The Weidt Group
30 Years of Innovation and Measurable Successes

- Founding Members Building Energy Performance Standards (B.E.P.S)
- Founding Members of ASHRAE 90.1 Committee
- Founding Members of the NFRC
- Participants in DOE’s Whole Building Design Round Table
- Pioneers in software for the A/E Industry
- Members International Program for Measurement and Verification Protocols (IPMVP) for New Construction
- Contributors to NCARB Sustainable Design monograph
- 8 LEED Accredited Professionals
- Contributors to the Minnesota Sustainable Design Guide B3
The Weidt Group

- 30 years in the energy study field
- Collaborated with others on award-winning projects
- Contractor for 4 utilities’ energy design assistance programs
- Authored works at national and international conferences
Where We Work

Code
Prescriptive w/ Performance Options

Guidelines
Prescriptive w/ Performance Options

Practice
Option Based w/ Prescriptive and Performance Variables

Design Assistance at the transformation sweet spot
Emerging Responses

- Integrated Design
- Equipment Improvements
- Focus on Operation
Emerging Responses

- Integrated Design
- Equipment Improvements
- Focus on Operation
Integrated Design

- Use the building itself to reduce energy use.
- Can the building be
  - a light fixture?
  - a ventilator?
  - a heating and cooling source?
What can be Integrated

- Site use with building location and form
- Building envelope and lighting design
- Building structure and thermal loads
- All of these together and more
Strategies Enabled by Integrated Design

- Extensive daylighting control
- Low-energy ventilation systems
  - Displacement Ventilation
  - Underfloor Air Systems
  - Natural Ventilation
- Radiant heating or cooling
  - Chilled Beams
Integration more properly refers to *process* than *product*

- Two things existing side by side are not necessarily integrated but they may exist side by side as the result of an agreement to disassociate as the result of an integrating process.
There is no integration without a desired goal/outcome

- There can be no integrated results without integrating tools and an integrating process
- The outcome should be measurable – or at least appreciable
Dis-Integrators

- Trust
  - those #@&! architects

- Risk

- Commitment
  - “Value Engineering”
We started with a premise that site, architectural, mechanical and electrical design decisions for a project can be made in an integrating fashion through the comparative analysis of component interactions as part of whole systems in order to produce more environmentally appropriate buildings.
Architectural Design Process
High Performance Design Perspective

Goals

Minimize load as a first priority

10% - 20%

Efficient systems meet the load

15% - 60%

Energy sources supply energy to fuel systems

1% - 5%

People run the systems

10% - 20%

Building design fixes the load

Building Shape
Glass location
Glass area & type
Insulation values
Thermal mass
Building Volume
Lighting concept
Mech. concept

10% - 20%

Envelope
Daylighting
Lighting
HVAC
Controls
District Heating
Domestic Hot Water

15% - 60%

Sun-passive heat
Sun-active heat
Sun-photovoltaics
Wind, Wood
Electricity
Gas
Micro turbines
Fuel cells

1% - 5%

Schedules
Controls
Maintenance
Setpoints
Windows
Equipment
Education

Renewable affordable non-polluting local source

Functionality efficiency comfort

Use simple, cost-effective systems.

Use appropriate sources of energy
Market Transformation Challenges
Influencing the Traditional Design and Construction Process

Business Plan
Site Selection
Pre-design
Schematic Design
Design Devel.
Contract Documents
Const. Admin.

Verf. / Validation
Bldg. Comm.
Bldg. Ops.

Operations

Owner / Developer
Decision Support
A/E Design Team
Design Support
Facility Manager
Operations Support

Commitment
Design Assistance vs Design Insistence

- Program Goals vs Project Goals
- Evolution of Design Practices
- Repeat Business
Less Time - More Influence

- Based on an orderly process and concise paper communications
- Create robust “what if” capabilities
- Market-driven concepts, well applied, sprinkled with cutting-edge ideas
- Maintain basic propositions of consulting and comparative analysis
Three basic kinds of information are needed:

- Information regarding policies and objectives
- Information regarding possible alternatives and consequences
- Information regarding the current state of the system
Information Processing Errors

- Failure to detect the information due to *overload* or *interference*
- Misidentification due to *insufficient* or *inadequate* clues
- Improper weighting of the informational factors due to insufficient conceptualization of the action choices

The greatest obstacle to discovery is not ignorance — it is the illusion of knowledge

Daniel J Boorstin, Librarian of Congress

From the Human Factors Design Handbook

From the Human Factors Design Handbook
Getting from Designed to Built

- Design
- Construction Documents
- Installation/Calibration
- Operation
- Maintenance
Implementation
 Rates by Year - ACEEE Fall 2006

<table>
<thead>
<tr>
<th>Stage</th>
<th>2005 (9 projects)</th>
<th>2004 (14 projects)</th>
<th>Program Average (24 projects)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection</td>
<td>100%</td>
<td>96%</td>
<td>95%</td>
</tr>
<tr>
<td>DCD</td>
<td>82%</td>
<td>91%</td>
<td>92%</td>
</tr>
<tr>
<td>CD</td>
<td>78%</td>
<td>88%</td>
<td>88%</td>
</tr>
<tr>
<td>DV</td>
<td>88%</td>
<td>85%</td>
<td>88%</td>
</tr>
<tr>
<td>V</td>
<td>88%</td>
<td>88%</td>
<td>88%</td>
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</table>
Findings
Technology Group Implementation Rate
### System Efficacy

<table>
<thead>
<tr>
<th>Component</th>
<th>Perfection</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Window size</td>
<td>100%</td>
<td>98%</td>
<td>95%</td>
<td>100%</td>
<td>85%</td>
</tr>
<tr>
<td>Sun shading</td>
<td>100%</td>
<td>98%</td>
<td>95%</td>
<td>91%</td>
<td>85%</td>
</tr>
<tr>
<td>Lighting design</td>
<td>100%</td>
<td>99%</td>
<td>95%</td>
<td>85%</td>
<td>85%</td>
</tr>
<tr>
<td>Calibration</td>
<td>100%</td>
<td>95%</td>
<td>95%</td>
<td>90%</td>
<td>85%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>90%</strong></td>
<td><strong>81%</strong></td>
<td><strong>70%</strong></td>
<td><strong>52%</strong></td>
</tr>
</tbody>
</table>

- **Source**
- Building Orientation & Footprint
- Window size & location
- Sun shading
- Glass types
- Space programming
- Interior surfaces
- Lighting design & control
Failure Points
Unsuccessful Implementation – Why?

- Designers have too little information about control system performance characteristics
- Documentation of control functionality, coordination of installation and calibration requirements are inadequate
- Controls are not explained to building operators or occupants
  - Facility operators who are not well trained in these systems exclude them from ongoing maintenance and operation plans

Didn’t Understand

Understood but didn’t fully document

Understood and documented but didn’t prepare the owner/user
Integrated Design - Summary

- The building design is part of the solution
- Best practices still emerging
- There will be bumps
- This is a key area for energy study
Emerging Responses

- Integrated Design
- Equipment Improvements
- Focus on Operation
So, how much light do we need?
**Lamp Efficacy Examples**

<table>
<thead>
<tr>
<th>LAMP TYPE</th>
<th>MEAN LUMENS per WATT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incandescent</td>
<td>12</td>
</tr>
<tr>
<td>T12 Fluorescent</td>
<td>67</td>
</tr>
<tr>
<td>Standard Metal Halide 400W</td>
<td>58</td>
</tr>
<tr>
<td>Pulse Start Metal Halide 320W</td>
<td>66</td>
</tr>
<tr>
<td>Standard T8 Fluorescent</td>
<td>83</td>
</tr>
<tr>
<td>High Output T5 Fluorescent</td>
<td>88</td>
</tr>
<tr>
<td>Standard T5 Fluorescent</td>
<td>89</td>
</tr>
<tr>
<td>HP T8 Fluorescent</td>
<td>94</td>
</tr>
</tbody>
</table>
Equipment Improvements

- Lighting example
  - Application (design) evolves, as does equipment (dependent and independent)

- Similar approaches will occur with
  - Fans
  - Cooling
  - Heating
  - Refrigeration systems
Energy Controls

Traditional
- Hardwired circuits
- Circuits define control of fixtures
- Fixtures and sensors are wired to a relay
- Change and repair requires rewiring and electrician, ladder setups and ceiling access
Convia®

- Nodes on a network
- Each fixture (node) can be controlled in multiple ways, independent of other nodes
- Fixtures and sensors can be on or off the grid
- Change possible without rewiring
Flexibility with Convia

- Reduced labor time for reconfiguration
- Can physically move components, easily
- Ease of expansion; items can be added progressively
Objective: 
A Control Spectrum

Control is possible at multiple levels

- **Individual**
  - Advanced building design guidelines recommend personal control
  - Individuals are satisfied and perform better when they have a measure of control over their environment

- **Zone/ Group**
  - Considerable savings are possible at zone level through occupancy and daylight control
  - Grouped control of lights provides a uniformity of appearance that may be aesthetically desirable

- **Building-wide**
  - New codes require building-wide automatic shutoff of lights after-hours
  - Building-wide controls allow facility managers to set limits to peak and overall consumption

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**Individual**

- Occupancy sensor control of
  - Task light
  - Individual ambient lights
  - VAV boxes, diffusers
  - Office equipment

**Building wide**

- Daylighting controls
  - Dimming
  - Switching
  - Strategic daylight switching
  - Dual level switching
  - Manual dimming
  - Occupancy sensor control (groups)

- Adaptation compensation
- Load shedding
- Central EMS sweep after hours
Energy Study

Objective

Quantify energy savings potential of controls designed with Convia in realistic building applications.

Two climates and utility rates
- Denver (5400 < HDD65°F < 7200)
- Las Vegas (4500 < CDD50°F < 6300)

Two buildings
- Office (194,000 sf, 6 stories)
- Library (50,000 sf, 1 story)

Two code baselines
- ASHRAE 90.1-1999
- ASHRAE 90.1-2004

Modeling protocol
- Appendix G - ASHRAE 90.1-2004
- Guides choice of HVAC system and blinds approach
Energy results
Denver office building (194,000 sf, 6 stories)

$220,000/yr total energy costs for ASHRAE 90.1-2004 baseline

Breakdown by end-use
- Heat 33%
- Cool 6%
- Fan/ Pump 7%
- Lights 30%
- Equip 24%
100%

Lowest wattage lighting design is aggressive with a direct indirect system at 45 fc with super T8s (0.77 W/sf)

Strategies possible with Convia are 6 of the top 10 energy strategies for this typical office building
- Similar in Las Vegas

Top Ten Strategies for Annual Energy Savings

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest wattage lighting design</td>
<td>$22,000</td>
</tr>
<tr>
<td>Dimming daylighting</td>
<td>$19,000</td>
</tr>
<tr>
<td>Best boiler</td>
<td>$16,000</td>
</tr>
<tr>
<td>Occupancy sensor control of VAV boxes/</td>
<td>$15,000</td>
</tr>
<tr>
<td>outside air damper</td>
<td></td>
</tr>
<tr>
<td>Manual dimming</td>
<td>$14,000</td>
</tr>
<tr>
<td>Occupancy sensor control of office equipment</td>
<td>$13,000</td>
</tr>
<tr>
<td>Switched daylighting</td>
<td>$12,000</td>
</tr>
<tr>
<td>Total Heat Recovery</td>
<td>$10,000</td>
</tr>
<tr>
<td>Dual level switching</td>
<td>$8,000</td>
</tr>
<tr>
<td>CO2 control outside air</td>
<td>$7,000</td>
</tr>
</tbody>
</table>

### Energy results

**Denver office building**

The present value of 5 years of energy savings ranges from $5000-$80,000 annually.

For 10 year time period, present values range from $10,000 - $150,000.

#### Present Value 5 years Energy Savings

<table>
<thead>
<tr>
<th></th>
<th>$0/SF</th>
<th>$0.26/SF</th>
<th>$0.52/SF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$0</td>
<td>$50,000</td>
<td>$100,000</td>
</tr>
</tbody>
</table>

- Switching daylighting controls
- Dimming daylighting controls
- Strategic daylight switching Private office
- Dual level switching
- Manual dimming
- Occupancy sensor (OS) control ambient lights
- OS control of task light
- Higher resolution OS control of ambient lights
- Adaptation Compensation
- Load shedding
- Central EMS sweep after hours
- Occupancy sensor control of VAV boxes/outside air damper
- Occupancy sensor control of office equipment
Value of Corrective Action
Magnitude of savings not implemented correctly
Present Value of 5 Years of Energy Savings at 5%

- Switching daylighting controls: Savings implemented 51%, Savings not implemented 26%
- Dimming daylighting controls: Savings implemented 61%
- Strategic daylight switching: Savings implemented 13%
- Private office: Savings implemented 13%
- Combined dual level switching: Savings implemented 13%
- Combined manual dimming: Savings implemented 13%
- Combined occupancy sensor control: Savings implemented 15%
- OS control of task light: Savings implemented 15%
- OS control of individual lights: Savings implemented 15%
- Open office: Savings implemented 15%
- Adaptation Compensation: Savings implemented 10%
- Load shedding: Savings implemented 25%
- Central EMS sweep after hours: Savings implemented 25%

Savings to be recovered through Convia
Emerging Responses

- Integrated Design
- Equipment Improvements
- Focus on Operation
Focus on Operation

- Lighting and fan system time schedule
- Occupancy controls
- Temperature resets
- Variable speed drives
- Carbon dioxide sensor reset
“Unstrategies”

- Simultaneous heating and cooling
- Plug load equipment running unnecessarily
- Mechanical systems running at less than ideal conditions
- Lighting controls bypassed
Example Project

Actual energy costs higher than expected

- Datalog electric loads and temperatures for several weeks
- Review energy management system logs
- Plow measurements back into an energy model…
Findings

- Operation (schedule) different than modeled
- More plug loads than assumed
- Fuel costs increased
- Some energy strategies working to partial effectiveness, or not at all
Example Project

Operational Strategies Impact

- Integrated Design with High Efficiency Equipment – 40%
- Additional Focus on Operation – 20%

Total Savings Potential – 60%

Cost of fuel and unforeseen operation changes – 18%
Focus on Operation

- Can be low-cost or no-cost
- Requires persistence
- Training key
- Measurement key
Program Considerations

- Integration
  - Needs structure
  - Feed the process ($)

- Equipment – Application Matters
  - “How” versus “How Many”

- Performance-based incentives
  - Administration (-)
  - Persistence (+)
  - Resistance (-)

- Cash vs Credit
Results
Energy Cost Savings

Credit - LEED Projects

Cash - Utility Projects

Average – 38%

Average – 30%

Energy Cost Savings (%)

- Lowest Savings Bundle
- Selected Bundle
- Highest Savings Bundle

Range of New Codes
Conclusions

- Tools to achieve high performance buildings
  - Integrated Design
  - Equipment Advances
  - Focus on Operation

- Set goals in design
- Revisit goals in operation
- Expect good things
Questions?

Thank you.