A Project to Advance the Development of Optimally Designed, Energy-Efficient, Healthy, Comfortable and Productive Office Buildings Based on Lessons Learned from California's Innovative State Office Building Program

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ABSTRACT

The purpose of the project described here is to develop information that will optimize the efforts of architects and engineers to jointly make design decisions which will result in energy efficient, healthy, comfortable and productive office buildings.

The project includes investigation of eight State of California energy-efficient office buildings constructed between 1977 and 1983. The eight buildings comprise approximately 1.5 million sq ft and house approximately 7,000 state employees. These buildings, most of which have been published, include a variety of innovative energy conservation technologies such as active and passive solar systems for heating and cooling, thermal mass, chilled water storage, rock thermal storage beds, closed and open atria, night ventilation, de-stratification fans, external shading devices, daylighting, innovative electrical lighting sources and control systems, computer and conventional energy management control systems, etc.

Work to date has included site visits to the eight buildings, interviews with various individuals responsible for operating and managing the buildings, identification of factors to be included during more comprehensive data gathering and building performance modelling, and a series of four seminars. The seminars were held with the participation of over 30 individuals including various members of the office building design firms and their consultants and representatives of state government agencies involved in project planning, design, construction or operation. The four seminars were 1) Architects and the Process of Design for Energy-Efficient Buildings; 2) Lighting and Illumination, Energy, Comfort and Health; 3) Ventilation and Air Quality, Comfort, Health and Energy-Efficiency; and, 4) Occupant Satisfaction, Comfort and Health.

This paper presents the results of the seminar discussions and the on-site investigations. Additionally, it describe some of the analytical tools being developed currently. These tools and the information gathered to date can provide significant help to architects and engineers during the design process. Future

work will include refinement of analytical tools and evaluation of building performance.

OUTLINE

PROJECT GOAL

- Post-occupancy evaluation of 8 state of the art state office buildings - why?

- Development of design tool to aid architects and engineers to design building s that act synergistically to provide energy efficiency, user comfort/health, and user productivity and quality work.

Make visible in a systematic way a lot of the different trade-offs that are avaiaable.
It's almost like a check list.
It's a design tool not a design methodology
This a design tool that can be integrated into any design methodology.
It is adaptable into any design methodlogy being used.

Coordination really entails taking the responsibility for how everything fits into the building.

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PROJECT PROCESS

- Field investigation (Preliminary)
- Seminars
- Literature review
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:                                                          :
:   Field investigation  <-------- model development       :
:                                                          :
:   Program investigation -------> model "testing"         :
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PROJECT OBSERVATIONS TO DATE
- FIELD
- SEMINAR
- LITERATURE

PROJECT CONCLUSIONS TO DATE
- Post occupancy evaluation needed desired by profession
- Difficult to separate out system failrues in some cases with management problems/failures ie causes of complaints
-Separation of designers and users (inlcuding engineers, managers as well as occupants) leads ot inefficiency in both design and ooperation.
- Design tool need
- Series of conclusions which fahave an impact on providing 1 + 1 = 3 buildings

<u>SITE</u> <u>VISITS</u>

- Air balance off
- Register defects
- Return/supply not providing adequate air circulation
- Low lighting levels not maintained
- Glare problems
- Automatic dimming controls ineffective
- Buildings not being operated as designers anticipated
- Population density increased from program levels
- Partition modes changed
- Air system noisy — possible causes
- Stuffiness where air volumes low and minimum outside air used
- Automated s;unshading devices break down, don't always respond in user-logical fashion
- Energy use monitoring bl;y operators not broken down in a

way that's useful to designers

COMMENTS FROM SEMINARS

Design process has many exisitng variations, no need to invent or try to determine the "best"

There a clear need to involve building operators in the design process (not just via 'aprovals')

Better consideration of user needs needed

- Does computer control whichjprovides inifniate operational vairiables equate wihth user ocntrolkl

- Do opening windows lockaed and inacceskssible equte with unsealed building image,

- Etc.

Training manuals should be budgeted.

COMMENTS

"INNOVATION SCAREY to old tinmers..."

"Building can be run by computer totally but not a good idea ..."

"Cost of energy, not amount used is critical..."

"Simple building to operate.

CONCLUSIONS [merge w/ Project concl. to date

USER MANUALS NEEDED

Simples effective management control of operation needed
Better fix on actual ventilation patterns

Architects and engineers need to make their design choices gbbased on better understianding of the impact of the tchoice on the final building product.

i.e., most energy efficient light fixtures may create ventilation flow problems.

Building operation should be thoroughly tested prior to occupancy

- Designers need to be better aware of likely managament/operational needs and strategies - they (deisgners) cannot control by simply training staff and providing manuals

This paper presents the results of the seminar discussions and the on-site investigations. Additionally, it describe some of the analytical tools being developed currently. These tools and the information gathered to date can provide significant help to architects and engineers during the design process.

Future work will include refinement of analytical tools and evaluation of building performance.

The analytical tools include the development of a model representing the relationships wbetween the key acotrs and the decisions they control and the relationships of the parameters as outcomes of those decision processes.

KEY ACTORS

Occupants
- Employees
- Employers
- Visitors

Designers
- Architects
- Engineers
- Landscape architects
- Space Planners
- Interior designers
- Specialized consultants

Clients
- Tenant agencies
- Buildings & Grounds Division, D/General Services
- Legislature
- Public

Management
- Building manager
- Building engineer
- Mainenance staffs
- Buildings & Grounds directorate

CRITICAL FACTORS: users

Lighting
Temperature
Air supply
Air quality
Humidity
Noise
Privacy
Space
Furniture
Equipment
Control over space

Control over environment
Views, visual relief/escape
Security
Exit options: emergency, relief/recreation

CRITICAL FACTORS: MANAGEMENT

Reliability
- Mechanical
- Lighting
- Security
- Maintenance

Cost
- energy
- maintenance
- durability
- replacement feasibility and cost

Flexibility
- Use change
- Operational variations - hours, climate, zones,

Safety

September 26, 1984 Draft (for discussion purposes only)

PRE-PROPOSAL DISCUSSION OF MODEL
COMPONENTS, MEASUREMENTS, OBJECTIVES, METHODS, ETC.

PURPOSE AND NEED
The purpose of this pre-proposal is to begin to describe the research program concept. This description will allow potential funding sources to indicate their interest in assisting us in carrying our goals to realization. Elements of the program are as follows

As building equipment becomes more sophisticated, the integration of building design components becomes more complex. Architects and engineers who oversee the building design process must coordinate the activities (ultimately the design decisions) of various specialized designers who deal with the systems and equipment which will result in producing the environmental quality in the completed building. Too often, the decisions of these design specialists are made independent of each other. The architect coordinates them, usually by assuring their fit in the building and with each other. However, their functional fit is often the result of n can result in conflicts. The best known are lighting and cooling, daylighting and thermal control, energy conservation and ventilation, air quality and mechanical system control, etc.

The complexity of modern building technology requires more explicit tools for coordinating design of the functional aspects of building equipment and systems. The purpose of this project is to develop useful tools to assist the architect in overseeing

the design process. This will be done by using the eight California State energy-efficient office buildings as case study subjects.
The reason for developing functional model fo the relationships of building; elements is to see that optimizing isolated de;sign decisions doesn't always lead to the best, ;most integrated building.

The model will assist in the process of allowing all members of the design team to more clearly understiand the impact of their design decisions on other members' decisions.

The eight state buildings present an unusual opportunity to study several different buildings, all with fundamentally similar functional programs, but in four different climates and utilizing a wide reange of energy conservation strategies. The populations of the eight buildings are similar - state office workers. And there are many available "control" buildings with populations similar to those of the eight energy-efficient buildings.

These eight buildings incoroporate various approaches to energy conservation and environmental control, were built at about the same time, have now had sufficient time to be "broken in," and are accessible because they are in the public sector. Furthermore, there is great interest in the design community to know more about the energy performance of these buildings. An evaluation of the energy performance along with the concomitants of the energy consequences of the technologies employed would assist designers as well as policy makers in determining the effectiveness of many currently popular energy conservation approaches. It would also assist in identifying potentially negative consequences of the use of the technologies employed in terms of the comfort, health, productivity and satisfaction of the occupants.