Economizers: Design, Performance, and Commissioning Issues

Economizer Basics

Instructor:

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- Senior Engineer
- Facility Dynamics Engineering

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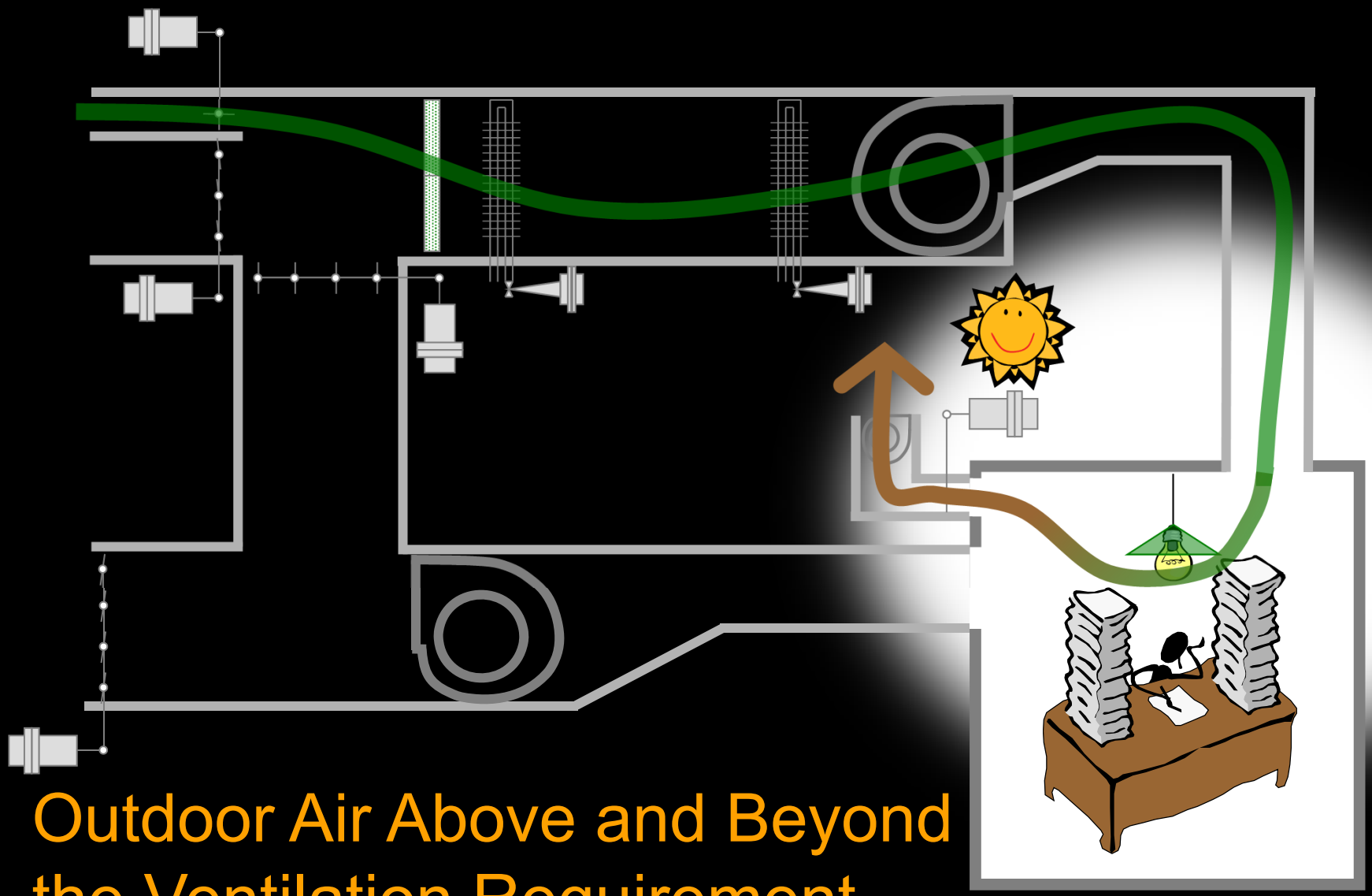
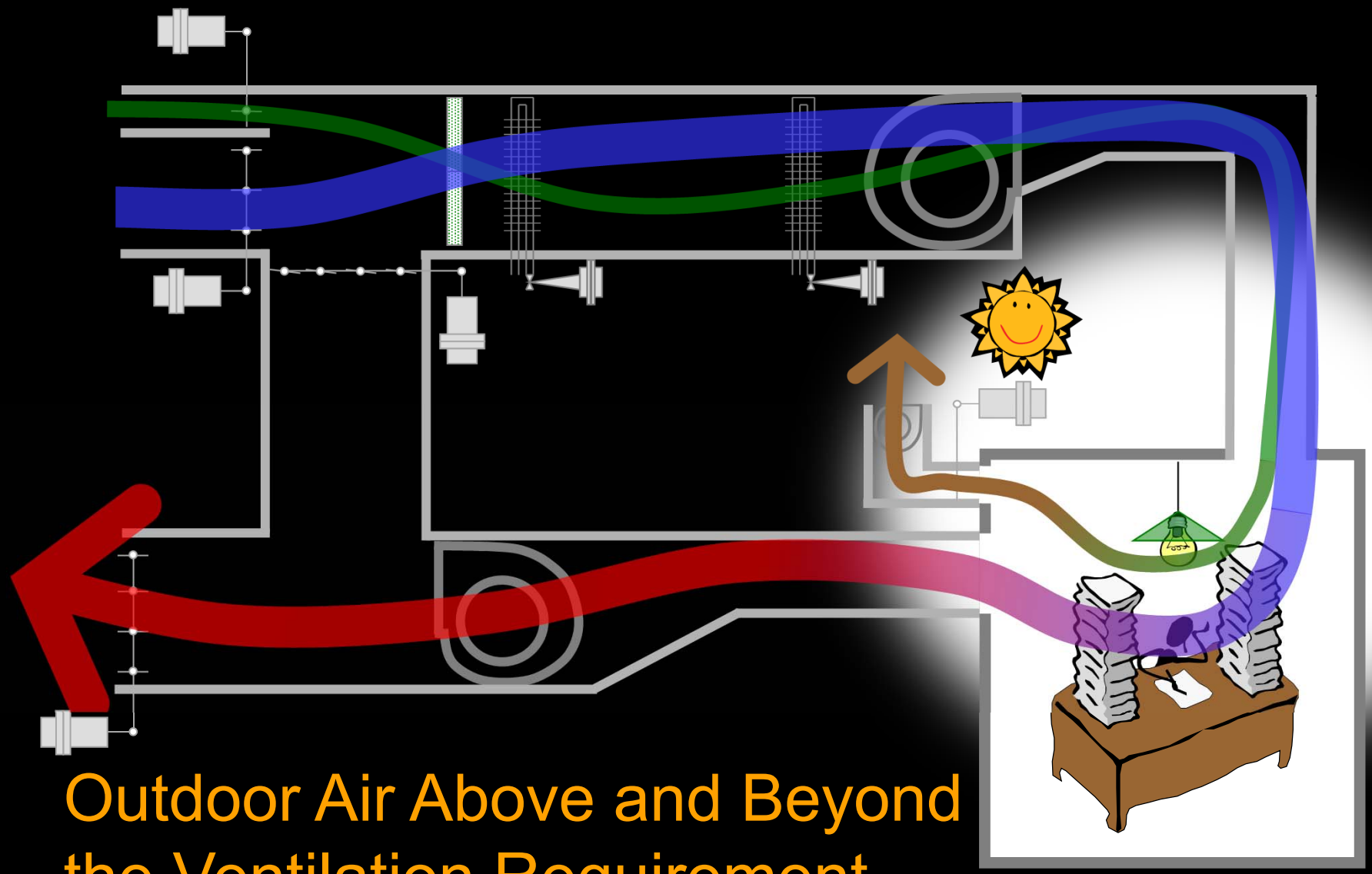
What's In This Module?

- How buildings use outdoor air; Ventilation vs. Free Cooling
- Heating vs. Cooling Processes
- Integrated vs. Non-Integrated Economizers
- Return vs. Relief Fans



Outdoor Air Above and Beyond the Ventilation Requirement



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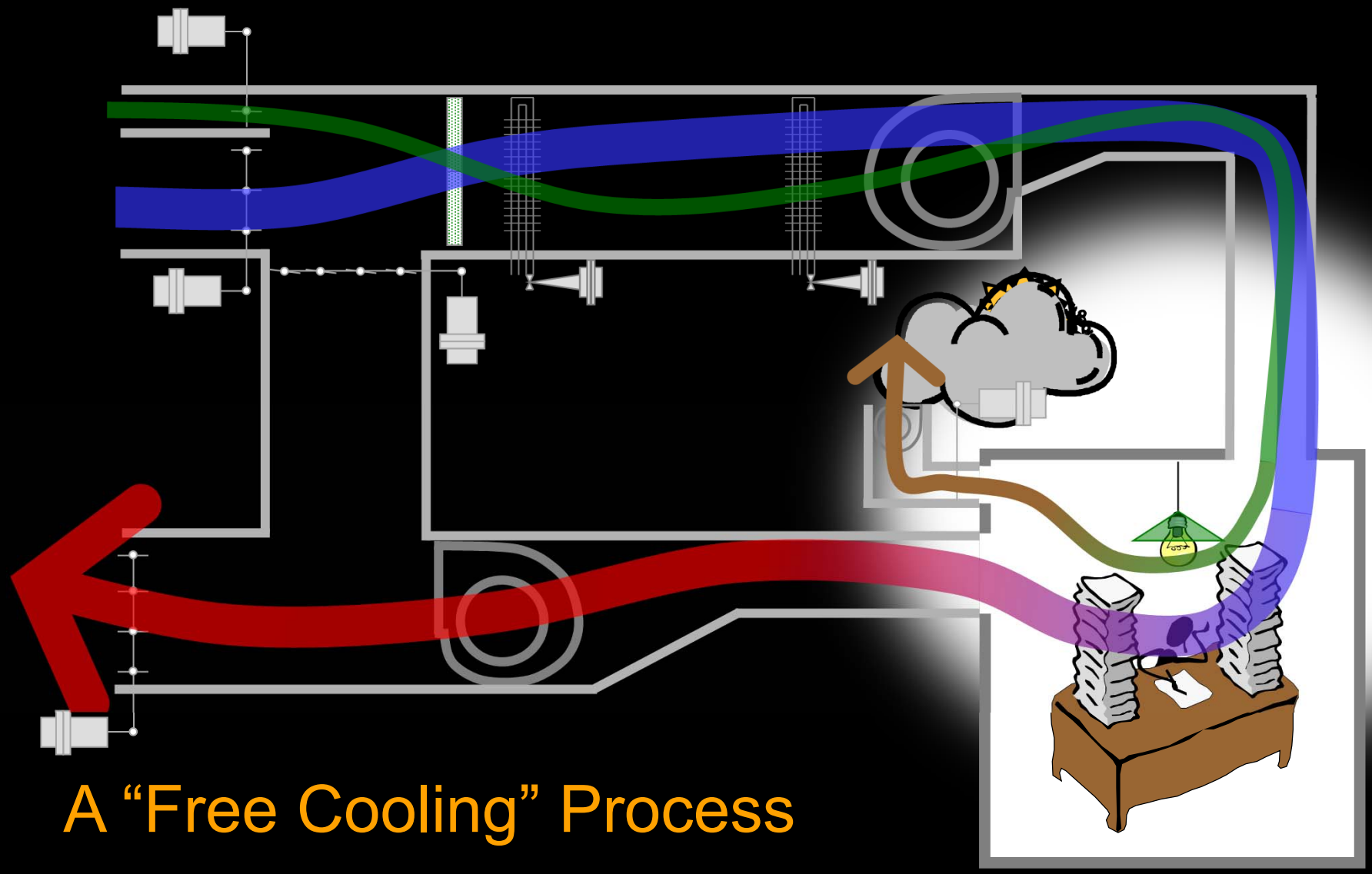


A “Free Cooling” Process

Definition

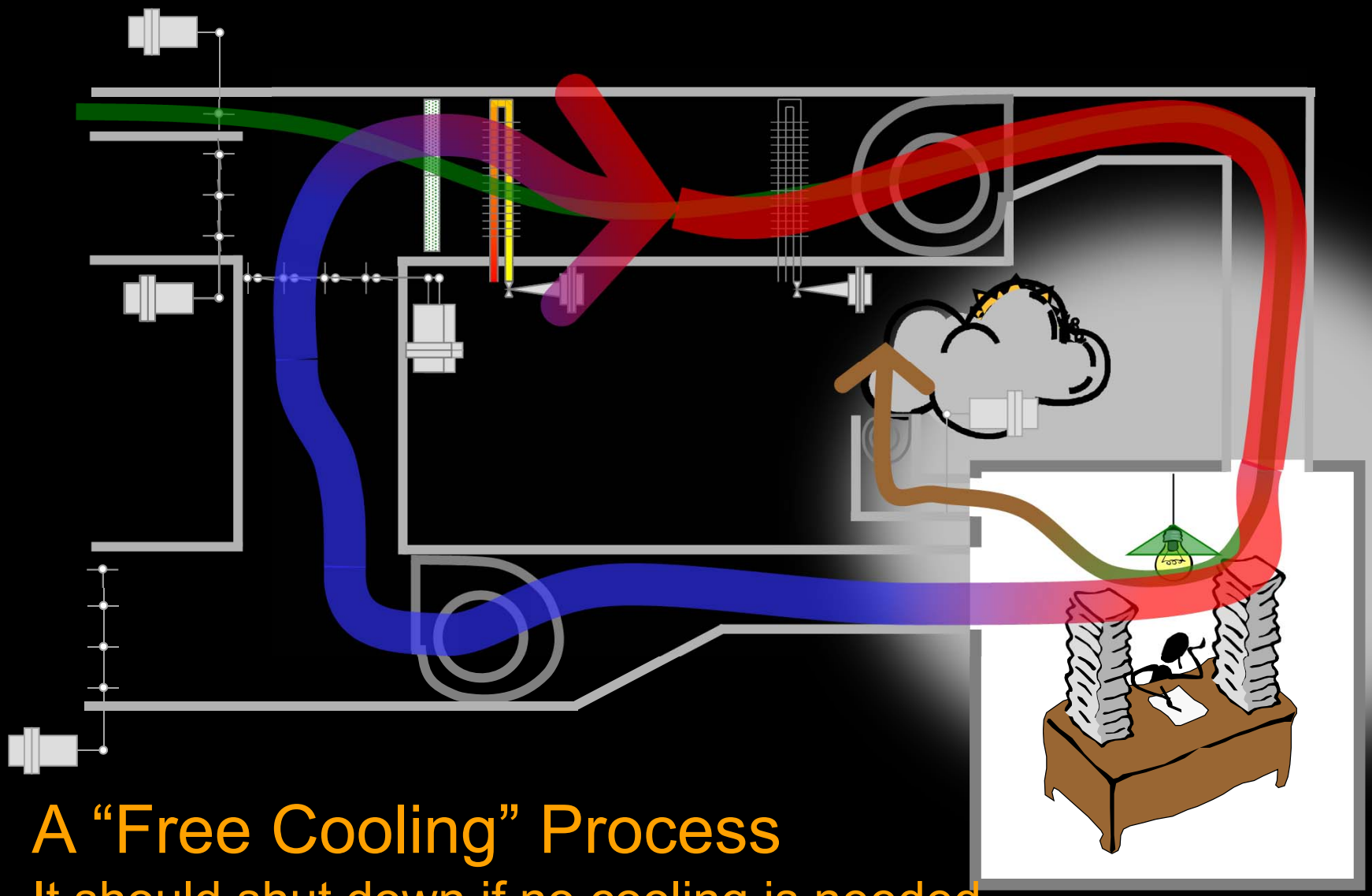
Cooling

A process that removes energy. For a space, this is often accomplished by circulating air through it at a temperature below the required set point. For an airstream, this is often accomplished by passing it over a surface that is below the required supply temperature. If the surface is below the dew point of the air stream, dehumidification (moisture removal) will also occur.

Definition

Heating

A process that adds energy. For a space, this is often accomplished by circulating air through it at a temperature above the required set point. For an airstream, this is often accomplished by passing it over a surface that is above the required supply temperature.

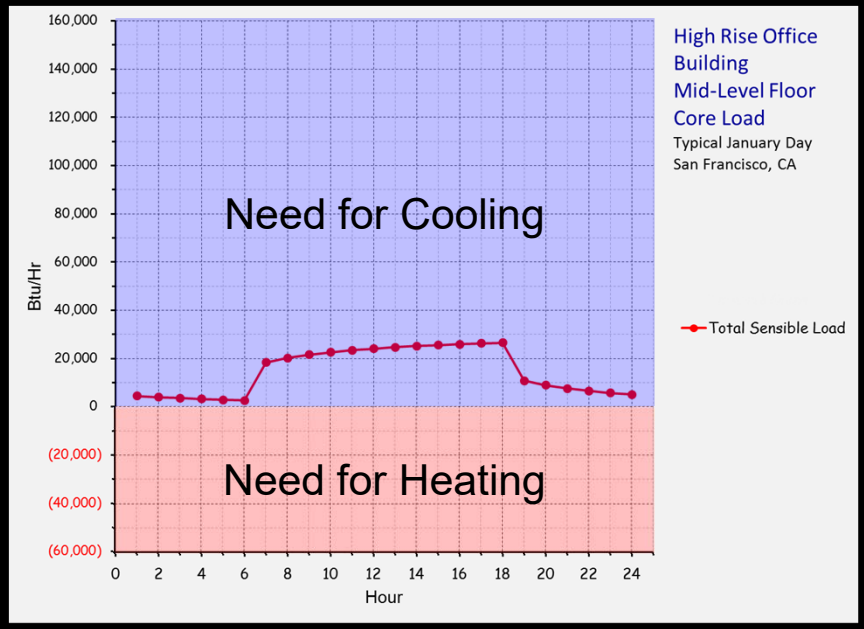


A “Free Cooling” Process

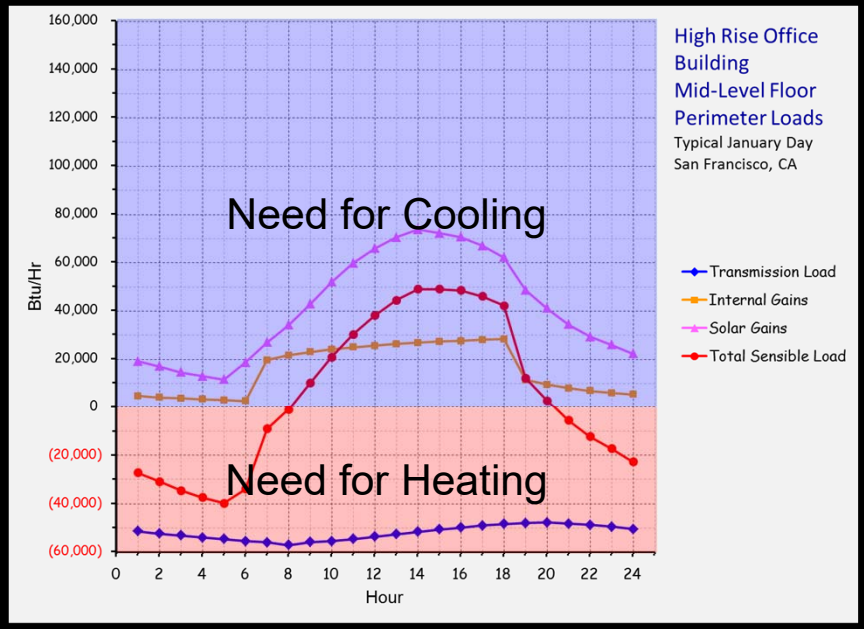
It should shut down if no cooling is needed

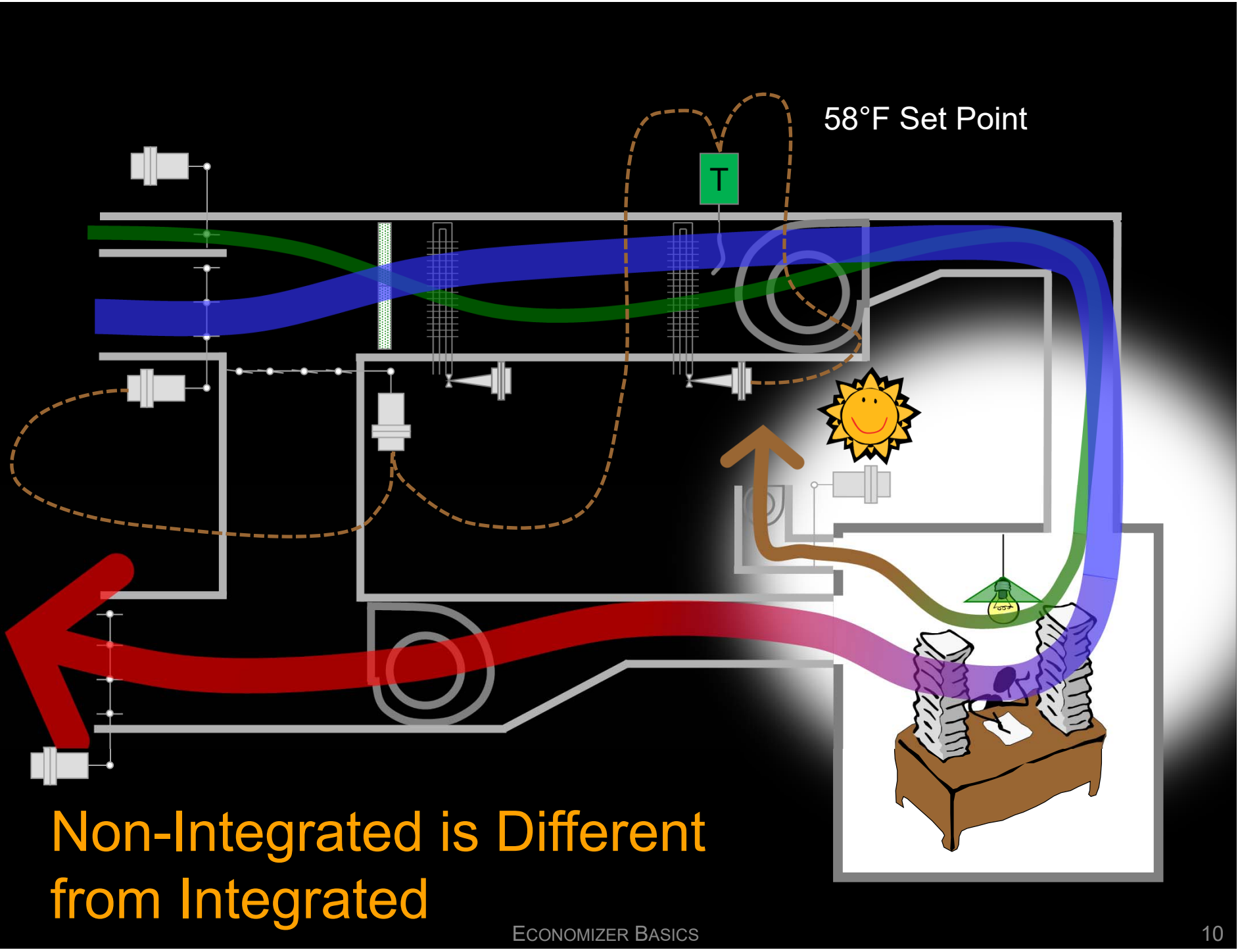
Should Core and Perimeter Zones be on the Same Economizer Equipped Air Handling System?

January Core Load Profile

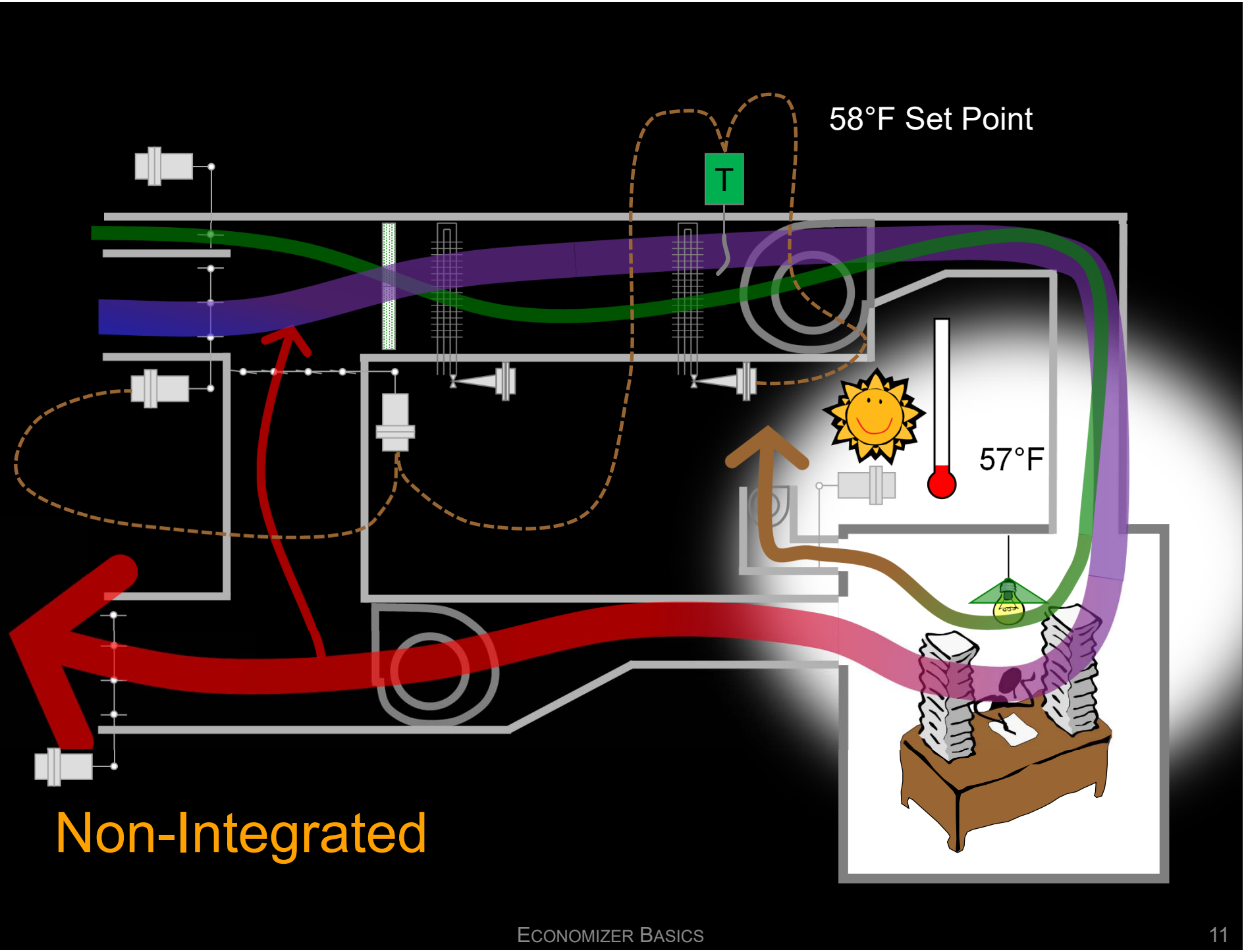


January Perimeter Load Profile

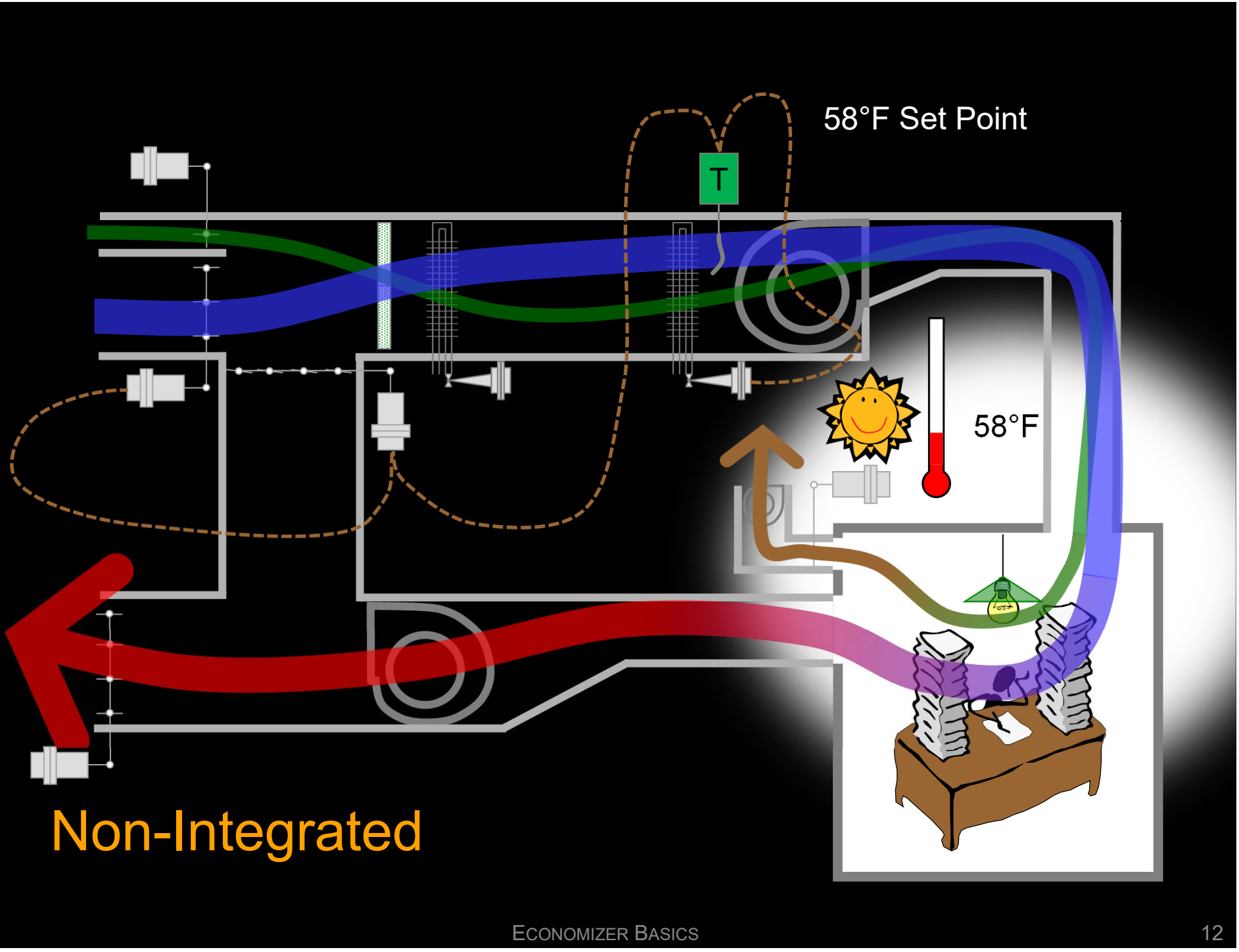


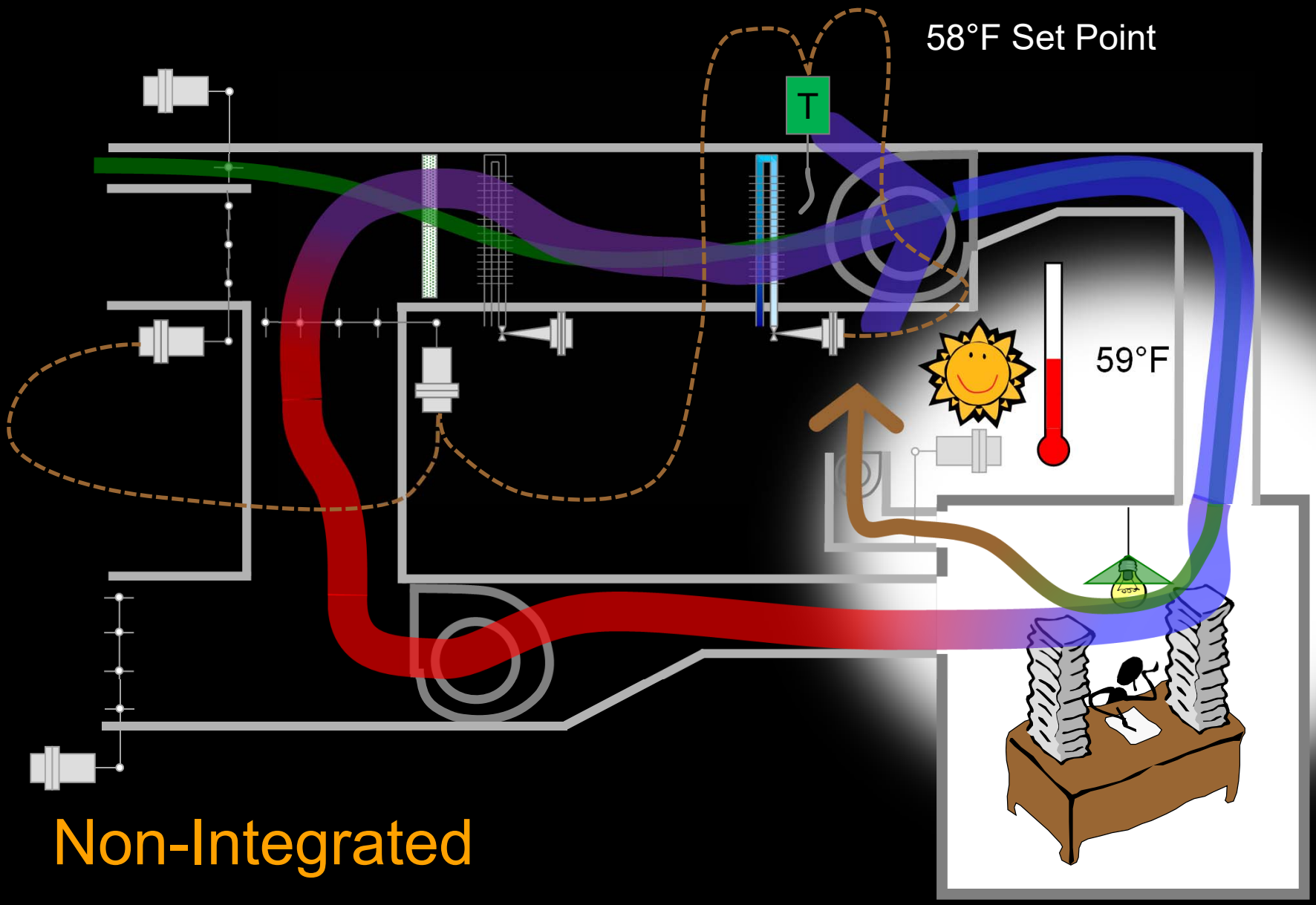


Non-Integrated is Different from Integrated

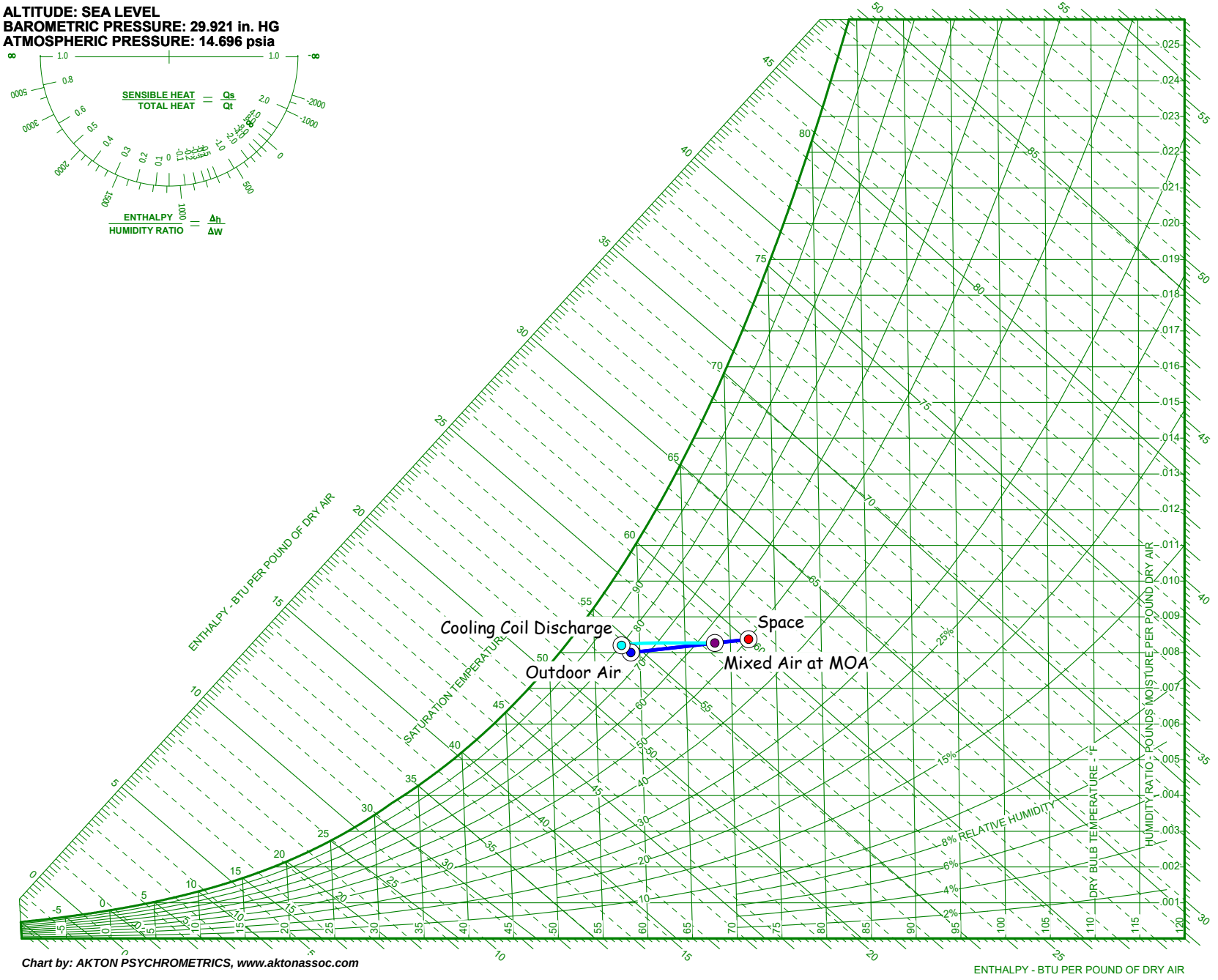


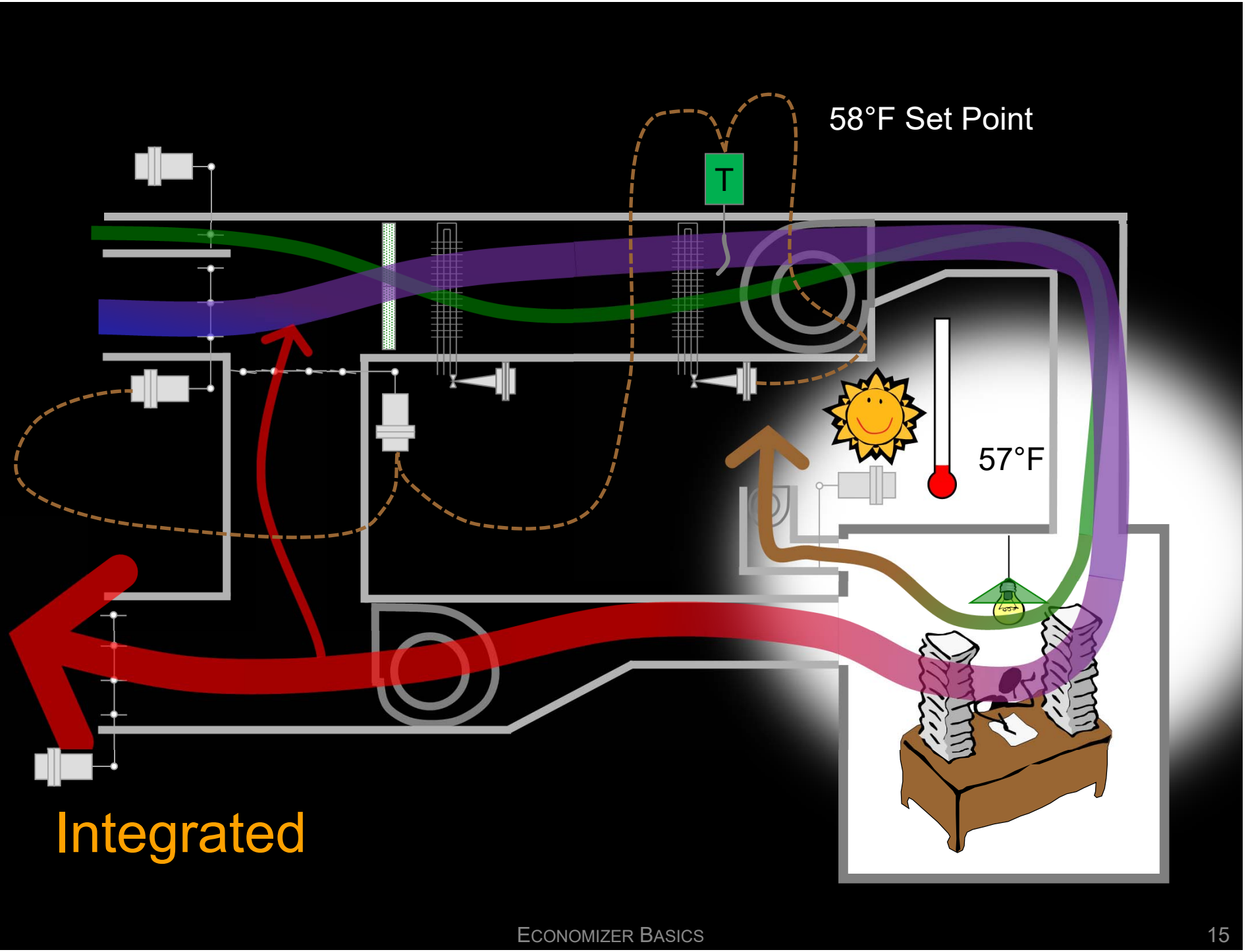
Non-Integrated

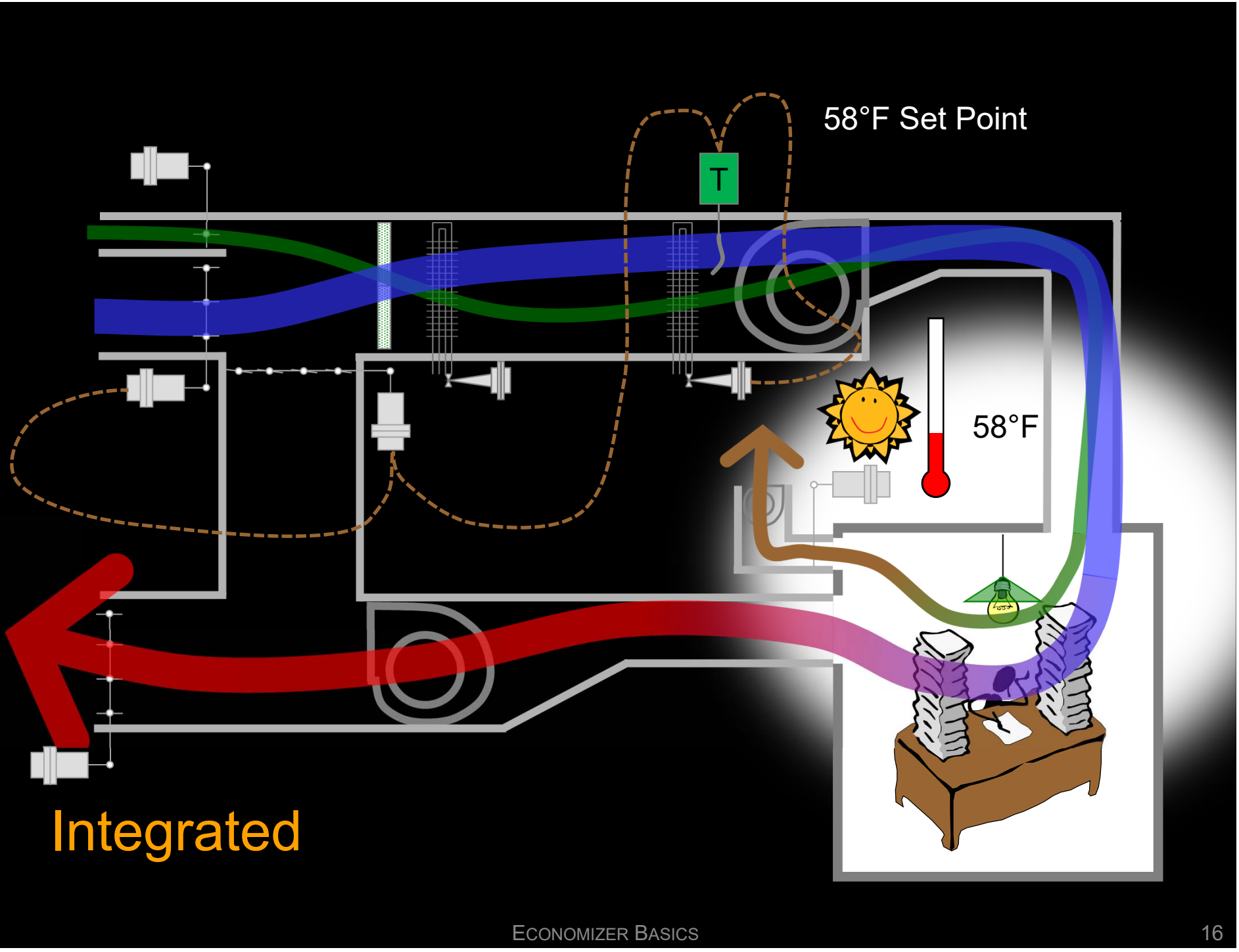

58°F Set Point
T
58°F
Non-Integrated

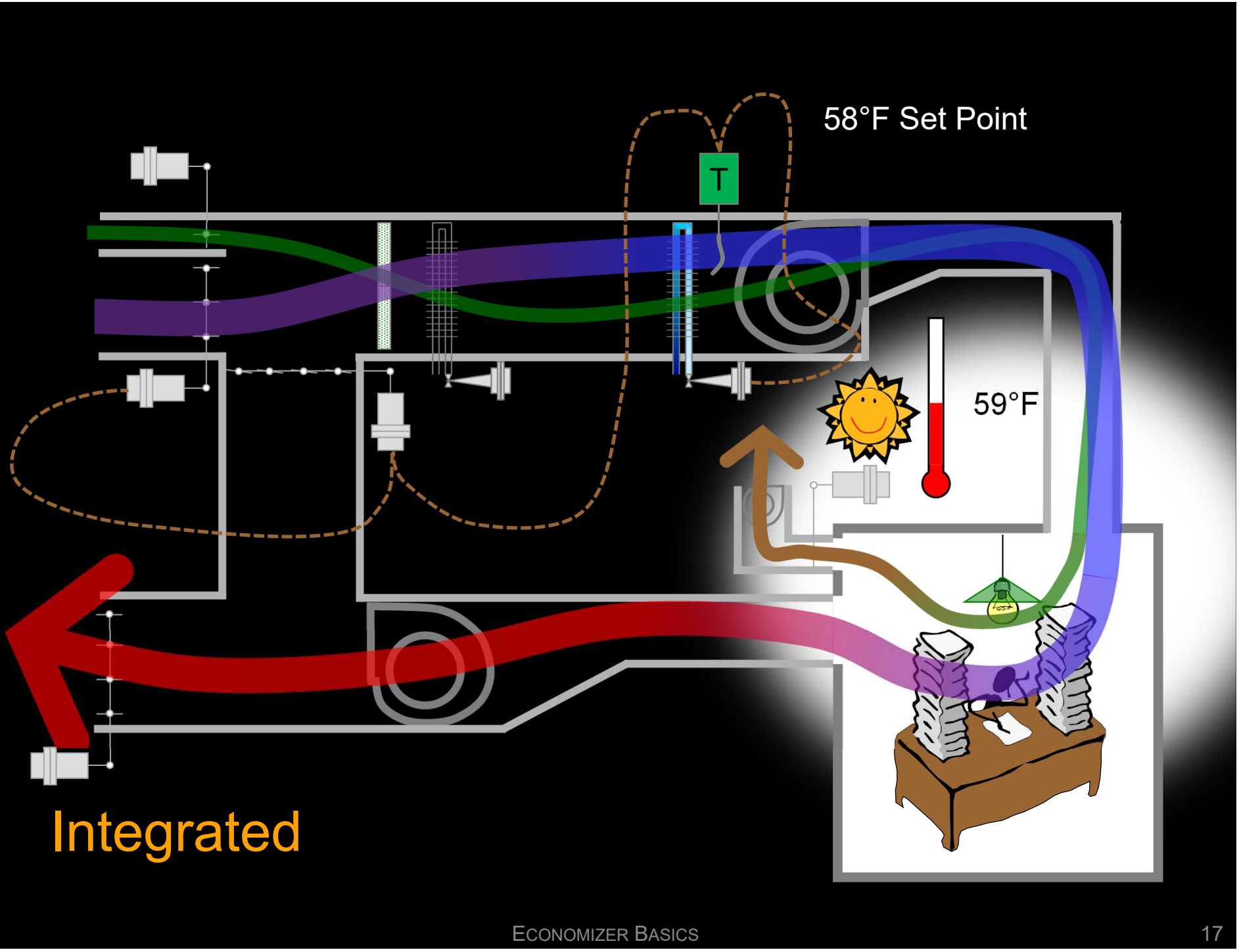


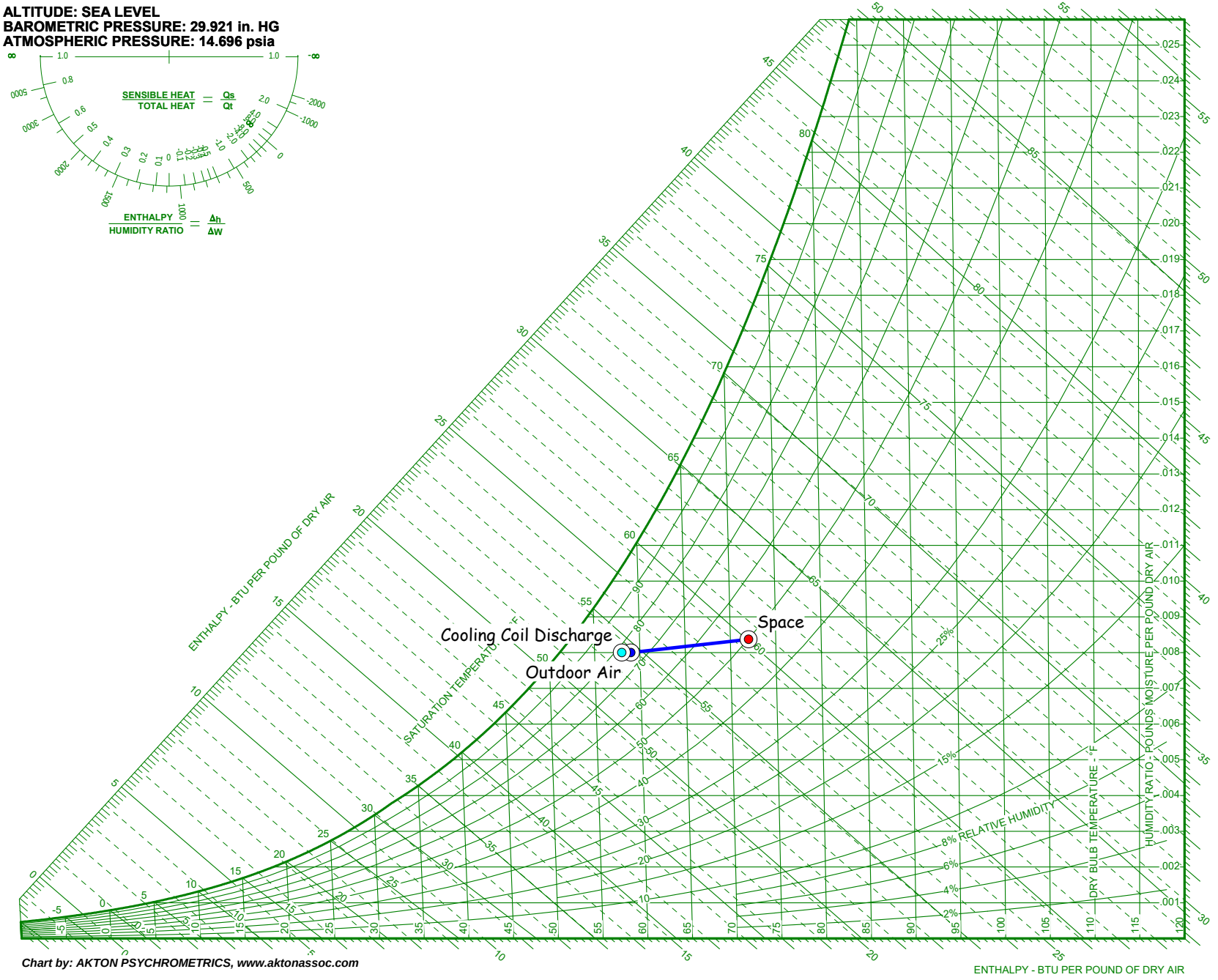
Non-Integrated


ALTITUDE: SEA LEVEL
BAROMETRIC PRESSURE: 29.921 in. HG
ATMOSPHERIC PRESSURE: 14.696 psia
SENSIBLE HEAT / TOTAL HEAT = Qs / Qt
ENTHALPY / HUMIDITY RATIO = Δh / ΔW
Cooling Coil Discharge
Space
Outdoor Air
Mixed Air at MOA
ENTHALPY - BTU PER POUND OF DRY AIR
SATURATION TEMPERATURE
DRY BULB TEMPERATURE - °F
HUMIDITY RATIO - POUNDS MOISTURE PER POUND DRY AIR
RELATIVE HUMIDITY
Chart by: AKTON PSYCHROMETRICS, www.aktonassoc.com


58°F Set Point
T
57°F
Integrated


58°F Set Point
T
58°F
Integrated


58°F Set Point
T
59°F
Integrated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RELATIVE HUMIDITY
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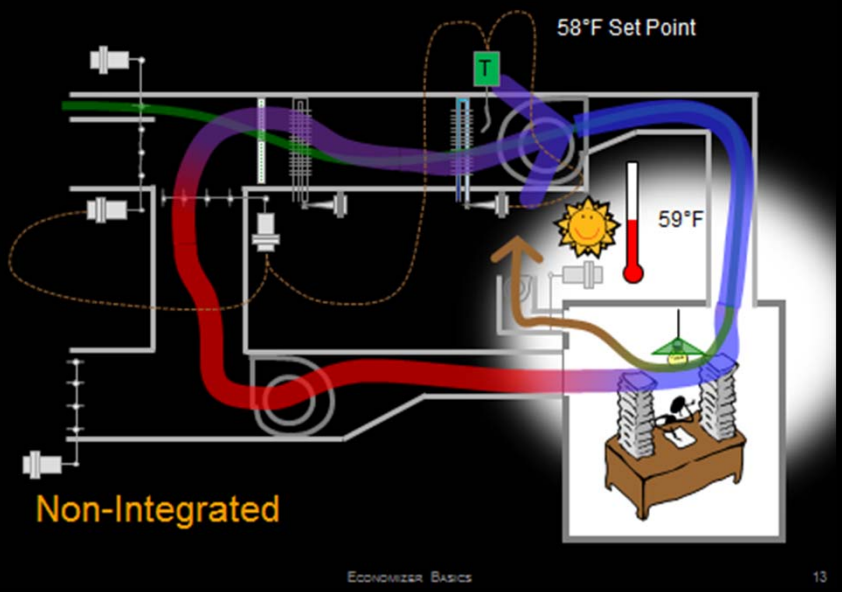
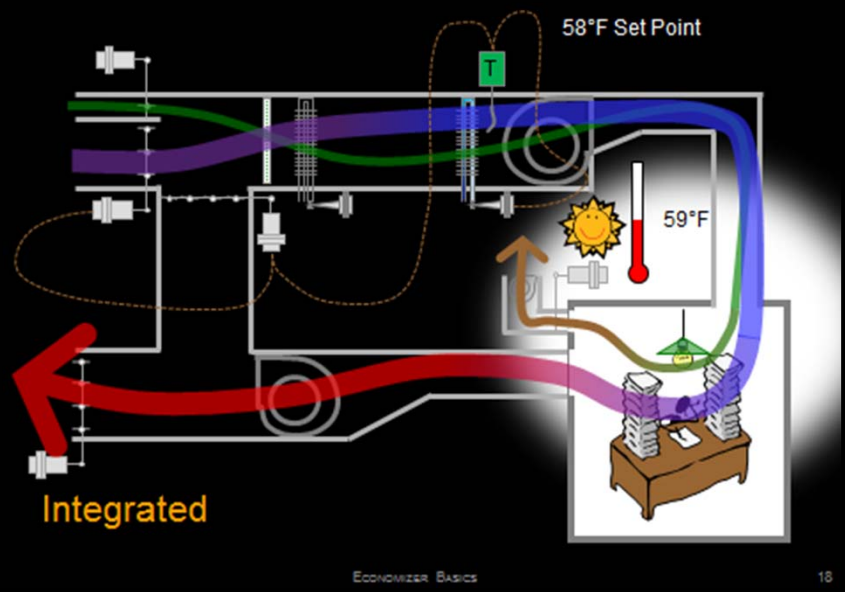
Non-integrated vs. Integrated

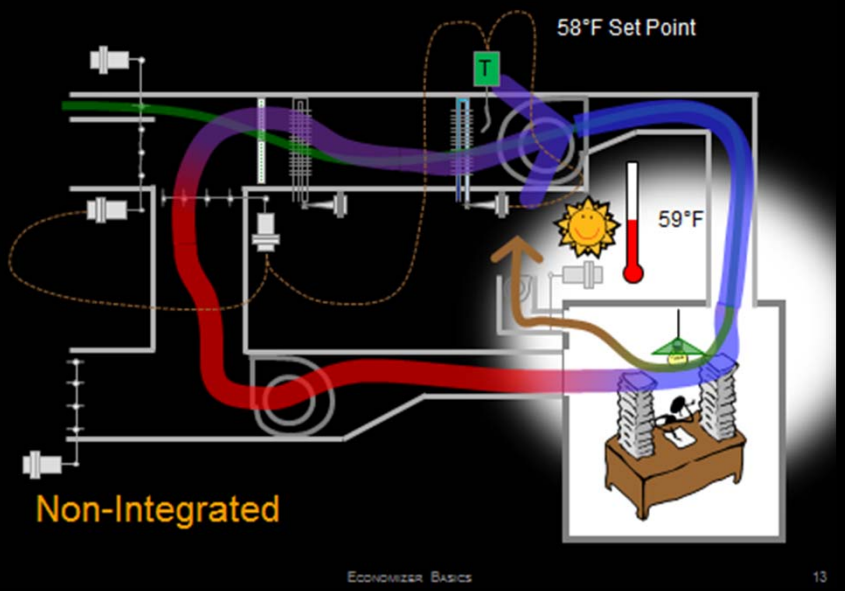


- Cooling coil load
- Q = 4.5 x cfm x Δh
- Q = 4.5 x 30,000 x (25.4 – 22.8)
- Q = 351,0000 Btu/hr
- Q = 29.3 tons

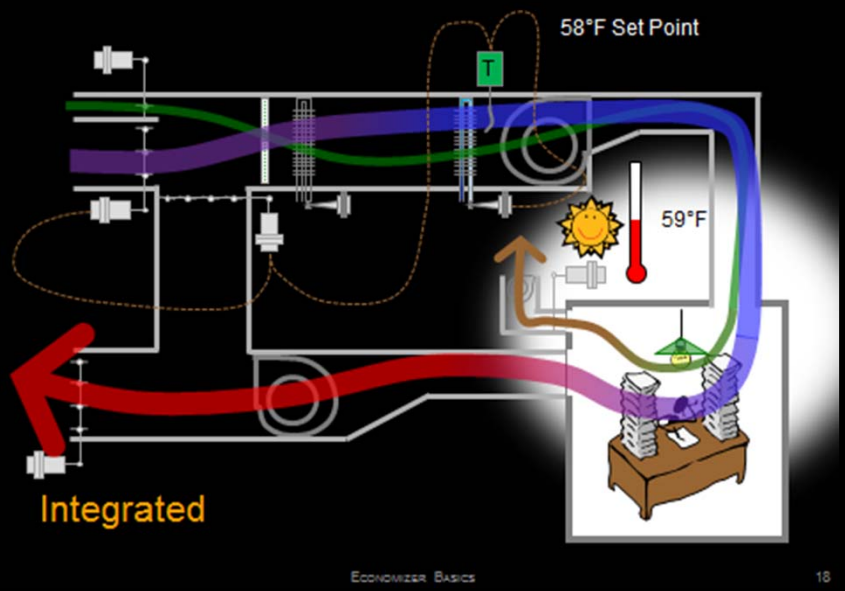


- Cooling coil load
- Q = 4.5 x cfm x Δh
- Q = 4.5 x 30,000 x (22.8 – 22.6)
- Q = 27,0000 Btu/hr
- Q = 2.3 tons

Non-integrated vs. Integrated

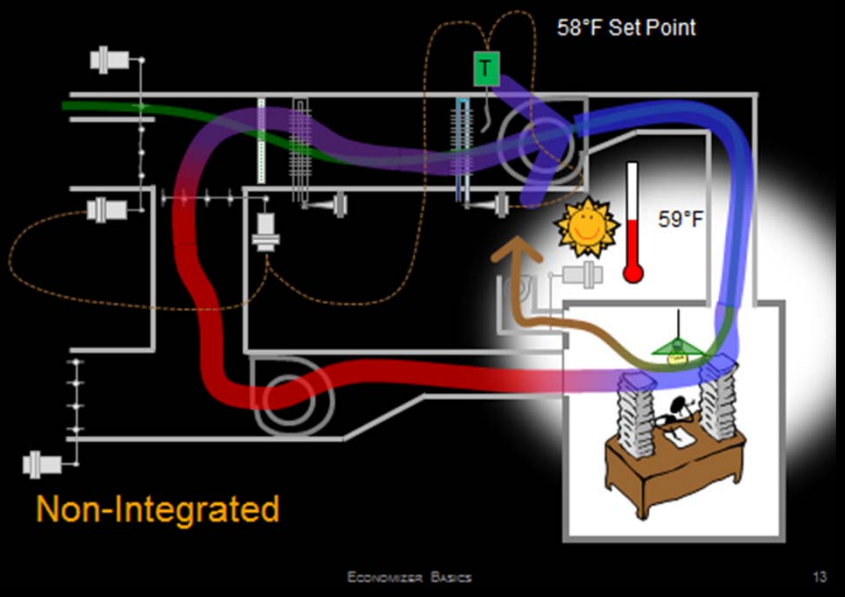


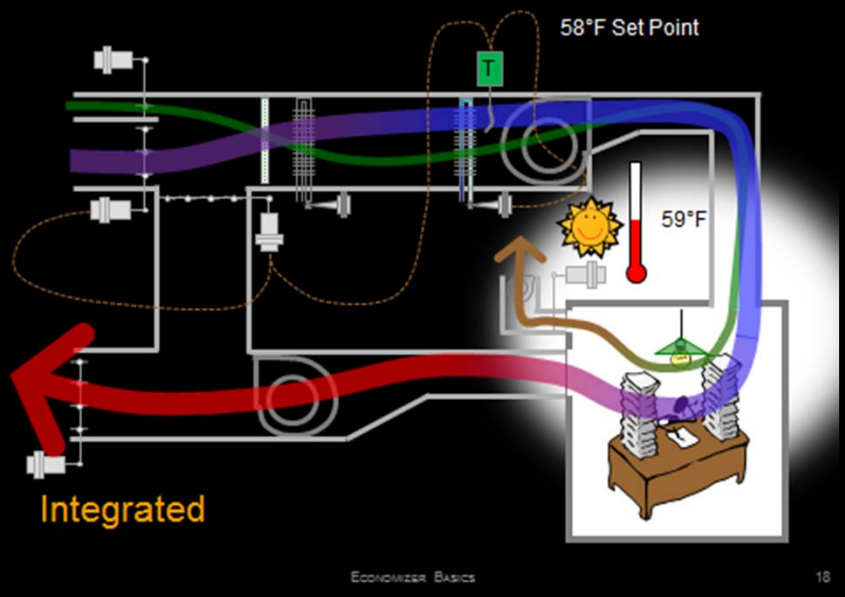
- Space Conditions
- Space temperature = 72°F
- Space RH = 50%
- Space enthalpy = 26.4 Btu/lb



- Space Load (average cooling coil leaving conditions)
- Q = 4.5 x cfm x Δh
- Q = 4.5 x 30,000 x (26.4–22.7)
- Q = 499,500 Btu/hr
- Q = 41.6 tons

Non-integrated vs. Integrated

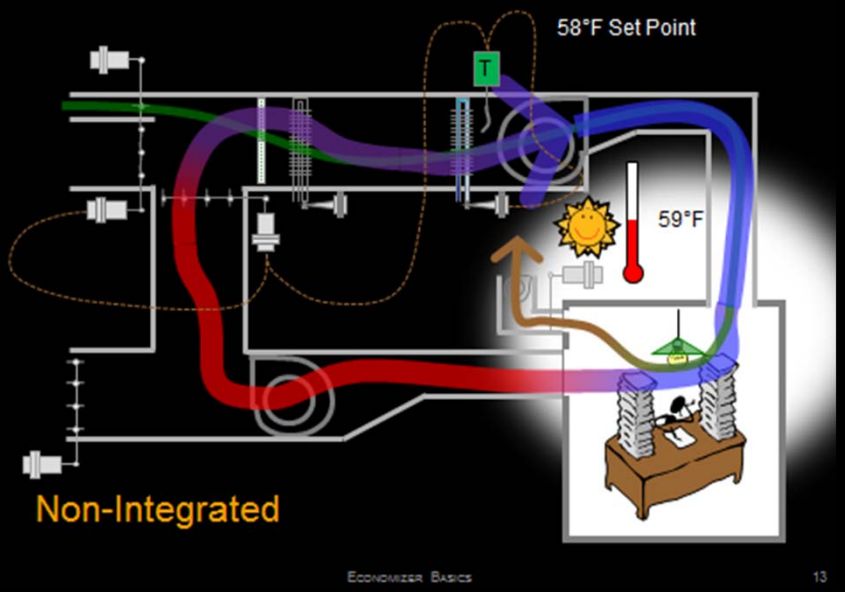


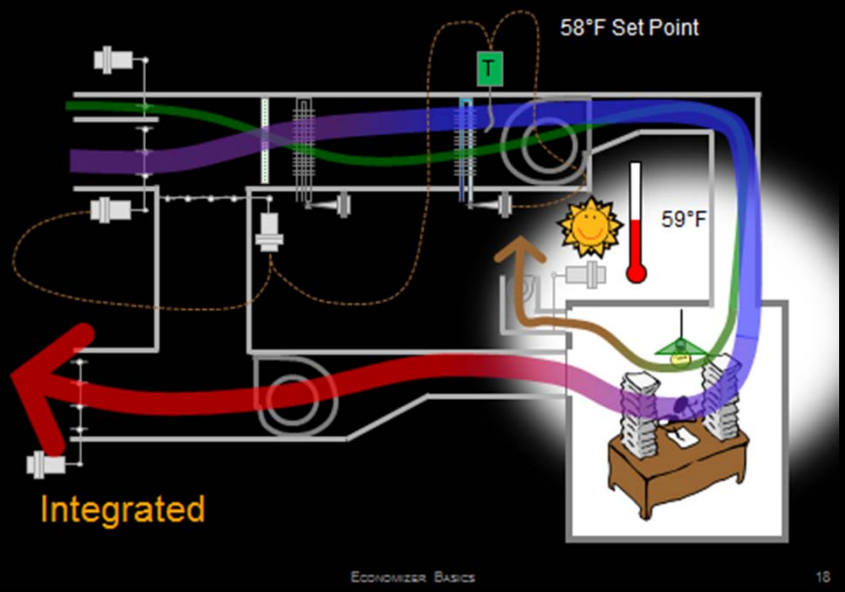


LOADS

Space	Coil – Non-Integrated Economizer	Coil – Integrated Economizer
• 41.6 tons	29.3 tons	2.3 tons

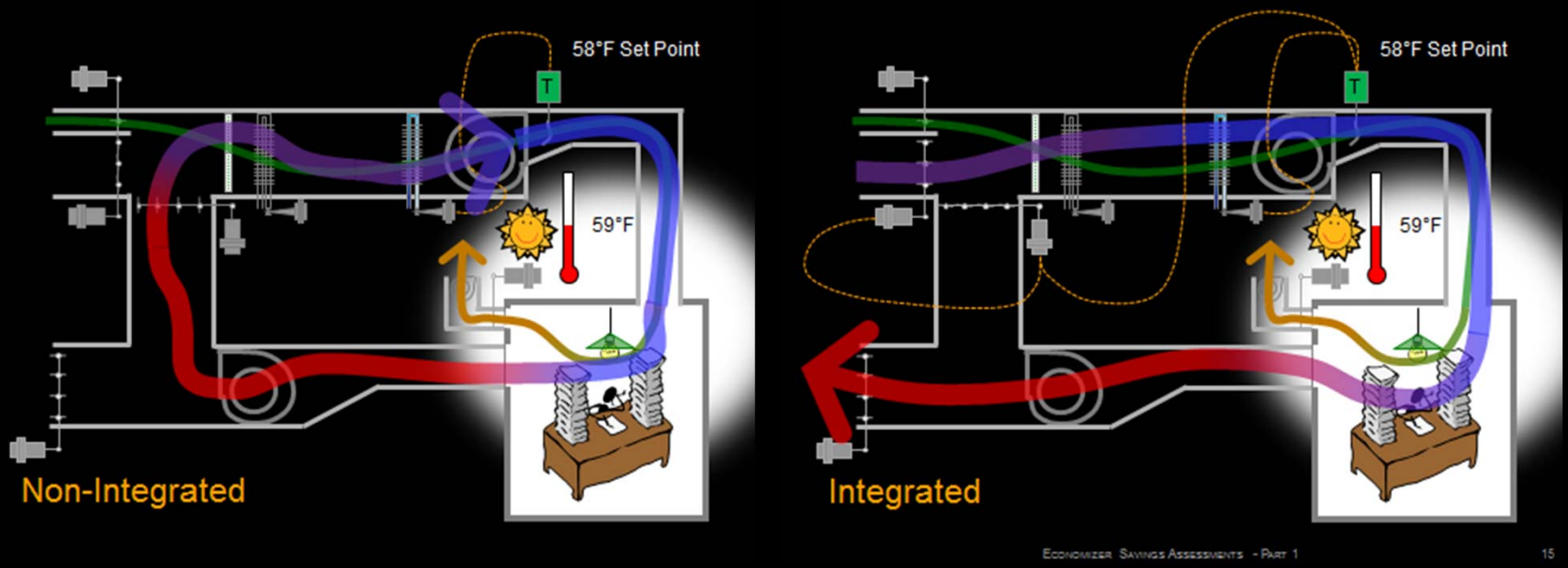
Non-integrated vs. Integrated





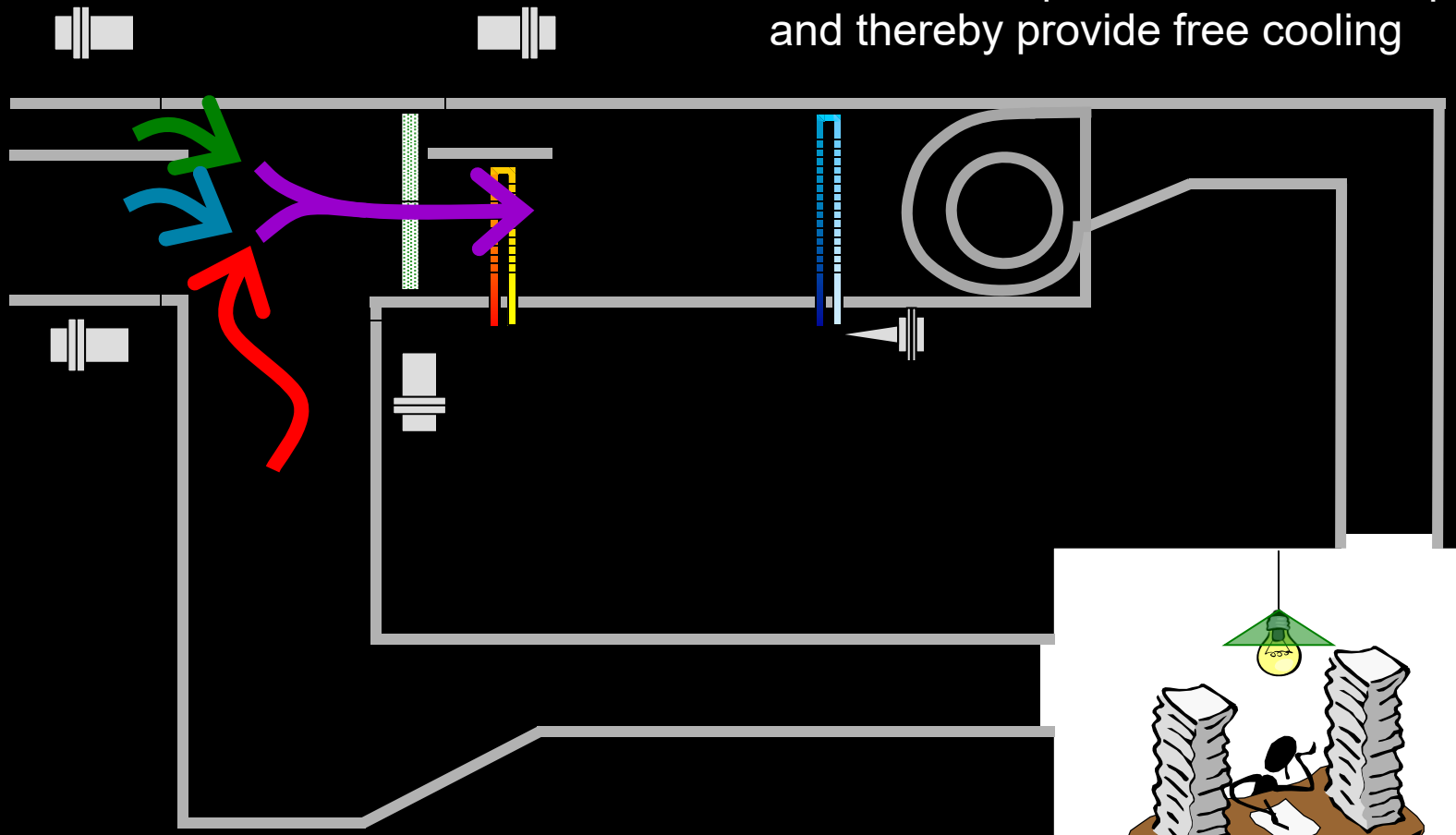
- LOADS
  - *The coil load often is not the same as the space load*
    - *Typically less if it is cool and dry outside*
    - *Typically more if it is hot and humid outside*

Non-integrated vs. Integrated

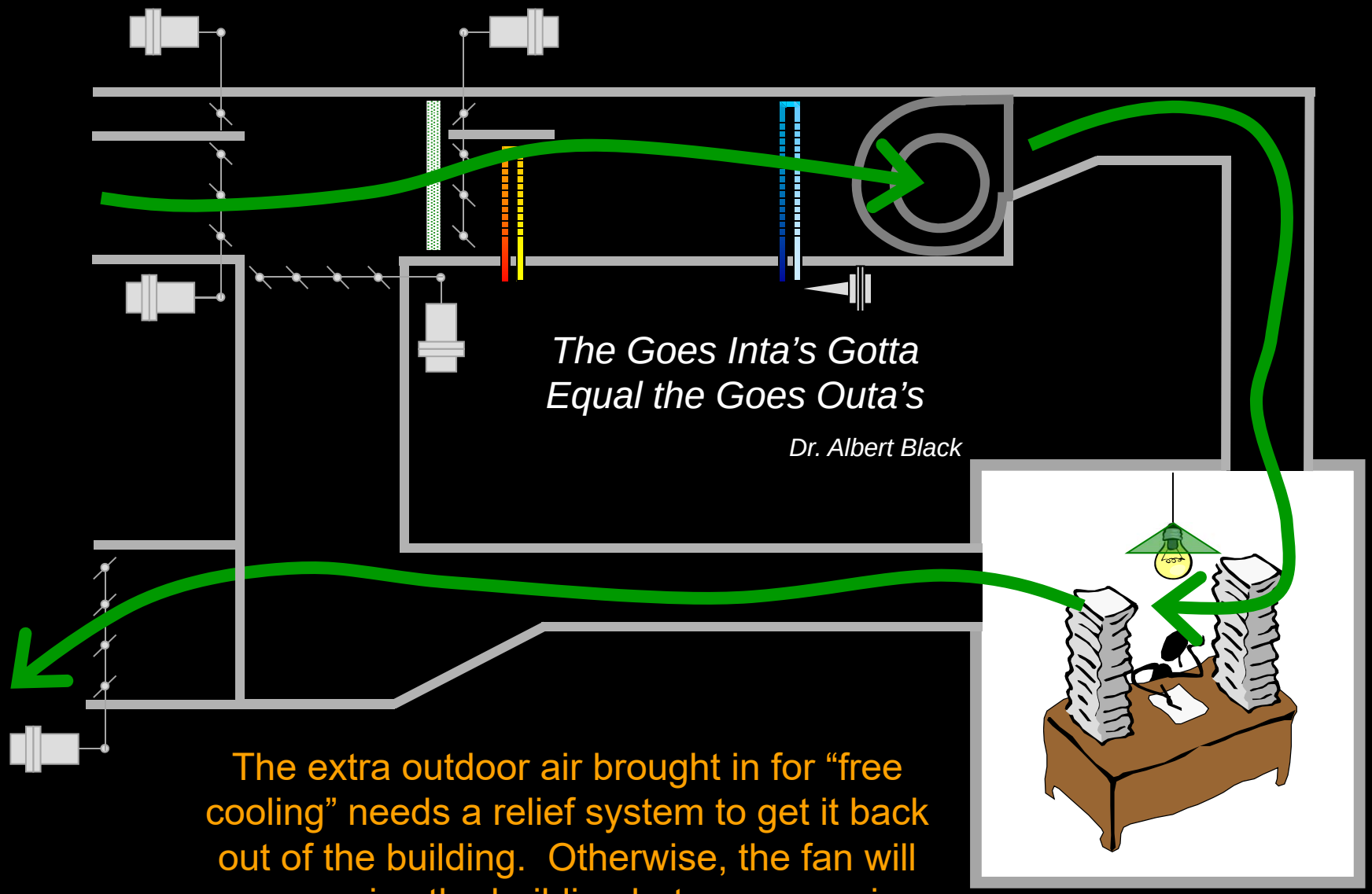


- LOADS
  - *The coil load often is not the same as the space load*
    - *Always the case for a 100% outdoor air system (all though at a very specific condition they could be numerically equal)*
    - *Integrated economizers are 100% outdoor air systems until the change-over happens at hot/humid outdoor conditions*

Economizers bring in outdoor air above and beyond the ventilation requirement, mix it with return air as required to control set point and thereby provide free cooling



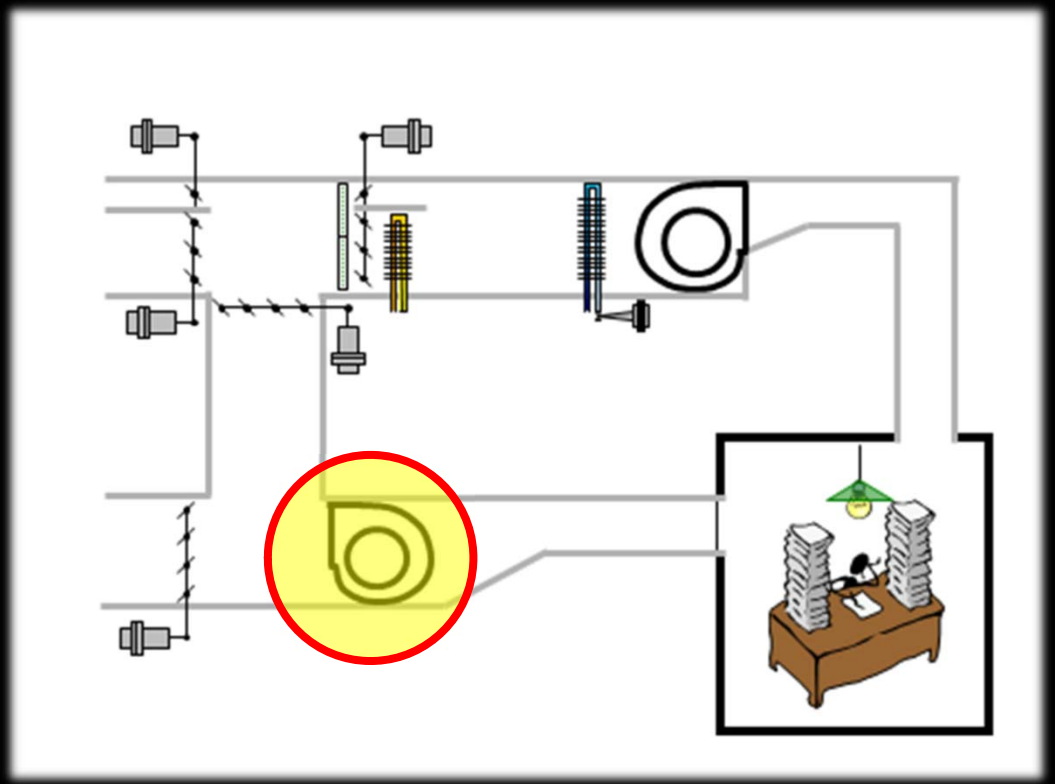
A Quick Word about Economizers, Return Fans, and Relief Fans



The extra outdoor air brought in for "free cooling" needs a relief system to get it back out of the building. Otherwise, the fan will pressurize the building but move no air

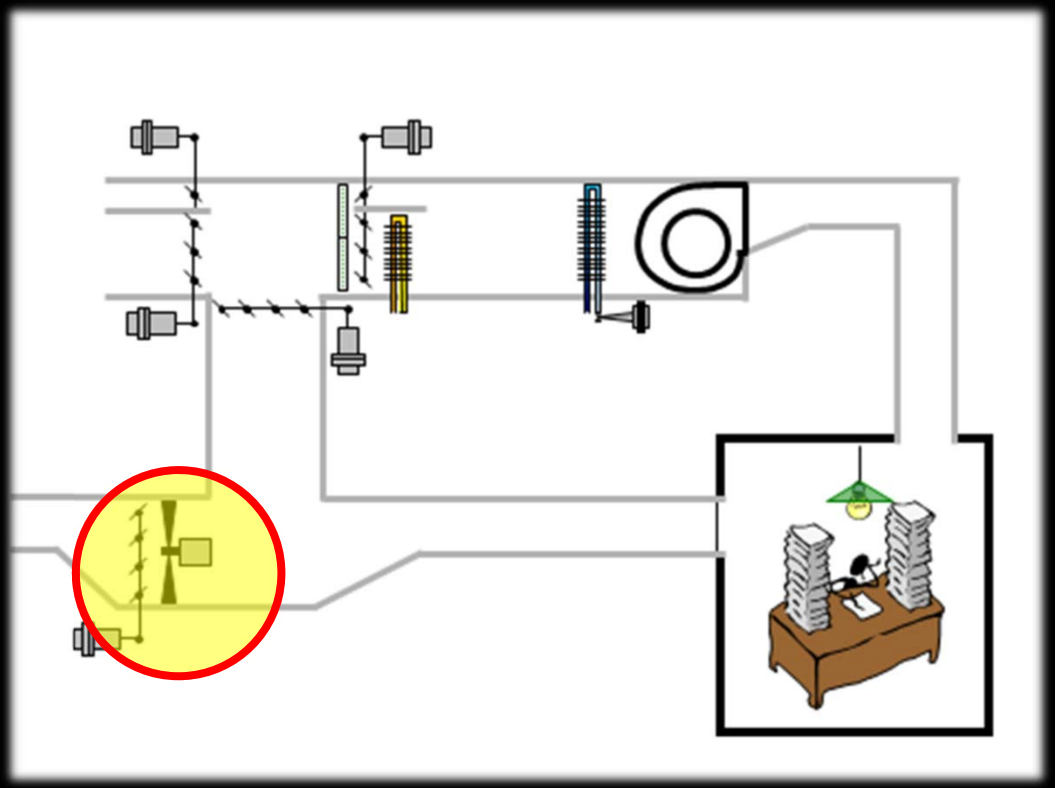
Return Fans

- Overcome the static pressure loss *between the zone and the air handling system*
- Operate any time the supply fan runs
  - Return air for recirculation
  - Frequently, deliver air to the relief louver for discharge to the exterior when operating on an economizer cycle
- Coordinating with VAV supply operation is tricky

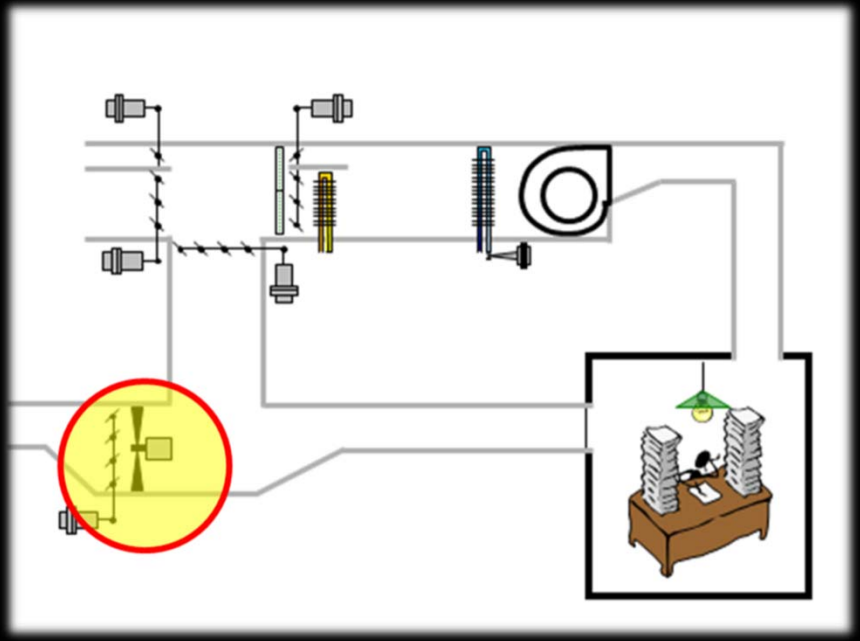


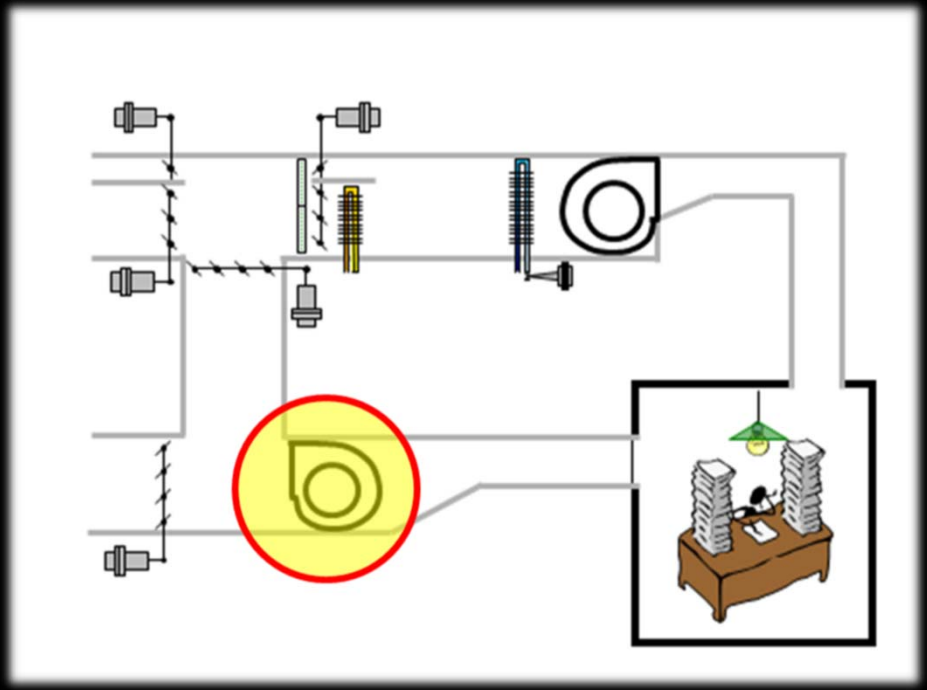
Relief Fans

- Overcome the static pressure loss *between the air handling unit location and the relief louver*
- Only operate during an economizer cycle
- VFD operation often coordinated with building pressure



A Side by Side Comparison





Bottom Lines

- Airside economizers bring in air above and beyond what we need to ventilate a building in order to minimize the cost of cooling
- Economizers are cooling process
  - Heating and economizing should not be happening at the same time
  - Consider separate HVAC systems for loads with dissimilar supply temperature profiles
- "Integrated economizer" refers to integrating the economizer cooling with mechanical cooling
  - Maximizes savings potential
  - Adds complexity
- The magnitude of the cooling coil load is often not the same as the magnitude of the zone cooling load
- Return fans and relief fans are different