Designing With Time (Un-Freezing the Music)

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INTRODUCTION

Architects tend to think of the products of their work as stationary objects, reposing on the landscape, viewed and used by many. We know that the design of a successful building must respond to the Delight aFnd Firmness criteria of Vitruvius. We also know that buildings must answer, in full measure, to the reason for the building, its use or Commodity.

While a building may be viewed as stationary, its use can not. Much of the rub of architectural design is accommodating dynamic use of stationary space. Designing for use, however, requires addressing concepts of Time.

The purpose of this paper is to explore how variability, which time permits, can again become part of a strategy in the development of ideas that will enhance and prolong abuilding's use thus reducing the need to rebuild with additional resources. This exploration will engage current responses to conditions of variability, alternatives to this current practice, and conclude with a Case Study to illustrate the principles discussed.

CONTEXT

Sustainability as an idea

This paper presumes that the argument for a sustainable architecture has already been made. Yet, having made that determination, we are left with questions of how to inculcate a sensitivity in our clients to consider life-cycle cost to the planet rather than to some other bottom line. Still, the bottom line of an idea (sustainability) requires a coupling with the bottom line of fact (economy). One potential connection lies within the idea of productivity.

Sustainability as a fact

Sustainability as an idea requires reference to sustainability as a fact. As architects we have aremarkable palette with which to work. The materials we specify have varied characteristics of durability, cost, and maintenance. They also have attributes related to thermal response, chemical composition (off-gassing), embodied energy (environmental cost of extraction of raw material, production, and delivery), and varying degrees of opacity (block/admit light/heat).

All thesecharacteristics have arelationship to sustainability. They all need to be referenced in making design decisions related to materials. Additionally, they all should be considered in the light of when they come into play.

SEASON – THE FOURTH DIMENSION

The denser we build, the more power intensive the functions within our buildings, the more we must rely on off-site sources of energy to meet on-site needs. We import electricity, gas, and water. We export waste.

To improve this import/export balance, we employ techniques of material use and placement that produce efficient thermal and luminous environments. In addition, conditions of imbalance can be minimized through efficient appliances and recycling, elements generally outside the influence of the architect. A building's design, however, can still aid or impede optimal conditions for effective use. To understand this, it is important to consider that a building may be considered as having "seasons."

There is the season of the day when a commercial/industrial building's use is most intense, when the sun and its light are available, when it's on and off-site environmental impact is greatest. This season is interrupted by the season of the lunch hour withmassive migrations to and from buildings that impact facilities such as elevators and exterior doors and when food preparation and service dominate the workplace. This season is further modified by daily weather patterns.

There is the season of the night, which for most buildings is the obverse of the season of the day; lower intensity of use, a cooler, darker environment.

There is the season of the week where the intensity of use reverses between the workplace and home during the weekend.

There are the traditional seasons of the year when clothing, outdoor activity, and use of comfort appliances (heat/cool, light) are conditioned by climate and weather.

There is, finally, the season of the building that, after birth, undergoes changes of occupant and occupancy, and ultimately, death by decay or demolition.

There is a dynamic to all these seasons, a variability that an enduring building must accommodate.

SEASONAL RESPONSE

The built environment provides us with certain stationary assets. A building can condition the environment to provide comfort from the effects of rain, snow, cold, heat, noise, and air quality. This same constructed environment can provide illumination and privacy. To achieve these assets, we must usually consume resources and export refuse.

Examining the idea of a building's seasons, we can also see that a building has variable assets, assets that respond to the building's constantly changing conditions. At one level the thermostat measures the changing conditions and calls for equipment to respond. This we might call the automatic or mechanical response. Coupled with this response is the effect of the building's orientation and configuration with regard to its exterior envelope. A roof overhang on a skin-dominated building may respond to a building's annual seasons, a louver system protecting glass on an internally dominated building might respond to the season of the day admitting light without glare and reducing the heat-gain component. These conditions of building response have always been considered within the province of the architect. But what of the building users' response to a building's seasons?

The occupant has always exercised choice in the use of space. Sometimes this takes the form of an additional appliance: the small fan or heater at an employee's desk, venetian blind or aluminum foil added to an adjacent window, reorientation of work surfaces or the addition of a task light for better illumination conditions. Often, these are responses required because they were not considered in the building's design or because, during the building's season, a change of occupancy required a change in that building's environmental response.

It has been shown that a critical component to a building's economic success is its ability to enhance the productivity of its users. We know that productivity is aided by a sense of comfort by the user, yet we still design buildings where the thermostat must be "secured" and windows sealed so that an "average" condition can be maintained. Certainly, one of the important variables in a building's use relates to our different metabolisms, eyesight, and hearing. We know instinctively that if we put one foot in hot water, the other in cold, the average result is not comfort yet we tend to design our buildings for "average" comfort that lowers the productivity of most of us who are not "average."

From this it can be seen that there is a need for user selected variability with regard to comfort in our buildings. There is a tendency to think that this will create chaos. Perhaps so concerning a "conventional" order, but a democratic society recognizes that harmony can come from a collective sensibility that recognizes both the individual and the aggregate.

There is a positive connection between productivity and sustainability. If productivity allows you to do more with less, then the impact on all resources (including worker time) is diminished. Correspondingly, if a building can enhance productivity for a variety of occupancies, its need for extensive renewal or replacement together with their concomitant dedication of monetary and environmental resources is diminished.'

CONDITIONS OF VARIABILITY

How can a building respond to the various seasons, uses, and users it will encounter in its lifetime'? To answer this question, we must examine the needs of the building's users under a variety of conditions (not just initial use).

The first indication of use relates to location. Is it in a commercial, institutional, residential, or manufacturing zone? How settled is that location's use; could it change substantially during the life of the building? What is the pattern of change, however modest? What conditions does the location enjoy (daylight, access, utilities)? How will these characteristicschange over the life of the building? Daylight shadowed by adjacent buildings, congestion limited access, utility costs becoming prohibitive for some uses. Are there local conditions that will restrict the buildings use (high crime area, industrial emissions which compromise health and/or degrade building materials, diminishing economic viability of surrounding property).

Consideration must be given to the potential variety of uses and their common characteristics (commercial to residential is possible, but what can a meat packing plant become?). Does change in use require a significant change in space, its quality, its scale? Are additions requisite to continued use or change in use?

The answers to these questions usually result in fairly gross responses (size and proportion of building, placement on site, floor to floor height) and are conditioned by an understanding of the building's total (birth/death) season.

The shorter seasons (day/night, week, year) are more directly related to variation sponsored by the user. Consequently, issues such as efficiency of communication must be understood in terms of individual preference if increased productivity is to be realized. Anonymous space that gives no clue to its potential general organization is no better than a highly structured space that can be used in but one way.? The living room where there is no provision to move the couch to face the fireplace in winter or the view, or the back yard; the office space where you must face the wall or must face away from it limit each space's effectiveness and, consequently, its sustainability due to "seasonal" response.

Much of the variation to which architecture can respond relates to opportunity. The opportunity to re-orient, move, recondition may relate to scale and proportion of space, structural module, method of illumination. The need for a smoke, or a breath of fresh air, a short stretch, focusing the eye on a distant object, knowing what is going on outside can be satisfied by opportunities to open or look out a window, visit a 30th story balcony, move your work place to or from a more intense light condition. Morning and afternoon activities may need to be movable as the daylight or thermal gain condition change throughout the day. Fewer people in a space may be more productive than more. Variability of position with its attendant response to working conditions may also produce more productivity. This variability also allows a building to find its effective use configuration rather than having to respond to an inflexible condition.[3]

Generally, people prefer daylight, people prefer fresh air. Daylight and fresh air, when intelligently introduced into a space in response to user desires and the building's seasons, reduces utility costs which reduces environmental impacts while enhancing productivity and promoting sustainability.

Variability, then, refers to a host of conditions that change over time. These changes are the product of seasons and user's response to conditions of individual comfort.

Complex conditions require complex responses. How can architects, who have so much already on their plate, deal with so many factors the commonalty of which is variability? The solution is to address these issues in a meaningful way without, as one of my studio professors once said, making a no-purpose space. We learn by doing and we do out of an awareness of issues.

Investigation reveals that the issues that an architect must address are essentially the same as the profession has always had. They may be enunciated through a series of questions adding only the dimension of time.

What are the properties of the site?
What will be the properties of the site?
What is the program for the client's use of the site?
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What is the appropriate architectural response?
What will be the appropriate architectural response?
To which we add the question:
How will the building's seasons of use require architectural accommodation?

CASE STUDY

Introduction

As an example of how the principle of variability and seasons might be used, I offer a recent project. While it is a skin-dominated, residential structure, the postulates behind its design are illustrative of the principles enunciated above.

The clients, an attorney and a writer, wished to build, in the least intrusive way, a residence near Winston/Salem, North Carolina (33°N, 5500 DD, temperate humid). They were interested in minimal enclosure to reduce environmental and economic impact (both required for sustainability), self-sufficiency, and an ability to live "with the land."

The program called for the customary residential spaces of kitchen, dining, living, bathing (2), utility, and sleeping (2). To this was added a home work area (mind) a work-out room (body), and a sun-space. The site, chosen with the advice of the architect, is several acres in a large lot sub-division of varied terrain, a relatively dense forest of deciduous trees with some cleared land near the access road. At an elevation of 1,000 feet it is somewhat higher than Raleigh, NC which was judged the site of the closest NOAA data. The critical characteristics of the site were judged to be its scale, the deciduous forest, and the variation in land form that allowed choice for optimal building placement with regard to energy efficiency, privacy, and minimal impact on the environment.

Response

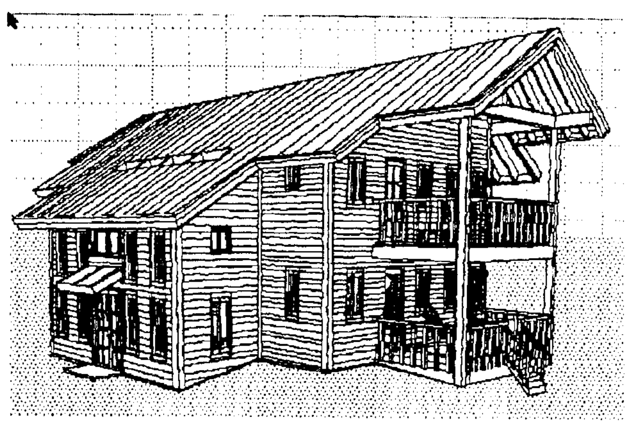

Fig. 1.

Plan

The plan evolved from a nine-square organization in a two story volume. The Kitchen occupies the central square on the lower floor with extensions to the North for the utility room (which serves as an air lock), to the East for Living/Dining, to the South for the Sun-space (also an air lock), and to the West for the Guest Bedroom. There are further extensions to the East (porch) and west (Gym).

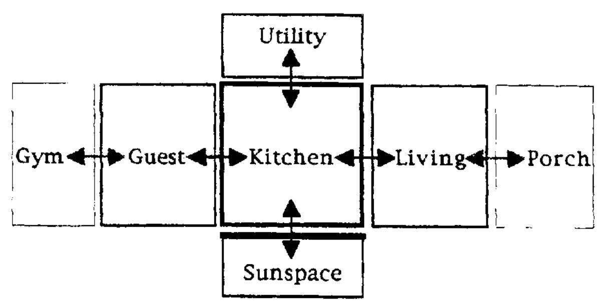

Fig. 2.

The upper floor places the work space in the center space with the Master Bedroom to the West and a porch as a further western extension together with a bridge over the Living1 Dining space below to another porch to the East.

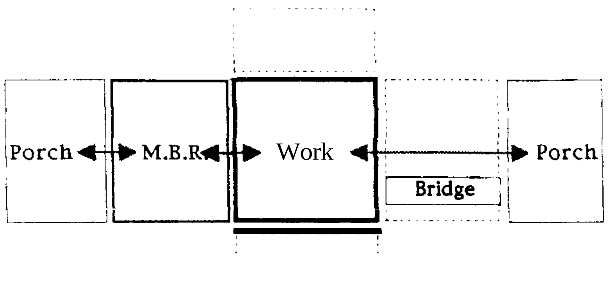

Fig. 3.

Section

The section provides an open volume for daylight and convective ventilation purposes and an 8 in 12 roof pitch to accommodate the possibility of thermal or photovoltaic panels in the future.

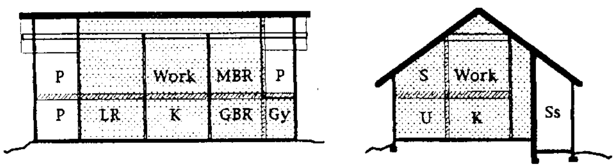

Fig. 4. Section looking south (left) and section looking east.

Material choices were made with an eye to durability as well as thermal performance. Frame walls and the roof are insulated to achieve high thermal transfer resistance (R24, R40), the thermal mass wall that separates the sun-space from the interior is 8" CMU grouted full to provide heat storage as well as time lag. Windows are located to provide light and/ or heat.

An energy analysis, using Solar 5 developed by Murray Milne at UCLA provides the following comparison of this design (Quaker Gap) compared to a residence of the same size but without concern for window orientation, thermal mass, or high insulation factors (Standard).

This analysis forecasts that annual energy costs for all functions (light, heat/cool/ appliances) will be $412 for the Quaker Gap model verses $1,194 for the Standard model.

Time zoneing (variability)

While the above design responses are fairly typical for an "energy efficient" house, these are abetted by the dwelling's ability to allow its occupants to respond to the building's seasons.

Climate

Thisclimate has four seasons, three distinctly different (Spring and Fall are similar).

During the winter with its colder weather, the leaves are off the trees the windows receive more light, and the sun-space as well as the house proper, gather solar radiation. The heat gathered and stored in the Sunspace can be held for use later in the day when the sun has "gone down," or accessed immediately by opening the connecting operating windows to the interior. The Master Bedroom and the Work Area upstairs enjoy the warmest zone (convection), while the kitchen with its energy use, provides some help in warming the lower floor. The relatively compact enclosed form minimizes the volume to be heated.

The summer, with its uncomfortable heat and humidity also is accommodated by the compact form aided by the shading factor provided by the tree leaves which affects all building envelope surfaces. During this season the Kitchen/ Living/Dining areas may operate as the work area while the Guest Bedroom may serve as the Master Bedroom to take advantage of the cooler lower floor.

Spring and Fall in this climate are extensive and glorious. During these seasons the house expands as all three porches come into play. Day and night activity moves out to the east and west periphery where the occupants can be with the site; working, eating, sleeping. During the warmer periods there may

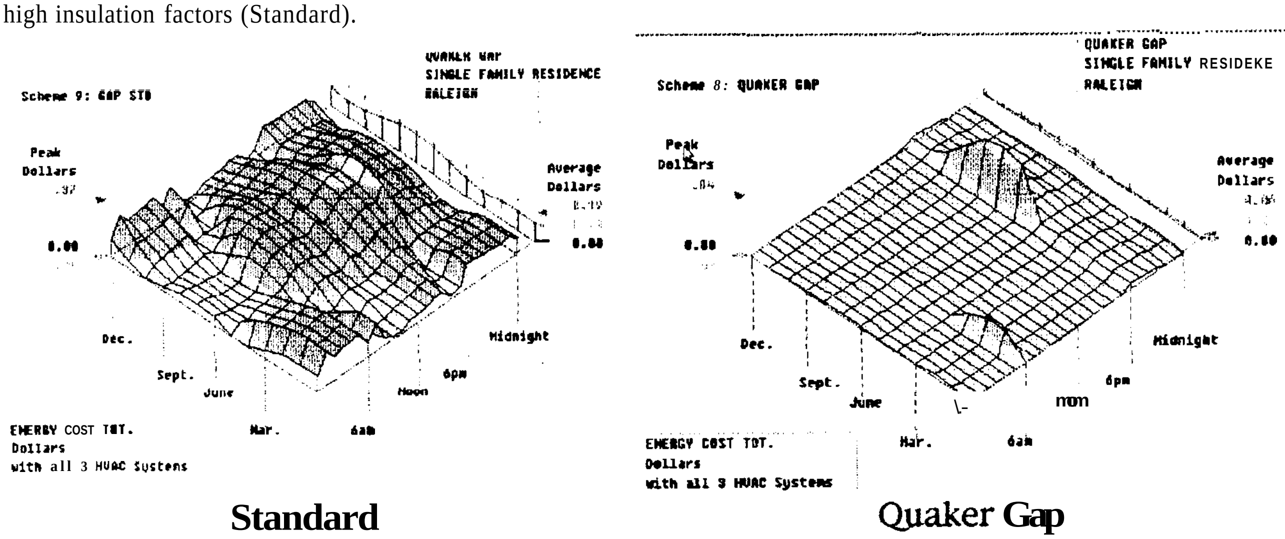

Fig. 5. Standard (left) and Quaker Gap.

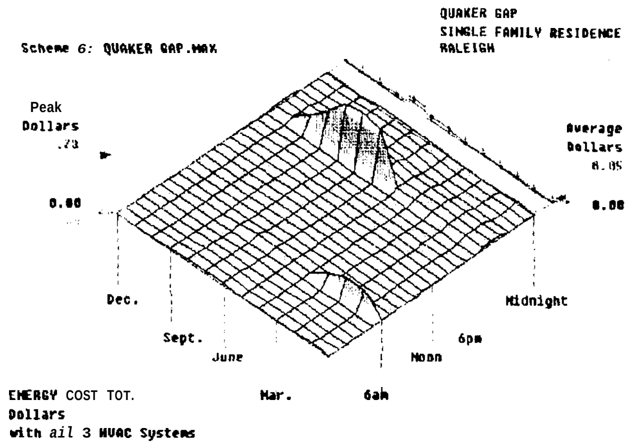

Fig. 6.

be a diurnal swing with daytime activities within the sheltered interior and night activities on the porches in the cool night air.

The objective is to provide a variety of conditions that can respond to climate and activity variables over time.

While conventional responses to achieving energy efficiency are impressive, see Solar 5 plots above, the house enjoys additional sustainable promise by providing for variability. The balanced season where no mechanical device is required for comfort (except perhaps a paddle fan), is extended (up to 6 weeks). Modifying the data that generated the above plots to reflect these characteristics, produces the following plot that results in an estimated annual energy cost of $172 (SOLAR5 data).

Additionally, the productivity of the inhabitants should be enhanced due to environmental patterns and choices. The building's inherent flexibility (besides the house's open plan, it can be expanded east and west) should provide viability over an extended period of time.

CONCLUSION

This case study has been presented as a specific example to illustrate the general case for a more dynamic approach to a building's program. While narrow in its typology (small house for an enlightened couple), it should serve to show that the dynamics of a building's seasons that are allowed to respond to user needs can be a powerful component of an evocative and enduring architecture and allow us to un-freeze the music.

NOTES

1 An interesting investigation into productivity in "Green" buildings has been documented by Judith Heerwagen, et al from the Pacific Northwest National Laboratory in their article "Do Energy Efficient, Green Buildings Spell Profits'!" in the Spring 1997 Issue of *Energy & Environtnental Management;* pp. 29-34. The article describes the performance of a case study building and the relationships of connected criteria. Of particular interest is the identification of three "Stewardships" which relate to both ecological and business progress.

2 For more on the limits to flexibility as an enhancement to productivity see D. Canter's *Psychology for Architects* (1982) (London: Applied Science).

3 Fred I. Steele, in his book *Physical Settings and Organization Development* (Reading, MA: Addison-Wesley Publishing Company, 1973) cites and article in *Progressive Architecture,* (January 1970), pp. 133-134 relating to variability in the Pembroke College Dormitories: The suites, with three or four rooms each, allow for differentiation in use by the students living in them. All rooms can be used as combined bedroom-study rooms, or students may cluster their study, sleeping, or social activities by sharing spaces. Rooms have been kept simple in configuration so that variations in patterns of use and furniture arrangement will have a discernable impact on the character of the rooms and allow students further opportunity to affect their immediate environment.... The solution is the anthesis of Eero Saarinen's Morse and Stiles Colleges at Yale, to which, alas, nothing can be added (or subtracted), and is, therefore, inorganic.