IQ4
GREENBRIEF
MAY 2008

< Virtual Environment >

INTEGRATED ENVIRONMENTAL SOLUTIONS

INTERPRETING PERFORMANCE ANALYSIS RESULTS

INTRODUCTION

The 4th edition of the IES – US Sustainable Impact Quantification (I.Q.) focuses on Interpreting Performance Analysis Results, which is another way of saying – "stepping into the numbers" to not only understand what they mean, but which ones are important. The scenario looks through the eyes of the architect and walks through 'next steps' to express how the scenario outlined in Sustainable IQ3 (BIM+Performance Analysis) could be taken further to develop creative solutions while also establishing a new type of dialogue with engineers. It is important to note that the graphical output shown is a forecast of the capabilities that will be available in the new release of the VE-Toolkits later this month. Also as the summer progresses look for IES training sessions (offered by IES staff on both sides of the Atlantic) such as "Leveraging Analysis for Sustainable Design", which is a hands-on interactive session guiding participants "into the numbers".

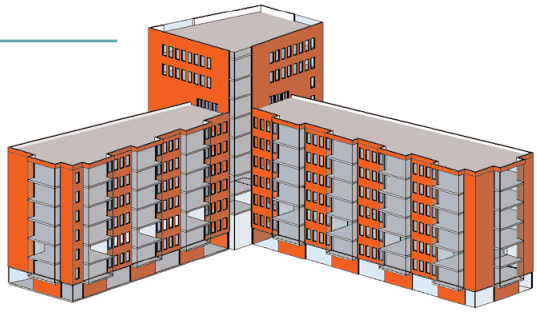
Kevin Settlemyre, Associate Director IES
LEED AP, USGBC LEED Faculty

SCENARIO:

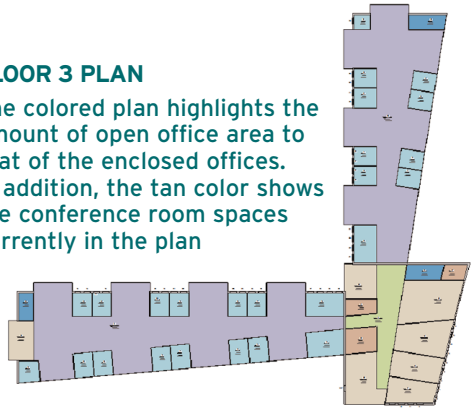
Nina Carbon (architect) reflects on the meeting a few days back where the project team made the collective decision to proceed with the "wing form" versus the other two options. The decision was based on the group evaluation of all the parameters (aesthetics, performance analysis, LEED) and their alignment with the sustainable goals for the project that were set at the first "green workshop".

The design needs to be carried to the next level of detail where the building skin and floor plan layouts are being shaped. She recalls a technique that has been useful in the past for building types with multiple floor plans that are similar. The technique involves investigating one of the floors in greater detail while keeping the other floors as the same singular spaces that were utilized in the earlier analysis of the building forms.

She knows she can go through more design analysis cycles in a quicker timeframe because she will have less geometry to change, while also reducing the computational time to complete the simulations. Based on past project results, she is also aware that she is in the "fuzzy number stage" where she will not be getting highly detailed results, but she will be able to analyze what moves on the facade and spatially could provide larger efficiencies as the models are refined. In the past she has also broken out a separate model for a typical floor to investigate the spaces to an even higher degree to assess multiple bounces of light, glare and internal airflow patterns within the space. As part of the process, she will also be tracking how the project compares to the Architecture 2030 Challenge target.



An image of the west and north facing facades of the BIM model that has been refined and is analyzed below.



FLOOR 3 PLAN

The colored plan highlights the amount of open office area to that of the enclosed offices. In addition, the tan color shows the conference room spaces currently in the plan

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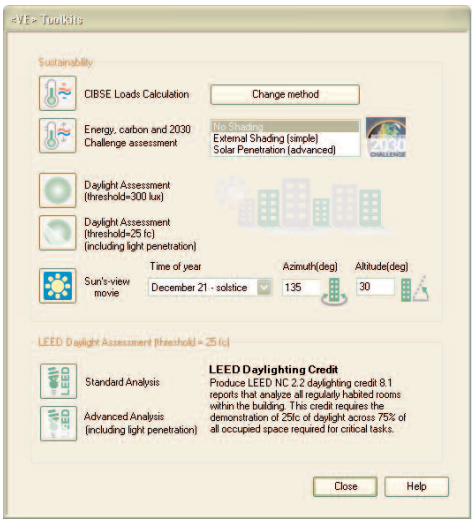
The third floor will be the focus across all three of the main areas. The owner's direction was to incorporate some enclosed offices throughout the plan, but to have a larger percentage of the floor area as open office space. The center portion is to include a series of conference rooms that will be utilized by the tenants on the floor as well as by outside people who will be renting the space for meetings and events. The space on the 7th floor will be the biggest draw, based on access to the roof gardens, but market research has shown that the lower floors will be booked a high percentage of the time as well.

The first pass centers on having the enclosed offices set up every other bay so that the larger glazed areas will provide daylight into the open office space. The enclosed offices will have larger punched windows, and will incorporate a glazed inner wall to increase the effect of "openness" in the space. Nina is hoping that this series of analysis will demonstrate to the owner that revisiting the discussion about having two highly glazed walls on the south and east side of the building, flanking the entry, might be a wise thing from an energy and "quality of daylighting" standpoint. Nina articulates the façade a bit more to address where secondary window locations and other fenestration will be located on the model to reflect the percentage of glazing that is being incorporated into the design. It is now time to do a few analysis runs.

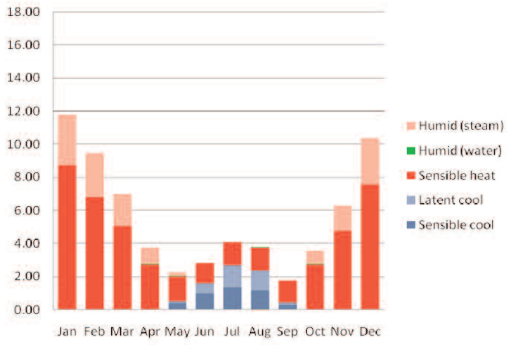
Using the VE-Toolkits Nina sets the model properties for the project (building constructions, building system and spatial types) and then selects the "Energy, Carbon and 2030 Challenge Assessment" button. The current design already has some components that would be considered high performance (R-20 walls, glazing Shading Coefficient = 0.4), and since she isn't supposed to meet with the engineer until later in the week, she is assuming a standard VAV system on the mechanical side. This will just serve as the starting point, which will provide information about the envelope and climate that can then be carried further.

The results output report (divided into six sections which can be navigated independently) allows the information to be reviewed and filtered in a number of ways at the building and spatial level. Nina takes a quick look at the "systems overview" to see that for her first run she is at a 28% reduction (~15,000 MMBtu) compared to the 2030 Challenge target of 50%. (Interesting, she thought the design would perform worse. It will be worth tracking the impact of the changes on subsequent runs on the "systems overview"). Next, she looks to the "Building System Energy" section (pictured on next page) to see what the largest contributors to the energy consumption are. The report highlights the largest amount for each of the areas, so that basic and more detailed comparisons can be made.

Nina Carbon recalls from the exercise as part of the "IES training session" where the group had to answer a series of questions comparing different climates to each other as well as getting more familiar with a specific climate. Since then she often refers back to the climate data as a way to brainstorm and ground thoughts pertaining to sustainable strategies. Since it is Boston, the highest heating and cooling months being January and July respectively, makes sense. However, it is a bit surprising that the heating energy consumption in the peak month is about 2.5 times that of the peak cooling month and almost double over the entire year. When the fan/pump energy is brought into this discussion as well, it demonstrates that a system other than the VAV system that was selected should be considered. The assumptions for the fan types and other equipment should be discussed with the engineer to identify where efficiencies are possible to reduce the fan/pump load which is a large percentage.



<VE> version 5.9 (June 2008) Toolkit Dialog Box prototype.



Graph of monthly climate data for Boston

It will be interesting to track the impact of the changes on subsequent runs on the "systems overview".

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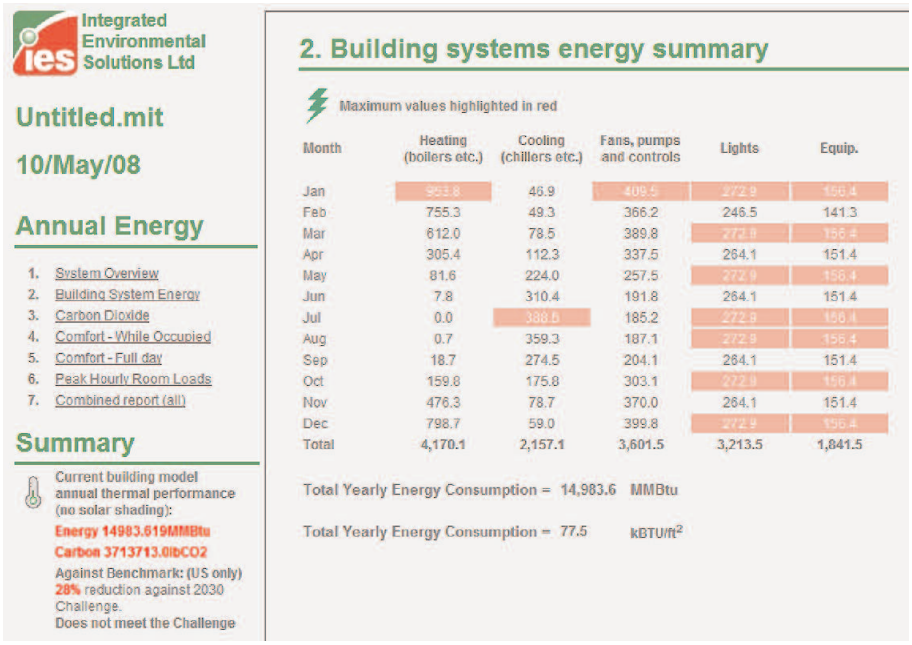
The lighting consumption is around 20% of the overall and the multiple months highlighted show that the lighting power density level (w/sf) and the occupancy profile are being held consistent throughout the year. Nina will have to take the model into the full **<VE>** to refine these two parameters as the design moves forward. In addition, Nina takes a quick glance at the Carbon Dioxide section to see that the VAV system and components contribute ~2.3 million lbs of CO_2 (1,150 tons) to the atmosphere each year.

Now she wants to target some spaces to investigate further so she goes to the Peak Hourly Room Loads section. One of the filters provided allows her to adjust the "Cooling Checks" value (Btu/h.ft²) to highlight spaces that are large offenders. From past experience Nina knows that spaces that are > 20 Btu/h.ft² are spaces that need improvement, but as she looks over the column, she can't help but think that the large percentage of glazing, particularly on the south and east, is a reason why quite a large number of spaces are above this threshold. She adjusts the threshold upward to 30 to see which spaces are the worst offenders. The prime suspects are offices 44, 46 & 47, as well as the tenant spaces on the right wing, which faces east west. In addition, the value for the stairway is very high, so that will be investigated as well.

Nina Carbon goes through the same "filtering & identification" process for the heating side as well and incorporates the additional spaces to target into the list that will be cross-referenced with the areas below. She does this process each time, so that she can cover the performance characteristics related to loads, yearly consumption and daylighting to inform decisions.

- Floor plan & Elevations (determine orientation & % glazing)
- Toolkit Output – Building Loads
- Toolkit Output – LEED Daylighting credit



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10/May/08

Annual Energy

1. System Overview
2. Building System Energy
3. Carbon Dioxide
4. Comfort - While Occupied
5. Comfort - Full day
6. Peak Hourly Room Loads
7. Combined report (all)

Summary

Current building model annual thermal performance (no solar shading):
Energy 14983.619MMBtu
Carbon 3713713.0lbCO2
Against Benchmark: (US only)
28% reduction against 2030 Challenge.
Does not meet the Challenge

2. Building systems energy summary

Maximum values highlighted in red

Month	Heating (boilers etc.)	Cooling (chillers etc.)	Fans, pumps and controls	Lights	Equip.
Jan	953.8	46.9	409.5	272.9	156.4
Feb	755.3	49.3	366.2	246.5	141.3
Mar	612.0	78.5	389.8	272.9	156.4
Apr	305.4	112.3	337.5	264.1	151.4
May	81.6	224.0	257.5	272.9	156.4
Jun	7.8	310.4	191.8	264.1	151.4
Jul	0.0	388.6	185.2	272.9	156.4
Aug	0.7	359.3	187.1	272.9	156.4
Sep	18.7	274.5	204.1	264.1	151.4
Oct	159.8	175.8	303.1	272.9	156.4
Nov	476.3	78.7	370.0	264.1	151.4
Dec	798.7	59.0	399.8	272.9	156.4
Total	4,170.1	2,157.1	3,601.5	3,213.5	1,841.5

Total Yearly Energy Consumption = 14,983.6 MMBtu

Total Yearly Energy Consumption = 77.5 kBTU/ft²

Toolkit Output (prototype of upcoming version) for Building System Energy section. The highlighted numbers signal the highest values for the year for each category. Note: the output shown is from a "development build" and does not contain all of the functionality that will be incorporated into the Toolkit.

TOOLKIT OUTPUT
BUILDING LOADS

Before diving into the spaces Nina Carbon glances at the overall results at the building level to begin to increase familiarity with the results and give them "the sniff test". She reviews the heating and cooling plant loads, as well as the overall occupancy and total airflow (cfm=cubic feet per minute). Next she sets the "filter thresholds" for the three detailed output sections of the results (Heating Loads, Cooling Loads, Sensible Cooling & Airflow Rates), takes the list of target spaces and cross references to see if they are exceeding the thresholds for these categories as well. She also makes note of additional spaces that could stand to improve.

TOOLKIT OUTPUT
LEED DAYLIGHTING CREDIT

To begin to understand the trade-off between energy and daylighting to determine the appropriate "% glazing" for the building, Nina brings up the LEED Daylighting credit output. At the building level the design is well above the 75% threshold required to achieve the LEED credit, which signals that there is an opportunity to reduce glazing in certain spaces that may be causing "hot spots" and adding to the cooling load. The legend above the table shows that there are two "filtering ranges" associated with this output. Spaces are highlighted if there "floor area above threshold" is between 50-75% daylight, and if the area is below 50%. Since she is trying to reduce the daylighting levels in some of the spaces, which might be experiencing significant heat gain, therefore increasing the cooling load, she will actually be targeting the spaces that are not highlighted and have a % area in the upper 80's to 100% range. Then she will take those spaces and cross reference them with the "targeted spaces" from the two previous investigations.

AUGUST 2008
IES VE SketchUp Plug in Now Available

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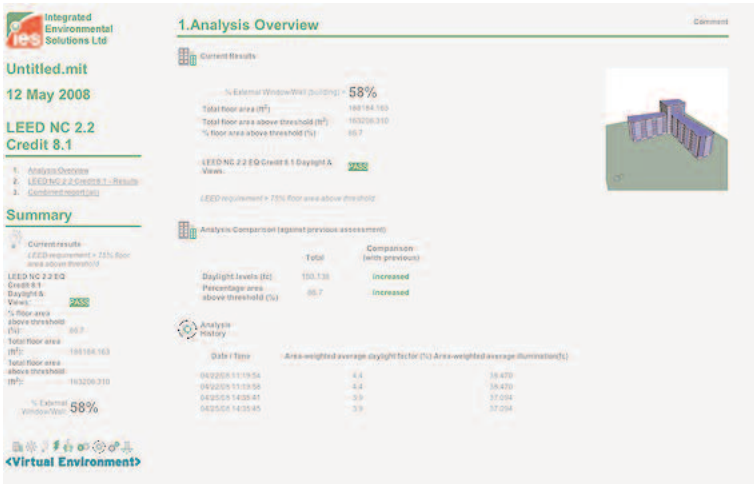
NEXT STEPS

Nina now has a more complete picture of the performance characteristics to combine with the aesthetic and other parameters to base her next design moves on. Some of the next steps will include:

- Lowering the % glazing on the south and east facades by a minimum of 30%
- Incorporate exterior shading on the south facade and investigate options for the west facade
- Reduce the lighting power densities and equipment loads to reduce internal gains
- Assess impact of operable windows for night flushing and natural ventilation in shoulder seasons months
- Increase exterior wall insulation from R-20 to R-28 to assess efficiency difference
- Target higher efficiency glazing and assess trade-off with daylighting levels

Nina Carbon plans on doing two more cycles of analysis with the VE-Toolkits prior to meeting with the engineer on Wednesday, and she might end up taking some of the promising strategies forward into some of the **<VE>** daylighting modules for further investigation. The goal of these analysis cycles is for her to develop a better understanding of the impact of building envelope strategies as the dynamics of the internal loads and percentage glazing change on the design. So that the collaborative sessions with the engineer, Tom Sizeless, on Wednesday and then the Owner, Louis F. Print and Engineer the following Monday can be taken further to develop creative solutions. The Owner has embraced the concept of the integrative design process, and is comfortable with the project team front-loading the process and doing multiple cycles of analysis to identify what the most effective solutions can be. To get above 50% carbon reduction for the project, collaborative investigations are crucial.

THE PERFORMANCE STORY WILL CONTINUE IN IQ5.



Toolkit Output (prototype of upcoming version) for Daylighting Calculation.

IES TRAINING SESSIONS

WE WANT YOUR FEEDBACK!

Leveraging Analysis for Sustainable Design – Striving Towards Carbon Neutral

Within an integrative design process, performance analysis (climate, daylighting, energy, airflow) plays an essential role for architects as one of the parameters informing design decisions and ultimately shaping designs that meet sustainable goals (LEED) and go beyond to carbon neutral. Using real-life examples, this interactive session provides a unique opportunity for architects to "step into the numbers" with a guide who is not afraid to use "pictures and graphics" to tell the story of the numbers, while increasing the understanding of how early stage analysis assessing the feasibility of sustainable strategies can be interpreted and inform "next steps" in the process.

Top tips and rules of thumb will be offered in this lively event which includes break-out sessions and plenty of debate.

Key words: Building Physics, Performance Analysis, Carbon Neutral, Performance Metrics, Mind Maps, Sustainable Design.

IES is currently planning session offerings in different cities in the US over the next 6-9 months, so if you are interested in having a session come to your area, please e-mail **usa@iesve.com** and let us know!

I.Q. TIP

INTERPRETING PERFORMANCE RESULTS PROCESS SUMMARY

The following is a summary of the steps described in more detail in the scenario

1. Assess whether to analyze full model, a typical floor or collection of spaces
2. Run the following VE-Toolkit simulations and save the results:
   a. Energy, Carbon and 2030 Challenge Assessment
   b. ASHRAE Loads calculation
   c. LEED Daylighting Credit
3. Review Energy, Carbon and 2030 Challenge Assessment output
   a. Ask yourself questions at the building and spatial level
   b. Develop list of spaces to target, and building strategies to consider
4. Review ASHRAE Loads calculation results
   a. Ask critical questions at the building and spatial level
   b. Cross-reference previously targeted spaces and add to list
5. Review LEED Daylighting Credit results
   a. Ask critical questions at the building and spatial level (see a pattern?)
   b. Cross-reference previously targeted spaces and add to list
6. Review plans with targeted spaces and strategies to develop next steps
7. Make changes to BIM and run through VE-Toolkits again!
8. Repeat until project exceeds current 2030 Challenge target (50% reduction)