Refrigeration energy demand is massive

The energy demand for the medical sciences building (MSB) is consistently within the greatest five of all buildings on campus. Unique to MSB are 50 cold rooms that are used to store specimens at a controllable temperature and relative humidity. The envelope of the cold room remains unchanged from its original 1969 construction. The purpose of this project is to meet the need for a reduction in energy demand by the cold rooms.

Design goal: Perform cold room functions while demanding less energy

The method used to reach this goal was to:
1. Consider Key Functions of a cold room (see Figure 1)
2. Determine how implemented design meets function currently
3. Determine the amount of energy each technology interfaces with
4. Propose new ways of meeting the functions that demanded the most energy

Figure 1. Partial functional decomposition of a cold room

Figure 2. Breakdown of weekday steady state energy gains that must be removed by electrically driven vapour compression system. The major contributors to heat gain are lighting and envelope transmission.

Visualizing our design

Knowing that the lighting and energy transmission through envelope form the largest portion of steady state heat gain (Figure 2), the four areas were targeted for improvement:

- **Polyurethane Insulation**
  - 2" (5.08 cm) thick rigid polyurethane insulation is added to reduce heat gain from transmission through walls.

- **Lighting**
  - These vanes reduce the infiltration of warm air and exfiltration of cold air when the door is actuated.

- **Infrared Sensor**
  - The infrared motion sensor reduces idle illumination by sensing when a warm body is present.

- **Refrigerant R600a**
  - The benefit of this refrigerant is the lower Global Warming Potential and Ozone Depletion Potential, when compared to R22.

The design results in 24% energy savings

Compressor Work Demand Each Weekday

Figure 4. Here, steady state energy demand for weekday conditions are displayed by category. The infrared sensor reduces idle illumination, and the energy demand to the compressor is less. The refrigerant category represents the total compressor work demand before and after the change of refrigerant.

Figure 5. Heat Flux contour plot showing the reduction in thermal energy transmission accompanying increased insulation thickness.

Key findings

In addition to 8 kW of electricity, approximately 7,000 kJ of compressor work can be saved per day by simply turning off the lights. In contrast, the energy demand of removing the heat gain from infiltration is insignificant.

The problem we defined was solved, but defining the problem is not straightforward: the user’s refusal to deactivate lights can be solved socially. Perhaps we have limited ourselves to a technical solution.

Future work

Tasks to be completed in the future include:
- Non-technological treatment to cold room light deactivation
- Consider replacing vapour compression with absorption system
- Determine cradle to grave environmental impact of improvements