CASE STUDY ONE
Student: Daniel J. Overbey
Date: February 23, 2006
ABS 731: Lighting Design and Technology
Instructor: Michael D. Kroelinger
- Introduction
- Project Background
- Climate Data Analysis
- Site Description
- Integration Building Systems
- Performance
- Critical Analysis
• Introduction
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• Integration Building Systems
• Performance
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INTRODUCTION

- Typical office buildings account for 46.5% of US energy use.
- EIA: *Lighting* and *cooling* account for apprx. 1/2 of their energy use.
- EIA: *Electricity* accounts for 54% of commercial building energy.
Commercial Building Electricity Consumption by End Use, 1999

(Raw data from Energy Information Administration 2004)
Site Energy Use in Commercial Buildings, 1999

(Raw data from Energy Information Administration 2004)
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BACKGROUND

- Client was Lockheed Missiles and Space Company (1979).
- Lockheed in-house design team already had their own design.
- CA gov. imposed temporary suspension – enter Leo A. Daly
Lockheed is Saving $51,535.00 a Year in Lighting Energy...

With the PAESAR PRF Daylight Compensator

Illustrations courtesy of the University of California, Berkeley
# Lockheed Building 157 - Fact Sheet

<table>
<thead>
<tr>
<th>Project</th>
<th>Building Name</th>
<th>Lockheed Building 157</th>
</tr>
</thead>
<tbody>
<tr>
<td>Client</td>
<td>Lockheed Missiles and Space Company, Inc.</td>
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<tr>
<td>Location</td>
<td>Third Avenue, Sunnyvale, California</td>
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<tr>
<td>Lat/Long/Elev</td>
<td>37.25°N / 112.03°E / 12 ft (site)</td>
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<tr>
<td>Architects</td>
<td>Leo A. Daly</td>
<td></td>
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<tr>
<td>Mechanical Engineer</td>
<td>Leo A. Daly</td>
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<tr>
<td>Daylighting</td>
<td>Lawrence Berkeley Laboratories</td>
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<tr>
<td>Lighting</td>
<td>Michael D. Shanus</td>
<td></td>
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<tr>
<td>Fire Protection</td>
<td>Richard M. Patton</td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td>Hensel Phelps</td>
<td></td>
</tr>
<tr>
<td>Interior Landscaping</td>
<td>Interior Landscape Design</td>
<td></td>
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<tr>
<td>Acoustics</td>
<td>Richard Hamme</td>
<td></td>
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<tr>
<td>Floor Area</td>
<td>580,000 sq ft.</td>
<td></td>
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<tr>
<td>Occupants</td>
<td>2700 engineers and support staff.</td>
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<tr>
<td>Cost</td>
<td>$50 million.</td>
<td></td>
</tr>
<tr>
<td>Cost in 2006 dollars</td>
<td>$101.6 million or $169.29/sq ft.</td>
<td></td>
</tr>
<tr>
<td>Stories</td>
<td>Five stories totaling 90 ft height.</td>
<td></td>
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<tr>
<td>Plan</td>
<td>560 ft x 250 ft.</td>
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</tr>
<tr>
<td>Site Description</td>
<td>Large campus adjacent to Moffet Federal Air Field.</td>
<td></td>
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<tr>
<td>Parking, Cars</td>
<td>Abundant surface parking in surrounding campus.</td>
<td></td>
</tr>
<tr>
<td>Foundation</td>
<td>Not published.</td>
<td></td>
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<tr>
<td>Vertical Members</td>
<td>Steel frame.</td>
<td></td>
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<tr>
<td>Horizontal Spans</td>
<td>Steel frame.</td>
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<tr>
<td>Glass and Glazing</td>
<td>15 ft high north and south glazing with tinted glass below light shelf and clear glass above.</td>
<td></td>
</tr>
<tr>
<td>Skylights</td>
<td>Diffusing glass (south sloping) and clear glass (north vertical glazing) above central atrium.</td>
<td></td>
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<tr>
<td>Glazing</td>
<td>Glass on north and south.</td>
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<tr>
<td>Roof</td>
<td>Built-up roof with skylight monitors and elevator penthouse.</td>
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<tr>
<td>Equipment</td>
<td>Central plant system located elsewhere on campus.</td>
<td></td>
</tr>
<tr>
<td>Cooling Type</td>
<td>Chilled water from central plant.</td>
<td></td>
</tr>
<tr>
<td>Distribution</td>
<td>Variable-air-volume.</td>
<td></td>
</tr>
<tr>
<td>Duct Type</td>
<td>Above ceiling.</td>
<td></td>
</tr>
<tr>
<td>Vertical Chases</td>
<td>At east and west walls.</td>
<td></td>
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</tbody>
</table>

Introduction

Project Background

Climate Data Analysis

Site Description

Integration Building Systems

Performance

Critical Analysis
Introduction
Project Background
Climate Data Analysis
Site Description
Integration Building Systems
Performance
Critical Analysis
# Climate Data Summary for Moffett Federal Air Field, Sunnyvale, CA

<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Degree-Days Heating*</td>
<td>468</td>
<td>338</td>
<td>323</td>
<td>227</td>
<td>146</td>
<td>60</td>
<td>27</td>
<td>23</td>
<td>32</td>
<td>103</td>
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<td>8</td>
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<td>56</td>
<td>70</td>
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<td>76</td>
<td>33</td>
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<td>Mean - Maximum</td>
<td>57</td>
<td>61</td>
<td>63</td>
<td>67</td>
<td>70</td>
<td>74</td>
<td>75</td>
<td>75</td>
<td>76</td>
<td>72</td>
<td>65</td>
<td>58</td>
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<tr>
<td>Mean - Minimum</td>
<td>42</td>
<td>45</td>
<td>46</td>
<td>48</td>
<td>51</td>
<td>55</td>
<td>57</td>
<td>58</td>
<td>57</td>
<td>53</td>
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<td>Mean - Average</td>
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<td>53</td>
<td>55</td>
<td>58</td>
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<td>65</td>
<td>66</td>
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<td>56</td>
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<td>Dew Point</td>
<td>40</td>
<td>43</td>
<td>43</td>
<td>45</td>
<td>48</td>
<td>52</td>
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<td>54</td>
<td>50</td>
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<td>Maximum % RH</td>
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<td>82</td>
<td>80</td>
<td>76</td>
<td>74</td>
<td>73</td>
<td>77</td>
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<td>Minimum % RH</td>
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<td>Precip. - Mean</td>
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<td>2.3</td>
<td>2.2</td>
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<td>0.1</td>
<td>T</td>
<td>T</td>
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<td>0.7</td>
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<td>Precip. - Maximum</td>
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<td>0.1</td>
<td>0.1</td>
<td>T</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>T</td>
<td>T</td>
<td>6.0</td>
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<td>% Clear Days</td>
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<td>19.3</td>
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<td>% Scattered Days</td>
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<td>24.4</td>
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<td>% Broken Days</td>
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<td>% Overcast Days</td>
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<td>14.8</td>
<td>15.6</td>
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<td>18.1</td>
<td>23.9</td>
<td>30.0</td>
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<td>Prevailing Direction</td>
<td>SE</td>
<td>NNW</td>
<td>NNW</td>
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<td>NNW</td>
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<td>Mean Speed (Knots)</td>
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<td>% Calm Conditions</td>
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<td>19.2</td>
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<td>7.9</td>
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<td>% Fog</td>
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<td>% Haze</td>
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<td>18.7</td>
<td>10.2</td>
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<tr>
<td>% Hail</td>
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<td>% Freezing Rain</td>
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<td>% Blowing Sand</td>
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<td>0</td>
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</tbody>
</table>

1945-1993 weather data for Moffett Field NAS, CA, US; Source: International Station Meteorological Climate Summary

Bioclimatic Chart for Moffett Federal Air Field, Sunnyvale, CA
% Days Observed for Particular Weather Conditions at MFAF
Sky Conditions Summary for MFAF

Month


Percent of Days

% Clear Days  % Scattered Days  % Broken Days  % Overcast Days
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Sunnyvale, California

(Map courtesy of Google Map data)
Moffett Federal Air Field, Sunnyvale, California

(Map courtesy of Google Map data)
Lockheed Building 157, Site Context

(Map courtesy of Google Map data)
Lockheed Building 157, Ariel View

(Map courtesy of Google Map data)
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Typical Plan

(Benton & Fountain 1990)
Typical Plan
(Egan and Olgyay 2002)

Transverse Section
(Egan and Olgyay 2002)
Diagrammatic Section describing the building’s eight luminous zones (third floor), daylight illumination (forth floor), the HVAC system (fifth floor) and the stack effect utilized by the atrium.

(Gardner 1984)
Wall Section Detail, South Façade

(Bachman 1995)

Five story building totaling 90-ft in height (27.9-m)
560 ft x 250 ft (73.2 m x 170.7m) in plan

Raised access floor system

Variable air volume HVAC above ceiling and in light shelves

Daylighting and cool white fluorescent supplemental lighting on photocell dimming. Fluorescent fixtures are ceiling suspended and integrated into perimeter light shelves.

15 ft high north and south glazing with tinted glass below light shelf and clear glass above.

Supplemental direct/indirect task lighting from lensed warm white fluorescent fixtures integrated into workstation.
Diagrammatic Section illustrating the field-measured illuminance levels across a typical section of a south-facing office corridor on January 31, 1983 at 9:00 a.m.

(Gardner 1984)
South Façade

(Garner 1984)
Office Corridor

(Garner 1984)
Atrium Interior

(Garner 1984)
Atrium Skylights

(Bachman 1995)
South Façade

*(Garner 1984)*
First Floor Cafeteria

(Bachman 1995)
First Floor Cafeteria

(Bachman 1995)
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• **Performance**
• Critical Analysis
PERFORMANCE: General

- *Relocation* of known workforce provided comparative opportunity.
- After first year of operation: worker absenteeism down 15%.
- In addition, worker productivity up 15%.
PERFORMANCE: Energy

• Daly’s goal to reduce company’s energy use by half barely achieved.
• First-year use: 19,600 Btu/ft²/yr (49% allowed by CA Energy Code).
PERFORMANCE: Economic

• Cost of building: $50 million (Daly’s special features: $2 million)
• 25% return on investment for Daly’s features (about $500,000 / year).
• Building projected to account for only 2% of 30-year-expenditures.
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1: Optimizing the Slope of the Ceiling

- Some daylighting experts claim that the design could have utilized the predominant clear sky condition better.
- However, overcast condition is comparable – plus consider haze.
- Design was actually optimized to handle both conditions adequately.

(Gardner 1984)
Existing Condition

Alternative 1: Flat Ceiling
Existing Condition

Alternative 2: Reversed Ceiling Slope
2: Daylighting & Furnishings

- Daylight strategy optimized under a “no furnishings” condition.
- Perhaps there was a “baseline” rationale.
- Qualitative data suggests that task lighting will often be necessary.

*(Gardner 1984)*
3: Atrium Daylight Delivery Adjustments

- Some daylighting experts believe that inside edge of the office spaces would benefit from the addition of light shelves.
- Illumination data tends to support this claim.

Illustration courtesy of the University of California, Berkeley (Gardner 1984)
Existing Condition

Alternative 3:
Existing w/ Inner Light Shelf
Existing Condition

Illuminance (ft) Comparison

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Maximum</th>
<th>Minimum</th>
<th>Avg./Min.</th>
<th>Max./Min.</th>
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<td>Existing Condition</td>
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<td>83.6</td>
<td>11.1</td>
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<td>7.5</td>
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<td>Alternative 1: Flat Ceiling</td>
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<td>76.7</td>
<td>8.7</td>
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<td>8.8</td>
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<td>46.4</td>
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<td>2.8</td>
<td>5.4</td>
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</table>
Works Cited


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