

## De Anza ES 74 Lighting - Lecture #2

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Instructor

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## Logistics

- <http://bhs.deanza.edu/faculty/sGould/index.htm>
- Field Trip - PEC
- Reading assignment -- See NLPIR web page  
<http://www.lrc.rpi.edu/programs/NLPIP/publications.asp>
- Scott Gould email is [scott.gould@stanford.edu](mailto:scott.gould@stanford.edu)

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## Review Lecture 1

- Definitions - CRI, Color Temperature. etc
- Lighting Quality
  - Average Light Level
  - Uniformity of Illumination
  - Direct/Reflected Glare
- Lamp Types
- Ballast Operation

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## Interaction of Lighting and HVAC

- Energy used by lighting ends up as heat
- This extra heat may need to be removed by mechanical cooling
- By improving the efficiency of the lighting system you may accrue additional savings on the HVAC system

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## T5 Fluorescent Lamps

- Fluorescent lamp 5/8" in diameter more efficacious than T8s
- Requires different ballast than T8 or T12 lamps.
- T5 Lamps are slightly shorter than T8s
- Available in different lengths and HO (high output) with excellent CRI.
- Much better efficacy in warmer (95 degree) ambient temperature fixtures than T8s.

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## T5 Fluorescent Lamps cont.

- Smaller diameter can increase fixture flexibility.
- Smaller size means less material. Better for the environment?
  - 60% less glass than a T12, 38% less glass than a T8
  - Less packaging, less mercury, etc.

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## Luminaires

- Open "Shop" Fixtures
- Plastic Lenses
- Parabolic Lenses
- Uplighting
- Task Lighting

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## Delamping

- Energy Saved by Removing Lamps from a Fixture.
- Works Best in Overlit Areas.
- Light Loss can be Offset by Installing:
  - Optical Reflectors
  - Lens Upgrades
  - Luminaire Cleaning
  - Higher Output Lamps T8 and T10
  - Task Lighting

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## Optical or "Specular" Reflectors

- Goal is to Improve Luminaire Efficiency
- First Consider
  - Reflector Shape
  - Reflector Materials
  - Efficiency of Original Luminaire
- Key is Reflector Design
- Common Materials are Anodized Aluminum and Specular Silver

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## Lighting Controls Introduction

- Lighting Controls are Devices that Turn Off or Dim Lights when Not Needed.
- Potential Savings
  - 30 % of the lighting energy
  - 10 % of the building energy
- Typical Simple Payback Less than Three Years.

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## Control Strategies

- Occupancy Driven
  - Manual Switches/ Occupancy Sensors
- Time Scheduled
  - Time Clock
- Manual Dimming
- Daylighting
- Lumen Maintenance
- Tuning
- Adaptation Compensation
- Load Shedding

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## Manual Switches

- No savings like off!
- Standard wall switch
- Advantages
  - Private Spaces
- Disadvantages
  - Public Spaces

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Advanced Technology Option

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## Occupancy Sensors PIR

- Passive Infrared (PIR)
  - Detects body heat
  - Lens design key!
- Advantages
  - Fewer nuisance trips
  - Better than ultrasonic with higher mounting
- Disadvantages
  - Direct Line of sight required

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## Occupancy Sensors -- Ultrasonic

- Ultrasonic -- Active
  - Emits ultrasound 25 to 40 kHz.
  - Frequency shift in reflected signal equals motion.
- Advantages
  - More sensitive
  - Better than PIR for odd shaped rooms
- Disadvantages
  - More false detections due to air turbulence, open doors, etc.

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## Occupancy Sensors - Dual Tech

- Combines Technologies into one Unit
  - Both sensors to turn lights on and one or the other to turn lights off.
- Advantages
  - Effective in most areas. Minimizes false detection.
- Disadvantages
  - Costs more.
  - Can still be left on as with ultrasonic.

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## Occupancy Sensors - Audible

- Microphone Detects Noise
  - Ignores constant noise.
- Advantages
  - Simple and inexpensive
- Disadvantages
  - Very sensitive to false "on" conditions

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## Types of Sensors

- Wall switches
  - Private offices
  - Automatic on/off or Manual on/auto off
  - Inexpensive to install
- Ceiling Sensors
  - Center of room "360" detection
  - Good for conference rooms & classrooms.

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## Types of Sensors cont.

- Wall and Corner Sensors
  - Large room and corridors
  - Good viewing angle
- Personal Sensors
  - For desk use
  - Detects small motion
  - Connects to single controlled outlet or plug strip
  - Task lights, computer monitors, small printers

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## Timers

- Simple, Local Devices. Ideal for Library Stacks.
  - Mechanical
    - Twist dial for set period
  - Electronic
    - Touch pad
    - "Time out" warning

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## Time Clocks

- Preset Schedule for Day or Week
- Mechanical and Electronic
- Astronomic feature -
  - Adjusts for seasonal variation in sunrise and sunset times
  - Good for outdoor lighting?

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## Manual Dimmers

- Reduces Light Levels by Reducing Power Input to the Fixture
  - Must select proper dimmer for the application
  - Incandescent
  - Fluorescent - requires special ballast
  - HID - May result in color shift

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## Photoelectric Controls

- Turn lights on and off according to the amount of light striking the surface of the sensor.
  - Indoor/Outdoor
  - Open loop/closed loop
  - Can be used with other lighting controls.

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## Lighting Control System

- Can Use a Combination of Controls as an Input
- Sweep System - Centralized Control
  - Part of Energy Management System
  - Relay systems that switch individual lighting circuits on and off at set times. Occupants can override the system with a wall switch or other signal.

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## Case Study - Occupancy Sensors Undergraduate Chem Lab

- **Challenges:**
  - Tall lab benches
  - Hours on 4,280 per year
  - Because of chemicals a "nuisance off" could be dangerous.
- **Solution:**
  - Two sensors per room
  - Good manufacturer's support
- **Payback**
  - Cost was \$4,490 Simple Payback 2 years
  - Hours from 4,280 to 2,555 hrs/yr

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## Environmental Issues

- **Lamp Disposal**
  - Proper disposal is important since it is the largest source of mercury in land fill after batteries. Mercury then leaches to ground water.
  - Require relamping companies to provide certificate of disposal.
  - Recycling is best. Mercury, phosphors, and glass can be reused.

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## Environmental Issues cont.

- Cost for disposal
- Newer Lamps use less mercury than old T12s
- Phillips "Alto" lamp
- Ballast Disposal
  - PCB - Polychlorinated biphenyls
  - Banned in 1976

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**Group Relamping**

- Light Output and Efficiency Decreases Over Time Due to:
  - Lamp lumen depreciation
  - Luminaire dirt depreciation
  - Lamp burn-out - rated lamp life

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**Group Relamping cont.**

- Cost Effective with:
  - High Mounting Height
  - Dirty or Indirect Systems
  - Metal Halide Systems
  - Uniform Hours of Operation
  - Aesthetics Important

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**Retrofit Process**

- Qualification
- Data Collection
- Engineering
- Construction and Commissioning

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## Lighting Audit

- Excessive Illuminance
- Inefficient Technology
- Poor Maintenance
- Excessive Hours of Operation
- High Electricity and Demand Charges
- Suboptimal Lighting Conditions

EPRI Lighting Retrofit Manual 1998

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## Halogen Torchieres

- Halogen Torchiere
  - 300 to 500 watts with dimming
  - \$20 first cost
  - 2,000 hours lamp life
- Compact Fluorescent Torchiere
  - 65 watts two level
  - \$70 first cost
  - 10,000 hours lamp life

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## Review Lecture 2

- T5 Lamps
- Lighting Controls
- Lamp Disposal
- Group Relamping
- Retrofit Process

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