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A COMMON LANGUAGE TO DESIGN CARBON NEUTRAL PROJECTS BY 2030

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ABSTRACT

The AIA 2030 Commitment urges architects to become agents of change in the face of a looming global climate crisis. The impact of energy demand and consumption in the built environment is dependent on early design decisions; architects must play a key role as climate leaders. AIA 2030 notes that the overall average predicted energy use intensity (pEUI) percent savings increased in their 2017 project reporting to 44 percent, with a two percent increase over 2016 (The American Institute of Architects, 2019). This was driven both by more stringent energy codes and expanded energy modeling with reporting signatories of the Commitment. Thus, to make meaningful impact early phase building energy modeling must be seamless integrated into the design process. It begins with knowledge. Bringing forth the knowledge (education and awareness) that comes with a specialized skill such as energy modeling to a national architectural firm can be daunting. It requires buy-in through all levels of the organization and most importantly a common vernacular. This paper examines an architectural firm's repositioning of inclusive design intelligence by establishing a common core curriculum centered around the integration of early phase building energy modeling with the desired outcome to achieve a carbon-neutral built environment.

INTRODUCTION

The American Institute of Architects (AIA) note that energy is a design problem (The American Institute of Architects, 2012). The solution then, as suggested, would be to "engage energy modeling directly with design generation, thus informing major design decisions and providing continuous feedback." However, familiarity with Design Performance Modeling (DPM), including being fluent in the vocabulary, technologies, methodology/approaches and software/tools that support the Integrated Design Process (IDP) is lacking and unsupported by the future needs of the architecture, engineering and construction (AEC) professions. Thus, a structured common core curriculum centered around the integration of early phase building energy modeling is a growing need to design carbon neutral project by 2030. Transforming the practice of architecture to respond to the climate crisis in a way that is holistic, in support of the 2030 Challenge, requires that the practice of architecture engage in iterative energy modeling throughout the entire design process to understand the interactive effects of various design decisions and to assess progress towards meeting energy use intensity (EUI) targets (Architecture 2030, 2019). Energy modeling will become even more important as the targets become more challenging in 2020 (80%), 2025 (90%) and 2030 (carbon neutral). The NCARB Practice Analysis of Architecture noted that the task of selecting building performance modeling technologies to guide building design (over 60% of the respondents) was identified as the most important and also noted as not performed (NCARB, 2012). Thus, most architects don't understand how design can respond to energy use, even though they acknowledge its importance in the built environment. The degree conferral of most architects (namely undergraduate) is then understood as inadequate specifically in building engineering physics which is the basis of knowledge for an Energy Modeler.

Energy modeler credentials such as a certified Building Energy Modeling Professional (BEMP), (ASHRAE, 2019), a certified Building Energy Simulation Analyst (BESA), (AEE, 2019), or equivalent are designed to recognize special expertise and demonstrated knowledge but does not necessarily prepare those beginning in the profession or practitioners for that matter (those without the building engineering physics foundation). Often, the fundamentals of energy modeling (practices and principles) and software-specific modeling workflows is often employed as on-the-job training similar to that of building a skillset through apprenticeship. The "burn-in time" for an energy modeler apprentice can vary greatly

and could extend to a period of two (2) to three (3) years satisfying the aforementioned energy modeling credential experience/eligibility requirements in addition to any educational requirements (e.g. constant practice in energy modeling). That type of rigor is impractical for someone in the practice of architecture where the intensity and duration of typical architectural services is prolonged in comparison to someone performing energy modeling services whom may be involved with multiple projects simultaneously. The architect need not become a technical expert in energy modeling but a firm working understanding, a common language, is desirable as architects are uniquely positioned to facilitate energy efficiency design discussion and decision making of a project. Moving towards a focus area of evolving the role of the architect where engineering and energy modeling is universally incorporated for optimizing design efficiency the disparate roles of the Modeler, Engineer and Architect could be actively engaged singularly as an Mod-Engin-Ect where the quality and performance of architectural design is elevated. Therefore, this paper attempts to provide a useful transparent framework, developed by an international design firm who is a signatory to the AIA 2030 Commitment, that encourages designers to learn the basics of energy modeling so that they can create simple models for their projects.

METHODOLOGY

Repositioning design intelligence in an inclusive international firm by establishing a common core curriculum centered around the integration of early phase building energy modeling requires a full range of human diversity and most of all, patience. Primary and relational stakeholders were identified that facilitated a key firm directive, energy model all projects. Change can often be slow even when adopting such a directive. However, the long-term benefits supporting an educational curriculum with contractual reporting procedures (e.g. The AIA 2030 Commitment) can yield long-term benefits in terms of being competitive and creating influence. Thus, a work plan was developed for rapid implementation. The purpose was to build the knowledge and technical capacity to energy model all project work in a way that improves the firms overall pEUI as it is reported to the AIA 2030 Commitment. The means by which the work plan was to be executed was through ten (1) core steps. Energy modeling *Education (Core #3)* and *Knowledge (Core #6)* are foundational to this paper.

1. *Resources & Budget* – Ensure that all projects include time and budget for this activity (energy modeling). Automatically allocate from service fee (profit is reduced for accommodation).
2. *Quality Consultants* – Ensure consultants conduct appropriate energy analysis at necessary quality and level (with reference to ASHRAE Standard 209-2018), (ASHRAE, 2018).
3. *Education* – Continue to develop broad staff design analysis knowledge and capacity across all offices in early design energy analysis and goal setting.
4. *Subject Experts* – Identify and enhance core group of energy/performance analysts.
5. *Capacity* – Engage in regional and global resources to supplement core group of energy /performance analysts.
6. *Knowledge* – Update and/or create new internal educational content with energy modeling process.
7. *Research* – Create research case studies with specific emphasis on client value and cost.
8. *Operations* – Ensure that design teams use internal project record resources as a primary means to track on-going project performance improvements and metrics.
9. *Operations* – Ensure that all project use the AIA 2030 Commitment Design Data Exchange (DDx), (AIA, 2019).
10. *Accountability* – Utilize a dashboard to manage progress and assist team to engage quickly and effectively.

New 21st century learners (Millennials) are highly relational and demand quick access to new knowledge (Blair, 2019). Thus, education is transitioning to quick access learning where learning tasks are to be interactive, engaging and appealing supported by technology. The potential to unlock innovative design thinking with energy modeling education was supported through an existing internal professional development resource, Workday Learning. Workday Learning combines professional development, peer learning, and required training into a single intuitive application (this includes tutorials, videos, and interactive quizzes). The *Subject Experts (Core #4)* developed a training curriculum that introduces building energy modeling at the early phase of the design process for designing high-performance buildings. The topics covered included best practices for building geometry setup, appropriate input parameters for envelope, HVAC and internal gains, and how to quickly explore design options and better understand their impact relationally to building performance. This training, on Workday Learning, also covered building benchmarking utilizing energy use intensity in relation

to a baseline building and tracked for standardized firm performance reporting. The learning objectives were:

- Understanding what building benchmarking is and how to benchmark a building using the ZeroTool™ and DDx utilizing energy use intensity in relation to a baseline building.
- Learning the parameters of a building envelope that affects the energy use intensity of a building by examining climate zone specific requirements of building envelope performance.
- Learning the best practices for building geometry setup, appropriate input parameters for envelope, HVAC and internal gains, and how to quickly explore design options and better understand their impact of building performance.
- Learning advanced features of Sefaira to compare design options for building performance.

The Early Phase Energy Modeling curriculum (*Figure 1*) has been structured in a way that architects would receive AIA continuing education as two (2) Learning Unit (LU) and Health, Safety, Welfare (HSW) credits. Utilizing the AIA/CES continuing education system developed by the AIA serves a dual purpose to the firm: enables architects to keep current, master new knowledge and skills, plan for the future, and responsibly meet the role society entrusts to a professional (AIA, 2019) and builds the knowledge and technical capacity to energy model all project work within the firm. The curriculum is self-paced, mobile and provides the core essentials in providing a common language (understood by all, universal) to design carbon neutral projects by 2030.

In support of the Early Phase Energy Modeling curriculum, a second learning engagement opportunity was developed to advance more hands-on learning and interactive discussion. This session was hosted over a video-web-conference so that the *Subject Experts* could connect to all regional and international offices of the firm. This engagement focused on: (1) an introduction to ZeroTool™ benchmarking tool (Architecture 2030, 2019), (2) project detail/input integration into the DDx, and (3) Sefaira (Sefaira, 2019) early phase modeling training. In particular, the early phase modeling training utilizing Sefaira encourages users to learn the basics of energy modeling so that they can create simple models for their projects. These simple models may address massing, building orientation and building envelope. Accompanying the training a supplemental step-by-step guide to perform the early phase energy modeling was developed purposefully to integrate a modeling workflow into the AIA DDx.

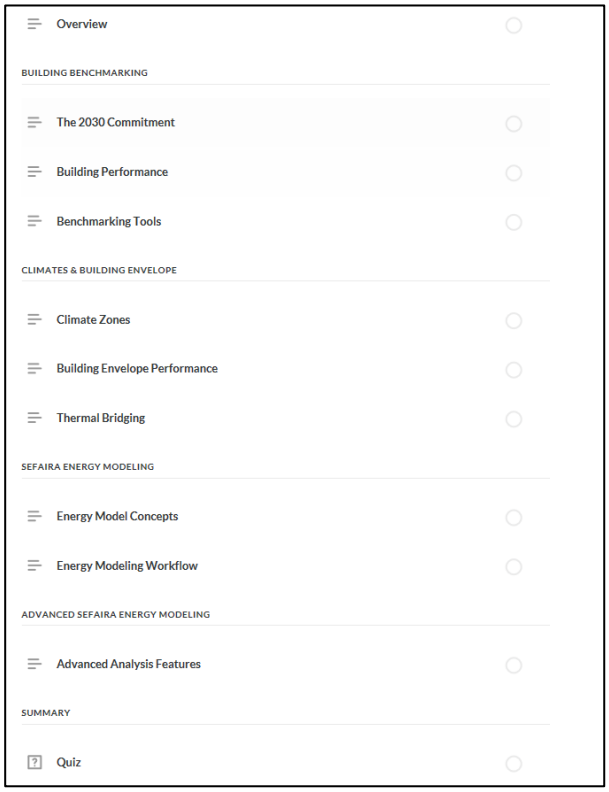

Figure 1 – Early Phase Energy Modeling Workday Learning Curriculum Outline

Defining consistent and relevant baselines is important in establishing meaningful benchmarks to track progress and compare performance. Thus, for building benchmarking the AIA 2030 Design Data Exchange (DDx) and Zero Tool is used to compare a building's design or an existing building's energy use intensity (EUI) with similar building types, understand how a building achieved its EUI (via energy efficiency, on-site renewable energy, and/or green power purchase in comparison to a baseline; the 2003 Commercial Building Energy Consumption Survey.

While several building energy modeling software were exhaustively evaluated, Sefaira met the immediate collaborative needs of executing the Energy Modeling Work Plan developed. The Sefaira energy modeling outcomes desired begin with the end in mind: identify passive design measures (envelope performance and orientation) that have the greatest reduction in energy use intensity that result in a 5% pEUI reduction. This includes (1) developing simplified massing models in Sketchup for analysis in Sefaira, (2) identify project

climate zone and applicable prescriptive minimum envelope thermal performance assembly U-Values, (3) simulating building energy performance in Sefaira, and (4) document project performance in the AIA DDx. A nominal 5% pEUI reduction was initially targeted as an initial entry point for performance improvement; more substantial reductions are planned in the future. Additionally, the pEUI reductions achieved through massing and passive design measures (not including natural ventilation or daylighting dimming) is meant to better prepare the architect(s) in integrated design discussions with other consultants (namely mechanical and electrical engineers) and project stakeholders.

The design influence desired from the workflow is schematically diagrammed in *Figure 2* with project integration timeline illustrated in *Figure 3*. The role of the architect in the context of early phase energy modeling, is predominately focused on Passive Design Measures (massing, orientation, window-to-wall ratio, envelope performance, thermal mass, passive solar heating, shading, daylighting and natural ventilation).

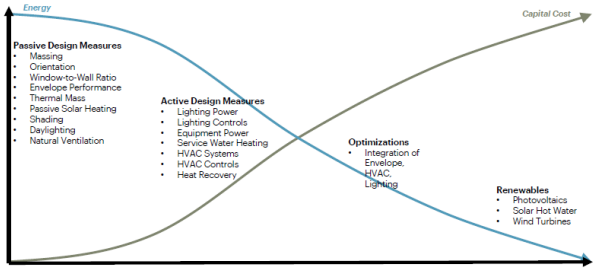

Figure 2 – Design Influence Utilizing Sefaira Energy Modeling Software for Early Phase Energy Analysis

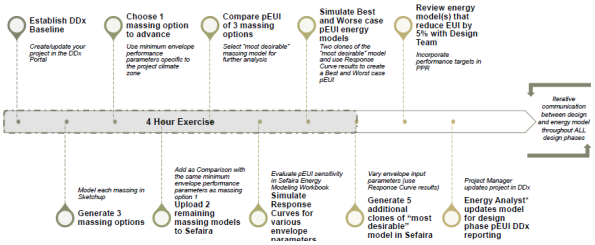

Figure 3 – Early Phase Energy Analysis Project Integration Timeline

The Early Phase Energy Analysis Project Integration Timeline helps to set the cadence for analysis and steps that need to be performed utilizing a developed workbook (Excel) that receives inputs from Sefaira to standardize reporting on projects. Utilizing Sefaira's Response Curve analysis feature, the user is able to determine the most sensitive passive design measure parameter that impacts the pEUI by accepting those results normalizing graphics in a developed Sefaira Energy Modeling Workbook and Report (*Figure 4*). The purpose of having a standardized report is to help facilitate discussion around the passive design measures with the firms *Subject Experts* and design team so that recommendations can be made and incorporated in the project design. It is recognized that other building performance indices or energy performance indicators and ratings such as energy cost index (ECI), fuel and energy cost, greenhouse gas emissions (GHG), heating and cooling system efficiency, lighting power density (LPD), Energy Star Score and Zero Energy Performance Index (zEPI) could be used to inform design however, the use of pEUI by which design alternatives are evaluated is purposefully aligned with the AIA 2030 Commitment (energy is the common denominator).

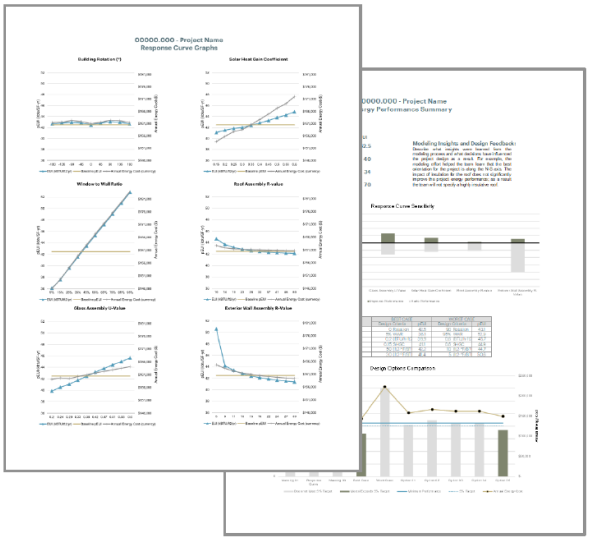

Figure 4 – Example Project Performance Report from Sefaira Energy Modeling Workbook

To build the knowledge and technical capacity to energy model all project work within the firm the Early Phase Energy Modeling curriculum is intended to be accessible by all; a necessary knowledge level-set to make progress towards outcome-driven design. Thus, the expectation is that all employees who are directly responsible for architecture and design (excludes Operations) enroll and complete the course requirements, in full. The core essentials found in the curriculum is also embedded as part of new hire orientation program and completed voluntarily for current employees of the firm. As more-and-more architects complete the Early Phase Energy Modeling curriculum, a series of additional learning modules are envisioned that further supports support the Integrated Design Process. This is a more intensive and

rigorous curriculum focused on design refinement subsequent to Concept and Schematic Design phases.

To assess compliance and guide progress, the AIA 2030 Commitment program and the Design Data Exchange (DDx) as the data management tool for all project related energy data is utilized. Bespoke quarterly internal reports are also generated from DDx project data exports assisting the firm in understanding progress. These reports are utilized by the primary and relational stakeholders aforementioned. With the recent 2019 data submission for the 2030 Commitment to the AIA, the firm that embraced the key firm directive, energy model all projects, and developed a common core curriculum centered around the integration of early phase building energy modeling was able to improve the overall predicted energy use intensity reduction percentage (reduction from baseline) to 50% (an improvement of 3.8% from 46.2% in 2018) and percentage of gross square footage that is energy modeled increase to 77.6% (an improvement of 32.4% from 45.2% in 2018). While the initial target of 100% and the predicted energy use intensity reduction percentage of 70% required by the AIA 2030 Commitment for the 2019 reporting period was not achieved, substantial progress was made within the firm in terms of repositioning within a 1-year time period (more than 76.7 million gross square feet of projects in design were submitted in 2019 alone). It is anticipated that more progress will be made towards the firm's said reporting goals in 2020.

CONCLUSION

The AIA 2030 Commitment urges architects to become agents of change in the face of a looming global climate crisis. The impact of energy demand and consumption in the built environment is dependent on early design decisions. The American Institute of Architects (AIA) note that energy is a design problem. The solution then, as suggested, would be to "engage energy modeling directly with design generation, thus informing major design decisions and providing continuous feedback." However, familiarity with Design Performance Modeling (DPM), including fluency in vocabulary, technologies, process and software tools that support energy and carbon considerations as an active element of design needs support. Building knowledge is a competitive business imperative. Thus, the delivery of energy efficient design solutions is a core characteristic to quality architecture.

Realizing the full potential of an architectural design firm is dependent on sincerely engaging early in energy design. Early phase building energy modeling must be seamlessly integrated into the design process by committing to utilizing energy modeling on every project to inform early design decisions and benchmark performance. Meeting the AIA 2030 Commitment goals will drive a more deliberate, integrated, and data-rich design process. Engaging energy as a key element of building design opens up potential for design innovation and value creation. This paper examined an architectural firm's repositioning of inclusive design intelligence by establishing a common core curriculum centered around the integration of early phase building energy modeling with the desired outcome to support a carbon-neutral built environment.

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