Solid State Light Conversion

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Acknowledgements

- Our Senior Design advisor Dr. Durbin
- WMU Sustainability Grant Committee
- Western Michigan Electrical and Computer Engineering Department
Background

- Outdated lighting in Floyd Hall classrooms
- T8 fluorescent tubes are flickering and often do not dim properly
- Non-intuitive user interface system
- More energy efficient lighting available
- Hazardous mercury in the fluorescent tubes
Design Goals

- Replace existing tubes with solid state lighting (LED panels)
- Improve overall lighting conditions
- Use manual and software calculations to achieve the required specifications for our focused room
- Install Android based application with a user friendly interface
- Generate long term cost savings
Classroom C-136

- 3 - T8 tubes per panel
- 12 - 2x4ft. panels
- 2 - 2x2ft. panels

Dimming Control panel
Light Panel Recommended

- Lumegen 2x4ft panel
- Dimmable
- Mercury Free
- CCT change

<table>
<thead>
<tr>
<th>SKU</th>
<th>LEDLFPN1000046524</th>
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<tbody>
<tr>
<td>Lumens</td>
<td>5500 Lumens</td>
</tr>
<tr>
<td>Wattage</td>
<td>50 W</td>
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<tr>
<td>Lumens Per Watt</td>
<td>110 lm/W</td>
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<tr>
<td>LED Features</td>
<td>Dimmable, Instant On, Long Life Span, Mercury Free, Warranty</td>
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<tr>
<td>Approvals / Ratings</td>
<td>DLC Listed, RoHS Compliant, UL Listed</td>
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<tr>
<td>Voltage</td>
<td>AC100-277V</td>
</tr>
<tr>
<td>CRI</td>
<td>80</td>
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<tr>
<td>Bulb Shape</td>
<td>Flat Panel</td>
</tr>
<tr>
<td>Base Type</td>
<td>Lay-In</td>
</tr>
</tbody>
</table>

4.7 ⭐️ Customer Reviews
Lighting Terminologies

- **Illuminance**: is the amount of light striking a surface unit (Lux)
- **Lux**: SI unit for illuminance
- **Correlated color temperature (CCT)**: the description of the warmth or coolness of a light source
Zonal Cavity Method

- Room C-136 with dimensions 23x35x10ft. (seating capacity = 30)
- Recommended illuminance for classrooms 300-500 lux
- Number of panels = 10 panels

![Diagram of zonal cavity method with labeled components: luminaire, ceiling cavity, room cavity, work plane, floor cavity, with dimensions Length (L), Width (W), Height (H).](www.electrical-knowhow.com)
Lighting Design Software DIALux

10 panels distribution to get between 300-500 lux in classroom C-136

http://www.dialux.com
Lighting Design Software DIALux
Cost Analysis for 1 classroom: C-136

Cost of Labor and Material

10 Panels = $700

Labor Cost = $480

Electric Cost = $120/Year

Total (1st Year) = $1,300

Cost saving at 10 years = $1,400
Cost Analysis for all Classrooms

Cost of Labor and Material

(10x15) Panels = $10,500

Labor Estimate = $7,200

Electric Cost = $1800/year

Total (1st year) = $19,500

Cost Saving Over 10 years = $20,964
Light Panel Selected

- 2ft x 2ft Flat Panel
- 40 Watt Dimmable
- 4400 Lumens
- CCT change
System Block Diagram
Functionality

- ON-OFF
- Motion detection
- Ambient light sensing
- Dimming
- Increase / Decrease
- Zone control
- Projector-Whiteboard mode
Motion Sensor

- Passive Infrared Sensor was used for motion detection
- Saves energy by turning lights off when the room is not occupied.

https://howtomechatronics.com
Ambient Light Sensing

- Light dependent resistor (LDR) was used.
- LDR is a semiconductor device with very high dark resistance.
- Saves energy when ambient light is present in the room.
- Generates long term cost saving
User Interface

- Android operating system
- Open source web application
- Drag & drop graphical blocks
The Bulb Group App

- Bluetooth connection
  - Connected
  - Disconnected
- 4 basic modes: ON/OFF, Projector, Whiteboard
- 3 default brightness settings
- Increment/decrement
Brightness Mode

High
75%

Med
50%

Low
25%
Zone Selection

Whiteboard

Zone 1

Zone 2

All Zones

The Bulb Group

Connect to bluetooth device

connected

ON | OFF

Zone Selection

Zone 1 | Zone 2 | ALL

High | Med | Low

Increase | Decrease

Projector | Whiteboard
Increase/Decrease Brightness

- Increase brightness by 5%
- Max reached 95%
- Decrease brightness by 5%
- Min reached 5%
Increase/Decrease Brightness

- Increase brightness by 5%
- Max reached 95%
- Decrease brightness by 5%
- Min reached 5%
Projector & Whiteboard Mode

- Projector mode
  Zone 1 at 25%
  Zone 2 at 50%

- Whiteboard Mode
  Zone 1 at 75%
  Zone 2 at 75%
Conclusion

• Improved the user interface for controller
• Restructured the zone control for lighting
• Proved a cost savings of $1,400 over a ten year span likely
• Completely removed the need of mercury from lighting system
• Achieved 90% of our targeted goals
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