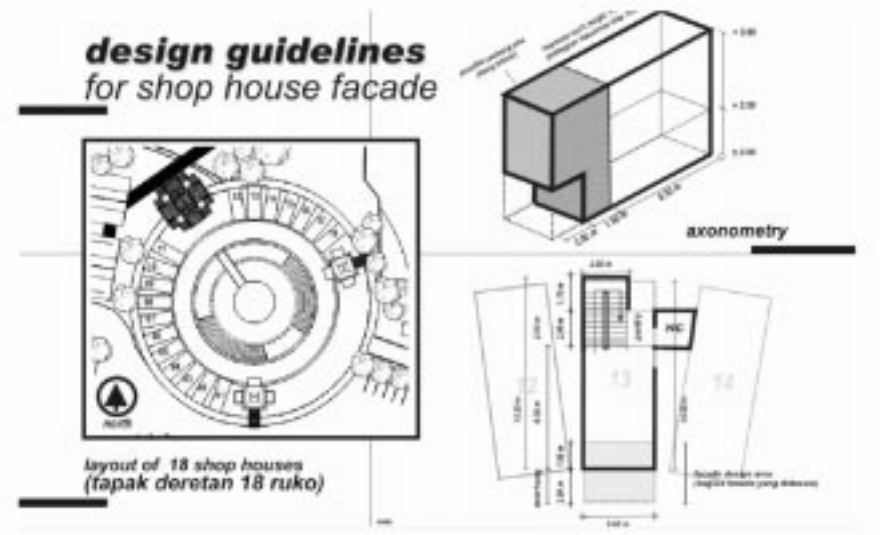

Fig. 1. Shop House Specifications.
Note. Courtesy of Dr Ikaputra.

of designers that had developed projects using green principles. These designers were interviewed in Jogja by the author using the questionnaire we had developed. A total of 37 persons received and completed the questionnaire. This is a suitably sized sample group [9] to develop and analyse data and to draw preliminary conclusions about the research questions. This was seen as an important step before proceeding to further project design.

PROJECT DESCRIPTION

This project began with an invitation from the architectural faculty at Gadjah Mada University in Jogja to design the shop house located within an Art Market (Pasar Seni), about 30 minutes south of Jogja on the road to Parangritis Beach (see Fig. 1 for design specifications).

This is a popular route for tourists and the site for the market is seen as half-way point on the journey to the beach where travellers can visit the Art Market and purchase goods. This project (and concept) was spearheaded by two professors within the Department of Architecture and Planning (Faculty of Engineering) at Gadjah Mada University: Dr Jatmika A. Suryabrata and Dr Ikaputra. These two faculty members developed and built the site plan and infrastructure that can be seen in Fig. 2. The majority of the shop houses were designed *pro bono* by a select group of international architects and designers.

In this particular project, the design of the shop house was created from the input of the author plus several students, as has been noted above. The author, using *Sketchup 4.0* software, developed the conceptual, exterior design of the shop house (see Fig. 3) and the students were responsible for the interior design of the project (using *Architectural Desktop 3.3*) (see Fig. 4), the preliminary selection of sustainable materials and an animated view of the project (using *3-D Studio*) (see Fig. 2). The students also provided valuable criticism as the design progressed through its various iterations.

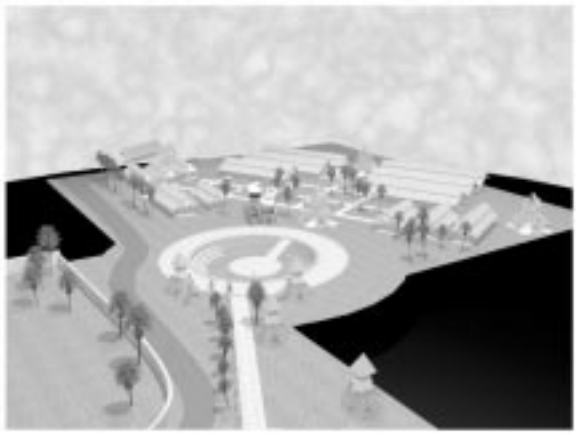

Fig. 2. Aerial View of Art Market.
Note. Courtesy of Brian Slaymon (IUPUI Student).

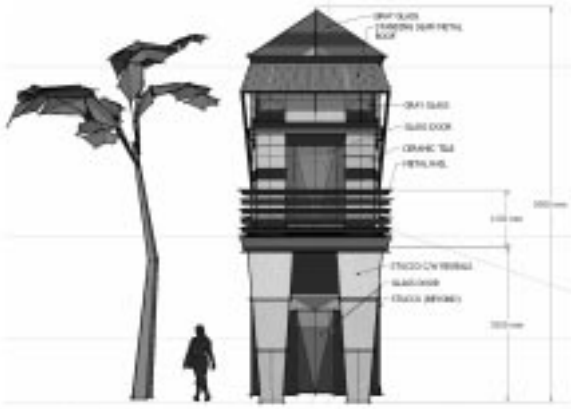

Fig. 3. Preliminary Front Elevation of Shop House (N.T.S.)

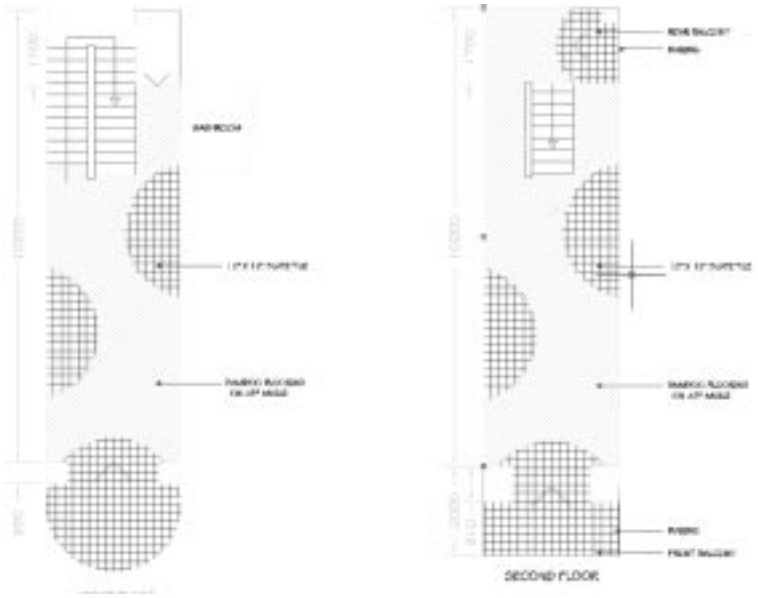

Fig. 4. Preliminary Floor Plans (N.T.S.).
Note. Courtesy of Sarah Helish (IUPUI student)

Fig. 5. Art Market Mural.
Note. Courtesy of Dr Ikaputra.

Local Context for Design

Many of the local artisans living and working in Southern Indonesia (Java) are remote from one another and are haphazardly distributed throughout a wide geographical area whilst struggling to make a living. Out of this has developed a chaotic urban aesthetic of retail shops and houses that makes it difficult for local craftspeople to entice international buyers and tourists. This also makes it cumbersome for visitors to find the retail outlets for the various crafts as they are located in several, distinct markets (pasar) within and around Yogyakarta.

The Art Market project addresses these difficulties for the many people involved in retail trading. It takes this disparate group of people and forms a collective presence within several professionally designed structures that are accompanied by an overall urban design scheme that includes park-like settings, playgrounds and murals created by local artists (see Fig. 5). In this particular prototypical Art Market, a cluster of open-air pavilions serve as spaces for the artisans to display their crafts (see Fig. 2).

Table 1. Question One: Rating of the Extent of Sustainable Practices

		Frequency	Valid Percent	Cumulative Percent
Valid	1	1	2.7	2.7
	2	11	29.7	32.4
	3	10	27.0	59.5
	4	9	24.3	83.8
	5	6	16.2	100.0
	Total	37	100.0	

Table 2. Question Two: Extent of Recycling

		Frequency	Valid Percent	Cumulative Percent
Valid	2	12	32.4	32.4
	3	9	24.3	56.8
	4	11	29.7	86.5
	5	5	13.5	100.0
	Total	37	100.0	

Table 3. Question Three: Alternative Energy Sources

		Active Solar	Passive Solar	Wind	Geo-thermal	Cogeneration
N	Valid	37	37	37	37	36
	Missing	0	0	0	0	1
Mean		0.41	0.19	0.08	0.03	0.22
Std. Deviation		0.498	0.397	0.277	0.164	0.422

Results from the Questionnaires

The questionnaire data were collected and organized within *Excel 2003* and analysed within *SPSS 12.0.1* software and simultaneously coded by an IUPUI student and by the author to establish inter-rater reliability. There were 37 participants with 24 males and 11 females (two non-answers). Four of these people were 45 years of age or over, eight were 40 to 45 years of age, three were 35 to 40, four were 30–35 years old, seven were 25 to 30, four were 21 to 25 and four were 19 to 21. Fifteen of the participants were educators, fourteen were architects, five were students and the rest did not specify. The following section reviews the data collected from the closed questions. Open questions are still being translated and coded and were not seen to be as crucial to the conceptual design stage.

Closed Questions

The first question in the questionnaire used a five point Likert scale to determine how the participants would rate the extent of the use of sustainable building practices in Indonesia, with a rating of 5 being the highest. Thirty per cent stated that they assessed at a low rate (2) and the next largest group (27%) at a moderate rate (3). The other percentages are noted in Table 1.

The second question asked the participants to rate the extent of recycling in Indonesia. The greatest amount of the participants ranked the extent as low (2) whereas the least amount (14%) ranked it as very high (5) (see Table 2).

Question three asked the participants to rank the extent of use of alternative energy sources in Indonesia. The highest mean was active solar technology (0.41) and the lowest was geothermal (0.03) (see Table 3).

Question four was directed at asking participants to rate the extent of use of alternative energy resources in Indonesia (see Table 4). The greatest percentage of the people (32%) rated the extent of use as moderate. The next closest (27%) was a high rating (4) and the next category was low (2) with 22%. The mean value was 3.43 or just above a moderate rating (see Table 4).

Question 5 asked the participants to rank the extent of the development of sustainable communities in Indonesia (see Table 5). The highest percentage (32%) of responses was in the category of very good (4) and the lowest (11%) was in the poor category (1). The mean value was 3.22, or slightly above a moderate rating (see Table 6).

Table 4. Question Four: Extent of Use of Alternative Energy Sources

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	8	21.6	21.6	21.6
	3	12	32.4	32.4	54.1
	4	10	27.0	27.0	81.1
	5	7	18.9	18.9	100.0
	Total	37	100.0	100.0	

Note: 1 = Non Existent, 2 = Low, 3 = Moderate, 4 = High, 5 = Very High

Table 5. Question Five: Statistics: Alternative Energy Sources

N	Valid	37
	Missing	0
Mean		3.43
Std. Deviation		1.042

Table 6. Question Six: Sustainable Communities

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	2	5.4	5.4	5.4
	1	4	10.8	10.8	16.2
	2	6	16.2	16.2	32.4
	3	5	13.5	13.5	45.9
	4	12	32.4	32.4	78.4
	5	8	21.6	21.6	100.0
	Total	37	100.0	100.0	

Note: 0 = No Answer, 1 = Poor, 2 = Fair, 3 = Good, 4 = Very Good, 5 = Exceptional

Table 7. Question Seven: Statistics: Sustainable Communities

N	Valid	37
	Missing	0
Mean		3.22
Std. Deviation		1.512

Question six asked participants how they acquired their knowledge of sustainable building practices. The highest mean (3.5) was books, meaning that this was the most preferred method of gaining information about sustainable principles when compared to the other methods listed in Table 7.

Questions 7–9 were open questions and were not included in this part of the research. Question ten, however, asked the participants to rank the extent of the use of bamboo, tile roofing, thatch roofing, coconut fibre and stone on a scale of one to five,

Table 8. Question Six: Acquisition of Knowledge: Methods

	Internet	Books	Experts	Lectures	In-House Communication	Journals
Valid	37	37	37	37	37	36
Missing	0	0	0	0	0	1
Mean	2.95	3.46	1.65	2.84	2.14	1.72
Std. Deviation	1.870	1.502	1.687	1.424	1.512	1.614

Table 9. Question Ten: Use of Stone

		Frequency	Valid Percent	Cumulative Percent
Valid	0	5	13.5	13.5
	1	1	2.7	16.2
	2	1	2.7	18.9
	3	4	10.8	29.7
	4	17	45.9	75.7
	5	9	24.3	100.0
	Total	37	100.0	

Table 10. Question Ten: Use of Coconut Fibre

		Frequency	Valid Percent	Cumulative Percent
Valid	0	5	13.5	13.5
	1	25	67.6	81.1
	2	4	10.8	91.9
	3	1	2.7	94.6
	4	2	5.4	100.0
	Total	37	100.0	

Table 11. Question Ten: Use of Thatch Roofing

		Frequency	Valid Percent	Cumulative Percent
Valid	0	3	8.1	8.1
	1	7	18.9	27.0
	2	18	48.6	75.7
	3	7	18.9	94.6
	4	2	5.4	100.0
	Total	37	100.0	

Table 12. Question Ten: Use of Tile Roofing

		Frequency	Valid Percent	Cumulative Percent
Valid	0	3	8.1	8.1
	3	4	10.8	18.9
	4	6	16.2	35.1
	5	24	64.9	100.0
	Total	37	100.0	

Table 13. Question Ten: Use of Bamboo

		Frequency	Valid Percent	Cumulative Percent
Valid	0	3	8.1	8.1
	1	1	2.7	10.8
	2	8	21.6	32.4
	3	16	43.2	75.7
	4	4	10.8	86.5
	5	5	13.5	100.0
	Total	37	100.0	

with five being the highest (zero was no reply). With respect to stone, 46% of them ranked it as a four with the next highest category (24%) being a five (see Table 9). Coconut fibre was ranked much lower than stone. Sixty-eight of the participants ranked this material as a one (the lowest ranking) with none of them giving it a high rating of five (see Table 10). Thatch roofing seemed to be slightly more popular. Forty nine percent ranked this material in a two category although no one ranked it higher than a four (5%) (see Table 11). Tile roofing was rated much higher than the other materials. Sixty-five percent of the participants ranked it in the top category (five) and none of them ranked it below a two (see Table 12). Bamboo was also popular with forty-three percent of the participants giving it a value of three. Twenty four percent ranked it as a four or above as well (see Table 13).

FUTURE DIRECTIONS

In summary, it is important to review the research questions posed at the beginning of this paper:

1. What is the current state and extent of sustainable building design practices in Indonesia?.
2. How can sustainable design principles be applied to a collaborative educational design project located within this country?
3. What are some of the sustainable building materials and practices currently being used in Indonesian architectural design practice?

In reference to question one, and in reviewing the results from the survey, it appears that, much as was noted above, Indonesia is still on the cusp of embracing sustainable design principles in their construction projects. For the most part, the answers did not rate the extent of the use of sustainable building practices as very high. The time is ripe to begin this process and a project of this scale is one that can be used as a pilot and is easily managed by undergraduate students.

This naturally leads into answers to question two. By using the shop house as a pilot study, both the students and the author can study how sustainable principles can be applied to a collaborative educational design project in Indonesia. It becomes the working model of this question. Through post occupancy studies an understanding of the success of the design will be forthcoming.

In assessing the materials used locally it can be determined from the questionnaire that stone, clay roofing tiles and bamboo are popular sustainable materials that should be considered as this project moves into the construction document stage. Currently the flooring and interior partitions are bamboo. Because of this, one student has been assigned more research into bamboo and will be conversing remotely with the bamboo labs at Gadjah Mada University in order to look at developing innovative approaches using this material. Another IUPUI student has been added to this project to look at suitable neighbourhoods for these types of markets. As the funding becomes available, the project should be able to establish a realistic budget that will require further analysis of the economics of the materials and sustainable approaches to be used in this project.

At the outset of this paper it was stated that sustainability involves a holistic approach to construction. This project not only looks at the various sustainable principles and materials to apply to the physical aspects of the design, but also considers the sustainability of the livelihoods of the artisans. It is hoped that this centralization of artisans and differing crafts will lead to more sustainable livelihoods for these people.

Moreover, as this country starts to rebuild, more sustainable approaches to construction will hopefully be considered as a result of the concepts embraced herein. Future studies in the area of sustainability in Indonesia should focus on how sustainable principles can be incorporated into every aspect of rebuilding this country in light of the 2004 tsunami disaster.

REFERENCES

1. S. F. Mendler and W. Odell, The HOK Guidebook to Sustainable Design, p. 1. Wiley, New York (2000).
2. International Institute for Energy Conservation and Y. Lingkungan, *High-Value Applications for Renewable Energy ad Energy Efficient Technologies in Indonesia*, p. 6 IIEC Publications, Washington (1997).
3. J. Gearing and M. Cheng, Green Seeds, *Asia Week*. **27**(18), 2001.
4. Environment News Service, 2005 http://www.ens-newswire.com/ens/apr2005/2005–04–27–02.asp
5. R. Witoeler, Address On The 6th International Seminar On Sustainable Environment And Architecture, http://www.menlh.go.id/terbaru/artikel.php?article_id=1467 (2005).
6. D. Larasati, *Sustainable Housing in Indonesia*, p. 3. Unpublished master's thesis, Delft University of Technology, Netherlands (2003).
7. Department of State Web Page: http://www.state.gov/r/pa/ei/bgn/2748.htm
8. R. Peterson, *Constructing Effective Questionnaires*, p. 49. Sage Publications, London (2000).
9. N. Sproull, *Handbook of Research Methods*, The Scarecrow Press, London (1995).

David Jan Cowan is the Director and an Assistant Professor of the Architectural Technology Program in the Purdue School of Engineering and Technology at IUPUI. He teaches courses in residential and commercial construction. He has been extensively involved in international projects in Indonesia and Brazil. His research interests and Ph.D. dissertation address issues of sustainability and energy efficiency in both cold and warm climates.