# Partnering with Industrial Advisory Board to Create Zero Energy Curriculum Certificate

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## Abstract

This paper describes the Indiana University Purdue University Indianapolis (IUPUI) Department of Engineering and Technology's multidisciplinary program's development of a Zero Energy Certificate program that maximizes its active Industrial Advisory Board (IAB) expertise. Combining our programs community engage project approach along with a highly active IAB, we are developing a certificate program that expands upon the growing world of zero energy. Our multi-facetted department includes, interior design, architectural technology, facilities management, construction management, and electrical engineering technology, and all these programs will play a role in the creation of a certificate leading to a multidisciplinary capstone studio course. The goal is to have student led multi-disciplinary design teams work together on a vertical structure to achieve a Zero Energy building design. Combining the efforts of five different degree programs coursework, we are looking to give students a real-world experience of give and take amongst peers, project management, and design development. Incorporating the building information modeling (BIM) approach, students will have developed the dynamic presentation imagery and needed construction documents to sell the concept. The multidisciplinary design approach has proven to be both challenging and rewarding in both industry and academia. Bringing together bright minds to attack a design problem functionally and systematically can evaluate the boundaries of all team members. This paper will focus on the teaching methods used in the development of the certificate product that were piloted during the schools first every U.S. Department of Energy's Solar Decathlon competition.

## Net Zero

Data from the U.S. Energy Information Administration confirms that buildings account for approximately 40% of total energy consumption in the United States [3]. This demonstrates the importance of being able to create environments that are energy efficient. Net Zero design means creating an energy efficient building which will over the course of a year combined with renewable design practices and technology can produce as much energy as it will consume from the grid it is connected to. Being able to develop this type of building means studying it from site selections, schematics, building envelope to interior finishes, and looking at the building information modeling (BIM) process utilized to maximize all the design team intellectual property.

Creating a Net Zero design experience for students means emphasizing the importance of the design communities' impact on the climate, and teaching principles of design that partner with this. The seven core elements and principles of design that all design programs highlight are line, shape, color, value, form, texture, and shape. The premise is how do they impact symmetrical and asymmetrical balance, pattern, emphasis, movement, and proportion, and basic user function. How do we design and develop spaces that maximize the end-user's productivity? Combining all this into cohesive yet energy efficient finished building is not an easy task. After some analysis of the program with our advisory board, internal faculty, and some external faculty from programs that have successfully done the integration, we believe our certificate program will mee the standards of the U.S. Department of Energy.

**Interactive Learning**

Prompted by an interactive exercise during one of our advisory board meetings where we asked each board member to create the ideal studio classroom environment, and several of them suggested flipping the classroom technology to the advantage of the teacher. Instead of fighting against tablets, cell phones, and other technology, utilize it to teach and inform. Teaching interior design and architecture has changed tremendously over the years, from slide-rules and T-squares to digitizers and mouse pads, to tablets and 3D software. Creating an environment where students are learning from students and having rich interaction with their professors/instructors is critical to this project. IUPUI's newest classroom space, the Active Learning Classroom of Valuable Experiences (ALCOVE) is being used as the model, with mobile furniture, easy connect Wi-Fi screens, and instructor tablets for mobile whiteboards. Entering its fourth semester in use, this classroom space became part of the evolution of our design program venturing into the Net Zero design world. Using the ALCOVE over the course of an entire academic year, we were able to set baselines for delivery methods, test out software, and collect data on furniture. We were also able to have live discussions with students from other classes in real time. As a part of the "End of Course Evaluation" we were able to assess student learning effectiveness, and some of the results were as follows:

- 71% of students said the classroom <u>increased their level of engagement</u> in the course materials.
    - 5% said it didn't did not increase their level of engagement.
- 76% of students said the classroom <u>facilitated their ability to collaborate</u> with classmates.
    - 8% said it didn't help them collaborate more than any other class.
- 63% of students said the classroom <u>enhanced their learning</u>.
    - 5% said the room didn't impact their learning.
- 74% of students said if given the opportunity, they <u>would take another course in this classroom</u>.
    - 5% said they wouldn't want another class in this classroom.

A couple other questions we were able to collect feedback on were

- How did collaboration screens for group work Impact student learning?
- How did collaboration screens for instructor content impact student learning?
- How did the group setting impact student learning?
- What were any general comments about the space?

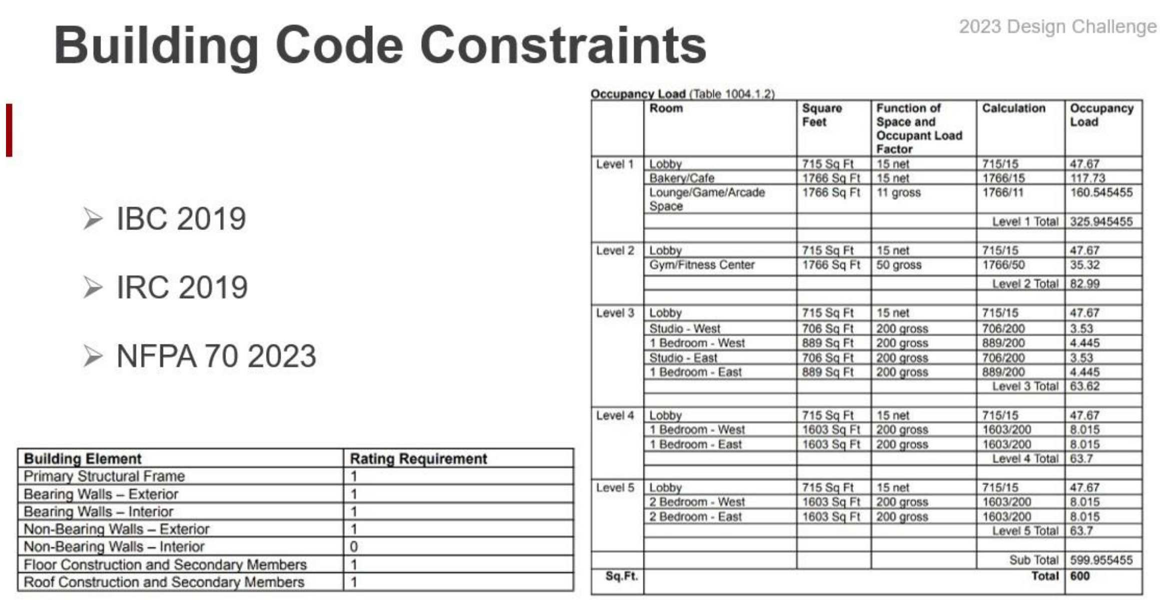
**Mentoring**

The certificate is grounded in participating in in the U.S. Department of Energy Solar Decathlon Design Challenge, was a great introduction of Net Zero design strategies into the curriculum, and one unexpected outcome was it also highlighted the need for intra-project mentoring. Utilizing our first year and sophomore design courses to develop the building shell and core, and then handing that off to the junior and senior engineering and design students for vetting was a unique opportunity for mentoring. Some rules that were put into place prior to the intra-project interaction:

- Junior and senior students had to utilize the shell and core without suggesting aesthetic design changes unless they were prompted by the net zero standards or building code requirements. They had to do a complete building code analysis of the proposed design to determine its feasibility and energy efficiency (see figures 1 and 2).

- We developed a few internal guidelines to encourage team dynamics across grade levels:

  - One of the project team leads must be working in senior capstone or graduate student.
  - One of the project team leads must be a first-year student or sophomore level student.
  - Our commercial sophomore interior design studio course would lead the design development of the commercial entity in the building.
  - Interior design capstone students would lead the final deliverables of all spaces.
  - Weekly meetings with all grade levels would be separate. The only constant at every meeting was the faculty project team lead.




| Building Element | Rating Requirement |
|---|---|
| Primary Structural Frame | 1 |
| Bearing Walls – Exterior | 1 |
| Bearing Walls – Interior | 1 |
| Non-Bearing Walls – Exterior | 1 |
| Non-Bearing Walls – Interior | 0 |
| Floor Construction and Secondary Members | 1 |
| Roof Construction and Secondary Members | 1 |

**Occupancy Load** (Table 1004.1.2)

| | Room | Square Feet | Function of Space and Occupant Load Factor | Calculation | Occupancy Load |
|---|---|---|---|---|---|
| Level 1 | Lobby | 715 Sq Ft | 15 net | 715/15 | 47.67 |
| | Bakery/Cafe | 1766 Sq Ft | 15 net | 1766/15 | 117.73 |
| | Lounge/Game/Arcade Space | 1766 Sq Ft | 11 gross | 1766/11 | 160.545455 |
| | | | | Level 1 Total | 325.945455 |
| | | | | | |
| Level 2 | Lobby | 715 Sq Ft | 15 net | 715/15 | 47.67 |
| | Gym/Fitness Center | 1766 Sq Ft | 50 gross | 1766/50 | 35.32 |
| | | | | Level 2 Total | 82.99 |
| | | | | | |
| Level 3 | Lobby | 715 Sq Ft | 15 net | 715/15 | 47.67 |
| | Studio - West | 706 Sq Ft | 200 gross | 706/200 | 3.53 |
| | 1 Bedroom - West | 889 Sq Ft | 200 gross | 889/200 | 4.445 |
| | Studio - East | 706 Sq Ft | 200 gross | 706/200 | 3.53 |
| | 1 Bedroom - East | 889 Sq Ft | 200 gross | 889/200 | 4.445 |
| | | | | Level 3 Total | 63.62 |
| | | | | | |
| Level 4 | Lobby | 715 Sq Ft | 15 net | 715/15 | 47.67 |
| | 1 Bedroom - West | 1603 Sq Ft | 200 gross | 1603/200 | 8.015 |
| | 1 Bedroom - East | 1603 Sq Ft | 200 gross | 1603/200 | 8.015 |
| | | | | Level 4 Total | 63.7 |
| | | | | | |
| Level 5 | Lobby | 715 Sq Ft | 15 net | 715/15 | 47.67 |
| | 2 Bedroom - West | 1603 Sq Ft | 200 gross | 1603/200 | 8.015 |
| | 2 Bedroom - East | 1603 Sq Ft | 200 gross | 1603/200 | 8.015 |
| | | | | Level 5 Total | 63.7 |
| | | | | | |
| | | | | Sub Total | 599.955455 |
| **Sq.Ft.** | | | | **Total** | **600** |

Fig. 1. Building code constraints.

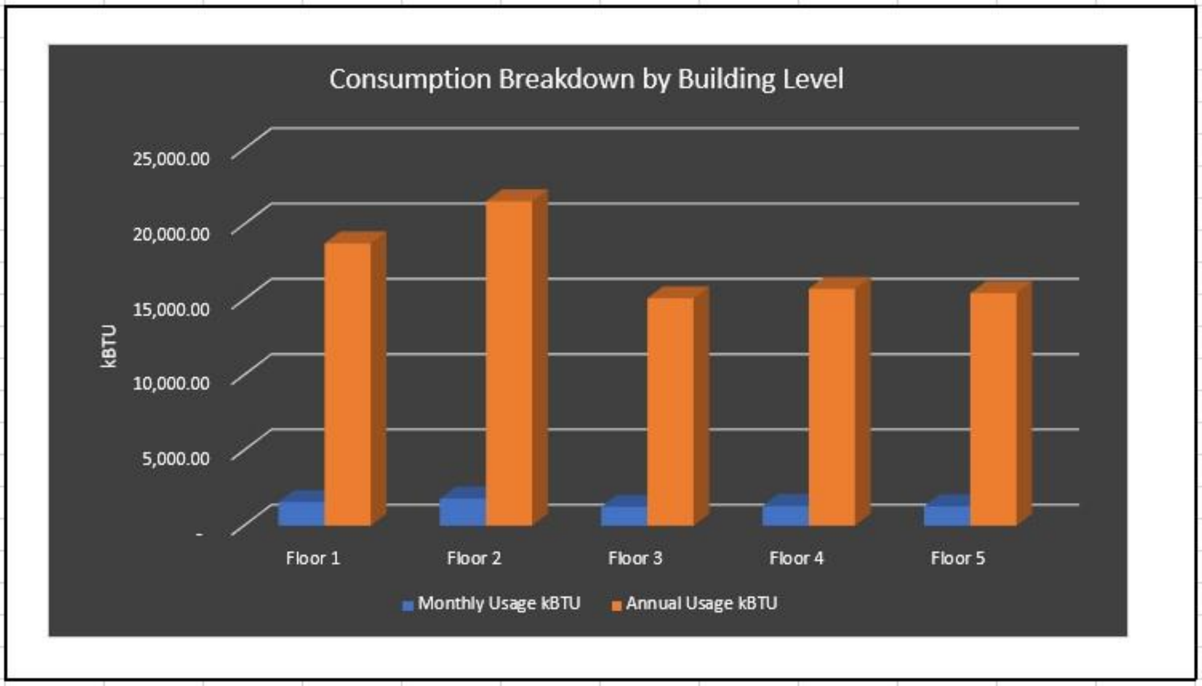


Fig. 2. Consumption breakdown.

**Evidence Based Design**

Evidence based design is a perfect inclusion in the classroom because it results in design students having fact-based approaches (see figure 3). "EBD is a relevant, useful tool for providing evidence that positively affects design decisions" (Codinhoto, Aouad, Kagioglou, Tzortzopoulos, & Cooper 2009). Having the means to generate detailed face-to-face team discussions with the technology to share screens into a larger group has proven to be invaluable, especially for the first year and sophomore level courses. The U.S. Department of Energy (DOE) Solar Decathlon® Design Challenge focuses on two critical goals:

1. to incorporate high-performance building design strategies into curricula
2. to inspire students to pursue sustainable building careers; designed to support educational programs in training the next generation of building design professionals.

The project used to launch our endeavor into this net zero energy design research requires a lot of research and data collection. A notable example of this is the prior to designing a living environment, we had to collect some current data about the markets and what renters were seeking.

AVERAGE U.S. APRTMENT SIZE: 941 SQ.FT. **(NOTE: 5% SMALLER THAN 10YRS PRIOR)**
AVERAGE MIDWEST APARMENT SIZE: 882-947 SQ.FT.
U.S. APARTMENT AVERAGE SIZE PER UNIT TYPE

- STUDIO-514 SQ.FT.
- 1 BEDROOM 757 SQ.FT.
- 2 BEDROOM 1,138 SQ. FT

**TOP 10 CITIES WITH LARGEST INCREASE IN AVERAGE SIZE BETWEEN 2008-2018**

- #1 LUBBOCK, TX 19% SIZE INCREASE
- #8 INDIANAPOLIS 5% SIZE INCREASE

- #10 SEATTLE 4% SIZE INCREASE

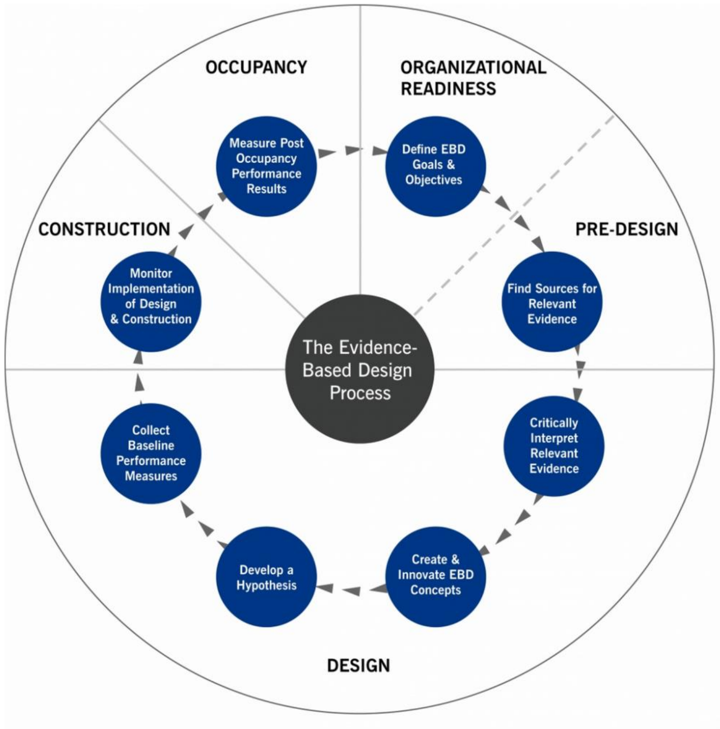



Fig. 3. The Center for Heath Design EBD).

**Multidisciplinary**

Creating a multidisciplinary design curriculum requires a faculty with varying skills, a student population not intimidated by team projects, and an audience to give critical feedback. Our continually active IAB along with the long-standing community engaged approach to our program offer plenty of audience. Within our school we have the following courses to be part of this multi-disciplinary program approach.

- Interior design technology
- Architectural technology
- Lighting design
- Visual communication BFA students
- Communication design MFA

Utilizing all the student skills listed above allows our program to create a diverse and effective design environment. In the current BIM culture, vertical structure design more than ever needs to lean on varying disciplines to ensure the end-user is getting a result that will serve them in the immediate future as well as the distant future. “For some, BIM is a software application; for others it is a process for designing and documenting building information; for others it is a whole new approach to practice and advancing the profession which requires the implementation of new policies, contracts and relationships amongst project stakeholders” (Aranda-Mena, Guillermo, et al, 2009).

With this in mind, we will craft some courses singularly and some grouped to effectively combine multidisciplinary practices with BIM:

**Singular Course Design:**

- *Building Sciences-Wood Framed Construction:* In this course students will identify and be able to design and detail small structures (under 4000 sq.ft.) with floor plans, wall sections, floor sections, simple roof sections, and a clear understanding of thermal bridging. Drawings from this course will then be passed on the Residential Single-Family Course. These students will also work in parallel with a designated electrical engineering course to help design lighting and electrical layout for structure.
- *Building Sciences-Brick/Steel/Concrete Construction*: In this course students will identify and be able to design and detail large commercial style/mixed use structures (under +4000 sq.ft.) with floor plans, wall sections, floor sections, simple roof sections, and a clear understanding of thermal bridging. Drawings from this course will then be passed on the Residential Single Family/Multi Family Course. These students will also work in parallel with a designated electrical engineering course to help design lighting and electrical layout for structure.
- *Single & Multi-family/-4000 sq.ft. Commercial:* Courses will work to develop building shells and interior architecture for designs passed on from Building Science-Wood Framed Construction. Divided into project teams, students will be assigned an IAB project team mentor, as complete a building analysis.
- *Commercial +4000 sq.ft.:* Courses will work to develop building shells and interior architecture for designs passed on from Building Science-Brick/Steel/Concrete Construction. Divided into project teams, students will be assigned an IAB project team mentor, as complete a building analysis.
- *Grouped Courses:* The following courses are still in the planning stage and with the Mechanical Engineering Technology course residing outside department this will require some additional planning and course coordination. To date the mechanical student input has been a deficit to the certificate planning due to the above-mentioned coordination. Once resolved we plan to create the following two additional courses:

  - Residential Interiors combined with Mechanical Engineering Technology
  - Commercial Interiors combined with Construction Management

**Conclusion**

The teaching methods used to create this certificate were based on the strengths of our department, lessons learned post-Covid, and evidence-based design teams. The pilot program was developed during the 2023 U.S. Department of Energy Solar Decathlon Design Challenge, our universities' first time competing in the competition. By utilizing Synchronous and Asynchronous teaching and learning methods in our new ALCOVE classroom we are able to leverage state of the art technology for students to collaborate. "At the core of education is effective instruction. Whether looking to teach a skill, establish learning protocol, or connect with students, the instructional strategies used by teachers serve as the foundation of these efforts" (Erwin, Centeio, Beighle, McKown, G. 2021).

This experience has generated a lot of positive feedback among my faculty colleagues, industrial advisory board members, and the students. The major victory came in competing in the Decathlon and developing several other research projects from it. This certificate will be a standard part of the curriculum in the Interior Design program, but will also be open to students in the in the other disciplines in our school, and will be centered around creating multi-disciplinary teams to compete in national and international yearly competitions such as IIDA, AIA, Solar Decathlon, etc. These institutions, and many others sponsor annual competitions that will allow us the ability to test our content knowledge against the rest of the world.

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## Biography

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