AUTODESK UNIVERSITY 2013

Saving the World One Building at a Time: BIM for O&M and LEED® EBOM Certification

Andrew Fisher – DPR Construction

FM3102-R **We tend to focus on designing and constructing new buildings, yet they represent only 2% of United States commercial buildings. Greening operations and maintenance (O&M) of existing facilities is critical, and more architecture, engineering, and construction professionals should be involved in the entire building lifecycle. The Building Information Modeling (BIM) processes and tools that we use for design and construction are essential to an O&M assessment and ongoing facility management. Autodesk® Revit®, Autodesk® Vasari, and Autodesk® Green Building Studio® all help with planning facility changes, in identifying heat islands, and for designing solutions. Whether a building model exists for a facility or not, point cloud data can be brought into Autodesk® Navisworks® to verify existing conditions. Cloud solutions from Autodesk, such as Autodesk® BIM 360™ Field help tremendously for verification, BIM viewing, and retro-commissioning. Come and learn how DPR Construction has approached BIM for the lifecycle.**

Learning Objectives

At the end of this class, you will be able to:

- Describe why sustainability for existing buildings matters
- Develop templates for using Autodesk BIM tools for O&M assessment
- Define where Autodesk BIM tools can help prepare for LEED Existing Buildings Operations & Maintenance (EBOM) certification
- Explain where verification tools and Autodesk BIM software can work together for the benefit of all

About the Speaker

Andrew Fisher, LEED® AP O+M, is the BIM applications manager for DPR Construction. He is a seasoned project coordinator with 10 years of AEC industry experience from the design side. Andrew earned degrees from UC Berkeley in Architecture and Legal Studies, and is one exam away from becoming an Architect. A top innovator at DPR Construction, Andrew is passionate about emerging technologies such as 3D printing and Augmented Reality. An avid speaker, writer and blogger, Andrew previously covered the events at AIA TAP and is currently working with his DPR colleagues on internal BIM education using iBooks. Contact Andrew at andrewf@dpr.com

Why care about the building that's already built?

Buildings account directly for over 30% of resource use --and nearly 99% of all buildings are existing.[1] When indirect environmental costs such as transportation of materials or personnel are included, the actual figure may be closer to 50%[2]. Day-to-day resource consumption may be higher during construction, but that is a small portion of the total building lifecycle. Process changes in building operations and maintenance will result in many years of cost savings for the building's owner.

For the AEC professional – taking a serious interest in the operations of a building will pay exponential dividends. It is an opportunity to:

- Learn about the efficacy of design, materials and components in operation
- Establish (or maintain) the relationship with an owner outside of typical project pursuits
- Put your LEED AP credential to use by identifying opportunities for change
- Expand the portfolio of service offerings for your firm
- Educate owners/operators about the benefits of BIM (for design, construction and FM)

"…Architects and engineers have largely overlooked an enormous potential source of design work… Facilities managers can give you long-term renovation and maintenance contracts on their buildings." --Fred Stitt[3]

This session is about exploring that potential source of work. Whether or not LEED EBOM is right for a particular building, firms that have embraced BIM have an advantage in engaging with clients. Why not use BIM to bolster a LEED-readiness assessment offering?

[1] "98-99% of the nation's building stock is… already built or near completion" – MIT Center for Real Estate
[2] Tony Rinella, bimSCORE
[3] Taken from his book, *Designing Buildings That Work,* on p 107.

LEED and Existing Buildings

The USGBC has developed a separate set of requirements for the certification of existing buildings. This has been further clarified with the arrival of LEED version 4 (Nov. 2013)

The criteria for an EBOM certification and those for new construction are similar in many areas, yet just 3% of buildings with EBOM were previously certified.[4] This seems to indicate that most EBOM candidates predate LEED Certification. (and likely BIM as well)

New with LEED v4 are different certification tracks for specific building types[5]:

- Warehouses and Distribution Centers
- Hospitality
- Data Centers
- Retail
- Schools

Meeting the criteria would not solve all of the owner's challenges, yet it's a good list of items to start exploring with an owner. BIM can help visualize the right conversations.

Leveraging BIM Skills: Add value early

There are two approaches with Autodesk Revit to add value in an initial pitch to the owner.

1. Rapid Energy Model
2. Color Fill Model Views by Space Type

In fact, these two approaches each speak to different aspects of building operations, and not strictly LEED points. Both are meant to highlight potential areas for improvement.

#1 – Rapid Energy Modeling

In DPR's first energy analysis trials (in 2010) we found that rapid energy modeling was 85%-95% accurate and took just a few days. The workflow devised by Autodesk [6]is a good option compared to the time and effort involved in a full energy audit.

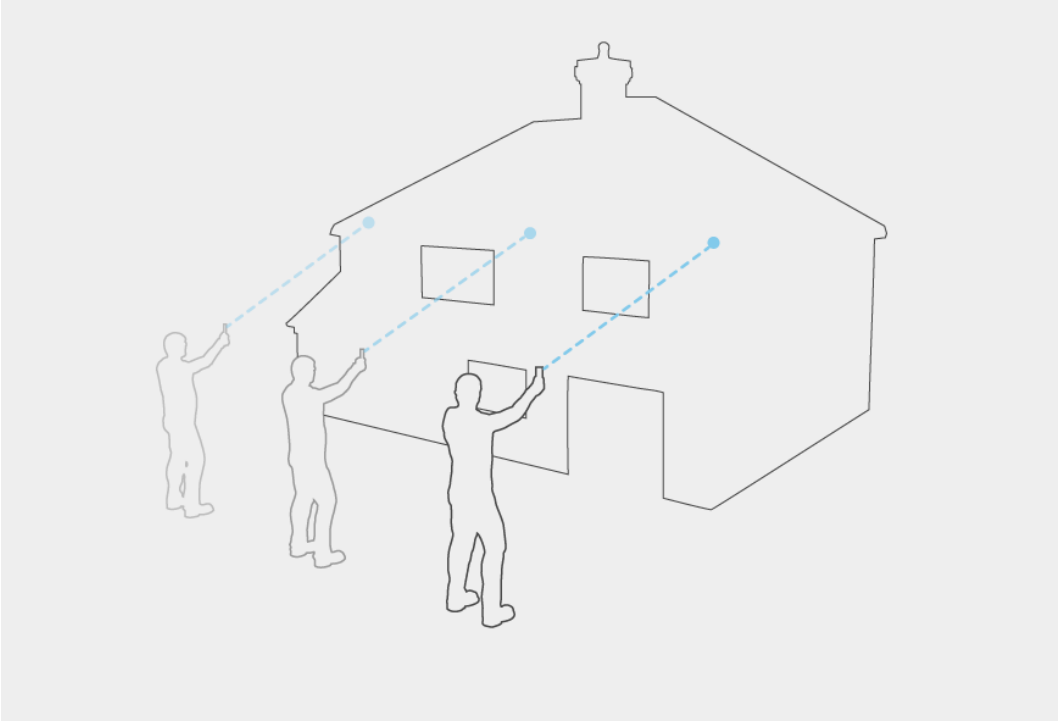
[4] Source: 'The LEED-EBOM Stress Test' by BuildingGreen Inc. p10.

[5] These distinctions don't come with much of a difference thus far – only one credit category *SS:7 – Joint Use of Facilities* is added to EBOM for Schools. Otherwise, the credit categories are the same, only the number of available LEED points per category may be different.

While the basic workflow for energy modeling hasn't changed since 2010, there are updated tools at our disposal. And… this sort of analysis is not a game of inches. Establishing solid/ watertight volumes is the key. As Autodesk has good process documentation on this already[7] there are just a few considerations from our experience.

Assuming no building model exists, the fastest way to capture the geometry is with photo capture. If you have subscription you can still access *Image Modeler 2009* (for how much longer is unclear) otherwise, *123D Catch* is available.

We've had good results by taking at least ten images for a single side of a building. Given the software limitations, it may be necessary to capture two sides of a four sided building in separate models. Capture corners with additional images approximately each ten degrees.



With a proper image capture (or two or more) you have the primitive to bring in to Revit.

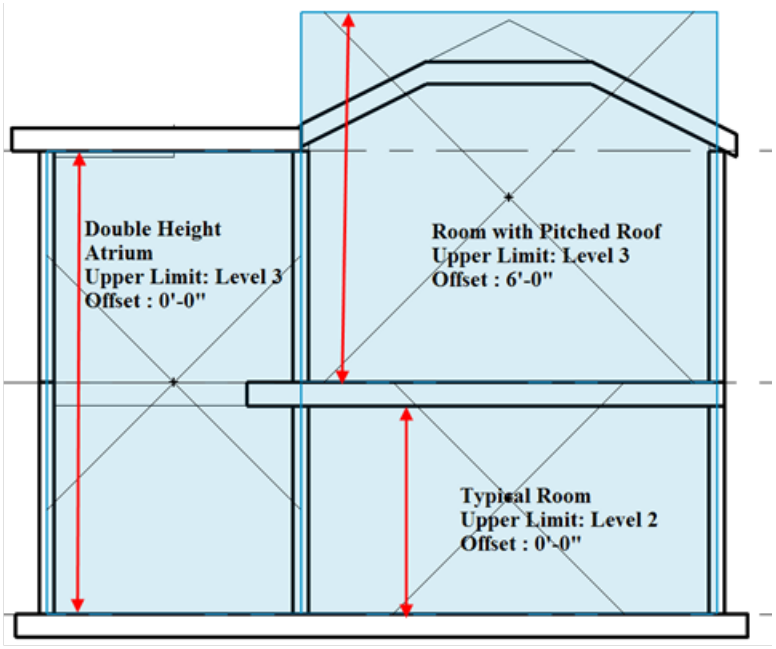
Be sure to also take a few field measurements of building elements you can use later as reference.

Time to BIM it up – If you've got some reference as-builts (Cad, PDF, or even paper) these can also be referenced in to Autodesk Revit to help establish the energy model. If your

[6] *Rapid Energy Modeling for Existing Buildings* by Autodesk and ICF www.autodesk.com/green
[7] *Gathering Existing Building Conditions for Performance Analysis when Documentation is not Available* by Autodesk

capture (and measurements) are all there is, you could consider creating just a building mass in Vasari. Energy analysis tools and the export for 3D printing are more accessible.

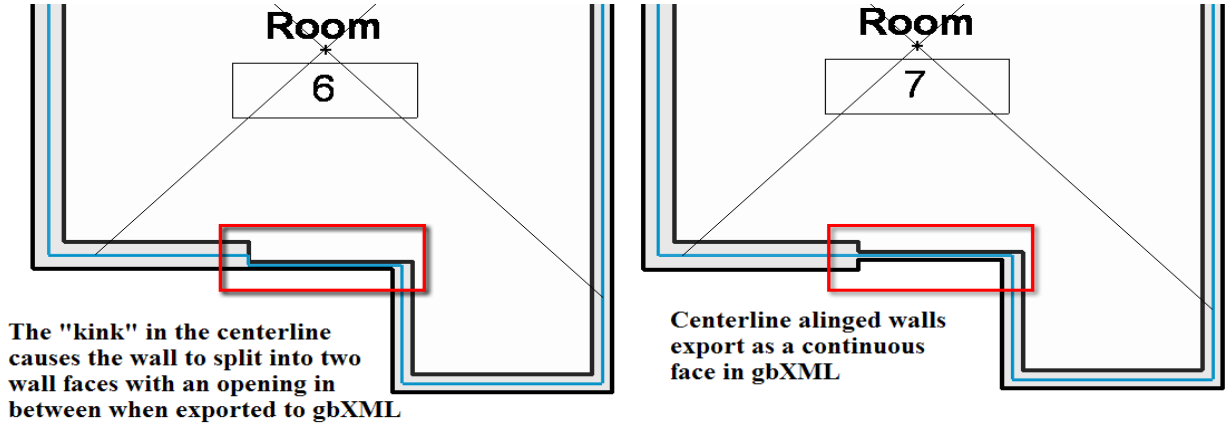
Keep the goal in mind – we are looking to develop a model that will give some baseline energy performance numbers. There's a real world cost and then what the energy analysis will suggest it should be. We've also realized a few practical constraints:



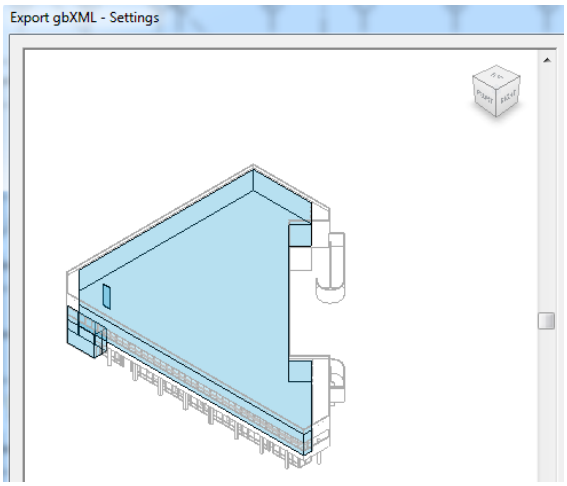
Modeling for energy analysis is different from design modeling:

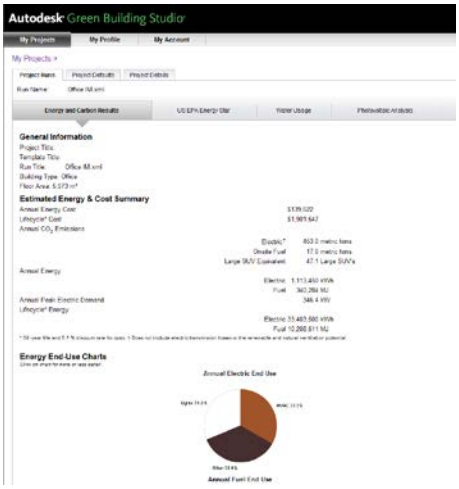
- Model only enclosed spaces.
- Partial height walls that don't enclose a space from all sides do not affect the thermal behavior of the space. Save that detail for lighting analysis.
- Room boundaries should completely enclose pitched roofs. i.e. if you have anything other than a flat roof, the rooms should be defined as going to the highest point of the roof.
- Assume surfaces are either 'opaque' or 'transparent'

With room/ space boundaries, choose to calculate 'by centerline' and look out for walls where the centerline is not aligned. Check the preview window when exporting gbXML.



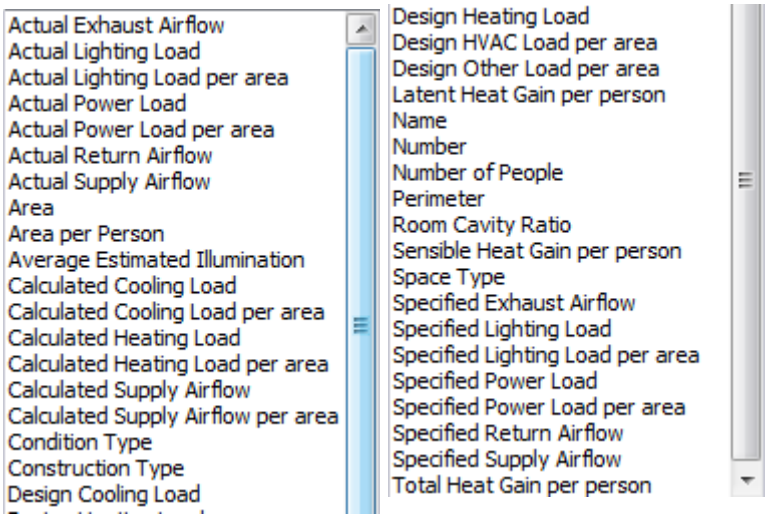
Arrive at a number – with your gbXML export and some building demographics[8] you can arrive at a number for what the building operation is going to cost.





#2 Color Fill Model Views

Disclaimer: There are still many people out there who haven't yet realized the power of parametric modeling. Simple information like square footage of spaces has value to those trying to establish (or negotiate) lease rates, or an owner considering minor additions or changes to their building. The purpose of using Revit's color fill is to communicate simple concepts in a series of views. – There's actually a lot of unused potential there… by default color codes are established room-by-room, but a variety of energy- and space-use schemas are possible.



[8] Even better: Review the various inputs that are available in GBS prior to running the model analysis – for example, knowing what the typical usage schedule for the building is (12/ 24 hours a day? 5, 6 or 7 days a week?) will improve the accuracy of the initial number.

Start with the 'low hanging fruit' – the Indoor Environmental Quality category defines a variety of space types that would determine, credit by credit, where certain spaces could be excluded from overall calculations. Most spaces are included in most cases, but with a little customization of the color schemes (Architecture Tab >> Room & Area panel >> color schemes) you can visually differentiate the areas of concern for credits IEQp1: Minimum IAQ performance, IEQc3: Thermal Comfort, IEQc4: Interior Lighting, IEQc5: Daylight and Quality Views, IEQc10: Occupant Comfort Survey. (The matrix covers the entire credit category, but only a few contain distinctions) [9]

An example color fill plan to show which rooms don't figure into the Interior lighting credit review

Whether or not your office has a standard naming convention for how rooms are used, the USGBC's 'IEQ Space Matrix' gives a good general list of rooms and further definitions relevant to Design/Construction and Operations/Maintenance.

By creating the room definitions and color schemes per USGBC's matrix in Revit, you can save these schema and import them into any project by the 'transfer project standards' option (Manage tab).

[9] At the time of this writing (Nov 2013) LEED v4 is the official/ latest version. The *IEQ Space Matrix* (available from www.usgbc.org) was last updated in October 2013, and references credit categories by their LEED 2009 definitions. In this document we've inferred the new category numbers by matching the definitions.

WORKSHEET 1: Crafting a Business Plan

(Please review and consider these questions **PRIOR** to your arrival at AU. Your answers to these questions will help drive the discussions we have in class)

1. My/my firm's expertise is in the following market(s)
   - o Schools
   - o Hospitality
   - o Data Centers
   - o Retail
   - o Warehouses
   - o Other _____

2. I have found that the LEED AP means greater credibility for me in conversations about sustainability. (Y/ N/ ?)

3. _____% of my firm's work comes from repeat clients

4. Our current business development efforts include building owners with no new project on the horizon. (Y/ N/ Don't know)

5. I currently work in a LEED certified building (Y/N)

6. I estimate that I miss ___ days of work due to illness each year.

7. My clients are BIM-savvy and know what to expect from building information models.

8. When taking on a remodel or retrofit project, we find that there –or- We typically make sure to hand over all important facility information to the building owner when they occupy their new building.

9. We keep our own list of preferred building products/vendors and strive to use these again on all future projects.

10. I personally have seen or experienced waste in building operations and felt that the situation would be different with better design and/or facility staff education

Sustainability = Innovation

At DPR Construction we value innovative thinking. Game-changing ideas do happen, but more often successful innovations are easily repeatable, simple to implement and only an incremental change from the status quo.

In our Newport Beach, CA office we added a simple power on/off system that eliminates plug loads overnight, so long as the last person out hits the 'kill switch'.

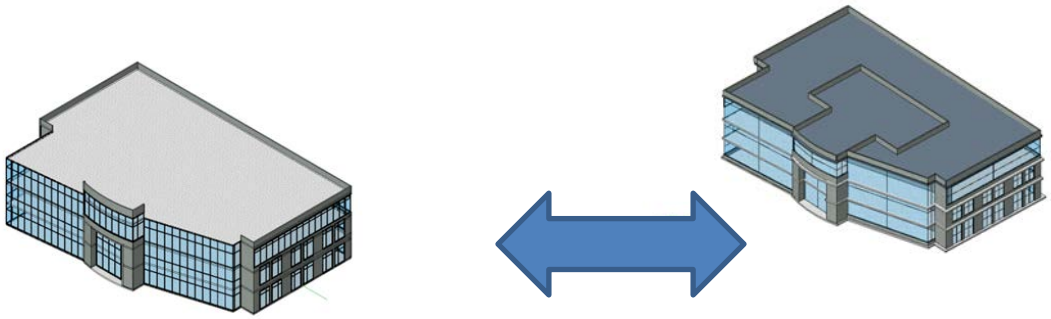
This may only save a few dollars a night, but over the course of a year the savings add up with very little change in user behavior.

Many forward thinking companies have shifted focus to consider sustainable practices as there is a direct value proposition. Some take a more nuanced approach -- Nike believes that their sustainable practices are all about being innovative; and value will follow.[10] DPR and Smithgroup JJR collaborated on the design of the new DPR Phoenix office. A variety of proven high-efficiency upgrades transformed a retail shop into a net-zero office - in the Arizona desert.[11]

Require, Design, Build, *Measure, Analyze, Improve (Repeat)*[12]

An assembly line is a common analogy for the building industry. There's a significant difference between the two since the Owner brings the requirements to the Architect, who then designs the project along with A/E partners, and then relies on the builder to execute the design. Industrial designers and others who work at the scale of parts have the advantage of controlling the whole process and verifying results quickly (even more quickly now with the ubiquity of cheap 3D printing) However we have a greater advantage – the opportunity to learn from each other's buildings.

"If we ask the right questions we can change the world." – Fenando Espana, Corner Cube



[10] Green to Gold, Esty and Winston
[11] http://www.smithgroupjjr.com/projects/phoenix-regional-office#.UpOH_vPTmUk
[12] Natural Capitalism, Hawken, Lovins and Lovins

High-profile building projects aren't built without challenges, but a successful design is what lasts; is what people want to talk about. Think of any project ten years post-occupancy -- schedule delays or the questionable constructability of the initial design is not on anybody's mind.

Sustainability is too often talked about in terms of process efficiency, or locality of manufacture. There's value there, to be sure. But more should be said about the efficacy of materials and assemblies in the service life of a building. We can speculate on the potential re-use of building materials or components, but would that future recyclability really have as significant an impact as a major building renovation (due to failing components) ten or twenty years sooner than expected?

Nearly every building in operation represents an opportunity. Consider your assessment program as a chance to improve the conditions for people, by using less of the planet's resources… and let profit come over time – Even if the first effort is a loss leader, you can bill something for your time and effort, which is more than clients are paying now for your business development.

BIM for O&M assessment

The reality of construction projects is that there is always schedule pressure – time is a factor in getting the project completed. Time lost is money lost, so for the sake of perceived value a great many changes (shortcuts) are taken. The opportunity to leverage our BIM tools/ skills towards building operations and maintenance means having the chance to focus on operational details in a concrete way.[13]

While such assessment can generally proceed on a predefined schedule with few dependencies, assessment should "*…consider improvements that will provide a return on investment within two years."* - Andrew Arnold, director of DPR Consulting

"Return on Investment 'thresholds' required for efficiency projects are often too high to allow for even mid-range efficiency improvements."[14] – Auden Schendler, Sustainability at Aspen Skiing Co.

[13] No pun intended
[14] "*Rotten Fruit*" Environmental Design + Construction, November 2012

The tangible goal of a LEED assessment should be to review the building's potential for LEED points, but the larger goal of your review should be to identify cost-saving projects.[15] Not all building owners and facility managers are going to care about a certification program, but all are interested in reducing costs.

There's value in both quotes above – Facility Managers do have operating budgets and proving ROI is necessary for them to make any progress. One way we can help bring our ideas to reality though would be to help make the argument for savings that may not have been considered in the ROI calculation to begin with – replacement value, time spent by maintenance personnel, tax incentives & alternative energy sources should be considered.

WORKSHEET 2: Creating Value

Please review and consider these questions **PRIOR** to your arrival at AU.

Your answers to these questions and others will help drive the discussions we have in class

- I've seen the following technical or process changes positively affect people
  a. _____
  b. _____
  c. _____
- I've seen the following technical or process changes positively affect our bottom line
  d. _____
  e. _____
  f. _____
- I've felt that the following changes have reduced waste or consumption
  g. _____
  h. _____
  i. _____
- If there was one thing I could change about the place I work (or live) it would be:
- I feel that my own clients have not been able to realize the true value of their projects because:
  - Some design element could not be implemented as intended
  - A material/ product choice did not perform as expected
  - There was not an effective handoff between parties
  - New technologies did not emerge in time to be incorporated

[15] People, Planet, and *Reduced Operating Costs* doesn't sound as good, but ostensibly accomplishes the same thing

"Like a G-Sa"

Other than the General Services Administration (GSA), will any client really care about taking the next step and pursuing EBOM? As stated previously, an assessment may result in identifying specific improvement projects as opposed to leading a building owner towards a decision to pursue building certification. If you can find and recommend changes that produce the 'positive ROI' that owners care about, you've still provided great value in the eyes of the owner and facility manager.

"LEED Certification creates a good framework for engaging in the conversation, but I wouldn't *lead* with LEED." – Joe Eichenseer, RAND Worldwide

The GSA recently made news by indicating in a press release that the GBI's 'GreenGlobes' initiative is equivalent to LEED.[16] This is an entirely separate program with different requirements. At first glance, Green Globes® for Continual Improvement of Existing Buildings[17] looks less restrictive:

- No Prerequisites
- Any conditioned space of 400 gsf or greater
- Requires 12 months of operational energy & water data

Is this system a better fit for your future O&M clients? All we can say, for now, is 'It depends.' The GreenGlobes website offers its own assessment program for a fee. So, whereas LEED may or may not be the best foot in the door, Green Globes certainly seems like a competitive certification program that isn't conducive to independent investigation.

The journey of 730 days – pursuing EBOM Certification.

Experience tells us that if a building has achieved another silver/gold/platinum certification already, it is generally likely to achieve the same level of certification for EBOM.

However… as you move past an assessment and towards pursuit of said certification, note that it's not a good idea to 'guarantee' any specific result.[18] As with any project, document the expectation clearly in writing. Your assessment program will give a good theoretical picture of what points are achievable, but the successful result (a specific level of LEED certification) is not within your control, nor can you say with certainty will be delivered.

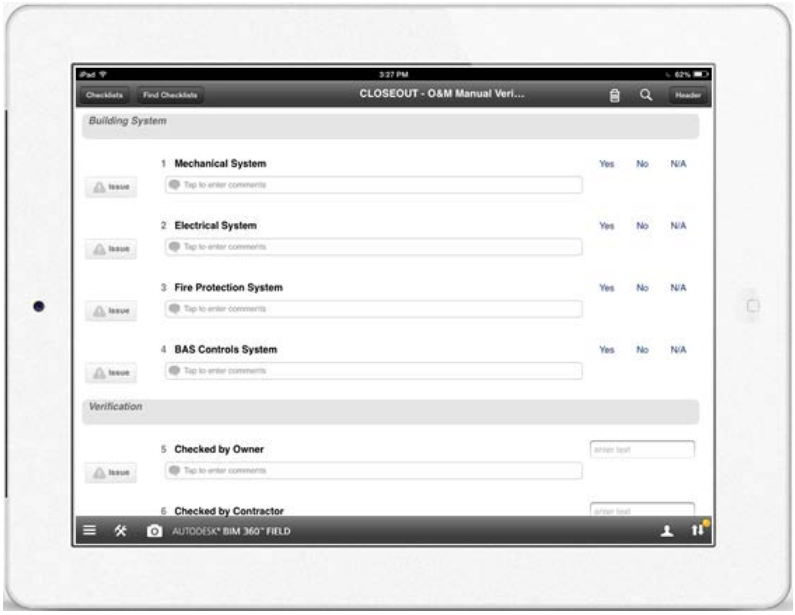
[16] see the press release here
[17] Green Globes CIEB program information
[18] Although the matter was resolved without a court decision, many cite southern builders v Shaw and proceed with caution.

You're going to be at this for a few years. Many of the LEED credit requirements involve long periods of data gathering with reporting requirements that include collecting and reporting all data within a very short window of time. (about a month to final and submit all reports) What does this ultimately mean? In order to satisfy LEED EBOM requirements, expect some up-front schedule planning. The only way to get disparate data collection efforts to wrap up at the same time is to stagger when they will begin.

Autodesk BIM 360 Field, for example…

When it's just a small team gathering data and measurements to feed into an energy model the coordination of efforts isn't going to be a huge effort (at least it shouldn't be) – but when several people are trying to gather routine data points over a long period of time, data collection, storage, categorization, etc. is a potential headache all its own.

While Autodesk BIM 360 Field was developed with construction projects as the intended use case, it's not too hard to make the case for crafting a template for EBOM tracking via this tool. There are currently two license models for the use of this tool – per project or via an enterprise (unlimited) license. While the former would add some overhead cost to an EBOM documentation, one would be hard pressed to find a better, more adaptable tool for tracking and reporting on just about anything.

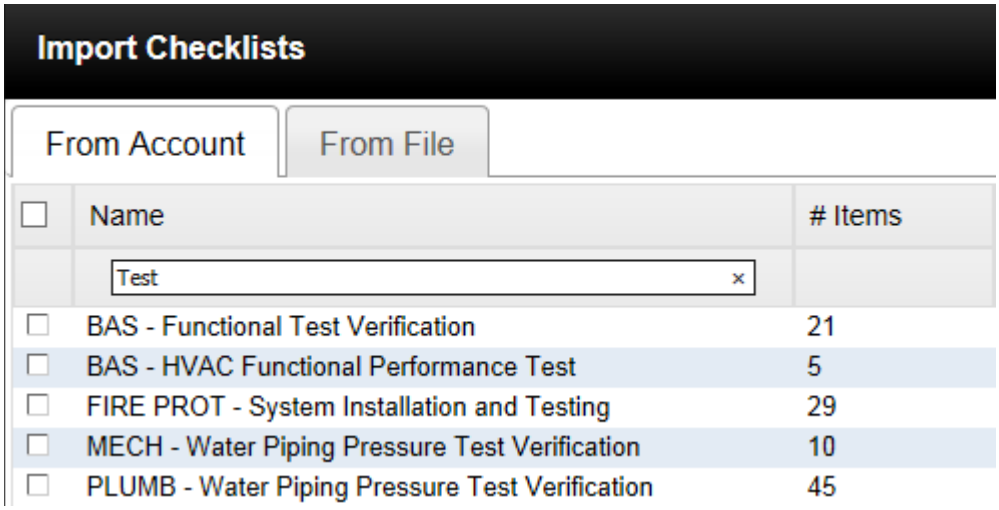


Autodesk BIM 360 Field – data collection is actually best done via iPad

Autodesk BIM 360 Field is highly customizable without programming skills or experience. Generally, any work process or quality control checklist can be captured in a repeatable format. The iPad becomes a digital data collector for everything – and Autodesk handles all the backend data collection via the cloud.

In short, Field is a great way to take the work out of doing the work. LEED credit categories for Materials and Resources as well as Indoor Environment Quality are concerned with sustainable purchasing. With a good checklist of consumables and a predictable delivery schedule, one can QC every order that comes in and verify against the 'known good' list. Missing items become issues for follow up. All the data becomes searchable and reportable. BIM 360 Field can run reports for you on a predefined schedule and send them to the appropriate inboxes.

Perhaps the best use for Field for LEED EBOM is in the Energy and Atmosphere credit category. EA credits 1, 2 and 3 deal with 'retro' commissioning of a building's equipment. As it happens, there is a checklist category in BIM 360 Field devoted to the commissioning effort. It's a simple matter to create the checklist templates required and to push these to any project as needed.



Functional and performance testing aspects of commissioning are virtually the same

Moore's Law

The LEED EBOM Energy & Atmosphere credit category also includes points for crafting a phasing-out plan for building equipment that is inefficient.

Where Moore's law[19] relates specifically to semiconductors and suggests that they double their efficiency every two years, there is an tacit assumption within LEED that equipment phase out should be planned on five or ten year cycles. To be effective at making O&M effective we should strive towards understanding what typical service-life is for equipment.

[19] http://en.wikipedia.org/wiki/Moore%27s_law

- How rapidly is the underlying technology improving?
- Do we know what normal operating efficiency reduction over time is?
    - Or can we determine this through retro-commissioning?
- Is there any buyback program for the old equipment?
- What about a tax incentive for replacing inefficient equipment?

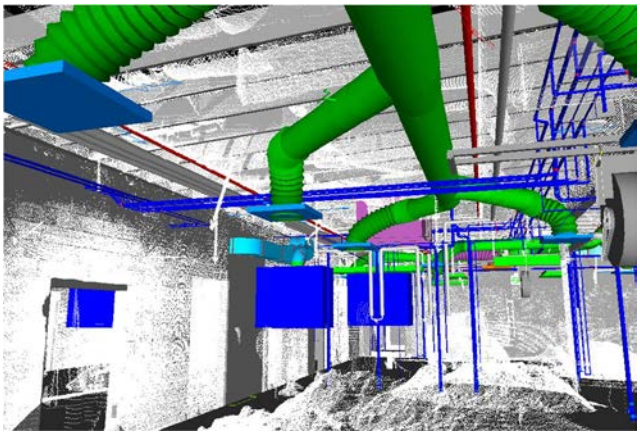
It may not be as linear as with computer upgrades, but if we get a good sense of where the breaking point is, we have a clearer picture of when the right time is to reach out to different building owners and operators.

Plan the work, work the plan

There's a lot of talk about 'green jobs' and whether they actually exist. I think the conversation around green jobs needs to change and here I would propose a different definition: 'A green job is the one you create by saving money on resource costs.'

The crafting of policies for day-to-day purchasing, pest management, green cleaning and waste management for Operations & Maintenance means office managers and third party service providers can get involved.

Measure twice…measure again?
DPR's laser scanning group has yet to find a set of drawings that exactly matches the data that comes back in a laser scan. While laser scanning may come with a high price tag, it is the only reliable way to sort out the truth from the fiction in as-builts or even our own O&M building models.



"We have run into multiple locations/ projects where "as-builts" were provided and were incorrect relative to the existing columns, walls, etc. and we had quite the battle to demonstrate that the building/walls/columns were not as the as-built drawings illustrated."

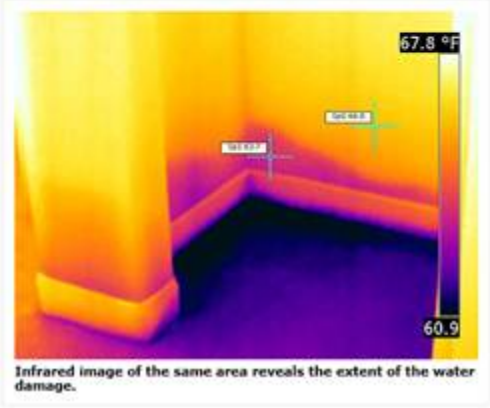
– Dave Goulette, DPR

If you can justify the cost up front, provide the owner with a laser scan as part of the initial O&M assessment. Knowing that the as-built is all but certain to be inaccurate compared to what was built, it makes sense to verify with a point cloud. This is also a great reference tool down the road; with Navisworks Manage it's easy to render the point cloud data along with just about any model files.

"When it rains, we start drinking"[20]

Actually, what should be said here is, "When it rains, my boss gets a big grin on his face." -- IR thermography is an underutilized technology that can gather data on construction quality through thermal imaging of a structure. Wet weather makes the insulation performance of a building envelope far more apparent on a thermal image. If energy models are indicating that the heating and cooling bills are too high for an existing building, there might be something missing (by something we mean proper insulation) Any thermal 'bridges' or gaps in insulation can be identified by a qualified technician capturing and reviewing IR images.

Standard digital image of water-damaged area.



Infrared image of the same area reveals the extent of the water damage.

Image credit Chapman Construction/Design (www.chap-con.com)

[20] There's a story behind this quote, but it doesn't make sense to share it in the context of this document

For more information:

Online Resources

- Vasari Beta 3
- USGBC
- LEEDuser
- Rand Facilities Management

References

"Natural Capitalism" by Hawken, Lovins and Lovins

"How Buildings Learn" by Steward Brand

"Green to Gold" by Esty and Winston

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