Autodesk BIM Workshop
Rocky Mountain Institute
Factor Ten Engineering (10xE)
Supermarket Retrofit Case Study

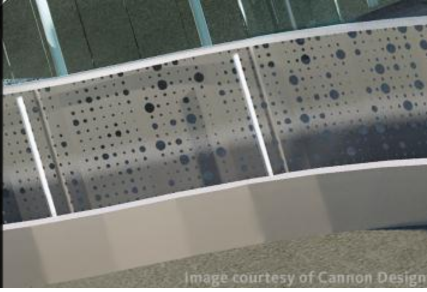

Image courtesy of Cannon Design

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AUTODESK CURRICULUM

Factor Ten Engineering (10xE)

Overview

10xE is a growing collection of educational resources to help students, faculty, engineers, architects and their clients bring integrative design to resource-intensive facilities & products — thereby saving money and helping solve critical energy and climate problems.

Integrative design produces fundamentally better results by rigorously applying creative engineering principles. When applied to energy-intensive facilities and products, integrative design achieves radically more efficient outcomes by asking different questions that change the design logic. Real-world examples offer powerful stories of huge energy savings by successful designers' smart designs.

Smart designers stand out in the engineering crowd as the ones who unlock solutions that serve their clients while unraveling daunting environmental problems. They know that even excellent engineers in one particular aspect of engineering will miss the innovation boat when they work only within the narrow confines of their specialty. The well-trained engineer who says, "Don't bother me with the bigger picture, I'll handle my piece of the job," …will be left behind in the emerging economy.

The winners will be the ones who understand that the engineering and architectural professions are moving in the direction of integrative design. A few examples: Once of interest only to a handful of green designers, LEED (Leadership in Energy Efficient Design) has rapidly become the standard of quality building design. Energy modelers are increasingly central to building design. And performance-based codes are now advocated by the International Code Council.

Innovative engineers and architects collaborate in teams that use each member's particular skills to iteratively design a whole system. They know a little secret: integrative design is not more difficult, it's just different. It's more than software, an algorithm, or deep understanding of one aspect of engineering; it's an advanced approach using whole-system thinking and collaboration.

Similar change is underway at universities where an increasing number of engineering and architecture faculty are finding ways to bring integrative design into curricula. They are developing relationships across departments; offering students more authentic and practical design experiences; exposing students to different perspectives; offering engineering degrees with an emphasis, for example, on energy and climate; and providing such unusual engineering classes as Creativity, Innovation and Vision.

To help creative engineers, designers, faculty, and student find their particular paths to integrative design, 10xE includes a set of design principles and other teaching materials that inform any design process, especially those for developing and refining energy-intensive facilities and products.

The Case for Integrative Design

Though many sectors of the economy will benefit from integrative design, its effect on energy is particularly dramatic and important. An era of cheap and readily available energy and resources has led to resource-inefficient design of the vast majority of power and industrial plants, commercial and residential buildings, vehicles and transportation systems, and consumer products.

Today however, when energy and natural resources are becoming scarcer, harder to access, and/or more expensive, and when the impact on the environment of using them in ever larger quantities is becoming a challenge, radical resource efficiency must be incorporated as a key design criterion.

Energy efficiency's potential is large[1] and little-tapped. Yet all official studies substantially understate its potential and overstate its cost, because they focus on individual technologies without also counting integrative design that optimally combines those technologies. The efficiency resource keeps getting bigger and cheaper as innovation, competition, and volume make energy-saving technologies more effective and less costly—both faster than they're being applied.[2,3] But even more important complementary advances in integrative design remain nearly invisible, unrecognized, untaught, and practiced only by a small subset of exceptional designers.

Examples for buildings, industry, and vehicles show that optimizing whole systems for multiple benefits, not disjunct components for single benefits, often makes gains in end-use efficiency much bigger and cheaper than conventionally supposed. Indeed, integrative design can often yield expanding rather than the normal diminishing returns to investments in energy efficiency, making very large (even order-of-magnitude) energy savings cost less than small or no savings.

Select Principles for Architectural Engineering Students

10xE is comprised of 17 distinct principles, but here we have selected four of the most applicable principles for architectural engineering students. To read more about 10xE and all the principles, go to www.10xE.org.

Define the end use

Designers often focus on the object to be designed, produced, and sold, not on why its users want it. But behind every artifact is a purpose—indeed, a stack of layered purposes. When you go to the hardware store to buy a drill, probably what you really want is a hole. But why do you want the hole? If you're trying to hang a picture on the wall, there are many ways to do that; indeed, there are many ways to achieve the purpose for which you

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[1] *E.g.*, in 2009, the NAS/NRC's *America's Energy Future* conservatively found that U.S. buildings can profitably save more electricity (35%) than projected growth in all sectors through 2030, while McKinsey & Company found profitable potential savings by 2020 totaling 23% of U.S. energy, worth over $1.2 trillion but costing less than half that ("Unlocking Energy Efficiency in the U.S. Economy," www.mckinsey.com/clientservice/electricpowernaturalgas/downloads/us_energy_efficiency_full_report.pdf).

[2] Some technological improvements are transformational: *e.g.*, biomimetic Fibonacci rotors (Pax Scientific,2008–), LED-optimized luminaires saving up to 98% of ASHRAE lighting power density (like Kim Lighting's 2009 outdoor "Warp9"), and adaptive-emissivity glazings (Serious Materials, ~2012).

[3] Brohard, G.J. et al. 1998: "Advanced Customer Technology Test for Maximum Energy Efficiency (ACT2) Project: The Final Report." Procs. Summer Study on Energy-Efficient Buildings, ACEEE, 207.67.203.54/elibsql05_p40007_documents/ACT2/act2fnl.pdf; technical reports at www.pge.com/pec/resourcecenter/, "Related Links."

wanted the picture hung. Understanding what you’re really trying to do, and why, will help reveal how to do the right steps in the right order.

Establish the minimum energy required
Use physics and building science to determine the theoretical minimum amount of energy or resources needed to provide the chosen end use. Then carefully consider how far each practical design constraint (e.g., cost, safety, performance, accessibility) moves you away from that theoretical minimum. Reduce the list of allowable constraints to the absolute minimum (e.g., safety, operability, and cost) and state them in the most generalized way possible to allow further explorations. Then systematically minimize or evade each constraint. That is, rather than taking accepted constraints for granted and later nibbling around their edges, carefully think through how to vault each constraint in order to yield far greater savings. To eliminate particular constraints, reframe or redefine how to achieve the ultimate purpose of each.

Use measured data and explicit analysis, not assumptions and rules of thumb
Develop specifications from data carefully measured for the specific design problem. In God we trust; all others bring data. Data trump assumptions. Check how well previous designs’ actual performance matched initial assumptions, and understand any differences. Question all rules of thumb—often opaque stews of old assumptions, such as cheap energy and obsolete technologies.

Achieve multiple benefits from a single expenditure
Each part, subsystem, or system should provide many benefits. Having each component perform just one function is a mark of dis-integrated design. Superlative integrative design can achieve several functions per component, weaving an intricate web of enhanced value.

Student Activity

Learning Objectives

After completing this lesson, students will be able to:

- Discuss how 10xE addresses conventional design problems differently
- Apply 10xE principles to a building retrofit
- Think critically about a building as a whole system rather than the sum of its parts
- Evaluate energy conservation measures for a building retrofit using Autodesk® and other software tools

Problem Statement: Existing Supermarket Retrofit

You are charged with an energy audit of an existing 100,000 square foot supermarket. Using the 10xE principles, develop a bundle of energy conservation measures that cuts energy consumption by at least 50% and describe how your recommended bundle satisfies the 10xE principles.

The following table gives a brief description of the current systems. See Appendix B for a more detailed description.

Table 1: Description of Existing Systems

System	Description
Site Data	• Located in Denver, CO • 24 hour operation • Front of store faces due south
Envelope	• Exterior CMU block furred out with 3.5” metal stud R-11 batt insulated gypsum board walls • R-20 continuously insulated roof • Double pane thermally broken aluminum frame windows, 7% glazing
Heating, Ventilation and Air Conditioning	• Constant Volume DX-cooling/natural gas heating rooftop units (RTUs) • 180 tons cooling (EER = 10) • 3,000 kBtu/hr heating input (80% efficient) • ASHRAE 62.1-2004 minimum ventilation (11,000 CFM) • Commercial kitchen hoods totaling 7,000 CFM exhaust and 2,000 CFM other exhaust
Interior Lighting	• Retail Space: 2.0 W/ft^2 fluorescent lighting producing about 85 foot-candles in the aisles. No daylighting. • Storage: 1.0 W/ft^2 • Office, Deli, Pharmacy: 1.5 W/ft^2
Refrigeration	• 1000 linear feet of open medium temperature cases • 700 linear feet of doored frozen food cases

A Note on Supermarket Refrigeration Systems

You are probably familiar with envelope, HVAC and lighting systems in buildings. However, you may not be as familiar with supermarket refrigeration systems. The following is a brief overview of refrigeration systems and their impact on building performance.

Refrigeration systems are generally made up of three components: display cases, compressors and condensers. Compressors and condensers function in the same manner as in any Rankine refrigeration cycle, so efficiency opportunities are similar to other refrigeration cycle opportunities. For time and simplicity’s sake, we will only consider the most unique part of the problem – display cases.

Display cases are where most of the refrigeration energy is consumed. The case refrigeration load is made up of internal gains due to lights and fan motors and external heat transfer due to convection and radiation. The case takes care of the loads by circulating air over the refrigeration coil and throughout the case. See the diagrams below.

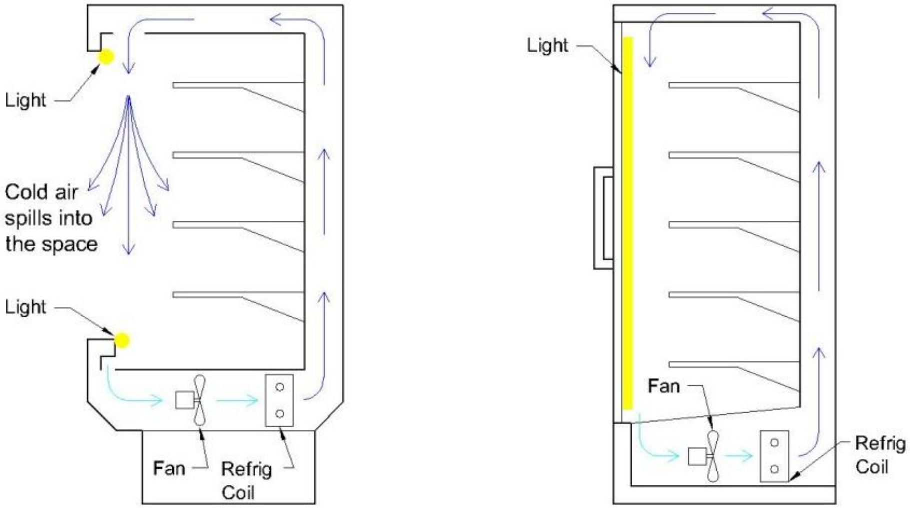

Figure 1. Refrigerated case diagrams – open case (left) and doored case (right)

There are essentially two types of cases: open and doored. Open cases cause a lot of cold air to be spilled into the conditioned space, creating a year round cooling effect. In the summer, this reduces the peak cooling load of the HVAC equipment, but in the winter, this effect increases the space heating load.

This effect is sometimes referred to as “case credit,” but we prefer the term “case waste” because this spilled air only introduces inefficiencies into the system. The inefficiency is obvious under space heating conditions, but even in space cooling mode, since the refrigeration compressors are less efficient than the HVAC system compressors, it would be more efficient to cool using the HVAC equipment instead.

Conversely, doored cases contain the cold by preventing air spillage. Depending on how often the doors are opened, this reduces the “case credit” by 80% to 95%.

Integrative Thinking: Where to Start

Start by defining the end use. What are the purposes of each system? Then, determine the minimum energy required to accomplish these purposes.

For example, interior lights provide visibility and highlight the products on the shelves. But what level of light is required for these tasks? Consider how many foot-candles are needed, and what is the most efficient way to achieve that level of light?

After establishing these parameters, be sure to use measured data and explicit analysis in your design, not assumptions and rules of thumb.

For example, many practicing engineers have pre-conceived notions of how large a cooling system should be (400 ft^2/ton?) or how much lighting power is required in a space (1.5 W/ft^2 ?). These round numbers were most likely based on rigorous analysis once, but have since been made obsolete or only apply to very specific circumstances.

Finally, when looking for a solution, try to get multiple benefits from a single expenditure. This is easiest to do when you think across system boundaries and consider the whole building with all its system interactions.

Designing integratively requires considering system interactions. Optimizing individual components with little consideration for their interactions does not yield an optimized whole system. As Amory Lovins wrote in *Natural Capitalism* (1999), “If they’re not designed to work with one another, they’ll tend to work against one another.”

For example, in a supermarket all systems have significant interactions with the HVAC system, but especially the refrigeration system. If you reduce the refrigeration case credits by eliminating cases or adding doors, you will decrease the need for heating, but you will also increase the need for cooling capacity. Additionally, if you are recovering heat from the refrigeration loop using a heat exchanger coil in the HVAC units, the reduction in heat recovery from reducing refrigeration loads will be large and it may no longer be effective to introduce the constant pressure drop of the coil in order to recover the heat.

Suggested Exercises: Evaluating Measures Using Autodesk Tools

Creating Energy Model Geometry in Autodesk Revit MEP 2012

http://www.youtube.com/watch?v=Pqx_7Ok9Kxo

1. Open new project in Autodesk® Revit® MEP 2012
2. Open an elevation view and change Level 2 to the height of the roof.
3. Create floor for entire building. Make sure to change to exterior.
4. Create exterior walls. Change construction type.
5. Create a roof. Change construction type.
6. Create interior walls. Change construction type.
7. Do not model ceilings.
8. Create windows and doors.
9. Create skylights if applicable.
10. Define spaces as bounded by the walls. Make sure space offset is set to zero at the floor and extends above the roof.
11. Create a space schedule.
12. Define zones and associate with spaces.
13. Create a zone schedule.
14. Make sure zones are set to occupiable.
15. Edit other data in the zones as desired. If you are using Autodesk® Green Building Studio® web-based service to do the analysis, this is critical. If you are exporting to DOE-2 or EnergyPlus, you can edit this data in those programs.

Exporting from Revit MEP 2012 to eQUEST® via Green Building Studio (GBS)

http://www.youtube.com/watch?v=LTp9__t9Ni4

1. Prerequisites: Have Green Building Studio 2010 Desktop application and eQUEST 3.64 installed. Create geometry, spaces and zones in Revit MEP based on the previous exercise
2. Click the Revit button (upper left corner) and choose “Export” > “gbXML”
3. Save to your project folder.
4. Log in to GBS online.
5. Create a new project within GBS.
6. Open GBS Desktop and sign in.
7. Load the .xml file from the location where it was saved by clicking “Browse gbXML File”
8. Click “Create New Run” and the file will simulate online through GBS
9. Once finished simulating and you are viewing the simulation results, click on the “Export and Download Data Files” tab.
10. Download the DOE2 file (*.inp) to a folder you create in your eQUEST 3-64 Projects directory (location of this directory varies based on your installation).
11. Download the .bin weather file to your eQUEST 3-64 Data/Weather directory.
12. Open eQUEST and choose “Select an Existing Project to Open”.
13. Change the file type to “DOE-2.2 BDL Files (*.inp)” and navigate to your project folder.
14. Enter a name for the project in the dialog box and select the downloaded weather file.
15. Visually check that the geometry was imported correctly by going to the “Building Shell” view “3-D Geometry” tab.

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Exporting from Revit MEP 2012 to Autodesk 3ds Max Design for Lighting Calculations

http://www.youtube.com/watch?v=8vlUegxZu5g

1. Prerequisites: Create geometry in Revit MEP 2012
2. Make sure light fixtures are visible in your views.
3. Load and insert the fixture.
4. Edit light photometric properties.
5. Create other mass objects (aisles).
6. Create space schedule showing zonal cavity analysis.
7. Switch to 3D view.
8. Turn lights on in rendering (View tab).
9. Export to FBX® file format (can only do from 3D view).
10. Import FBX into 3ds Max Design.

Light Level Analysis in 3ds Max Design

http://www.youtube.com/watch?v=N65Lt52bVx8

1. Create materials and assign to objects.
2. Delete light fixture objects (separate from photometric object).
3. Create a light meter.
4. Calculate light meters.
5. Export to point-by-point data to CSV file.

Computational Fluid Dynamics (CFD) Modeling Discussion

Innovative HVAC systems, such as displacement ventilation and radiative heating and cooling, have been proposed for supermarkets, but rigorous analysis of these proposals has been limited due to the complex nature of supermarket specific equipment and indoor environmental conditions. There is a significant opportunity for these and other types of innovative systems to be applied to supermarkets if the research into the underlying fluid dynamics issues supports the technology.

Specifically, research is needed into how well these systems provide thermal comfort relative to conventional systems, especially as they interact with refrigeration equipment and large occupancy loads. In the context of 10xE, this research would support the principles of explicit analysis (obviously) and multiple benefits because such innovative systems could drastically reduce fan energy while improving thermal comfort and increasing heat recovery effectiveness through the use of water based systems.

Assessment

In Rocky Mountain Institute's analysis of similar existing supermarkets, we found many opportunities for improvement.

For the envelope, we recommended eliminating the complicated drywall framing and insulation system on the exterior walls and moving to a continuous, insulated metal panel (R-20), which would reduce construction costs by eliminating multiple steps, increase R-value and reduce infiltration. Additionally, we found that increasing the roof insulation to R-50 showed an enormous savings because not only did it reduce total HVAC energy consumption, it worked to shift peak loads later in the day due to thermal mass, which led to a reduction in peak cooling capacity of 20 tons. Controlling solar gains on the southern face of the building was a no-brainer, although it did not yield very large savings due to the low window to wall ratio.

For daylighting, we recommended a simple double domed diffusing fiberglass skylight with a skylight to floor ratio of 4%. We explored other options, such as sawtooth monitors and glass skylights, but found that the low capital costs of the fiberglass skylights could not be offset by the small increase in performance from much more expensive options.

We found that the electric lighting system was providing much higher light levels than necessary in the retail area. Our research and analysis showed that we could cut the lighting power density in half (2.0 to 1.0 W/sf) while maintaining an adequate average light level of 45 foot-candles (as compared to the 85 foot-candles in the existing store). Additionally, by adding an ON - 2/3 - 1/3 - OFF stepped daylight control to the retail space and shutting of 1/3 of lights at night, we reduced lighting consumption by over 80%.

Outside of the retail space, we found that the storage area had proper light levels, but by adding motion sensors, we could reduce lighting use by 10%. We also recommended reducing levels in the Office to 0.9 W/sf, 1.1 W/sf in the Pharmacy and 1.2 W/sf in the Deli/Bakery.

On the refrigeration side, we recommended putting doors on as many cases as possible and converting exclusively to EC fan motors and LED lights, which in combination reduced peak refrigeration loads by 25% and total refrigeration energy by 10%. In addition, by using LED lights on all cases, we were able to also include motion sensors to control the lights – something that is not possible with fluorescents due to the low temperatures. Previous studies have shown a nearly 50% savings in refrigerated case lighting just from motion sensors.

By putting doors on all cases, we also reduced space heating by 40%, but this was offset by an increase in space cooling due to the loss of "case credits," so the overall impact on HVAC energy use was not as large.

Most of the savings for HVAC came from the above outlined load reduction measures, as opposed to any system level changes. Because the climate in Denver is heating heavy, we did not recommend an upgrade to higher efficiency compressors. Nor did we recommend a change to a chiller/boiler based system due to the large infrastructure costs and relative effectiveness of packaged units for conditioning large volume spaces.

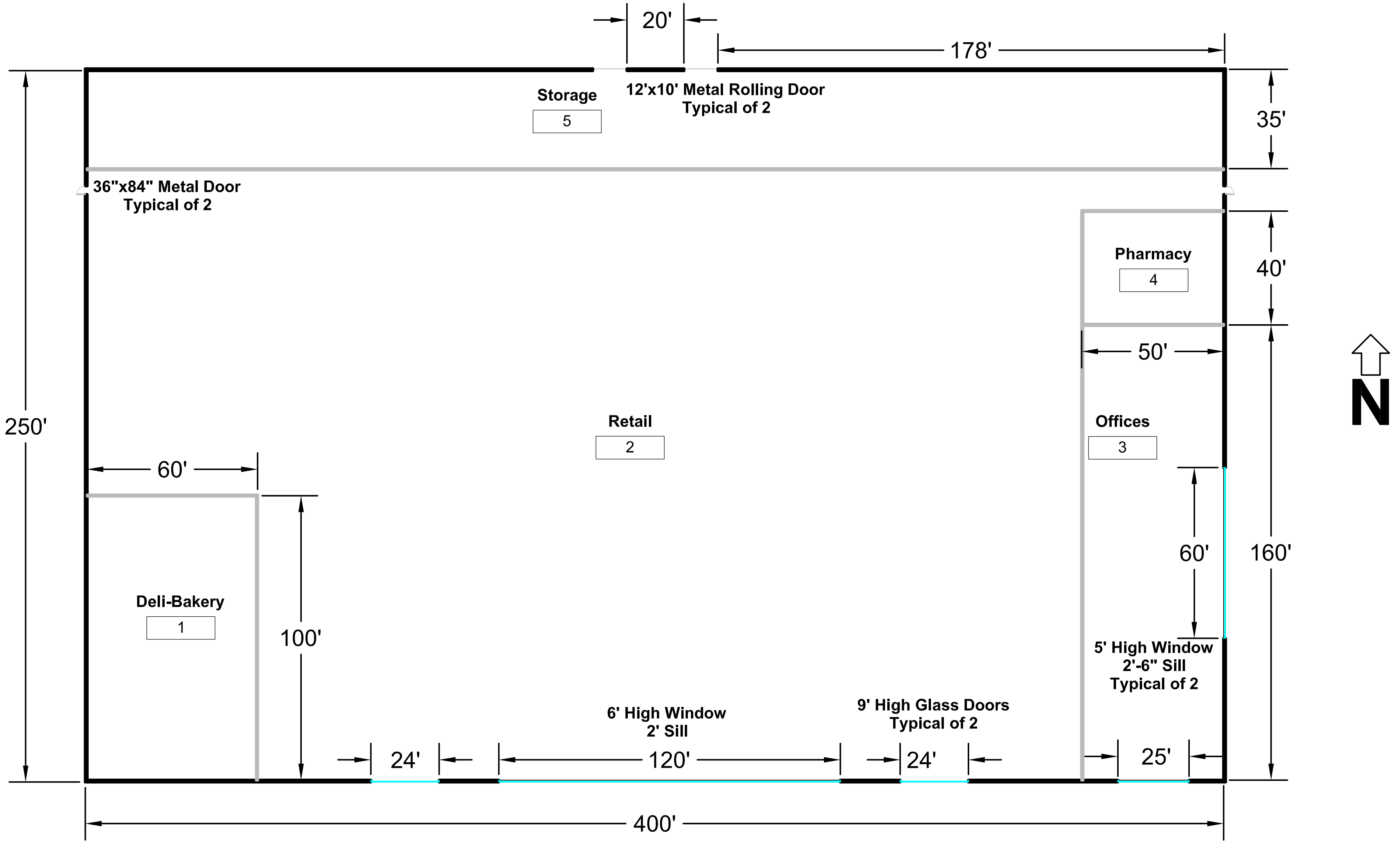
We did recommend that all RTUs be retrofitted with VFDs. Also, we recommended that demand control ventilation be utilized in combination with demand control kitchen hoods

Overall, the above package of recommendations resulted in a total energy savings of over 50%.

Appendices

Appendix A: Supermarket Layout

The following page is a simplified store layout suitable for energy modeling purposes.


20'
178'
Storage
5
12'x10' Metal Rolling Door
Typical of 2
35'
36"x84" Metal Door
Typical of 2
Pharmacy
4
40'
50'
250'
Retail
2
Offices
3
N
60'
60'
160'
Deli-Bakery
1
100'
5' High Window
2'-6" Sill
Typical of 2
6' High Window
2' Sill
9' High Glass Doors
Typical of 2
24'
120'
24'
25'
400'

Appendix B: Detailed Existing System Descriptions

System	Sub-System	Existing Condition
Envelope		
	Dimensions	See plan in Appendix A. 100,000 sf. 18' average roof height.
	Walls	Hollow CMU with 3.5" metal stud w/ batt insulation
	Roof	R-19 continuous insulation over metal seam roof, absorptance = 0.70
	Infiltration	0.05 Air Changes/Hour Average
	Windows	Double pane, thermally broken aluminum frame, standard SHGC
Lighting		
	LPD (W/sf)	Retail: 2.0, Offices: 1.5, Pharm: 1.5, Storage: 1.0, Deli: 1.5
	Fixture type	Retail: 3 lamp, 8' long pendant, 12' on center rows, 14' AFF
		All others: 2x4 2-lamp fluorescent, 9' AFF, equally spaced
Refrigeration		
Medium Temperature Cases (30°F Case, 20°F SST)	Doors	None
	Length (lf)	1000
	Loads (Btu/lf)	1186.3
	Credit (Btu/lf)	600
	Lights (W/lf)	35.8
	Fans (W/lf)	12.5
Low Temperature Cases (0°F Case, -10°F SST)	Doors	All cases
	Length (lf)	700.0
	Loads (Btu/lf)	431.6
	Credit (Btu/lf)	90.6
	Lights (W/lf)	28.1
	Fans (W/lf)	19.5
	AS (W/lf)	36.2
	Defrost (W/lf)	23.4

System	Sub-System	Existing Condition
HVAC		
	Air distribution	Constant volume packaged rooftop units
		0.0005 kW/CFM
	Heating	80% efficient natural gas fired heat exchangers.
	Cooling	DX; EER = 10
	Ventilation	9,700 CFM; fixed volume
	Kitchen Hoods	Constant volume, 8,000 CFM, On from 4AM-11PM
		0.0003 kW/CFM
	Other exhaust	On 24 hours, 1,000 CFM
		0.0002 kW/CFM
Plug & Process Loads		
	Cooking (Natural Gas)	100 kBtu/h equivalent peak capacity
	Other equipment power density (W/sf)	Retail: 0.3, Offices: 1.0, Pharm: 2.0, Storage: 0.3, Deli: 2.0

Appendix C: List of Possible Efficiency Measures

Envelope & Glazing

- Higher R-value walls
- Additional roof insulation
- Highly reflective roof
- Tighter construction
- Lower SHGC windows
- Lower U-value windows
- Window overhangs

Lighting

- Lower LPDs (must meet minimum lighting levels)
- Better control in office area (bi-level switching, motion sensors)
- Motion sensors in storage area
- Turn off some lights at night in retail

Daylighting

- Skylights
  - Domed fiberglass
  - Flat glass
- Control Options
  - Stepped control (100-67-33-0)
  - Fully variable dimming

HVAC

- Variable air volume
- More efficient cooling for RTUs
- Smart exhaust hood controls (VAV, optical smoke sensors)
- Demand control ventilation
- Heat pumps
- Dessicant wheel heat recovery

Refrigeration

- Electronically commutated (EC) fan motors
- LED lights
- Case light motion sensors
- Doors on medium temperature cases (except produce)
- Evaporative condensing

Internal Process Loads

- Process equipment circuit timer control

Appendix D: Detailed Energy Model Information

A fully functioning eQUEST 3.64 model has been provided as a guide. This model is compatible with and is being provided with Rocky Mountain Institute's Model Manager tool – a freely available Excel-based tool that accesses eQUEST batch processing capabilities as well as results extraction functions.

Model Manager gives you the capability to change eQUEST parameter values from Excel, as well as to simulate multiple eQUEST runs with one click using DOE-2 batch functionality.

The provided zip file includes the Model Manager spreadsheet and all required eQUEST files. This gives you the capability to change most of the important parameters in the eQUEST model without being an expert eQUEST user. However, you may use the model independent of Model Manager if your skill level allows. Be aware that many global parameters are used throughout the model, so if you see a value in pink in the energy model, be careful because this means that the value is controlled by a global parameter (GP). If you enter a value manually, you will be overwriting the GP and it will no longer function as intended with Model Manager.

In order to use the provided material, go to http://www.rmi.org/rmi/ModelingTools and download Model Manager. Set it up according to the User's Manual and get the example model working. Then, extract the provided files to the eQUEST 3-64 Projects folder. You will then be able to manipulate values in the Batch Runs tab. The following table is a list of parameters that you may change and how they affect the model:

Parameter	Description	Baseline Value	Acceptable Values
LPD Storage	Lighting Power Density (LPD) (W/sf) for Storage	1	Number > 0
LPD Retail	LPD (W/sf) for Retail	2	Number > 0
LPD Pharmacy	LPD (W/sf) for Pharmacy	1.5	Number > 0
LPD Office	LPD (W/sf) for Office	1.5	Number > 0
LPD Deli-Bakery	LPD (W/sf) for Deli-Bakery	1.5	Number > 0
Reduce Retail Lights Night	Turn off 25% of lights in Retail from 12 AM – 6 AM	NO	YES/NO (All Caps Mandatory)
EPD Storage	Equipment Power Density (EPD) (W/sf) for Storage	0.3	Number > 0
EPD Retail	EPD (W/sf) for Retail	0.3	Number > 0
EPD Pharmacy	EPD (W/sf) for Pharmacy	2	Number > 0
EPD Office	EPD (W/sf) for Office	1	Number > 0
EPD Deli-Bakery	EPD (W/sf) for Deli-Bakery	2	Number > 0
RTU Fan Control	Fan speed control for RTUs (Constant volume or VAV)	Constant	Constant/ Variable
RTU OA Control	Outside air volume control for RTUs (Fixed or demand control)	Fixed	Fixed/DCV
RTU EER	Energy Efficiency Ratio for RTUs	10	Number > 0
Exterior Wall U-Value	Exterior Wall U-Value	0.074	Number > 0
Retail Glass Cond	Glass conductance for Retail Window (see eQUEST manual description of conductance)	0.57	Number > 0
Retail Glass SC	Shading coefficient for Retail Window	0.57	Number > 0
Retail Glass Overhang	Overhang depth (ft) for Retail Window	0	Number > 0
Office South Glass Cond	Glass conductance for south Office	0.57	Number > 0

	Window		
Office South Glass SC	Shading coefficient for south Office Window	0.57	Number > 0
Office South Glass Overhang	Overhang depth (ft) for south Office Window	0	Number > 0
Office East Glass Cond	Glass conductance for east Office Window	0.57	Number > 0
Office East Glass SC	Shading coefficient for east Office Window	0.57	Number > 0
Office East Glass Overhang	Overhang depth (ft) for east Office Window	0	Number > 0
Roof R-Value	R-value of roof insulation	19	Number > 0
Roof Absorptance	Solar absorptance value of roof	0.7	Number > 0
Med Temp Length (lf)	Length of Medium Temperature Refrigeration Cases	1000	Number > 0
Med Temp Credit (Btu/lf)	Case Credit for Medium Temperature Cases	700	Number > 0
Med Temp L+F (W/lf)	Combined value of lighting and fan wattage in Medium Temperature Cases	48.3	Number > 0
Low Temp Length (lf)	Length of Low Temperature Refrigeration Cases	700	Number > 0
Low Temp Credit (Btu/lf)	Case Credit for Low Temperature Cases	90	Number > 0
Low Temp L+F (W/lf)	Combined value of lighting and fan wattage in Low Temperature Cases	47.7	Number > 0
Med Temp Case Motion Sensors	Adjust case lighting power schedule to account for motion sensors on medium temp cases (43% reduction)	NO	YES/NO
Low Temp Case Motion Sensors	Adjust case lighting power schedule to account for motion sensors on low temp cases (43% reduction)	NO	YES/NO
Refrigeration Heat Recovery	Space heat recovery from refrigeration system	NO	YES/NO
Refrigeration Condenser Type	Ref	AIR-COOLED	AIR-COOLED/ EVAP-CONDENSER
Storage Daylight	Daylighting in Storage via skylights	NO	YES/NO
Retail Daylight	Daylighting in Retail via skylights	NO	YES/NO
Pharmacy Daylight	Daylighting in Pharmacy via skylights	NO	YES/NO
Office Daylight	Daylighting in Office via skylights	NO	YES/NO
Deli-Bakery Daylight	Daylighting in Deli-Bakery via skylights	NO	YES/NO
Skylight Ratio	Skylight area to roof area ratio	0.04	0 < X < 1