Performative Architecture: Outcome of Assumptions

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In the book American Building 2, James Marston Fitch recognizes architecture as an instrument capable of modulating energy flows responsible for the meso-environment atmosphere and subsequently requested the discipline of architecture judge buildings through their performance. These assertions published by Fitch in 1947 were not aimed at climate change or energy demands, but instead were concentrated on architectural accountability. The core lecture course Environment | Building | Systems [EBS] acknowledges Fitch's request and posits the methods and techniques used to shape interior environmental conditions cannot be conceived in isolation, but, instead as a collective of interconnected decisions– a system thinking approach.

Through a union of lectures, workshops, hands-on exercises and physical testing, the EBS course introduces students to the looming energy and environmental issues facing the discipline of architecture. Course content is delivered explicitly through the lens of energy, reframing investigations in architectural precedents, proposals and analysis not led by formal interests but through performative measures. Operating as a supporting course to the technical and integrated studios, design ideas are tested, interrogated, and analyzed as students are exposed to the successes and failures of their architectural strategies.

The paper Performative Architecture: Outcome of Assumptions, will focus on the evolving curriculum within the EBS course; specifically two exercises employing physical testing and environmental metering– a Climate Walk and a Foam-Box-Model– linking atmospheric conditions with design decisions through quantifiable data of thermal modulation. Through a series of systematic iterations investigating color, shading elements, thermal mass and phase change materials students learn how to manipulate the temperature profile of the meso-environment through form and material. The physical testing provides quantifiable empirical data to otherwise assumed outcomes of design decisions. The primary course objective is to provide emerging students methods and techniques to address the imminent pressures of climate change through performative architecture.

> 'Man's energy and health depend in large measure on the direct effects of his environment.'[1]
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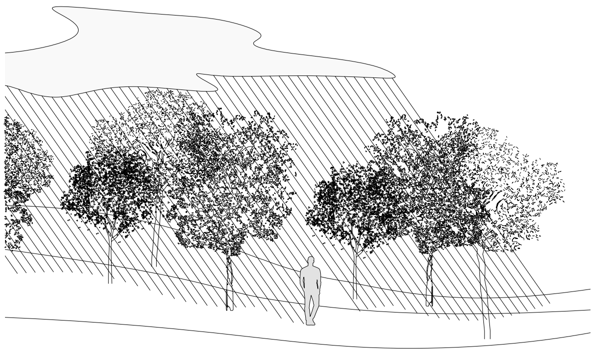
> —Victor Olgyay (Architect 1910 - 1970)

A GLANCE THROUGH THE LENS OF ENERGY AND ENVIRONMENT

As architects, we must come to terms with the fact that we design and make in the physical realm. This act of construction mandates the accumulation of matter and the expenditure of energy through the conversion of said matter into usable construction materials. These energetic processes are at the service of an architectural intention– to define or create interiority from exteriority. This act is a conscious and deliberate drive towards the control of human comfort. The humanistic predisposition to alter one's environment from the uncomfortable into the comfortable is achieved in two steps: the compartmentalization of a portion of the macro environment into a smaller meso environment and the modulation of energy flows between and through these two, now distinct environments (figure 1). James Marston Fitch referenced the space between the macro and micro scale as the meso environment in his seminal work, *American Building 2: The Environmental Forces That Shape It*.[2] Embedded in the management of the meso environment is an architectural agenda for energy; the pushing and pulling of energy and matter to modulate: *warmth, coolth, dry, wet, dark, light, security, etc…*, establishing a very clear argument that buildings are by design enormous dissipaters of energy. However, under no circumstance should describing a building as an enormous dissipater of energy be understood as a measure of qualification for good or bad, right or wrong but instead as a proposition of productivity. Through this lens, the productivity of the building or buildings are measured by the type and amount of work achieved by the architectural elements as related to the dissipation of exergy into a state of entropy.

This measurement of productivity, or work, is more simply defined as the building's performance –the productive output of form as work is the critical factor in considering a building's design. This notion is antithetical to the ideas of form and apriori, yet the discipline of architecture must begin to seriously contribute towards a healthy, long-term, built environment. The architectural discipline must ask, *how can our design*



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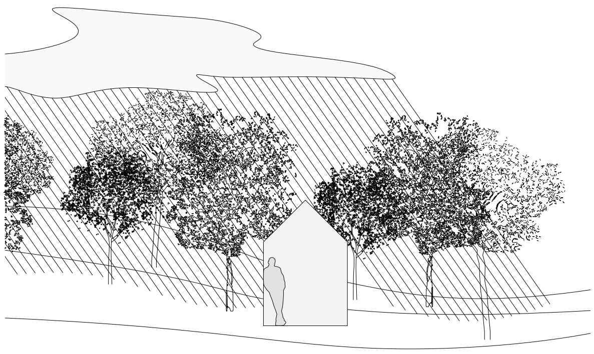

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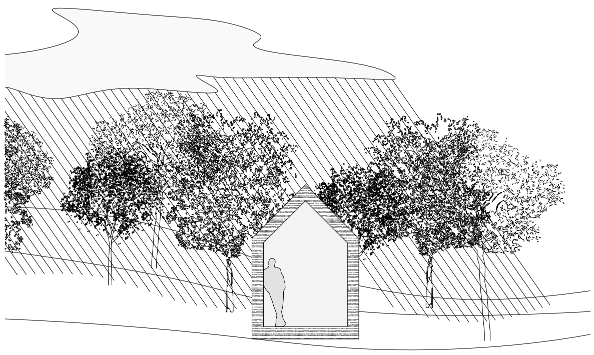

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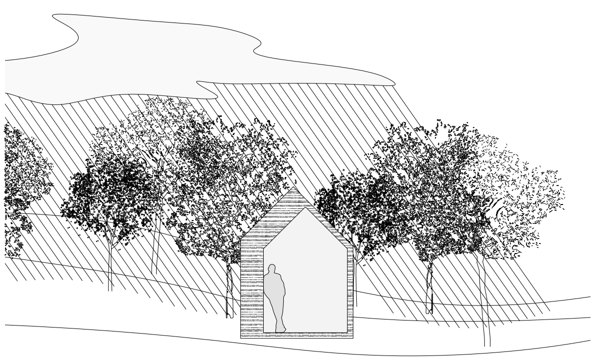

Modulating the connection between the Macro_terrestrial Meso_architectural

Figure 1. MICRO MACRO MESO environment diagrams expanded from James Marston Fitch's work in American Building 2. Image Credit Christopher Meyer.

processes shape ideologies and methodologies towards architectures that dissipate energy in the most productive manner possible? The repetitive calls for architecture to acknowledge and take charge of an effective energy agenda are not new agendas nor are they geographically isolated, meaning this is both an old and global concern. This call to action is combating long standing and narrowly focused architectural practices operating under a limited understanding of architecture and energy. The paper *Performative Architecture: Outcome of Assumptions* takes the position that architecture should be conceived through the lens of energy and environment. Instilling an architectural agenda for energy and environment arguably begins within the walls of the University and in the space of pedagogy, for all intents and purposes this is a proposition of and for design pedagogy.

Environment | Building | System, a core seminar course within the NAAB accredited undergraduate and graduate architecture program at the University of Miami School of Architecture is positioned to challenge existing and rooted practices in architectural education. The intention of the course is to address the long-standing and oft antiquated ideological and methodological approaches in the early stages of design; targeting the environmental survey of the project site. The paper will focus on two exercises developed to challenge enrolled students to investigate their environmental surrounds and the subsequent impact these forces can and will have on their building's established micro environment.

A RIFT IN ARCHITECTURAL EDUCATION

The aim of architectural education is to prepare students with an ideological position in architecture– to challenge one to engage how architects, as creators, perceive and construct the built environment. For the purposes of the course Environment | Building | System [EBS],it is imperative a commitment to the act of building is declared. This is a decision to grapple with the obstacles accompanying the construction of one's ideas and excludes the position of *'doing nothing'* as the best path for energy and the environment. This pedagogical commitment denies architecture the opportunity to straddle the line between the practical and theoretical realms; thus, if you must build, what are you building? The course focuses on the testing of these ideological positions through small-scale mock-ups evaluated on their performative outcomes.

Consequent to the transformation of an idea into a physical form is a continuous relationship with energy, for buildings this is best described as an open exchange of energy and matter. An inescapable truth, the built environment will always and continuously engage in an energetic exchange with its surrounding environment. For developing students, it is important to reinforce that a conscious or unconscious disregard for the laws of physics and thermodynamics does not bypass the responsibility of a building to negotiate this open exchange of energy and matter [as energy will continuously and one hundred percent, transfer until it reaches a state of entropy.] Instead, this disregard positions the building into a state of vulnerability. Furthermore, when a building loses track of an energetic or environmental agenda a conflict between the desired conditions and the reality of performance is forged. This misalignment between agendas is played out over the course of the building's life, requiring large amounts of high-grade or processed energy to run the building systems. This misalignment dilutes the capacity of the building's energy performance to a cycle of balancing thermal gradients into a state of comfort. For the western society, this means maintaining approximately seventy-five degree fahrenheit indoor temperature with sixty percent relative humidity[3]--regardless of the locale and climate zone. The course asserts the common cause for disconnect between a building and its climate environment is the lack of basic site information and a misunderstanding of the environmental forces that will inevitably act on the building. Through two exercises focused on the introduction and evaluation of foundational knowledge of energy transfer, students learn to make visible the environmental forces at play.*

**It should be noted these two exercises, Climate Walk and Foam Box Model, focus on the operational energy, excluding the emergy of materials and processes implemented in the construction cycle.*

TEACHING TO MAKE VISIBLE THE INVISIBLE

Connecting the climatic forces acting on and around a project site to an architectural proposal requires the development of a clear methodological approach engaged throughout the design process. The first step of this approach is to decipher the climatic forces acting on the site, or simply to identify, measure and define the energetic behaviors of the surrounding environment. Additionally, to emphasize the integration of climate analysis into the design process and build familiarity for the students, the course provides a redundancy in site documentation through a range of exercises, climate sites, metering equipment, and data analysis. As the students gain confidence in the metering process the transition into data analysis helps create a platform to deploy acquired information through architectural proposals.

These first steps of a design exercise objectively grounded in environmental factors and psychometrics can look and feel very abnormal when compared to the subjective approach of the tabula rasa in which design emerges solely from an artistic perspective. One could define this shift in approach as a rebalancing of the architecture to an amalgamation of art and science. A shift that is proven needed if the discipline of architecture is going to contribute in a meaningful way to the issues emerging from a changing climate; including the irrational growth in demand for high grade forms of energy and building resources with enormous emergy accounts.

As architectural curriculums emerge from the quagmire of modernist education an opportunity to leverage energetics as a foundation principle has surfaced. The two exercises, Climate Walk and Foam Box Model[4] aim to displace strategies aligned with best guess assumed approaches to a science of architecture and energetics. These exercises are not intended to be a high-level engineering exercise, very much the opposite. The expectation is to reconnect the students with the environment they live, work, play and sleep to clarify the active and continuous exchange of energy through architecture.

Figure 2. Thermal imaging exposes the thermal gradients of our environment. Image Credit, EBS course

'DO NOT FIGHT FORCES, USE THEM.'

—Buckminster Fuller (American Architect 1895 - 1983)

All of the environmental forces– air movement, thermal patterns + heat transfer, insolation and humidity– have significant impacts on comfort. In order for our architecture propositions to nurture productive engagements with the surrounding milieu, we must first understand the composition of our environment. What are the environmental forces at play? How do we make sense of our sensorial experiences? How does our perception of space compare to the psychrometric data?

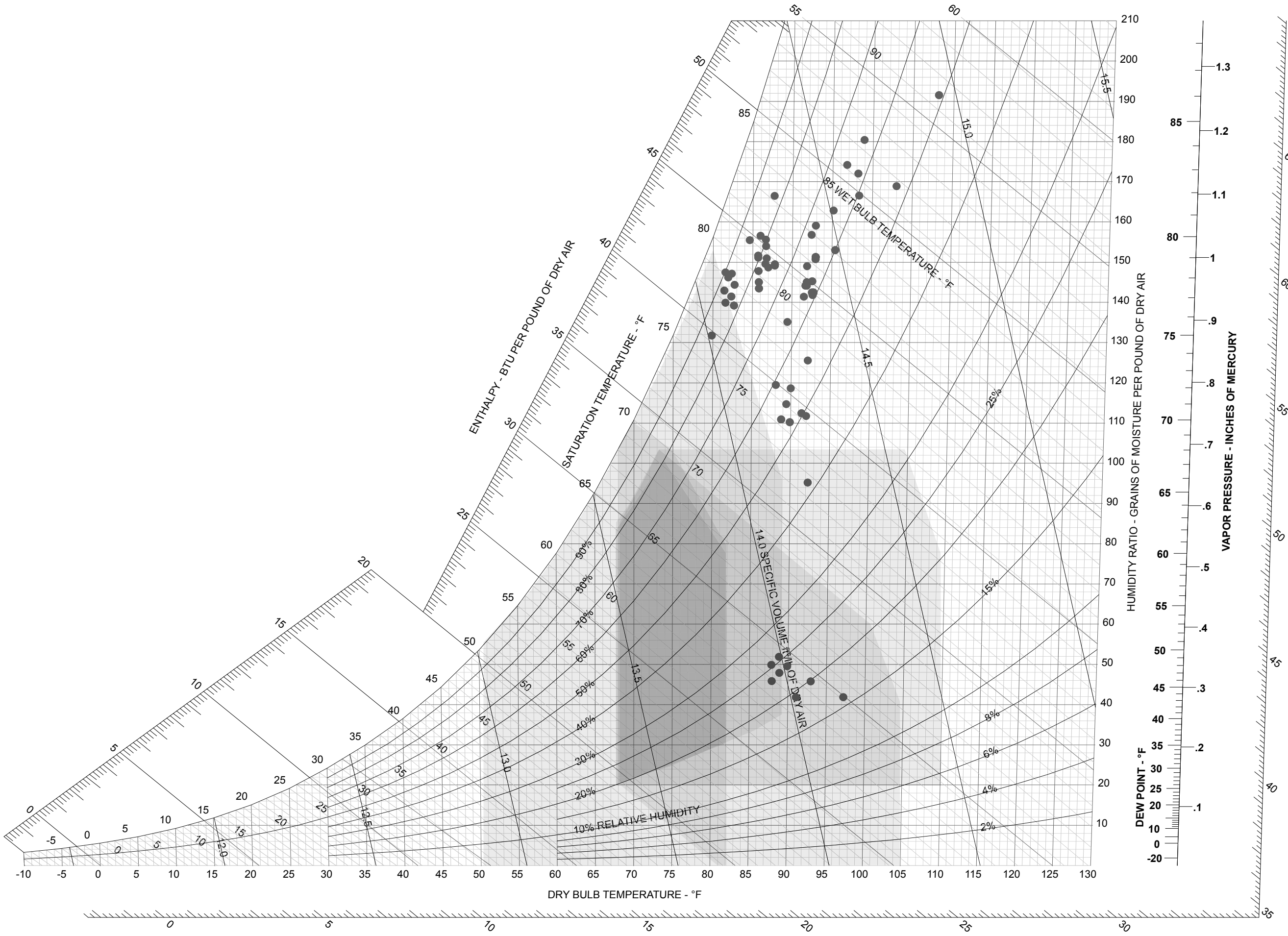

Figure 3. Psychrometric results from the Climate Walk exercise indicating the range of environmental milieu found within the University of Miami's Coral Gable Campus. While the temperatures remain within a few degrees the difference in humidity levels sets the difference in comfort/discomfort. Image Credit, EBS course

The Climate Walk exercise at its core is an atmospheric immersion. Armed with basic metering equipment– an environmental meter, and infrared thermometer– students embark on a Climate Walk to search out extreme conditions within the urban environment, coolth and warmth. The search is limited to exterior spaces only, meaning actively heated or cooled spaces are excluded. Ambient air temperature, relative humidity, dew point, lumen levels, wind speed and the surrounding surface temperatures are recorded and mapped as a means to compare the psychometrics of multiple locations. The act of mapping the data points is vital to understanding psychometrics and the range of human comfort, however, possibly more important is the tuning of the sensorial effects on the body with quantifiable data displacing the assumptions. The students gain empirical knowledge of the varied climate characteristics as they simultaneously experience and record the range of conditions.

These initial processes build a capacity to observe, a learning through observation to identify the invisible climate forces and a deeper understanding with the various sensorial observations inherent to one's body. The Climate Walk exercise challenges the oversimplification of comfort as merely hot or cold. The body, communicating with its surroundings through an open, active and continuous exchange of energy experiences either convective, conductive and/or radiant modalities. In other words, an uncomfortably hot space could be the result of elevated ambient air temperatures or conversely thermally charged surfaces radiating energy to or from the body. The result may be generalized as uncomfortable; however, these are two very different environmental conditions. The experience and subsequent documentation of these range of sensations challenges the students to acutely define what they are experiencing. Once the experiential portion of the exercise is complete, it is critical to relate the various observations by the students to architectural proposals and the ability to establish fundamental alignments with these primary modes of energy transference. For example how context or orientation can engage convective and radiant modes of energy transfer through different architectural methodologies.

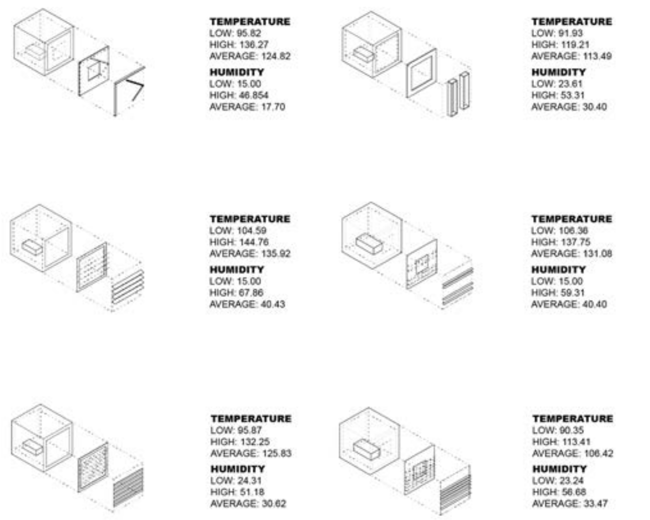

Figure 4. Selected Foam Box Model tests; Temperature and relative humidity levels were recorded over a set period of time. The collected data was compared against parallel tests to understand the performative outcomes of the design studies. Image Credit, EBS course

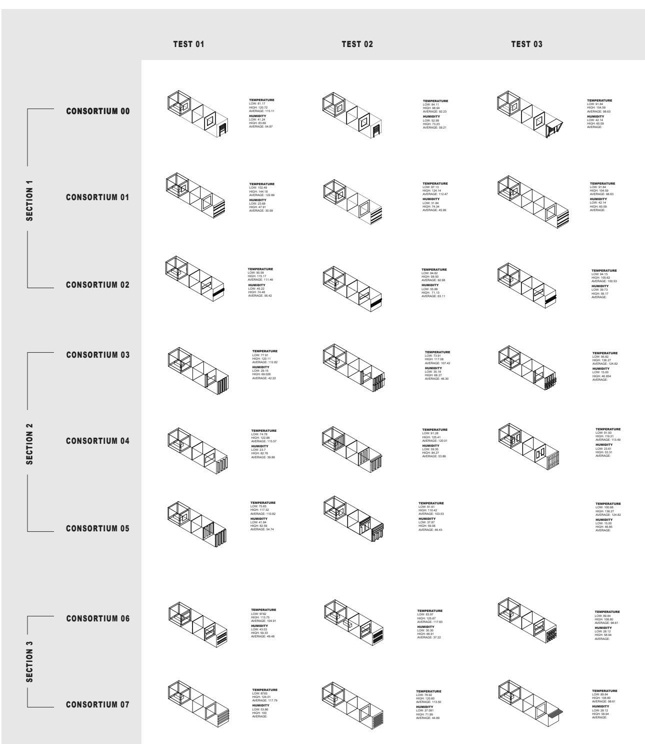

Figure 5. Taxonomy of Foam Box Model tests; Each section was composed of approximately eight groups testing a shared set of design parameters simultaneously. A total of three tests per section were conducted with increasing parameters. Image Credit, EBS course

INTERIORITY | EXTERIORITY

The body serves as an architectural proxy, as students are meant to sense firsthand the environmental forces their architectures will soon face. A narrow-minded approach to energy's impact on architecture has the ability to be dislodged [even if temporarily] to perceive energy as an offering to architectural form. The schizoaffective pursuit of modernity to build hermetically sealed environments is not amenable to the open exchange of energy and matter between architecture and environment. Architecture is drastically limited in its capacity to leverage form- making for the extraction of work from the surrounding energetic forces. The second exercise, Foam Box Model, positions architecture as an agent in the active dissipation of energy; what happens when architecture accepts energy?

The exercise Foam Box Model deploys rudimentary principles of solar shading, absorption of electromagnetic radiation, and phase change materials to curb, shape and mold the interior temperature profiles over time. The project's approach looks at two moments: the transmission of energy from the exterior environment through the building envelope into the interior and secondarily, [once the energy is trapped] energy dissipation strategies. Together these two moments examine sensible and latent heat exchange.

Using a set of identical foam boxes or models, elevational studies are organized into two categories: percentage of glazed area, and shading elements [oriented horizontal or vertical] to be tested. Varied iterations of shading elements defined through set parameters are analyzed for their impact on the transmission of heat energy through the prescribed elevation. The lack of an active mechanical system adjusting the interior temperature and relative humidity allows the students to witness dramatic temperature changes of their space.

At the conclusion of the solar shading tests, students are requested to deploy phase change materials as a passive strategy to bend the interior temperatures. The temperature profiles are recorded with a data logger on the interior and exterior simultaneously mapping the changes in temperature over time. The data loggers map the inflections in thermal exchanges exposing the flowing of energy and subsequently the pressures acting on the model. The exercise poses the question, if architecture can be charged with shaping and molding temperature profiles to produce comfort can the dependency on active systems be diminished? Architecture can in fact be asked to dissipate energy actively and productively; to do work. It is mandatory to have a clear description of the environmental forces or the design proposals are based on assumption.

CONCLUSION: THE UNHOLY UNION

The trajectory of the architectural profession depends greatly on the strength and leadership of architectural education to see and act on the future, now. The vast majority of NAAB accredited schools of architecture include as part of the core education a building system studio(s) and companion integrated seminar course(s). A self-critique of the 'systems-based courses' would expose long standing commitments to traditional techniques that reinforce standards and processes that can no longer be afforded by our environment; such approaches are aligned with global construction ecologies, high energy and carbon processes, hermetically sealed buildings and crippling dependencies on active mechanical systems. The reliance on these processes are directly linked to a building's lack of ability to acknowledge the context that it is situated within, compounded by the inability to engage the environmental forces in a productive manner.

The two simple yet impactful exercises, Climate Walk and Foam Box Model, aim to reconnect the architectural proposal to site, defining a bond between the built and natural environment. Through the deciphering or decoding a project site, assumed environmental conditions are replaced by the documented psychometrics. This simple process has great potential to diffuse the future energetic scuffle between the building and surrounding environment.

A union of two very divergent characters, that of art and science, a certain Dr. Jekyll and Mr. Hyde circumstance has the capacity to address the very serious issues in a changing climate and environmental degradation. If architecture accepts the challenge to address the impending obstacles associated with a rapidly changing climate--a disciplinary shift towards science based approaches is required. The most basic step towards an architectural agenda of energy and environment is the connection of the early moments of the design with reality of the environmental conditions. Architectural education must ask, how can our design processes shape ideologies and methodologies towards architectures that dissipate energy in the most productive manner possible? How do our buildings work for our climates?

ENDNOTES

1. Olgyay, Victor, and Aladar Olgyay. 2015. Design With Climate: Bioclimatic Approach to Architectural Regionalism. Princeton: Princeton University Press, 14.
2. Fitch, James Marston. 1975. American Building 2, The Environmental Forces That Shape It. New York: Schocken Books, 16-18.
3. ASHRAE Standard 55-2017 Thermal Environmental Conditions for Human Occupancy and ASHRAE Standard 62.1-2016 for relative humidity in occupied spaces
4. Climate Walk and Foam Box Model exercises developed in collaboration with Erik Olsen, PE, Managing Partner Transsolar KlimaEngineering