“Master Aggregators” - Facilitating Greener Design & Construction

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ABSTRACT

Acting as “master aggregators”, design and/or construction professionals must lead the effort to design and build more energy efficient, sustainable projects. A variety of sophisticated modeling and analysis tools are available to support this mission. More and more owner representatives are recognizing their responsibility to be more conscious of environmental sustainability. Not only are potentially greater economic returns recognized, it’s the right thing to do.

Understanding this challenge, the market has developed a series of tools for all industries to employ in their business models to create and maintain a more sustainable environment. In the AEC&O (Architecture, Engineering, Construction and Operation) industries, Environmental Management Systems (EMS) have been adopted by most public agencies as well as many private enterprises as a method to track and constantly raise the bar for environmentally sustainable buildings. One of the higher technological tools, Building Information Modeling (BIM) can also serve as a driver in which many other tools can be integrated to support the overarching program management and asset management of facilities, yielding maximum initial energy impacts, as well as life cycle impacts.

This paper serves to both challenge owner/developers by raising the bar of their program requirements to include environmentally sustainable design and construction goals as well as educate their operators to maintain their facilities, practicing and following through on the implemented design intent. It serves to demonstrate the importance of identifying a project-team lead collaborator, a “master aggregator” responsible for: shepherding good green design; enabling the drivers with appropriate

tools; bolstering decisions with analyses; training of the end users to keep their attention on the most critical life cycle impacts yielding greener building design, construction and operations.

INTRODUCTION

Practices of the world's populace are currently unsustainable. If we as a society do not reach a point where our activities are sustainable, then we will eventually consume all available resources and generate a level of pollution that will mean the earth is no longer capable of sustaining human life. First and foremost we must reduce our depletion of the earth's energy resources. The building construction industry has a great opportunity to make a major impact on reducing this energy depletion. Buildings must be designed, constructed and operated with the goal of using zero energy (zero energy buildings). Understanding this challenge, the market has developed a series of tools for designers and facilities managers to create and maintain more sustainable buildings. Environmental Management Systems (EMS) has been adopted by most public agencies as well as many private enterprises as a method to track and constantly raise the bar of the acceptable level of environmentally sustainable building. One of the higher technological tools, Building Information Modeling (BIM) can serve as a driver into which EMS can be integrated as an overarching program management and asset management of facilities yielding maximum initial, as well as the more critical life cycle impacts.

"master aggregators" or project-team lead collaborators, be they owner's representatives, program and/or project managers need to guide projects from "cradle to cradle", from the cradle of pre-design to the cradle of ribbon cutting when a building itself will begin its life. These professionals must serve as ""master aggregators"" working with designers during the pre-design and design phases ensuring intelligent life cycle analyses are being performed. They must raise the level of consciousness of the

builders assisting them in reducing their negative impact on the environment. And lastly, they must be prepared to work with facilities' managers able to train them on these new technologies in order that they will integrate them into their engineering duties to successfully manage and maintain their assets further reducing negative environmental impacts. These "master aggregators" must therefore be familiar with all these tools, even the technologically savvy tools able to monitor the design and construction process to ensure the specifications are depicted and followed yielding more energy efficient buildings equipped with fully operational and commissioned intelligent building systems, continually improving upon their energy performance striving toward the goal of zero energy buildings.

More and more owners are recognizing their responsibility in this process. All federal agencies are committed to have implemented environmental management systems by the end of 2005. In addition, private developers have found green buildings to be more attractive to tenants. Private industry has also noted an increase in productivity of its employees in green facilities. Hence, the need for these knowledgeable ""master aggregators"" is becoming more critical to the success of these environmentally sustainable efforts. Not only are potentially greater economic returns recognized, it's the right thing to do. Recognizing this, owners are adding environmental requirements to the quality services presently furnished. Always mindful of one's clients' scope, schedule and budget, professionals in the AEC&O industries must now be mindful of their projects' impacts on the environment.

BUILDING INFORMATION MODELING

One of the technological tools enhancing the design and construction of more energy efficient buildings is Building Information Modeling (BIM). BIMs are the creation of highly organized, easily usable data storehouses able to handle cost, schedule, fabrication, maintenance, energy analyses, rendering and animation, as well as other information throughout facility lifecycles. As information is integrated in a BIM from pre-design through building commissioning and facility maintenance a coordinating professional able to promote BIM usage and integration functioning as a master aggregator is necessary. This professional is in the unique position to insure all stakeholders take on environmental challenges and employ the appropriate tools at the appropriate time to optimize the design and construction to meet all aspects of one's clients' goals including environmental sustainability.

- BIM's performance analyses can be used to evaluate sustainable alternatives. "A/Es can study and track the effects of building and system design changes as they work, optimizing designs as the project progresses," writes Bernstein.
- BIM allows A/Es to study very specific changes in siting, showing the various effects of the environment and the elements, before construction begins and changes are still possible.
- "Reliable, consistent information about the building is available digitally to support various analyses required for sustainable design."
- "Drawings are integrated with project data-from engineering performance analysis to materials specifications, so the building's digital representation reflects its properties and performance."

- "Parametric modeling, which defines relationships among building elements, makes it possible to change one aspect and see and understand its effect on related design and performance characteristics."
- A/E teams can more easily show clients the benefits of different sustainable choices through virtual walkthroughs.
- Given that commercial and residential buildings consume 70% of the electricity in this country, which amounts to 40% of total energy use, according to Bernstein, BIM can incorporate energy analysis tools so that in the next 10 years the U.S. could save $4 billion in electricity costs, not need 175 new power plants, and significantly reduce carbon dioxide emissions.
- “With the power to create relationships and order among design, engineering, scope, and budget data, BIM transforms information into a meaningful, functional representation of all building elements," summarizes Bernstein. "BIM introduces an unprecedented measure of design precision that benefits both the environment and the building industry itself." (Phil Bernstein, 2005).

BIM – SIMPLIFYING FLUID DYNAMIC ANALYSIS

Building Information Modeling (BIM) was developed for the design arm of the industry to improve the coordination of documentation, fast generation of design presentations for client approvals, and most importantly better communication throughout the design and construction process. However, the interoperability of BIM also allows for fluid dynamic analyses; including fire and smoke, crowd dispersal as well

as thermal, day-lighting, shading, and building life cycle cost analyses. These analyses all have the potential to prove or disprove the environmental sustainability of a project.

PB uses state of the art energy simulation software integrated within the Building Information Model to aid in the analysis of energy usage in buildings as well as shading studies. This software analyzes design alternatives that improve energy efficiency while maintaining thermal comfort and cost-effectiveness of buildings. By utilizing a BIM as the basis of a simulation, alternative design options as well as accurate estimates of the proposed building's energy consumption, the interior environmental conditions and energy operation cost can be obtained.

PB is also able to take a BIM, simulate real world day-lighting as well as artificial lighting of a space and evaluate the lighting effects of any given design both visually and quantitatively. Light intensity can be specified with daylight standards, in photometric units, or industry-standard data formats for manufactured lighting fixtures. Using the BIM to incorporate both energy and lighting simulations energy consumption is minimized while optimal comfort is achieved.

LIGHTING DESIGN SIMULATION

- A highly accurate ray-tracing simulation for the analysis and visualization of lighting in design.
- Input: scene geometry, materials, luminaires, time, date and sky conditions, (for daylight calculations).
- Calculated values include spectral radiance (i.e. luminance + color), irradiance (illuminance + color) and glare indices.

Figure 1: Graphic Rendering of Day-lighting Study

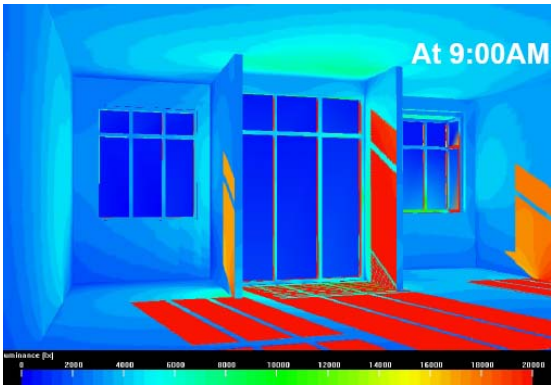

Figure 2: Computational Fluid Dynamic Results

Figure 3: Graphic Rendering of Day-lighting Study

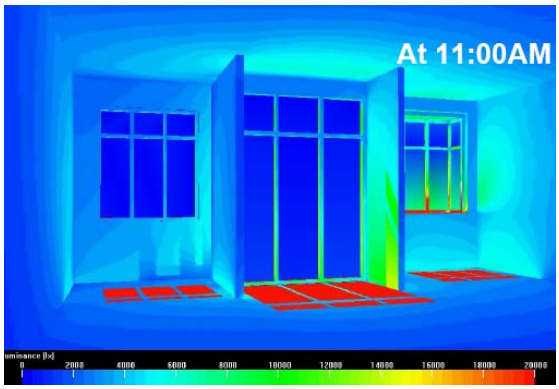

Figure 4: Computational Fluid Dynamic Results

LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN (LEED)

As LEED becomes the adopted environmentally sustainable design standard in the United States, many owners are requiring their new projects attain LEED certification or better. As such, complex engineering analyses of the design, detailing monitoring of the construction, and accumulation of the operation data are necessary. As clearly demonstrated above, Building Information Models have the potential to provide the necessary level of detail of these analyses. Green Building Studio from GeoPraxis Inc. streamlines this process during the design phase analyses reducing the overall design costs related to the energy analysis process. John Kennedy, GeoPraxis

President and CTO states, “The incorporation of our connectors by the major building information modeling and CAD vendors enables the Green Building Studio web service to use the wealth of information in the early design stage models. It creates a geometrically correct equivalent thermal energy model and provides almost immediate feedback on the energy implications of architectural design scenarios” (Kennedy, 2005). Green Building Studio is launched from an Internet browser. Within minutes the results are viewed providing energy statistic of the project represented by the model.

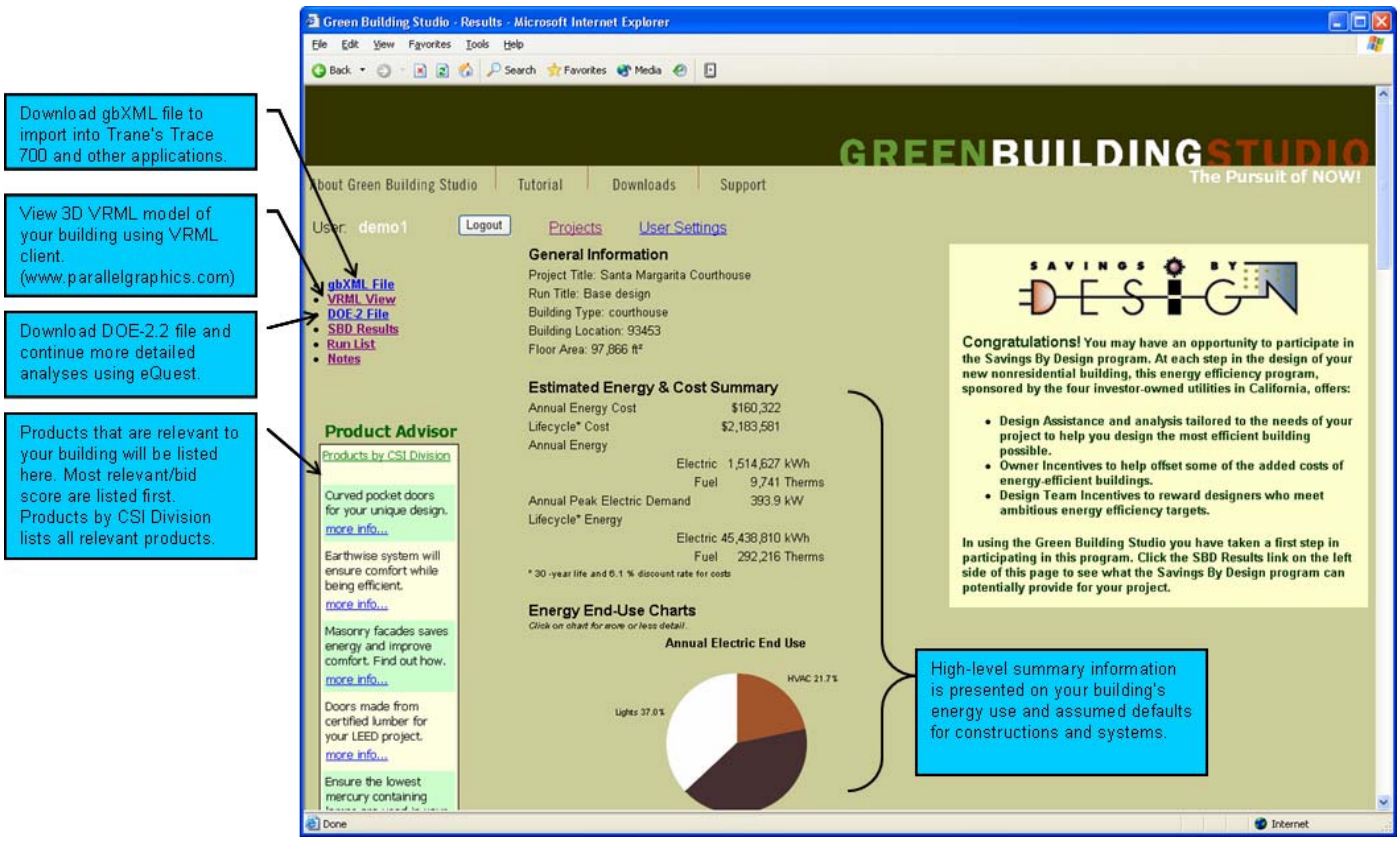

Figure 5 GeoPraxis Information Graphic

Modifications can be applied and the analysis run repeatedly with the resultant analyses received in moments allowing the designer to weigh options more coherently. Green

Building Studio (GBS) relies on a large network of relational databases containing hourly weather data, design data, and regionally relevant libraries of default building characteristics with common energy code baselines. It can even make recommendations regarding building products appropriate to a specific building further assisting with the LEED certification process" (Green Building Studio, 2005).

GBS also affords the designer with alternative product information with "Product Advisor". This is a new advertising and sales channel for manufacturers, providing very detailed pre-qualified leads and building information derived from early design stage BIM or 3D-CAD models and local energy standards. Green Building Studio, Inc. has a formal go-to-market partnership in place with Autodesk, Graphisoft, and Bentley (representing the more well-known and widely used 3D software companies). Using gbXML for data exchange, GBS is one of the first engineering analysis tools to deliver true interoperability between building design teams using CAD, engineers using energy models such as DOE-2, and building product manufacturer's like Trane using Trace700 for sizing and pre-sales design, (Green Building Studio, 2005).

Figure 6 – GBS Record from PB Design Project

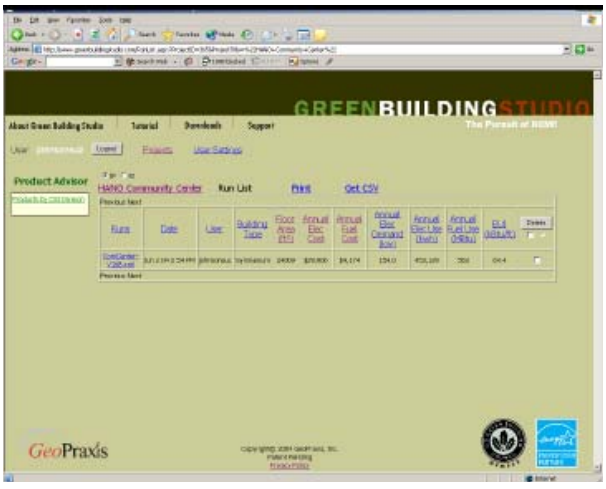

Figure 7 – GBS Record from PB Design Project

Figure 6 & 7 are examples of Parsons Brinckerhoff, BIM Projects using Green Building Studio. PB has found GBS simple to work with. Time needed to run overall energy analysis has been reduced greatly. Submitting the GBS output to LEED further streamlines the process.

However, reportedly, the design arm of the AEC&O industries has been slow to adopt BIM. A number of theories have been published explaining this unfortunate pace. Owners should not have to wait for the design industry to implement BIM. Owners should take the lead and hire a “master aggregator”, familiar with the technology, to take traditional design development bridging documents, and translate this 2D and specification documentation into an intelligent modeling tool. Once the project has been virtually constructed, analyses can be completed to assess the cost, the sustainability, the constructability and logic behind the construction. Revisions can be made to the design in response to these analyses. Once corrected, the model can be used by the contractor to serve as the basis for shop and fabrication drawings. As Phillip Bernstein FAIA states, “Recognizing the inherent waste and inefficiency of the construction process today, owners will insist that traditional design/fabricate/build/operate silos break down.” We, as environmentally conscious professionals must aid owners in reducing this waste by facilitating the implementation of BIM. We can facilitate the breaking down of these silos by bringing all the information together. P. Bernstein further states, “BIM will be the central, control model at the core of design decision-making” (Bernstein, 2005). Replacing the present day fragmented nature of the building industry, ““master aggregators”” must encourage collaboration of stakeholders. It’s in everyone’s best interests to do so, and BIM is the tool to achieve this. As our clients are

demanding more energy efficient design and construction solutions, “master aggregators” must be in a position to ensure the best designs and construction methods are implemented to yield this outcome. We must understand our client’s goals, be proficient with EMS, familiar with BIM and its applications, and confident with state of the art tools able to successfully achieve those goals.

BIM AS AN AS-BUILT DELIVERABLE TO THE OWNER

It has been documented that numerous design firms currently use BIM, IFC compliant 3D modeling software when designing projects. However, these files are typically not included as part of the deliverables package to the owner and are therefore not used to their fullest extent in the overall life cycle of the building. The master aggregator must take on the responsibility to “keep the BIM alive”, continually applying data to the model enhancing it as it evolves as a construction management tool and ultimately into an asset management tool. In all phases the owner, with the guidance of the master aggregator, must consult the model to assess the environmental impacts (apply CFD analyses), the economic viability (cost analyses) as well as the social impacts (present the rendered model as a communication tool to the community) of the project optimizing the triple bottom line. This is met by providing detailed collaborative data allowing the owner to make responsible decisions. Specifically in this role, as owner representative, as master aggregator, we must serve to shepherd the model as a conceptual design tool through the design and construction process and ultimately as an asset management tool.

In the construction phase of the building lifecycle, a BIM makes information on building quality, schedule, and cost concurrently available. The builder can accelerate the quantification of the building for the estimating of environmental-engineering purposes and for the production of related estimates and construction planning and logistics. Assessing alternate products (locally procured, lower total embodied energy, readily renewable or recycled alternatives) can be studied and understood easily. The builder can quickly prepare plans showing site use or renovation phasing for the owner, thereby communicating and minimizing the impact of construction operations, further reducing environmental impacts (reducing emissions, noise and/or traffic) at a construction site. The end result is that the builder has the potential to rapidly assess alternatives further reducing negative environmental impacts further maximizing the use of environmentally friendly products without increasing his/her administrative costs.

In the management phase of the building lifecycle, the parametric, as-built, “living” BIM provides access to information on the use or performance of the building; its occupants and contents; the life of the building over time; and the financial aspects of the building. The building information model provides a digital record of renovations and improves move planning and management making it more readily responsive to environmentally sustainable design solutions. Physical information about the building, including mechanical efficiencies and energy usage can be monitored thereby optimizing this usage. The landlord is also able to access detailed information about the building finishes. S/he can readily monitor wear and tear of materials directly able to influence subsequent renovations potentially taxing the environment less.

Additionally the maintenance and operation procedures of the facility can also be stored in the parametric Building Information Model. This could include Material Safety Data Sheets (MSDS); as more environmentally friendly products are available, the ability to make an informed assessment to consider implementation is simplified. The knowledgeable facilities' manager will keep the model updated. Repair diagnosis potentially becomes more intelligent. For example, a tenant identifies mold on the gypsum board ceiling. The facility manager can first view the BIM, without the need to open up the ceiling, can see, for example, a rain water leader makes a 90 degree bend above this location. S/he may deduce the connection is leaking. If the BIM is linked with the BMS, a read-out of the water pressure of this pipe can be read bolstering the hypothesis. S/he can then order the materials as well as the labor needed to make the repair, all prior to opening up the ceiling as the sizes and materials are all recorded in the BIM. The BIM therefore potentially assists in diagnosis and confirmation of issue, reduces repair response time, hence cost, as well as optimizing the tenants' environment. The positive impact potential is great; however it depends upon properly trained personnel committed to keeping the model updated and using it to its full advantage. A tool is only as good as the user.

CONCLUSION - COLLABORATION IS KEY

It is therefore our collective responsibility to encourage professional collaboration throughout the lifecycle of a project. It is our responsibility to guide the owner to demand the designer create a BIM in the design phase o study computational fluid dynamic analyses of smoke and fire, crowd egress as well as day-lighting and shading

and even thermal studies, as well as a rendering animation simulation tool. We must further guide the owner, our client to have the BIM used as a construction management tool linked with schedule (known as 4D), and providing quantity take-offs. Finally the client must be committed to providing a facility operations staff eager to work with the model throughout the life of the facility continually maximizing the efficiency of the maintenance of the facility. They must be engaged early on assisting in the decision making process insuring the continued application of the BIM, and embrace their ultimate responsibility to keep the BIM updated and active. In order to successfully reduce the present impacts the building industry makes on the environment, all the professionals involved must work collaboratively guided by this overarching goal. As "master aggregators" we must work to encourage collaboration on all levels. Studies have shown that BIM is most successful when employed by teams working in collaboration integrating their information utilizing a single model. We stand challenged to serve as "master aggregators" streamlining the design and construction process integrating environmentally sustainable requirements ultimately improving the product, the schedule and budget and possibly most importantly, the environment, for us all.

REFERENCES

Bernstein, P. (2005, ***Head of Autodesk Buildings Practice, Copyright Institute of Management & Administration Oct 2005)***

Kennedy, J. (Copyright© 2005 Green Building Studio, Inc.; www.geopraxis.com)

FIGURES

1. Parsons Brinckerhoff, Graphic Rendering of Day-lighting Study

2. Parsons Brinckerhoff, Computational Fluid Dynamic Results

3. Parsons Brinckerhoff, Graphic Rendering of Day-lighting Study

4. Parsons Brinckerhoff, Computational Fluid Dynamic Results

5. Geopraxis, Green Building Studio (www.greenbuildingstudio.com)

6. Parsons Brinckerhoff, GBS example