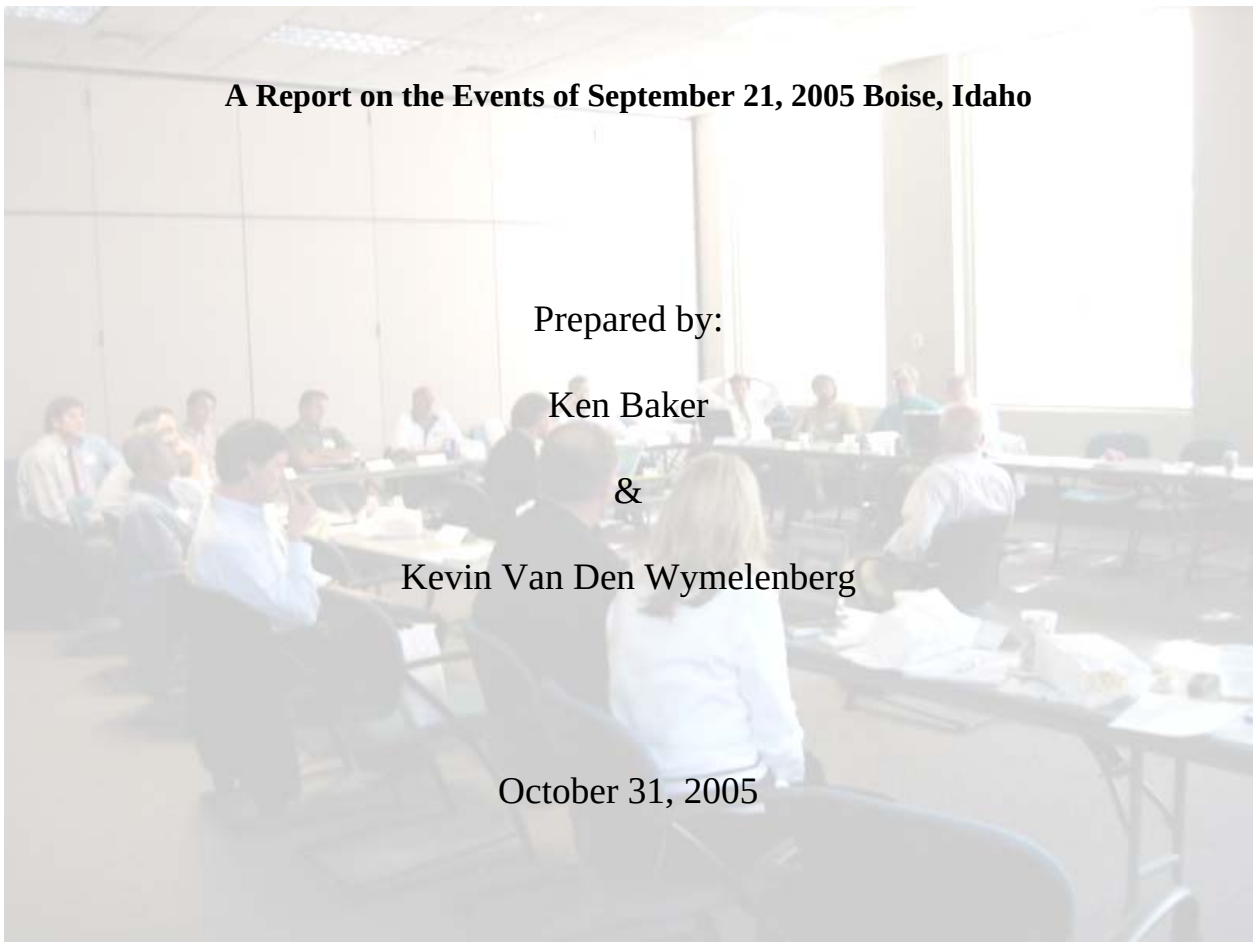
NATURAL VENTILATION

&

EVAPORATIVE COOLING FORUM

Part 1 of: Strategies for Reducing Peak Demand in Idaho Power Service Territory and the Inland Northwest Climate



A Report on the Events of September 21, 2005 Boise, Idaho

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&

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BACKGROUND

During June of 2004 the University of Oregon Energy Studies in Buildings Laboratory in collaboration with BetterBricks, published a booklet entitled *Natural ventilation in Northwest Buildings*. Contracted through BetterBricks, the Commercial Sector Initiative of the Northwest Energy Efficiency Alliance, the publication is an informative look at natural ventilation and cooling principles and strategies that can be utilized for buildings in the Northwest region.

Co-authors Brown, Kline, Livingston, Northcutt and Wright looked into a number of factors that would affect successful implementation of natural ventilation strategies including, the ASHRAE adaptive comfort model, human productivity benefits of natural ventilation, building envelope load reductions strategies, macro and micro wind analysis, temperature considerations, micro climate analysis, shifting occupancy patterns, optimizing building orientations and an analysis of building types suitable for natural ventilation implementation. Fortunately, there were also several built examples that provided case studies of working systems that were included in the publication.

By the fall of 2004, Palladino and Company, through contract with the Putnam Price Group and BetterBricks developed a Power Point presentation highlighting the principles of the booklet. It was during a one-hour natural ventilation presentation on this topic that Darlene Nemnich, Idaho Power Company Conservation Program Manager, first considered the idea that this soft technology could provide a viable strategy for utility summer peak load reduction. With input from Kevin Van Den Wymelenberg of the University of Idaho Integrated Design Lab and Ken Baker, K energy, and urging of Sue Seifert, Idaho Division of Energy, the concept of an Idaho specific natural ventilation forum was formulated.

During a four-month period of regular meetings, Nemnich, Van Den Wymelenberg and Baker developed a wish list of invitees, drafted and sought comment on a forum purpose and agenda, confirmed speakers and presentations, and organized the logistics and process for the event.

The purpose of the forum was refined to considering the probability for success of natural ventilation and evaporative cooling strategies implemented in typical Idaho building types with the challenges and opportunities of Idaho specific macro and micro climate considerations.

Natural ventilation and evaporative cooling experts from throughout the Northwest and California were invited to provide short presentations on targeted topics from general background information on Idaho building characteristics and climatic conditions to specific information on items such as the availability and use of design and modeling tools such as Energy Scheming, computational fluid dynamics modeling and wind tunnels. Select design professionals from Idaho were invited to attend and participate in facilitated discussions at the end of each presentation. The forum agenda, speaker contact information and copies of the presentations are included in this report as appendices.

Natural ventilation and evaporative cooling are ideally suited for the bulk of Idaho climate regions. A caveat of sorts comes from Terry Egnors' Climate Responsive Design session where he notes that the most cost-effective ventilation change and corresponding energy saving strategy we could facilitate would be the proper installation and use of HVAC system economizers. Terry reports that 60-70 percent of the installed economizers in the Pacific Northwest are either non-functioning or not functioning properly. Clearly, this is an area where much savings could be generated through an installation education and maintenance program.

Evaporative cooling systems and strategies could also be of great value in Idaho. Evaporative systems can reportedly operate at about one-third of the energy cost as compared to a comparable cooling capacity generated by typical DX cooling systems while still providing effective cooling for building occupants. One potential issue associated to direct evaporative cooling is occupant adaptability to humidity. The direct systems do humidify the air to levels that may be 20 to 30 percent over the very dry Idaho air building occupants are accustomed to. An indirect system may prove to be the most effective and acceptable in our region. This system may cost more and can not provide the same level of cooling that a direct system can provide.

According to Southern California Edison's Tony Pierce, there is a residential evaporative cooling system that is available and effective, and which can be retrofitted to a existing homes. This technology could prove valuable in discussions of residential demand reduction and may be worth a closer look.

This report is preliminary. The main purpose is to document the key points and discussion of the September 21st 2005 forum. There is a combination of approaches that could be taken to effect change in the Idaho building market cooling strategies and therefore reduce summer peak cooling demand. Many of these *'next steps'* are outlined in the section of the same name in this report, but in general, education of building owners, architects and engineers will be of primary importance in any approach.

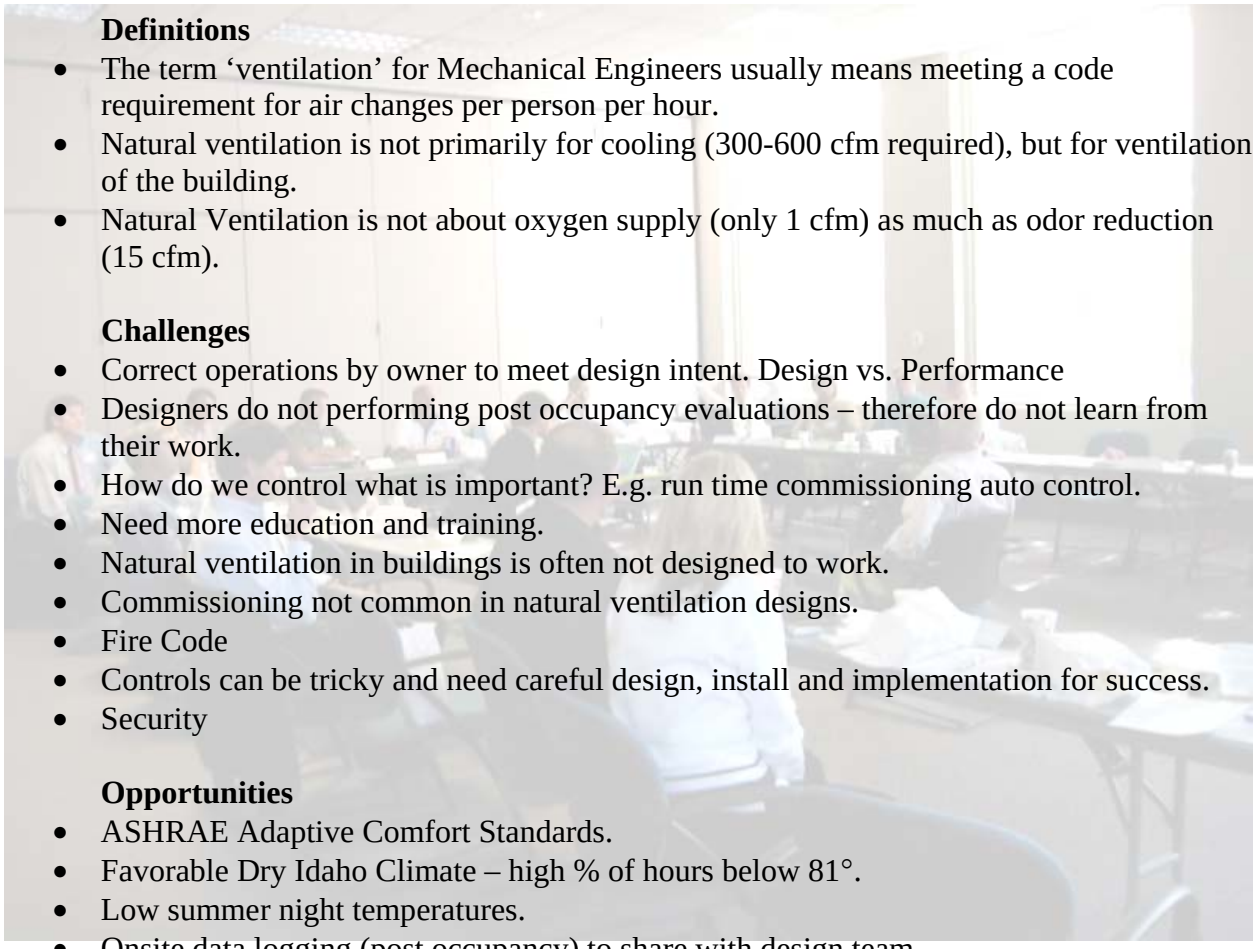
In summary, in the words of G.Z. Brown and Mike Hatten, our primary concern should be minimizing the loads that impact our new buildings and the success of any potential cooling strategy. The people, lighting, building envelope and systems all drive the need for cooling. If buildings were to be designed with a better understanding of loads in mind, the need for cooling could be reduced dramatically. And if buildings were designed with greater efficiency in the envelope, were carefully scheduled, were built with higher thermal mass, high performance windows, were oriented to minimize summer solar gains, and made effective use of mixed mode natural ventilation and evaporative cooling strategies, the need for cooling in such buildings could feasibly be eliminated. Therefore, the significant growth of summer peak demand that Idaho Power must meet could be slowed drastically.

PRESENTATION SUMMARIES

A total of nine presentations were made throughout the forum. The following are highlights or key pieces of information noted from each session:

1. Natural Ventilation for Idaho

G.Z. Brown, University of Oregon – Energy Studies in Buildings Lab, set the foundation for the discussion with a presentation from the "*Natural Ventilation in the Northwest*" booklet that he co-authored.



Definitions

- The term 'ventilation' for Mechanical Engineers usually means meeting a code requirement for air changes per person per hour.
- Natural ventilation is not primarily for cooling (300-600 cfm required), but for ventilation of the building.
- Natural Ventilation is not about oxygen supply (only 1 cfm) as much as odor reduction (15 cfm).

Challenges

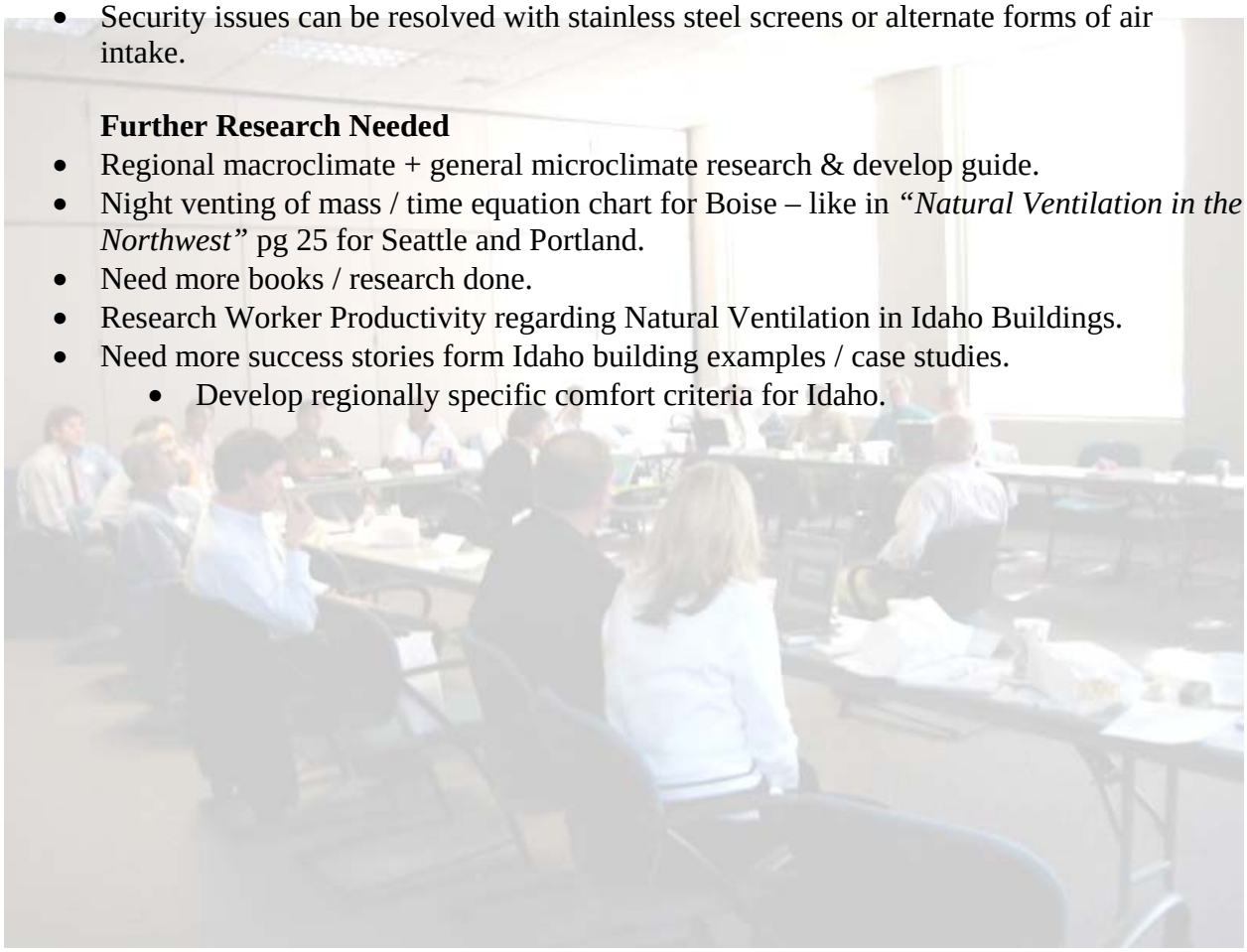
- Correct operations by owner to meet design intent. Design vs. Performance
- Designers do not performing post occupancy evaluations – therefore do not learn from their work.
- How do we control what is important? E.g. run time commissioning auto control.
- Need more education and training.
- Natural ventilation in buildings is often not designed to work.
- Commissioning not common in natural ventilation designs.
- Fire Code
- Controls can be tricky and need careful design, install and implementation for success.
- Security

Opportunities

- ASHRAE Adaptive Comfort Standards.
- Favorable Dry Idaho Climate – high % of hours below 81°.
- Low summer night temperatures.
- Onsite data logging (post occupancy) to share with design team.
- Design long-term Measurement + Verification into buildings.

Strategies

- Do not hold natural ventilation to a standard that is we do not hold mechanical ventilation to.
- Control Loads (People, lights, equipment, envelope)
- Orient building to optimize effects of wind direction and solar loads.
- Building owner is key to adaptive comfort success.
- When outdoor real time temperature is above 81° we need to look for temperature shifts provided by night cooling of mass, occupant loads during hottest days or spatial adjacency shifts resultant from energy programming exercise.
- The key to nighttime ventilation is to control the loads during the day.
- Security issues can be resolved with stainless steel screens or alternate forms of air intake.



Further Research Needed

- Regional macroclimate + general microclimate research & develop guide.
- Night venting of mass / time equation chart for Boise – like in *"Natural Ventilation in the Northwest"* pg 25 for Seattle and Portland.
- Need more books / research done.
- Research Worker Productivity regarding Natural Ventilation in Idaho Buildings.
- Need more success stories form Idaho building examples / case studies.
    - Develop regionally specific comfort criteria for Idaho.

2. ASHRAE Adaptive Comfort Standards

Peter Alspach, ARUP, provided an informative presentation on ASHRAE's Adaptive Comfort Standard.

Definitions

- PMV = Predicted Mean Vote method VS Adaptive Comfort Standards
- ASHRAE uses 80% vs LEED 90% comfort acceptance standards.
- If you choose to use ACS, you cannot use mechanical cooling and the space must be naturally ventilated. .
- ASHRAE Advanced Comfort Standard. Three types of adaptation necessary: 1) behavioral or psychological is most significant; 2) adaptive comfort requires time for acclimatization. Adaptive comfort in Boise is about 84 degrees or 3 degrees above ASHRAE 55-2004; and, 3) understanding the relationship of building type to type of control systems.

Challenges

- Client/user input is most critical to make Adaptive Comfort Standards work. Why? Perception of comfort.
- How to deal with hot day strategies?
- Acceptance by people?
- Liability associated with natural ventilation for mechanical engineers.
- Using Adaptive Comfort Model the thresholds are very small / demands very small margin of error – need good deal of modeling & sensitivity studies of control strategies.
- How to structure fees to capture a fee for using no mechanical or very small with natural ventilation strategy.
- Charles Paulin indicates that adaptive comfort model will be hard to sell to developer-based projects.

Opportunities

- Designing within the typical ASHRAE comfort standard – 80 to 81 degrees for cooling – is professionally legitimate.
- Potential power outages may be a driver for occupant control of windows.
- Occupants prefer to have control of environment.
- First lower cost in several buildings types.

Strategies

- Occupant training is important for natural ventilation be successful.
- Need to have a building management system that takes care of daily data logging. Let occupants concern themselves with comfort.
- Increase Rates / Summer Peak Demand Charges / Incentives for occupancy shifts.

Further Research Needed

- Need an avenue of expertise & info / research locally.
- Education strategy for mechanical contractors, building owners and Mechanical Engineers.

3. Idaho Climatic Design Considerations

Terry Egnor, Microgrid, presented Idaho specific climatic data and design considerations.

Definitions

- Value engineering is rarely valuable or engineered.

Opportunities

- Working economizers could make a significant impact on cooling savings. Up to 70 percent of existing economizers are not working.
- If natural ventilation takes the place of economizers we could realize great savings but with perhaps more cost.

Further Research Needed

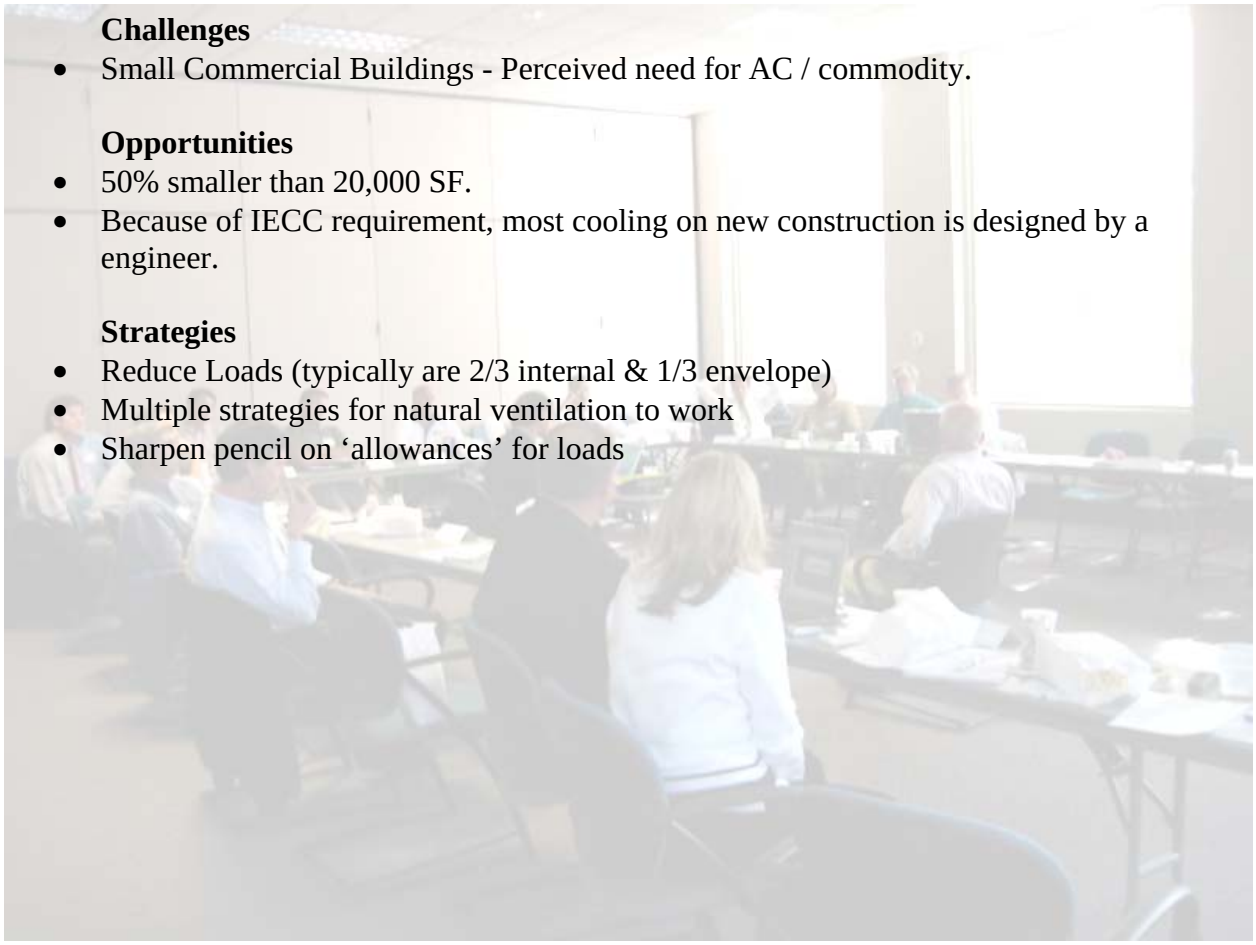
- Economizer Installation and Maintenance Education Program
- Case Studies of Evaporative Cooling in Idaho Buildings

4. Baseline Commercial Building Stock of Idaho

Curt Nichols, Idaho Power Company, gave an interesting presentation on the commercial building baseline for Idaho. Many of the notes below were from a open discussion that followed Curt's presentation.

Definitions

- Building stock in Idaho is 75% single story.
- 10 % without cooling currently.
- Prevalence in Idaho of 5 ton roof top units. (can add economizer for $200 each)



Challenges

- Small Commercial Buildings - Perceived need for AC / commodity.

Opportunities

- 50% smaller than 20,000 SF.
- Because of IECC requirement, most cooling on new construction is designed by a engineer.

Strategies

- Reduce Loads (typically are 2/3 internal & 1/3 envelope)
- Multiple strategies for natural ventilation to work
- Sharpen pencil on 'allowances' for loads

5. Case Study Insight Architects Offices

Russ Phillips, Insight Architects, spoke on the natural ventilation features of his firms' new building;

Challenges

- Tall operable windows are a big problem. Insight left the upper windows open from June through August – used AC in afternoons – lost some cooling out of these upper windows.
- Security is an issue to get most out of night ventilation.

Opportunities

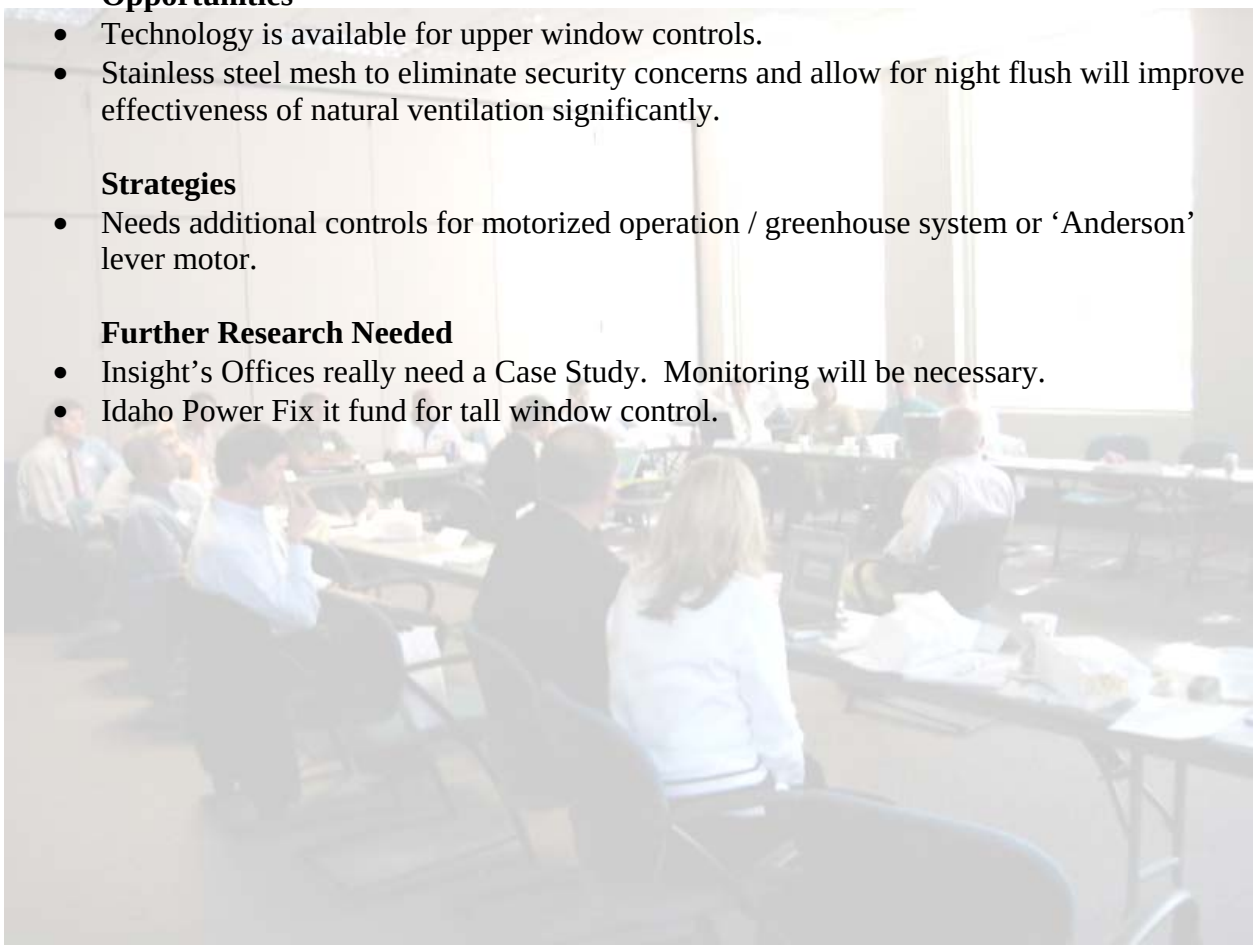
- Technology is available for upper window controls.
- Stainless steel mesh to eliminate security concerns and allow for night flush will improve effectiveness of natural ventilation significantly.

Strategies

- Needs additional controls for motorized operation / greenhouse system or 'Anderson' lever motor.

Further Research Needed

- Insight's Offices really need a Case Study. Monitoring will be necessary.
- Idaho Power Fix it fund for tall window control.



6. Evaporative Cooling Strategies & Mixed Mode Systems

Mike Hatten, Solarc, provided the group with an update on the state-of-the-art in evaporative cooling strategies and equipment

Challenges

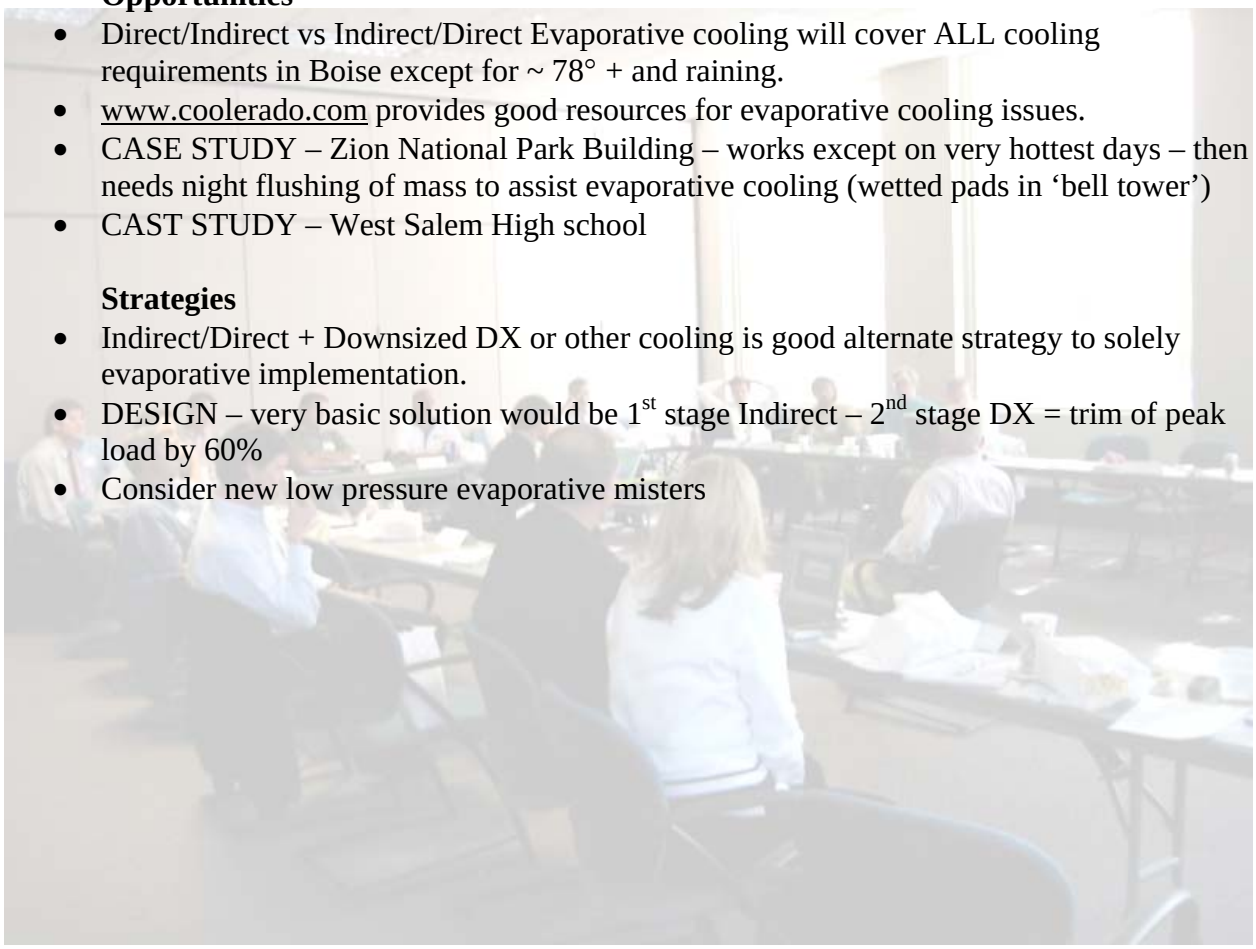
- High pressure drop – difficult to get airflow in natural ventilation solution
- Open water / air delivery may be misconstrued as a health concern. Just needs careful construction.

Opportunities

- Direct/Indirect vs Indirect/Direct Evaporative cooling will cover ALL cooling requirements in Boise except for ~ 78° + and raining.
- www.coolerado.com provides good resources for evaporative cooling issues.
- CASE STUDY – Zion National Park Building – works except on very hottest days – then needs night flushing of mass to assist evaporative cooling (wetted pads in 'bell tower')
- CAST STUDY – West Salem High school

Strategies

- Indirect/Direct + Downsized DX or other cooling is good alternate strategy to solely evaporative implementation.
- DESIGN – very basic solution would be 1st stage Indirect – 2nd stage DX = trim of peak load by 60%
- Consider new low pressure evaporative misters

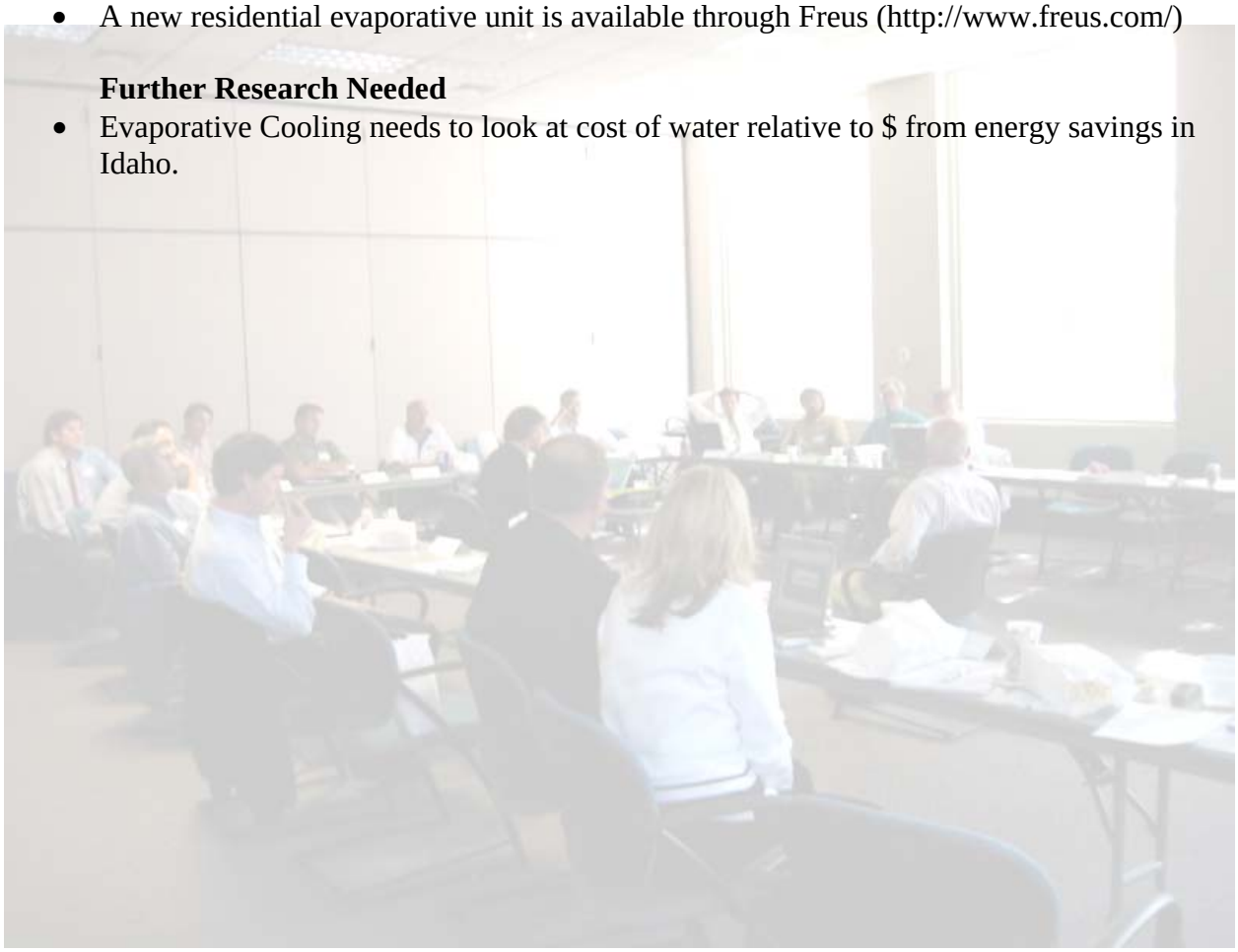


7. Residential Evaporative Cooling for Demand Side Management

Tony Pierce, Southern California Edison, provided the residential perspective with a presentation on a residential evaporative cooling program for peak demand reduction.

Opportunities

- Indirect/Direct evaporative cooling may require only .22 kW/ton while compressor-based systems typically use 1.25 kW/ton.
- SCE has case studies on evaporative cooling technologies including pre-coolers.
- ASHRAE now sets standards for effectiveness for evaporative coolers
- A new residential evaporative unit is available through Freus (http://www.freus.com/)



Further Research Needed

- Evaporative Cooling needs to look at cost of water relative to $ from energy savings in Idaho.

8. Modeling for Natural Ventilation

G.Z. Brown highlighted the use of modeling tools such as energy scheming, CFD modeling and the use of wind tunnels.

Definitions

- Small 30" square x 6'-10' wind tunnels are used for visual massing models both exterior and interior.
- Large 8' square (by many feet long) wind tunnels are used for more accurate mapping of external pressures in conjunction with CFD modeling.
- TAS software is a type of CFD modeling used by University of Oregon.
- ARUP uses Fluent Airpak and other CFD tools.
- Ailios – airflow directions (in/out)

Challenges

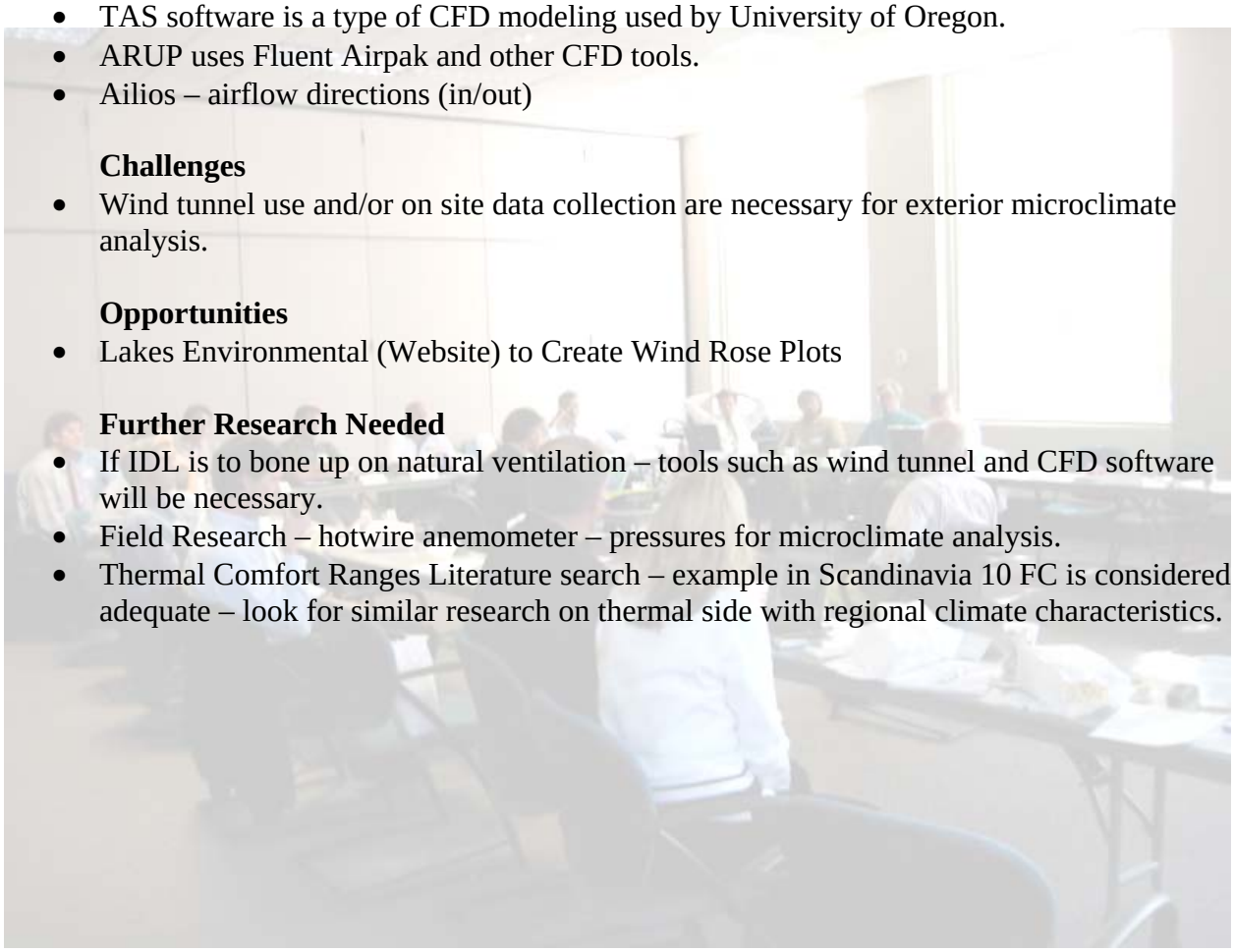
- Wind tunnel use and/or on site data collection are necessary for exterior microclimate analysis.

Opportunities

- Lakes Environmental (Website) to Create Wind Rose Plots

Further Research Needed

- If IDL is to bone up on natural ventilation – tools such as wind tunnel and CFD software will be necessary.
- Field Research – hotwire anemometer – pressures for microclimate analysis.
- Thermal Comfort Ranges Literature search – example in Scandinavia 10 FC is considered adequate – look for similar research on thermal side with regional climate characteristics.



9. Challenges and Opportunities of Systems Integration

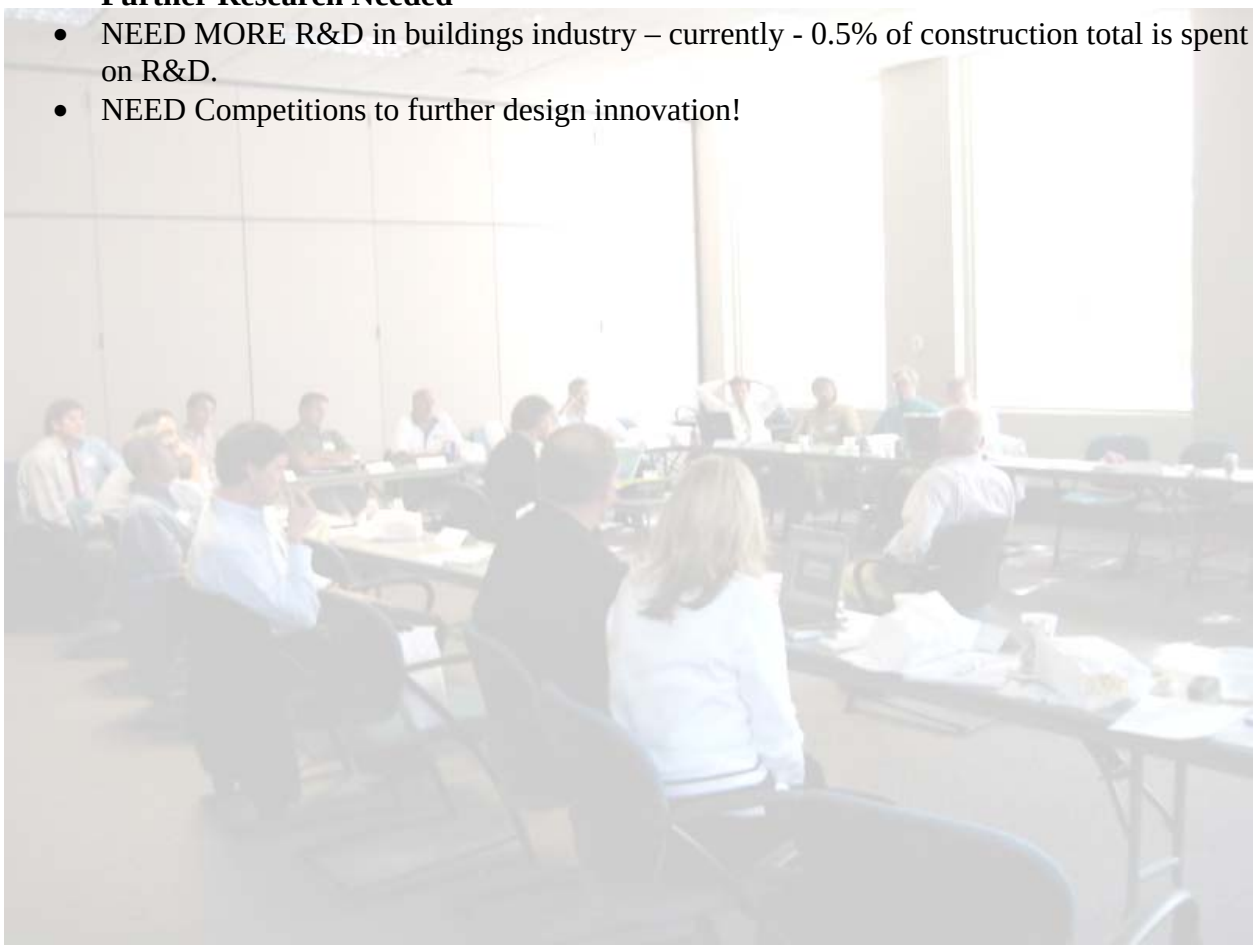
Doug Bors, Sophometrics, led a provocative discussion on the challenges and opportunities of system integration.

Opportunities

- G.Z. suggests targeting large institutional owners as next step
- Look for 'Design Build Operate Maintain' 30 yr Corporations as owners – Owner hires CM and CM hires the rest of design team…. Different process = Different Results.

Further Research Needed

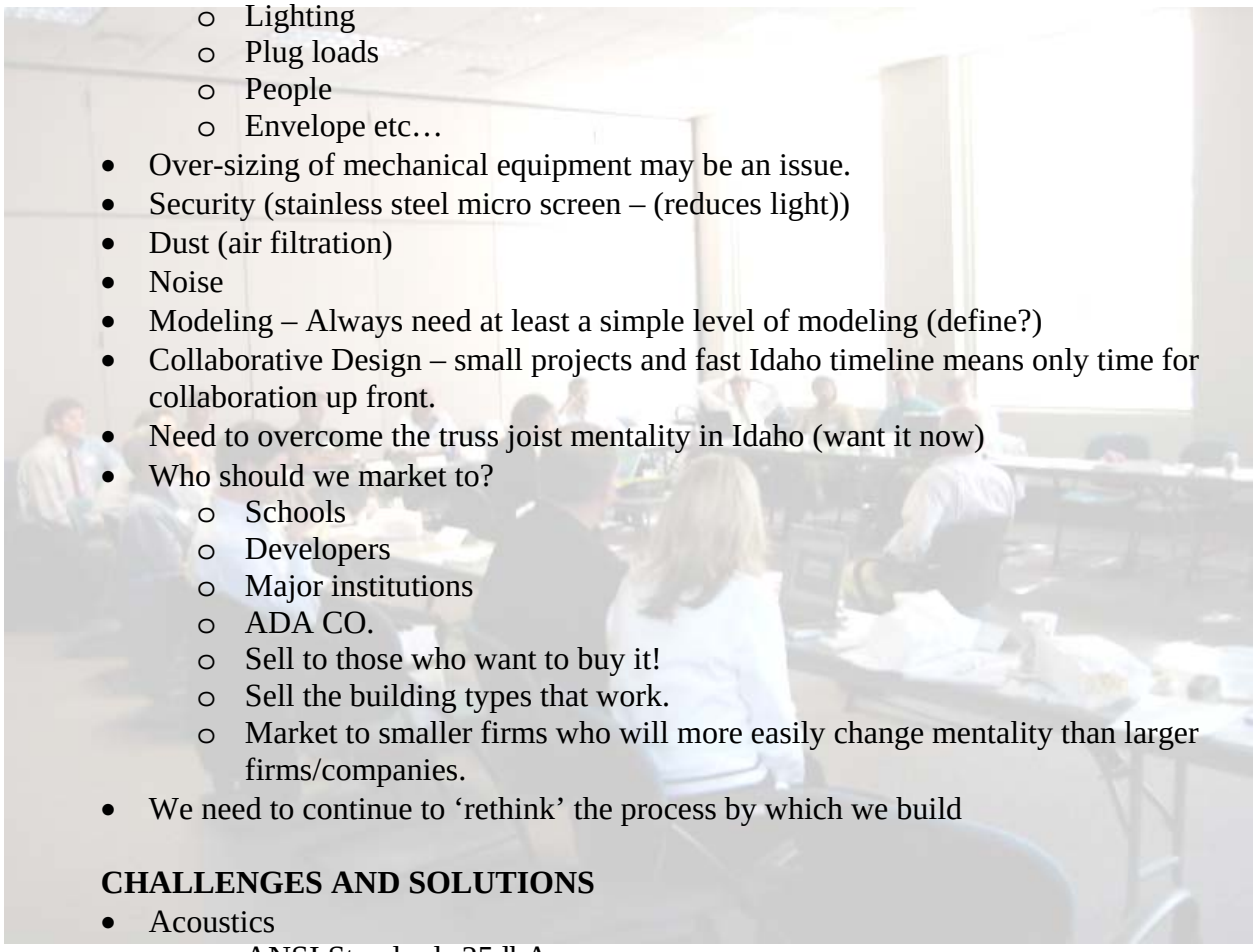
- NEED MORE R&D in buildings industry – currently - 0.5% of construction total is spent on R&D.
- NEED Competitions to further design innovation!



FLIP CHART DOCUMENTATION

OTHER ISSUES:

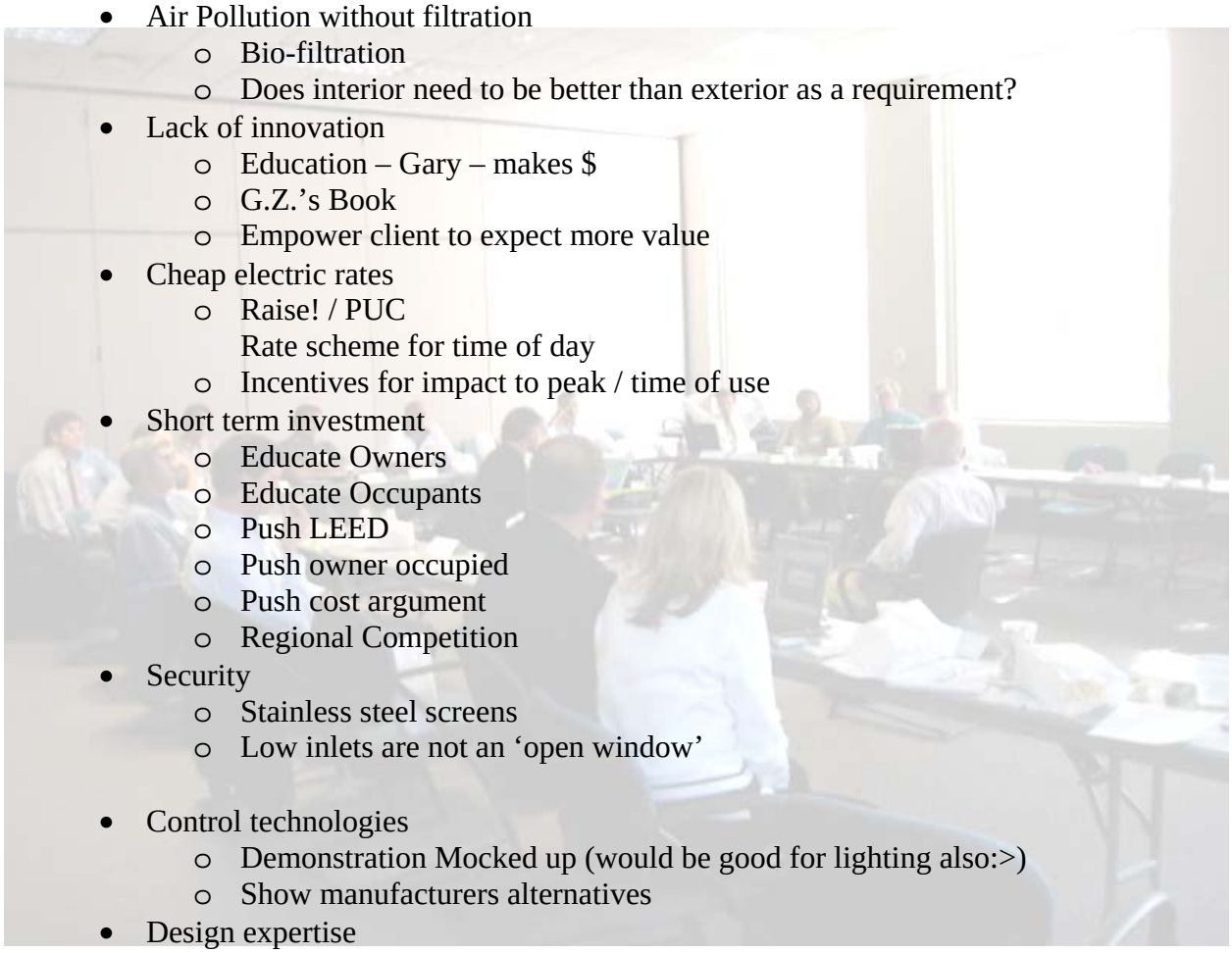
- What is the effect of dynamic change?
- How do we need to structure Mechanical Fees for natural ventilation?
- How do we reduce liability for mechanical engineers?
- NEED assessment for Climate Responsive Design for this area. (Boise)
- How will mixed mode control packages interface with roof top units?
- Load reduction needs to be a first order strategy
    - Lighting
    - Plug loads
    - People
    - Envelope etc…
- Over-sizing of mechanical equipment may be an issue.
- Security (stainless steel micro screen – (reduces light))
- Dust (air filtration)
- Noise
- Modeling – Always need at least a simple level of modeling (define?)
- Collaborative Design – small projects and fast Idaho timeline means only time for collaboration up front.
- Need to overcome the truss joist mentality in Idaho (want it now)
- Who should we market to?
    - Schools
    - Developers
    - Major institutions
    - ADA CO.
    - Sell to those who want to buy it!
    - Sell the building types that work.
    - Market to smaller firms who will more easily change mentality than larger firms/companies.
- We need to continue to 'rethink' the process by which we build



CHALLENGES AND SOLUTIONS

- Acoustics
    - ANSI Standards 25dbA
    - Isolate acoustics form air
    - Careful interior adjacencies
    - "Prius phenomenon"
    - Façade Treatment / venting locations
- Uneducated owners
    - Example of Gary Christiansen
    - Have a good DEMO to take naysayers to – allow to experience
    - Regional examples
    - Current events / energy prices
    - Empower them to ask for more from their design team

- Need for increased design fees
  - Utility Buy Down initially
  - Tie fees to performance net cost
  - Structure time up front in contracts
  - Owner education regarding life cycle
- Building Codes / Fire Codes
  - Use alternate methods of calculations
  - Education of code officials and jurisdictions
  - Eric Makela sets precedent
  - Fire?
- Air Pollution without filtration
  - Bio-filtration
  - Does interior need to be better than exterior as a requirement?
- Lack of innovation
  - Education – Gary – makes $
  - G.Z.'s Book
  - Empower client to expect more value
- Cheap electric rates
  - Raise! / PUC
    Rate scheme for time of day
  - Incentives for impact to peak / time of use
- Short term investment
  - Educate Owners
  - Educate Occupants
  - Push LEED
  - Push owner occupied
  - Push cost argument
  - Regional Competition
- Security
  - Stainless steel screens
  - Low inlets are not an 'open window'



- Control technologies
  - Demonstration Mocked up (would be good for lighting also:>)
  - Show manufacturers alternatives
- Design expertise
- Modeling capabilities for design
- Perceived lack of user comfort
- "4000" years of building (OR JUST 40!)
- Change in occupancy
- Lack of mass

UTILITY COORDINATION

- EWEB Credit for shifting occupancy to shave peak. (peak occupancy avoidance)
- Bundle Incentives to include Natural Ventilation
- IDL Bundle for expertise
    - Daylight
    - Natural ventilation
    - Load reduction

NEED A FOLLOW UP MEETING / MEETINGS!

- Invite financers / developers / banks / owners
- Integrated Education process
- Stand alone vs. integrated piece????
- Back to basics of building – self sufficient – power failures not a problem
- Work on A PROJECT in depth!
- Run a meeting with practitioners and talk about Natural Ventilation Issues / 'working group' locally. Who to bill?
- Real Projects.
- Have a day where regional experts are available and invite 'book' local architects for desk crits!
- NEED TO SEND Around Barriers / Solutions to group to 'round it out'.

MODELING FOR BASIC VS COMPLEX

Basic Project – Like Insight Architects Offices

- Run some calculations
- Run single zone thermal model of cross/stack vent
- Spreadsheets
- ARUP uses in house 2 zone software
- EnergyPlus
- Complex Project – Multi story / atrium / mixed uses
    - Multi-nodal Airflow Modeling ($$$)
    - Inflow / Outflow modeling
    - Wind tunnels for exterior pressures
    - Microclimate analysis
    - Energy Plus
    - TAS
    - ESPR (UK)

NEXT STEPS

Suggested: Work with authors to develop *Part 2 of: Strategies to Reduce Peak Demand in Idaho Power Service Territory*. This work would include market barrier analysis, outline for an Idaho building cooling design guide, micro climate research, prioritization and implementation plan for other possible next steps listed below, and estimates for service territory savings potential associated with various strategies below.

FUTURE ACTIVITY IDEAS

1. Provide a grant to Insight Architects for screens and/or actuators to open their windows.
2. Data collection and Commissioning of Insight Offices with Case Study to follow.
3. Develop education plan including a keynote series for 2006-2008.
4. Enhance local design assistance resources (IDL) with proper tools for physical and digital modeling as well as onsite post-occupancy data collection and microclimate data collection / analysis.
5. Initiate a fix it fund for buildings to insure that natural ventilation systems are operating efficiently.
6. Develop Economizer install and maintenance education plan.
7. Start a natural ventilation users group.
8. Set up a natural ventilation design competition that would work like the one for the zero energy new homes.
9. Restore natural ventilation in an old building.
10. Work with Ada County to create an example “best practice” building.
11. Provide an incentive for natural ventilation
12. Focus on the “Gems” or tipping points for moving natural ventilation forward.
13. Coordinate with ASHRAE to add natural ventilation to their spring technical conference.
14. Get low impact buildings as a topic on the Boise City Club’s series of growth-related topics.
15. Create a prescriptive incentive for natural ventilation – possibly based on the area of controllable openings.
16. Require Energy Scheming software use on incentive applications – or provide a bonus for its use.
17. Provide natural ventilation insurance to fix problems that occur.

SPONSORS

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Appendix A: September 21st 2005 Forum Agenda

IDAHO NATURAL VENTILATION AND EVAPORATIVE COOLING FORUM

Idaho Power Company, 1221 West Idaho Street, Boise, Idaho
September 21, 2005
8 am to 5:00 p.m. (Lunch and refreshments will be provided)

Considering the general climatic conditions of Idaho; humidity, wind, stack, and temperature; and the physical characteristics of typical commercial buildings, where are the specific technologies and cost-effective opportunities for natural ventilation?

AGENDA

	TOPIC	**SPEAKERS**
8 a.m.	Welcome and Introductions Round Robin, Who are you?	Darlene Nemnich
	Introduction to the day's purpose and process. Support – IPCO, BB, IDL Purpose: To build a case for Natural Ventilation And . . . Evaporative Cooling Process: Presentations and Discussions	Ken Baker
		Kevin Van Den Wymelenberg
8:15	Natural Ventilation in Northwest Buildings	G.Z. Brown, University of Oregon
9:00	Discussion What are the most significant issues from Charlie's presentation?	Group
9:15	The Adaptive Model for Comfort Standards	Peter Alspach, ARUP
9:45	Discussion Can we apply this model? How, what are The challenges?	Group
10:00	Break	
10:15	The Idaho Climate – Macro and Micro	Terry Egnor, Microgrid
11:00	Discussion What are the Key microclimate considerations?	Group

When does the microclimate become a show-stopper?

11:15	The Typical Idaho Commercial Building	Curt Nichols, IPCO
11:45	Discussion How are ID buildings good candidates for NV and Evap cooling? What are some of the issues with Idaho buildings?	Group
12:00	Lunch is provided	
12:15	Insight Offices – Lessons Learned	Russ Phillips, Architect
12:35	Integrating Evaporative Cooling Considerations	Mike Hatten, Solarc
12:55	Residential Evaporative Cooling What are Evap cooling considerations we should Consider?	Tony Pierce, So Cal Ed
1:15	Quick Brain Storm: Issues for Idaho Looking at potential barriers and solutions Occupant Site Security Others	Group
1:30	Break	
1:45	The Role of Wind Tunnel Simulations How important is this tool? Does it fit with Idaho building types?	Discussion
2:15	Energy Scheming & CFD Modeling	G.Z. Brown & T. Blomquist, UO
2:45	Discussion: Modeling for Idaho At what point in the design do we consider this? Who is responsible? What are the issues?	Group
3:15	Challenges and Opportunities of Integration	Doug Bors, Sophometrics
3:45	Discussion: Integration in Idaho – What are The Questions we should be asking?	Group
4:00	Discussion: How do you sell natural ventilation and evaporative cooling to A&Es? What do we need to do to sell these design strategies in our market?	Group
4:30	Discussion: What are the best natural ventilation and evaporative cooling strategies for Idaho?	Group

Where is the most value?
What tools or expertise do we need to develop or have on hand?
Now does NV and evaporative cooling system integrate with other cooling systems?

Next steps?

5:00 Adjourn

Appendix B: Presentations