

Traveling Michel Serres' Passage du NordOuest: what happens, once the ice breaks?

A reflection on architectural research conducted
between the humanities and engineering.

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ABSTRACT:

This paper investigates the complex design process for sustainable buildings mediating between spatial composition and architectural typology on one side and thermal, climatic conditions and energy use on the other hand. The theoretical base is Hermès V Le Passage du Nord-Ouest (Serres, 1980) by the French philosopher and mathematician Michel Serres (1930 -), where he is searching for a passageway from the exact sciences to the arts and humanities. While both are looking to explain the world with their own methods, they are turning their backs at each other. The shipping passage in the North of Canada connecting the Atlantic and the Pacific serves him as a metaphor for this complex thought space linking, connecting and dividing, these two explanations of the world. This text is dealing with the connection of places, which seemingly are separate: rigidity and phantasy, myths and exactness, quantitative and qualitative knowledge. Based on this understanding the paper analyzes the design process between architecture and engineering as a passage passing four overarching theoretical frames crossing between geometry and perception, drawing and material, atmosphere and typology, technology and desire thus befriending quantitative and qualitative methods of design thinking. The research analyzes a built experiment, the Interlock House, which focused on the relationship of spatial composition and air flow as a means of energy transfer, the impact of passive and active environmental controls and systems on architectural design and improved building energy performance. The means to travel the passage: proportions, thermal detailing, natural ventilation strategies and daylighting are here identified as key moments for sustainable design. Design communication for sustainable buildings needs to convey information between multiple entities with opposing language systems and thus equals a map rather than a flow chart. A collaborative design methodology emerges from these passages when the ice breaks.

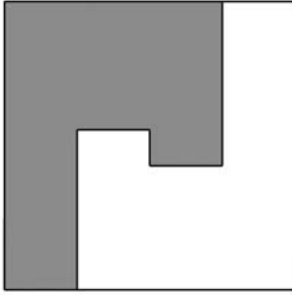
CONFERENCE THEME: On Approaches

KEYWORDS: Design Communication, Sustainable Buildings, Integrative Design Thinking, Interdisciplinary Collaboration, Natural Ventilation

I. INTRODUCTION: RESEARCH THE PASSAGE DU NORD-OUEST

Open space architecture which is well-tempered in light, color, materiality and space can become a climate device to make daily life comfortable and sustainable. The presented research is a continued analysis (Passe 2007) of the complex relationship between spatial composition in free-flow open space typology on one hand and thermal and climatic conditions within buildings on the other. It asked how spatial design theory of transparency in space can contribute to and enrich the development of sustainability and the reduction of energy consumption in buildings. The research started with a re-reading of selected architectural icons of modernism which use free-flow open space through diagrammatic drawings and simulations with computational fluid dynamic (Author 2009) and proposed and built a solely solar powered house with a large interdisciplinary university team to develop design strategies for sustainable buildings.

The name of the Iowa State entry to the U.S. Department of Energy Solar Decathlon, the Interlock House, provides the starting point for implementing the design strategy. Within the project, the concept of 'interlock' had many meanings: the spatial integration of active and passive environmental control systems; the densification of urban neighborhoods by adding new housing units to existing



INTERLOCK HOUSE

Figure 1: Design diagram: Interlock House. (Team 2007)

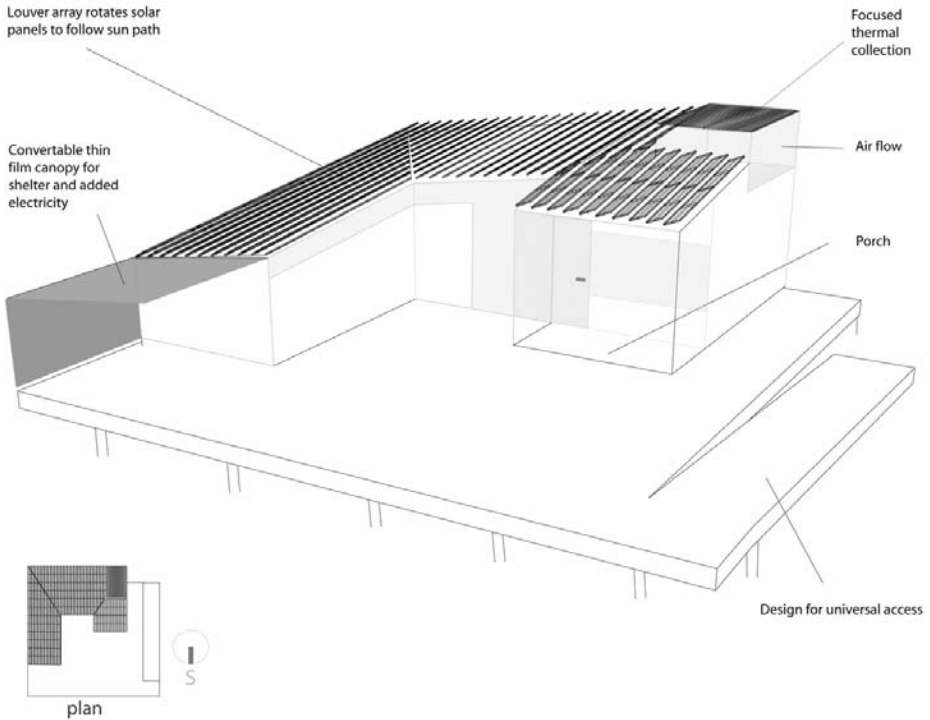


Figure 2: Three-dimensional design diagram. (Team 2007)

fabric; an active connection between the occupant and their landscape and climate; the relationship between the two main processes of energy conversion - thermal and electric; and the multidisciplinary nature of green building design which brings together architecture, engineering, science, and art. The Interlock House is designed as a climate device. The design process to derive at this house was an interlocking communication and translation system, which connected parameters on various levels of disciplines, construction techniques, and thermal properties, climate of seasons, user patterns and comfort requirements. A process of translation developed across the disciplinary boundaries.

The French philosopher and mathematician Michel Serres (1930 -), in Hermès V Le Passage du Nord-Ouest (Serres 1980) is searching for a passageway which leads from the exact sciences to the arts and humanities. While both are looking to explain the world with their own methods, they are turning their backs on each other. The shipping passage in the North of Canada connecting the Atlantic and the Pacific serves him as a metaphor for the complex thought space linking, connecting and dividing, these two explanations of the world. This text is dealing with connections of places, which seemingly are separate: rigidity and fantasy, myths and exactness, quantitative and qualitative knowledge. The Northwest Passage serves here as a metaphor for the complex design process between disciplines needed to produce and perceive sustainable architecture.

2. METHODOLOGY

This paper analyzes the design methodology of an interdisciplinary team while designing the Interlock House as a passage between architecture and engineering through four overarching theoretical frames crossing between geometry and perception, drawing and material, atmosphere and typology, technology and desire thus mediating quantitative and qualitative methods of analysis. The means to transverse the frames are passage culminating in the design effort as a synergy of hard and soft facts (Connor 2009). For sustainable design these passages are proportions, thermal bridge detailing, natural ventilation and daylighting.

This methodology opens the potential for a new interdisciplinary design thinking where the harsh communication boundaries between the disciplines and dialectics are broken up and a singular architect as author is replaced by a jointly working team. Neither of the passages can exist without either side of the frames.

The 2009 Solar Decathlon competition measured and evaluated each house in five subjective and five objective contests which is comparable to a travel through the Northwest passage. The subjective contests evaluated architecture, engineering, market viability, communications, lighting design and the objective contests comfort zone, hot water, net metering/energy balance, appliances, home entertainment were measured with built in instrumentation. Some contests were task based such as hot water and appliances. Other contests such as comfort zone and net metering were directly measured throughout the course of the competition time. Each house was equipped with shielded temperature and humidity sensors to measure interior air characteristics. Bidirectional wattnodes and current transformers were used in each house to determine the overall energy balance. Sensors were also placed in the center of the exterior competition site to measure environmental temperature, humidity and insolation on a horizontal surface. The competition assigned points based on how well a team met the criteria for each of the ten competitions. Specifically, full points were awarded in the comfort zone competition for maintaining an internal temperature between 72°F and 76°F and maintaining an internal relative humidity level between 40% and 55% during all scoring periods.

The design process can also be read as a performative map representing a house which creates its own thermal environment. The design team was using simulation and modeling maps to understand and communicate the energy performance and thermal and visual quality and atmosphere of the house at the same time. The central entity, bringing all these assumptions together, is the spatial configuration of the house based on the spatial concept (Fig. 1 and 2) of efficient and generous distribution of the collected heat energy which manifests itself in section and plan of the building. The spatial concept balances the need for a tilted south-facing surface for the photovoltaic array, the use of thermal heat and cooling vents and the capturing of energy with the envelope and thermal mass. It incorporates natural air flow and ventilation strategies to enhance comfort and thermal balance. The interrelation

of all parameters manifests itself in a balance of flows. A strong feature therefore is the exploitation of natural convection to create vertical flows. Material flows, energy flows, air-flows, and the movement of inhabitants are intrinsically and spatially related.

In the following the process will be narrated by first indicating the duality of the frame followed by the passage, indicating the design means which opened the connection. As with Michel Serres, the passages are attempts to communicate between two seemingly unrelated opposites.

Michel Serres' travel agent for the Northwest Passage is Hermes, the messenger of the Gods in Greek mythology. In secular terms Serres describes the interaction of qualitative and quantitative information as a process of language, which translates or maps back and forth between the domains. Thus the passage is opened with communication. Every participant breaks the ice. Hermes is also the god of travelers and merchants, the messenger from gods to humans, thus also the god of communications. Michel Serres is suggesting that the Northwest Passage between science and humanities is communication, learning each other's language and respecting each other's contribution. The concept of translation, the in-between is what is important to understand and connect the opposing sides. No single team member incorporates all necessary knowledge, thus team collaboration is necessary to break the ice. The passage is open when participants do not turn their backs at each other, but face each other and share a common language and goal.

The common language between Engineers and Designers in the process to develop a sustainable building is a performative map or model, which acknowledges quantitative and qualitative knowledge as essential parameters to understand and research architectural phenomena and the communication within an integrative design team can make it apparent to all parts. Design teams have to develop a decision making processes without a singular decision maker, which is more similar to maps rather than hierarchical flow chart! And it is equally important to agree upon joint evaluation criteria and parameters for a continued mapping of the decision process as it is to identify obstacles and conflicts.

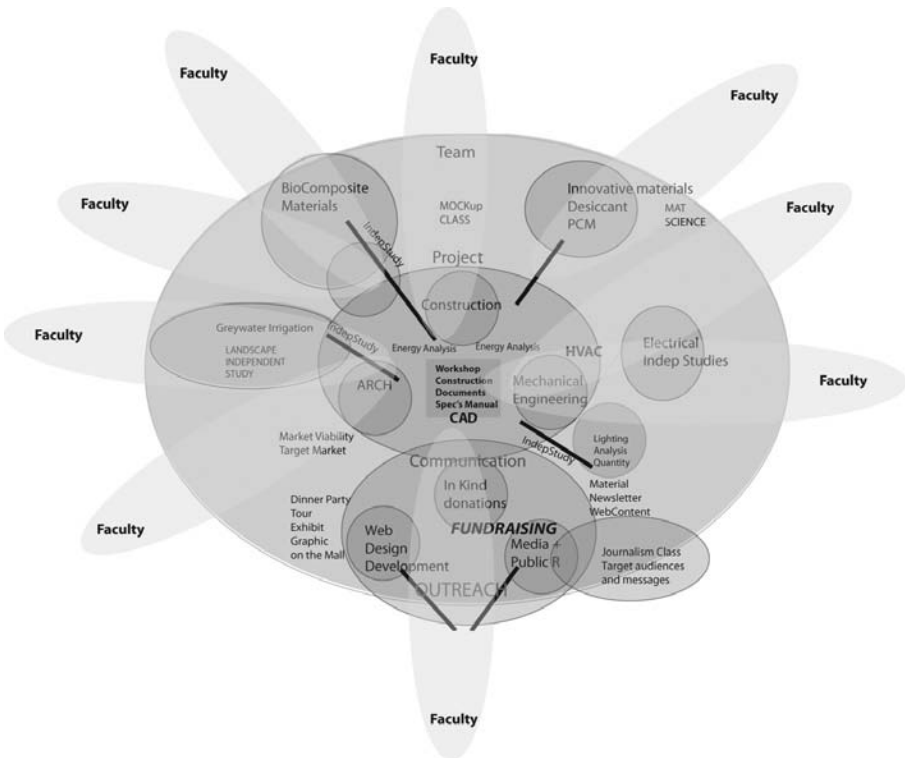


Figure 3: Map of team organization (Passe 2009)

The team organization diagram (Fig. 3) developed was not hierarchical, but mapped a spatial relationship of responsibilities rather than a chain of directions and orders. The formal outcome of the team work is not predetermined as can be seen in the comparison of the initial design sketch (Fig. 1+2) from the proposal stage and the final built form (Fig. 4-6). Michel Serres traces in the Northwest Passage relationships between the Global and the Local, between global meteorological patterns and local climates. This paper attempts to trace these strategies within the design process.

3.FRAME: GEOMETRY – PERCEPTION

This first frame addresses the mechanisms and modes of production going to and fro and thus bridging the gap between theory, design studio and practice, between analysis and synthesis. As Serres points out, synthesis retains connective thinking (Serres 1980). In this frame geometry and perception are connected with the passage of proportional relationships.

3.1 GEOMETRY

The means architects rely on to develop and describe an architectural project is geometry, the science of properties, relationships and measurements of points, lines, curves and surfaces. It is an exact but completely abstract and immaterial science with-in mathematics. Space in its dimensions is thought to be defined with geometrical means. Geometry could be seen as the underlying alphabet for the language of space with its grammar and vocabulary of proportion, compositional rules, harmonies, disharmonies, elements, notations (Passe 2007).

The Interlock House was designed by drawing a three-dimensional grid into space as a system of orientation and a proportional relationship for all elements in the interior and exterior of the spatial composition (Fig.4). The Interlock House is a small house designed to feel roomy. Composed of three spatial modules, the private zone of sleeping and bathing is located in the western third, with the Kitchen and everyday dining in the eastern third. The center is a luminous Hall and a Sun Porch enclosed on three sides by easily movable walls that separate or link activities within these zones or to the decks outside to offer multiple and reconfigurable patterns of inhabitation within a compact, energy-efficient footprint.

Adjusting the house to suit the weather also allows for seasonal changes in lifestyle. For example, the Hall is protected in winter by the closed Sun Porch, which warms the house (Fig.5). In winter, activities may re-focus inward and the furniture can be re-arranged to fit patterns of living at that time of year. The wide range of climate conditions in Iowa with design temperatures in winter of -6 degrees Fahrenheit and 90/74 degrees Fahrenheit in summer create special design challenges and opportunities.

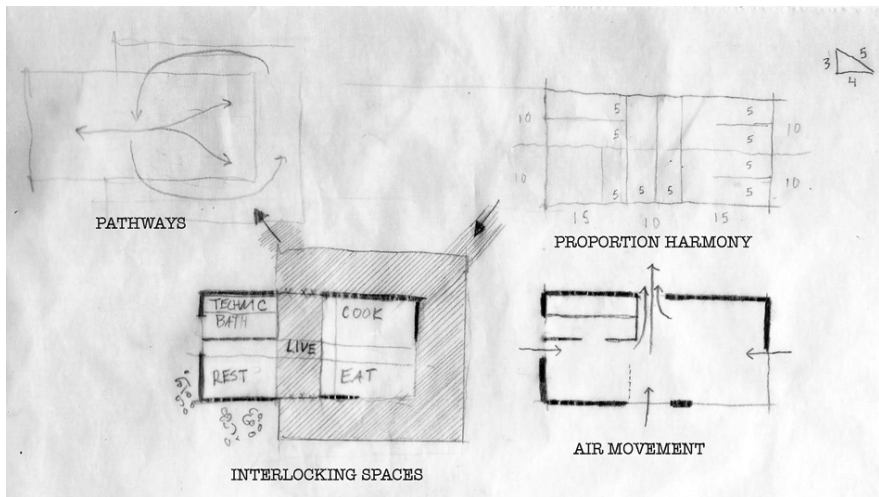


Figure 4: Conceptual sketch of house geometry. (Team 2008)



Figure 5: Seasonal patterns and spatial types (Team 2009)

3.2 PERCEPTION

Space cannot be perceived; what one can perceive are the borders of space, the edges, the thresholds, the materialization of the limits of space, the limitation of space makes it visible. The human visual perception therefore is not geometrical but spatial, such as the two eyes produce two separate images on the retina, which the brain merges together and through the slight difference of the two images we can estimate and perceive dimension, distance and space (Passe 2007).

The Interlock House is solely solar powered and full of light and air. Designed with high north clerestories and interlocking spatial volumes, daylight and artificial light wash the walls and ceiling, animating their sculptural quality, making the interior appear larger and brighter.

3.3 THE DESIGN PASSAGE CROSSING: PROPORTION

Spatial proportions are indicated by harmonious relationships of parts to the whole. The Golden Ratio and the Fibonacci Spiral are powerful tools to create basic harmonies based on the mathematic principle, that if two ratios are equal, their cross-product is also equal. Based on musical harmonies related to the human body proportions in architecture are indicators of beauty since antiquity. All major measures in the Interlock House are based on the ratio of 2:3 or 2:4 or fractions thereof (see Fig. 4 + 5).

4. FRAME: DRAWING – MATERIAL

This frame discusses the translation process between the concept of the drawing and the construction process. This is the most common but complex interface between soft and hard facts known in architectural production.

4.1 DRAWING

For multiple centuries the key skill of the architecture profession was to put lines and signs on paper. The key artifact and method of investigation of the architect has been the drawing and anything connected to the making of it. Drawing is thinking with a pen and now with a mouse or touchpad. Designing is a process of transforming to fit the artifact on paper to the thought of the mind. Drawing is a means to bring geometry in relation to perception, to work out relationships in space. The paradox of architecture is the translation process into building, into materialization, into a structural, spatial entity. While the method of drawing, whether perspectives, orthogonal projection, axono-metric view with real measurement and proportion informs the design of the space, the distortion of proportions through the perspective perception of the built form informs the user (Passe 2007).

Contemporary Computer Aided Design or Drafting has changed the potential for team work. A set of drawings on vellum has been replaced by a digital model, which carries multiple layers of information *and* final drawings, renderings and perspective views, the decision for which can be made *after* the model has been completed. Designing with CAD demands a totally changed discipline of drawing,

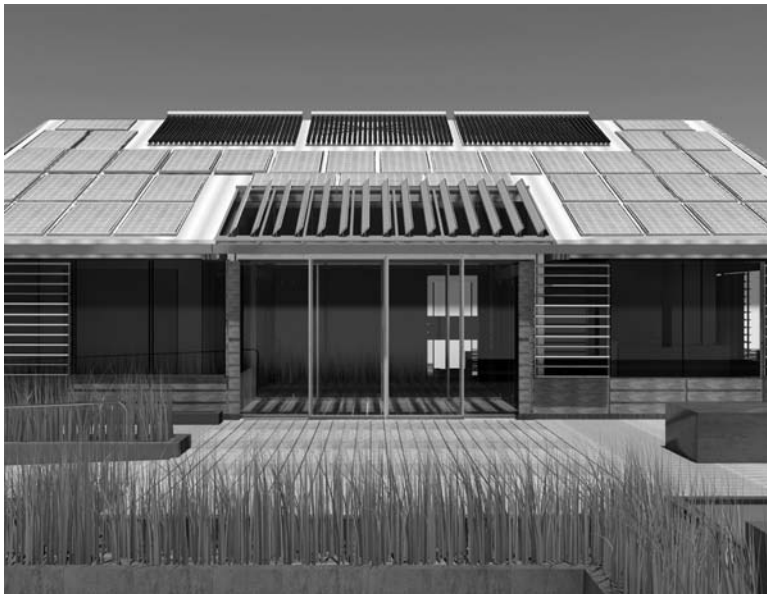


Figure 6: Rendering of south facade conducted in architectural media class ARCH 436 (Kiel Uhl 2009)

RAISE WINDOW SILL TO 30 INCHES (SOUTH WALL) -- **KEIHLY, DARCI**
SOUTH WALL RAFTER DETAIL--CHANGED --**ANDY**
WASHROOM--SECTION--DETAILED --**MELISSA**
STRUCTURAL--ADJUST --**ANDY, DARCI**
LIGHTS & CHILLED BEAMS--UPDATE TO MOST RECENT --**DAVIS, JENNIE**
REDRAW ALL SECTIONS--**DARCI**
SITE PUT IN TO ALL SECTIONS AND PLANS--**BRENT**
FLOOR PLAN--LAYER MANAGEMENT (LAYWALK) -- LAYER WALK ON ALL REF DRAWINGS--**ALL MANAGERS**
ADD LOFT IN CLERESTORY PLAN--**TRAMANH**
FLOOR PLANS MUST BE REFERENCED CORRECTLY--ENTIRELY GRAY WHEN REF'D --**BRENT**
DETAILS -- REORGANIZE -- MAKE CURRENT IN ALL DRAWINGS--**MELISSA**
SHEET GRID ADDED (DIFFERENT THAN STRUCTURAL GRID)--**ANDY**
LABELS --CLEAN UP AND CLARIFY THROUGHOUT--**ALL SHEET MANAGERS**
NEW WINDOW SIZES THROUGHOUT--NORTH CLERESTORY, WINDOW ABOVE SUNSPACE (TIM), SOUTH WALL--

Figure 7: CAD Sheet management (Team 2009)



Figure 8: Visualization of heating and cooling system embedded into the building fabric. (Andrew Becker 2009)

which is more process based than task based. Building Information Modeling provided the basis for this interdisciplinary team to collaborate and also conduct the translation from drawing to building through the three-dimensional model (Fig.6-8).

The organization of the drawing set to communicate materiality and to communicate a spatial reality and perception was the key to the travel of the Northwest passage, thus to design. The organization of the digital construction documentation demanded a linear hierarchy, but needed a spatial mapping structure.

4.2. MATERIAL

The making of architecture is the manifold translation process from drawing to material; it includes the material sciences, engineering, fabrication techniques and so forth. Any material ages in time, with natural materials, like this white cedar shiplap façade, this process is very obvious and visible. But also concrete, steel and even plastics react with the atmosphere. Lightness or heaviness are assumptions due to material joints, the way foundations are detailed, roof lines are put together, edges of openings are outlined, ideally to meet the concepts depicted in the drawing (Fig. 9).

The learning of this translation process in architectural education has multiple challenges, both from within and from outside of the disciplines, for example from the construction industry. Detailing the making of a joint is not considered part of the architectural challenge. In this case, the detail had to be developed and the materials found as the team was also the building of the house.

Very few tools exist, which can support a design team to determine the sustainability of a material decision. Many questions had to be answered to determine priorities. It had to be determined, whether the material should be natural, easy to handle, recyclable or renewable or how much waste is produced. The life cycle of a building and its 'cradle to cradle' approach was introduced as equally important design decision making parameter (McDonough 2002).

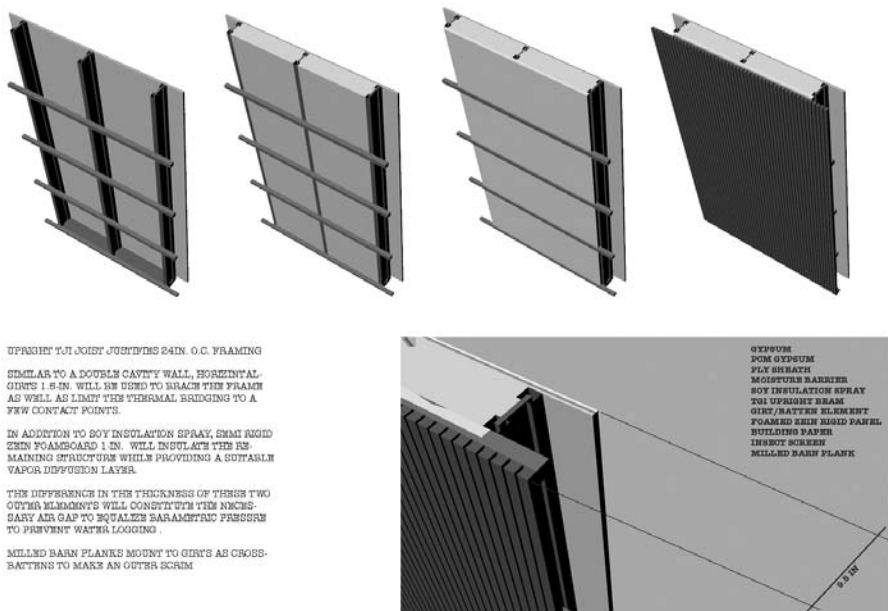


Figure 9: Different wall sections considered for the house envelope (Eric Smith 2008)

4.3. THE PASSAGE CROSSING: DETAILING JOINTS

Energy efficient detailing included the reduction of thermal breaks. The wall structure for the house was designed in two layers so that only minimal thermal bridging could occur. The team collaborated with material researchers (Grewell, Jarboe et al) in a search for new insulation materials with low thermal conductivity through foamed bio-based composite materials for thermal performance and environmental stewardship. Additionally it was important for the team to utilize the double function of materials, so that they perform usability functions as well as tasks for human thermal comfort like thermal mass in countertops, pebbles and floor boards. Finally the team worked with a door manufacturer to build doors with vacuum insulation for the North wall of the Interlock House with an R value of 40 so that a wall, which could be fully opened in mild seasons, could also act as a thermal resistant barrier in the cold of the Iowa winter.

5. FRAME: ATMOSPHERE – TYPOLOGY

5.1 ATMOSPHERE

The open plan can act as a design and functional strategy for thermal flows in appropriate seasons. The atmospheric quality of space is defined by physical quantities: plenty or lack of oxygen, and constantly changing humidity, heat, wind, pressure or tension (Table 1). The perception of space though deals with the atmospheric qualities. A space with a draft is regarded as not comfortable in connection with a prescribed use, like working or doing any sort of physical activity, but a breeze nevertheless can make natural ventilation possible and can be very pleasant.

Environmental characteristics have a huge impact on the development of spatial language, symbols and icons as culture is manifested through atmospheric and climatic properties. Humidity, dryness, heat, cold and light intensity have left their mark in the built form, roof type, surfaces, and openings of buildings. Buildings position themselves in relationship to the direction of the sun, the prevailing winds, etc. The need for vision, light, heating and cooling is based on the interrelation between the climate outside and internal needs. The porch as a spatial device met all of those needs (Fig. 10).

The overarching goal is to reduce energy consumption and to increase spatial delight by design. For this to occur, spaces above and below need to be interlocked and intertwined so that the air can move about freely (Passe 2009).

5.2 TYPOLOGY

‘Typology of use’, ‘typology of space’, ‘typology of structure’ are common terms in the discussion of architectural forms. There is a long discussion in architectural history and theory on the meaning and relevance of the term type and typology (Passe 2007). Reyner Banham (Banham 1969) very clearly points out that architectural type also forms the relationship to the external climate: the massive block or the tent-like structure not only engage differently with materials (brick walls versus light structure) but also imply a different use of space: the fixed and the loose boundary (Fig. 11). This house was designed to change its boundary with the seasons and solar radiation.

Common patterns relate to spatial types with a strong impact to climate and spatial ventilation, which is obvious in the typology of the dogtrot house of the American South, which for part of the year also functions in Iowa. The open plan typology used for the Interlock House fulfills various purposes. The Sun Porch (Fig. 6/10) is a semi-private indoor and/or outdoor space with a southern exposure that creates a warm microclimate. The north side of the house has a cooler microclimate, providing respite from summer heat and creating a more public, sociable space where inhabitants can interact with surrounding residents, enabling front-porch living.

The north entry doors are vacuum insulated for maximum efficiency during cold months. In the winter, only one of the four doors is likely to be used or the inhabitants might come and go exclusively through the Sun Porch, leaving snow boots and heavy coats to drip and dry in a space that functions as an airlock. The Sun Porch is enclosed on three sides by two different movable glass wall systems. When the exterior wall is fully open, the porch is open to the deck and garden. In the summer, the Sun Porch can serve as a shaded outdoor room. In a recent HB 2009 paper (Author 2009) the CFD

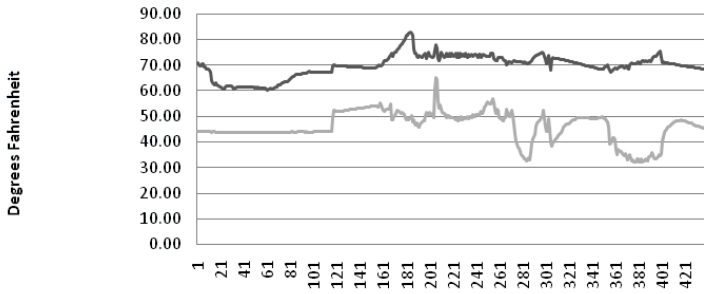


Table 1: Temperature and humidity profile during contest week in October 2009

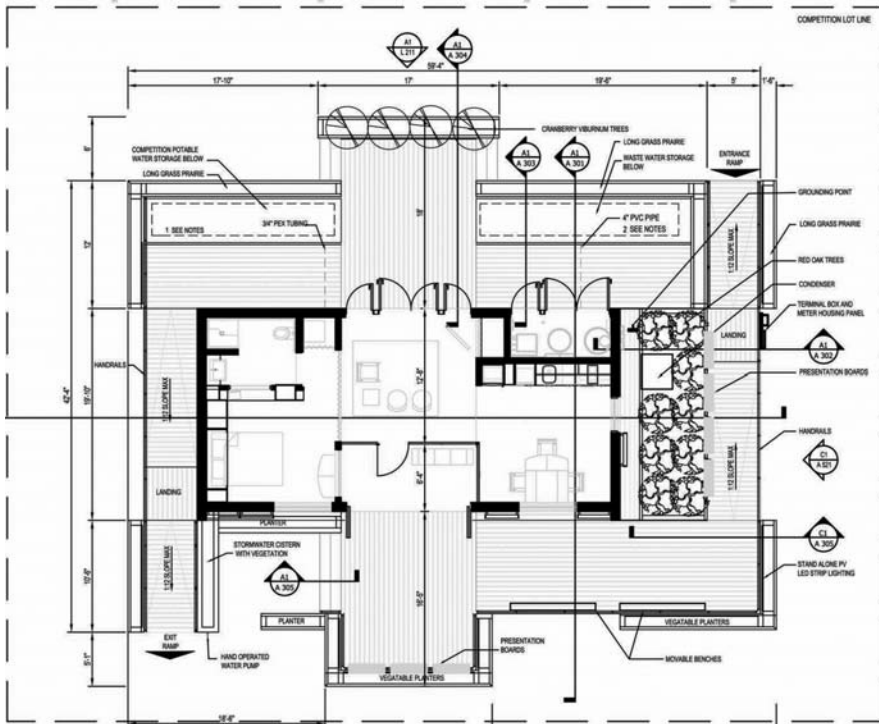


Figure 10: Site plan oriented North (Team 2009)

simulations show, that double high spaces cool a space quicker than single height spaces, therefore the Interlock House is designed with an open section as well as an open plan of high expanding vertical spaces for passive cooling due to the accelerated vertical convection.

5.3 PASSAGE: VENTILATION STRATEGIES

In the fall, spring, and milder summer months, the Interlock House can be cooled using natural ventilation. In order for natural ventilation to be effective as a passive cooling mode, there must be at least ten air changes per hour. The evaluation of the operable area of windows has been based on the wind speed required for each room to achieve ten air changes per hour. The Beaufort scale describes wind speeds in qualitative terms, but there are also numerical values associated with each level of the

Scale Number	Speed (mph)	Description
0	0	Calm; Smoke rises vertically
1	1–3	Wind motion visible in smoke
2	4–7	Wind felt on exposed skin; Leaves rustle
3	8–12	Leaves and smaller twigs in constant motion

Table 2: Ventilation figures (Engineering team 2009)

Room	South (mph)	North (mph)	South (Beaufort)	North (Beaufort)
Kitchen	0.79	0.17	-1	-0
Hall	0.06	0.05	-0	-0
Bed/Bath Rooms	0.77	0.17	-1	-0
Whole House	0.14	0.09	-0	-0

Table 3: Current Design Results—Minimum Required Wind Speeds for 10ac/h (Values recalculated May 26, 2009)

scale. Ideally, the wind speed necessary to have ten air changes per hour in a given room would be less than a three on the scale, with the lowest number being the most desirable. The average summer wind speed for both Iowa and Washington, D.C., falls in the three Beaufort scale range. Average wind directions for both locations are generally from south to north. The north-south orientation of the house lends itself easily to natural cross ventilation.

According to the calculations in Table 2 and Table 3, even the slightest breezes will effectively cool the house. This is largely due to the sizable openings of the operable windows. This means that on days that actually have a breeze above a one on the Beaufort scale, only a few windows need to be opened for effective natural ventilation.

The mentioned recent HB 2009 paper (Passe 2009) presents similar temperature patterns for the Viipuri library. The ventilation system for the Interlock House was designed with this knowledge in mind.

The views demonstrate a reduction in temperature with increasing velocity within the library's large reading space as the room cools due to airflow through the entrance. The vertically connected spaces cooled significantly faster than adjacent spaces. While general patterns can be retrieved from those two simulations, due to the complexity of the spaces and their parameters, predictions can only be made for individual spaces and involve elaborate modeling skills and knowledge of weather patterns. The novelty in the three-dimensional approach presented ... is the combination of thermal distribution and air velocity, and the possibility to evaluate them in a three-dimensional composition.

(Passe 2009)

5. FRAME: TECHNOLOGY – DESIRE

In Hermes V Serres introduced Zenon who walks the coast and never reaches his destination because at increased level of scale, the boundary becomes longer and longer. A wall divides and connects, acting simultaneously as boundary and threshold.

6.1 TECHNOLOGY

Prior to the development of mechanical air-conditioning, vernacular architecture used passive-building integrated strategies of spatial composition, ventilation heat retention and thermal storage

as an integral part of their cooling concept. House typologies like the bungalow adapted for Iowa in the late 19th century integrated colonial experience from British India with building technologies developed in New England using shade, material properties and natural ventilation. One main feature in this spatial strategy was the porch, a transient space, which acted as a main social gathering space, a shading device in summer and a sunspace in winter increasing seasonal comfort. Since the development of mechanical air conditioning in the U.S. building industry of the 1950's (Ackermann 2002), devices for heating and cooling have been separated from the design process and the porch as a climate device has disappeared from new residential neighborhoods, only images remain.

The ISU team investigated the potential of the porch for passive cooling strategies for the Iowan climate in its various forms through Ecotect analysis and with a variety of enclosures to develop intrinsic transient spaces for energy efficient and culturally rooted sustainable residential buildings in Iowa. The design team investigated vernacular strategies and combined them with contemporary passive means of thermal mass storage for night cooling. The aim was to maximize their potential as a conceptual cooling device and integrate them with innovative active mechanical ways of cooling through desiccant dehumidification.

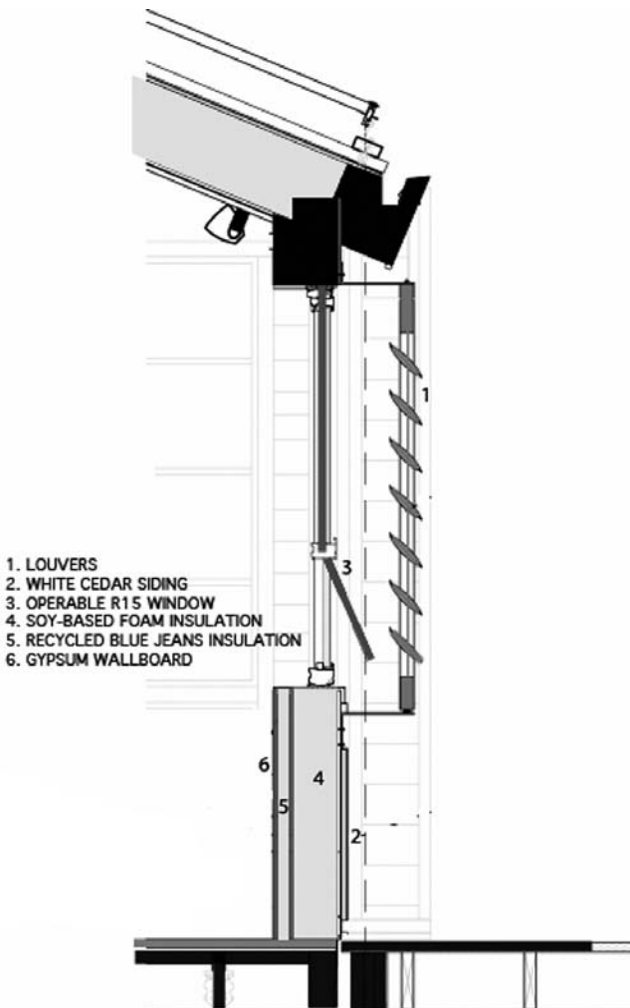


Figure 11: Wall section with high R-value (Team 2009)

The porch / sun space was designed as a climate device (Fig. 5, 6 + 10). The spatial composition of the Interlock House is seasonal. The Hall and Sun Porch can be reconfigured and opened to the elements. The Sun Porch, with added thermal mass in the floor, mediates light and heat and encourages convective loops to heat and cool the house. A louver system spanning the south façade also mediates light and heat and reduces the active cooling load in summer months. The louvers allow occupants to manipulate light and heat according to activities and privacy needs. The house requires active manipulation of its doors, windows, and exterior louvers to influence airflow and to maximize or minimize heat gain and loss. This reliance on several basic passive solar and ventilation techniques helps reduce the energy demands for the active systems. The effective meshing of the active and passive systems needs an alert and motivated resident. The long-term goal is to *integrate* the effects of passive design strategies into the energy performance evaluation of mechanical HVAC equipment for residential buildings in Iowa and equivalent climates, thus reducing energy requirements of mechanical (HVAC) systems.

6.2. DESIRE

The Interlock House was designed as a home and not as a machine, because there is still a desire for well-temperedness, for feeling and touch, the smell of nature in addition to application of energy-efficient technology. The passive strategies of the house were designed with an active user in mind engaging the occupants and their desire of personal control.

The Interlock House's lighting strategy is layered and hierarchical in order to enhance the aesthetic experience and functional needs of occupants and to address comfort and safety. Special attention is given to the role of light and color surfaces in supporting normative changes in vision that occur with aging.

Keeping Universal Design principles in mind, depth perception is enhanced by selecting colors that sharpen edge contrast. Through the selection of non-shiny surfaces, and the use of adjustable louvers to diffuse daylight, the Interlock House is able to increase the level of illumination needed, without increasing glare.

6.3. THE PASSAGE CROSSING: DAYLIGHTING

The Interlock House lighting strategy begins by optimizing daylight and minimizing the need for artificial illumination through the use of windows on the south, east and west sides of the house and high north clerestories (Fig. 12-15). Large windows on the south side and Sun Porch allow a maximum amount of daylight into the house, while built-in movable louvers adjust the quality and quantity of light as needs and activities change across the day and season. A sunny summer breakfast is even more delightful when warmth, brightness and glare can be modified by simply sliding a louvered panel that diffuses light without blocking it out.

Light levels throughout the house were considered. Conditions were studied for October 12th 2009; the sun angles are specific to that date and the longitude and latitude locate the structure towards the eastern end of the National Mall in Washington, D.C. The period of time studied—from 6:00 a.m. until 5:30 p.m.—includes sunrise and sunset. The team studied three atmospheric conditions—clear skies, partly cloudy and overcast conditions—as they each yield very different lighting effects.

7. CONCLUSION: THE ICE BRAKES

The Northwest Passage, Hermes and Zenon act as metaphors in Michel Serres critique of the current divide between the humanities and science. I have used the same metaphors to show how the divide between engineering and architecture can be overcome with a novel team design approach. The conceptual outline of a mind map as organizational structures for design teams will remain a task for further research into project based team strategies, but it can already be stated from experience, that without a changed decision structure in the design team, true sustainability, where aspects of humanity are addressed interwoven with aspects of science will not be achieved. The design practice



Figure 12: Clear sky 8.30 am. (J. George 2008)



Figure 13: Clear sky 10.30 am. (J. George 2008)

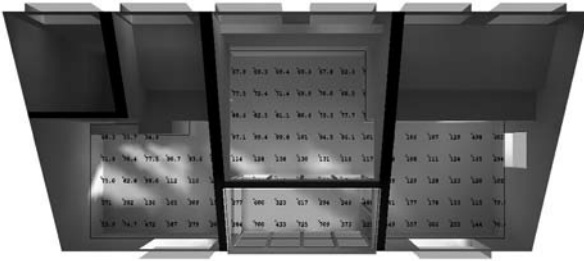


Figure 14: Partially cloudy 8.30 am. (J. George 2008)



Figure 15: Actual interior 10.30 am. (U. Passe 2009)

of the architect's profession, such as spatial layout to create social places related to topography, sun orientation and climate through its composition and beauty need to be part of standard engineering approaches as well as measured performance needs to become part of standard design evaluations. The need was revealed in the four narrated passages of proportion, detailing, ventilation and daylight, where the team jointly managed to reach the outlet of the passage.

ACKNOWLEDGEMENT

As indicated, the Interlock House was a team project and would not have been possible, with the effort of all. The website <http://www.solard.iastate.edu> lists all team members and financial sponsors. As lead faculty PI I am indebted to all my colleagues and students who contributed their expertise and time to the project.

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