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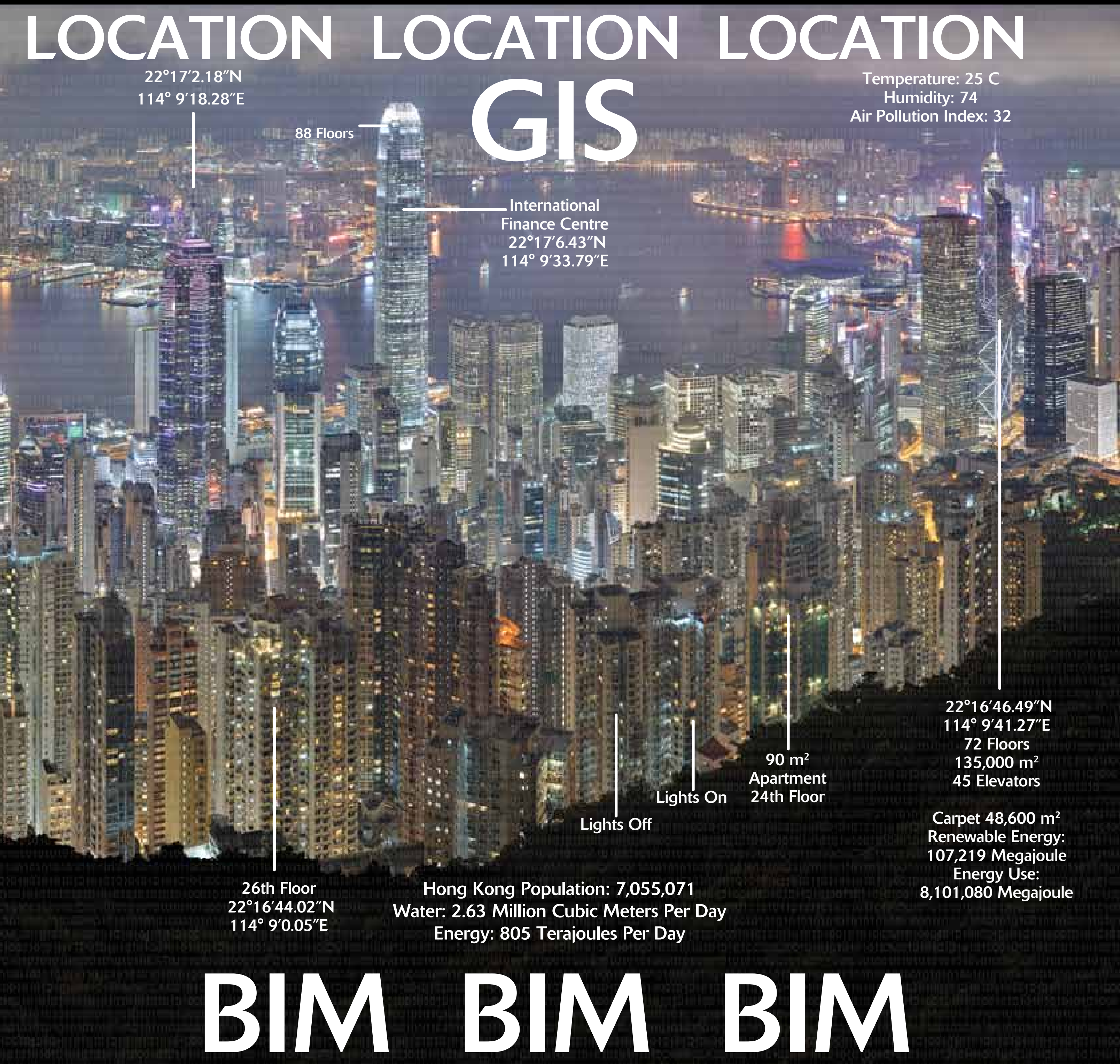

Photo of Hong Kong from Victoria Peak: Samuel C. Louie | 392M | 22°16′42.08″N | 114° 8′47.86″E

Savings Through Collaboration:

A Case Study on the Value of BIM

By Michael P. Cannistraro, P.E., LEED AP

THE NEED FOR BUILDING INFORMATION MODELING (BIM) in the construction industry is apparent. Nearly all of the top architecture, construction management and MEP (mechanical, electrical, plumbing) firms have embraced the transformative technology and software that engineers use to continue to enhance the BIM product mix. What began as a simple, object-based visual aid for the most progressive designers has grown into a dynamic, multidimensional tool that helps streamline the construction of projects of all types and sizes. The user-base for BIM has also expanded to include project partners from a variety of disciplines, ranging from architects to sophisticated subcontractors.

To this point however, quantitative data proving the return on investment of BIM is yet to be substantially proven in a real project environment. In 2009, Boston-based mechanical construction firm J.C. Cannistraro LLC formed a BIM Task Force to study exactly how BIM had improved its construction practices. To quantify the savings that were becoming evident through the growth of BIM adoption in the industry, J.C. Cannistraro examined $500M of past work and separated its projects into three categories. Each category differentiated the projects and determined the grounds for comparison based upon the method used for design. Base contract data was gathered for all plumbing, HVAC and fire protection projects and the total value of all change orders for each trade was compiled for each project. The six years of construction data included more than 400 new construction and renovation projects and was separated into 3 categories: 2D projects, 3D lonely BIM projects and collaborative BIM projects (note, lonely BIM is building models for internal use only).

2D projects referred to projects built using the traditional design-bid-build method. For these projects, the firm was awarded the contract after an approved set of design documents were already released. In each of these instances, mechanical infrastructure was installed strictly based upon the use of 2D CAD drawings.

The 3D lonely BIM category identified projects that were coordinated by J.C. Cannistraro using 3D modeling software, but not necessarily by the entire project team. For projects in this category, the firm's modelers coordinated the mechanical systems in 3D with fabrication-level detail, based upon traditional 2D design documents. On these projects, these steps were completed while working in concert with the general contractor/trade-specific subcontractor's 2D coordination process.

The collaborative BIM category consisted of projects that were designed and installed by a project team that was substantially experienced in BIM. The construction team was assembled early in the pre-construction process and a fully-coordinated, construction-ready model was completed prior to construction. Collaborative BIM projects required that construction managers and major subcontractors were all proficient in BIM.

The comparison of the firm's projects resulted in a natural, downward trend in percentage of total change orders. The data suggested that as project teams embrace collaboration and high-level BIM use, cost savings become increasingly more significant. **FIGURE 1** shows that through collaborative BIM efforts, 10 to 20 percent of a project's finances can be saved and possibly reinvested into a project. **FIGURE 1** also supports the common assumption that when BIM is professionally executed, it enables a project team to erase costly errors during pre-construction, therefore saving additional time and money for the owner. While the ultimate goal is to keep the cost of change orders at zero, there is clearly a downward trend in change order percentage when a BIM-centric approach is taken.

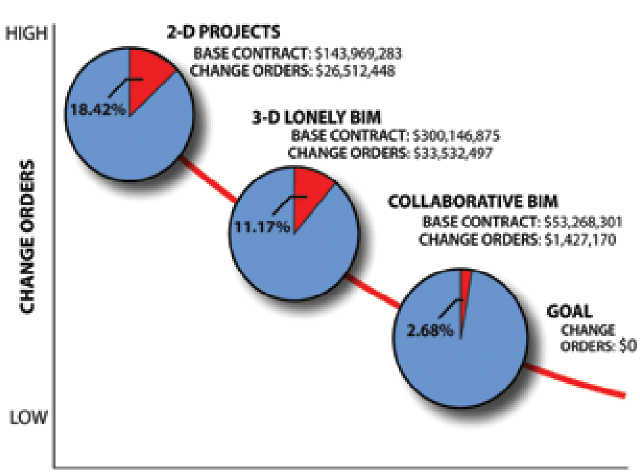

Figure 1. BIM use and change order comparison.

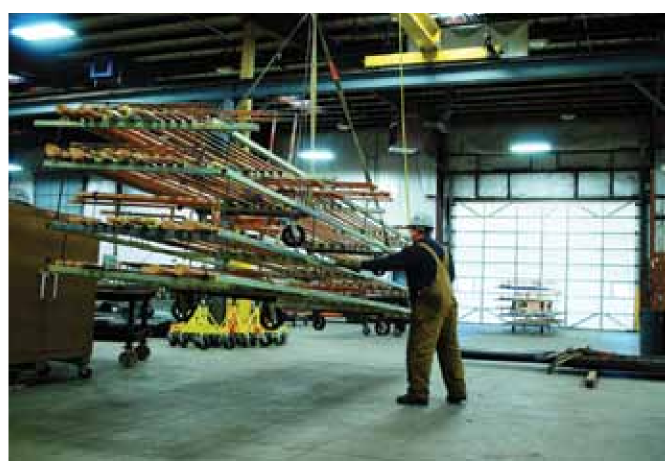

Figure 2. The set of 4 racks in the photo represents half a floor of laboratory piping and contains over 1,000 feet of pipe for 12 different systems.

Given this data, it is clear that projects using strictly 2D design methods are not taking full advantage of the resources available to the construction industry. While the use of BIM is a company standard at the firm, the number of future 2D projects in the marketplace is expected to decline in the coming years as owners continue to see positive results from BIM. While 3D lonely BIM projects have shown improvements in cost savings through change order reduction, there will always be waste as long as key members of the project team are left behind.

It is widely accepted that the interoperability of modeling technology is one of the leading concerns in the adoption of BIM. According to research completed by McGraw-Hill Construction, "79 percent of BIM users believe that improving the interoperability gap among modeling programs is the best way to improve the overall value of BIM."[1] However, the issue of interoperability does not solely pertain to software. It extends to the entire design-development process, which uses traditional delivery methods that exclude key members of the AEC and subcontractor teams. In fact, the lack of design interoperability is one of the leading factors driving firms to practice lonely BIM. Truly accurate BIM incorporates the means and methods of construction and therefore requires the subcontractors' involvement.

When a project successfully implements the collaborative BIM process, the savings are not limited to a decreased number of unexpected changes. Collaborative BIM allows companies to employ lean methods that eliminate waste and add value to the overall project. Early participation in BIM coordination gives J.C. Cannistraro and other contractors the opportunity to provide practical solutions for constructability complexities.

For example, at the Genzyme Biologics Support Center in Framingham, Massachusetts, the firm delivered laboratory floors earlier than scheduled by pre-fabricating custom racks of laboratory piping **(FIGURE 2)**. Before leaving the shop floor, wheels were welded directly onto the racks and bundled into assemblies that made up half a floor of laboratory piping (1,000 feet of pipe for 12 different systems).

This lean suggestion saved time in the field for installation, avoided worries about space restraints and helped alleviate some of the construction manager safety concerns. Using the Last Planner Scheduling method, the firm's foremen and project managers worked together to set weekly, look-ahead schedules and establish milestones that gave the owner and construction manager a realistic timetable of expected completions. Such methods can be further augmented by BIM solutions that grant model access to foremen in the field via wireless tablet PCs.

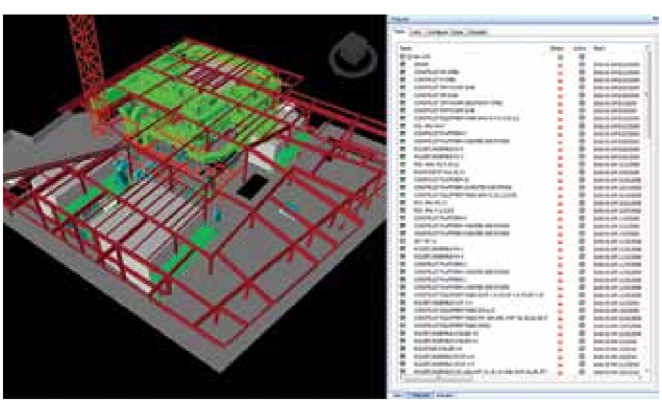

Figure 3. BIM-Enabled scheduling played an integral role in delivering the fifth floor mechanical room at Massachusetts General Hospital's Building for the 3rd Century.

Massachusetts General Hospital's "Building for the Third Century" is a large-scale, new construction project that has become one of the leading case studies for successful BIM implementation. Though this was not an IPD or design-assist project, the owner (Partners HealthCare System) and the general contractor (Turner Construction) made collaboration an important part of the preconstruction process. Having the subcontractor co-located with the project team during design and coordination revealed HVAC installation details that may have gone unnoticed in a 2D environment. Noticing these observations and making appropriate adjustments prior to construction ultimately led to savings for the owner.

The firm also used 4D BIM-enabled scheduling to plan and visualize the rigging plans for equipment and piping deliveries. The project featured several custom air handling units, each made up of eight tractor-trailer-sized segments and a delivery portal just big enough to fit one flatbed truck. J.C. Cannistraro modelers, project managers and field foremen worked with precision to plan virtually the exact delivery paths of all piping and equipment in the hospital's fifth floor mechanical room **(FIGURE 3)**. Through off-site prefabrication and this level of coordinated scheduling, the mechanical room is set to be delivered four months ahead of schedule.

Today's owners are aware of the benefits of BIM and are demanding its use on future projects. Groups such as the U.S. General Services Administration (GSA) are making commitments to use BIM on all buildings moving forward and have awarded contracts to the most BIM-proficient firms around the country. This increase in BIM awareness will lead to increased expectations and there will be no room for models that are not 100 percent accurate and equipped to process multi-dimensional features such as 4D scheduling and 6D facilities management.

Assembling the project team early brings subcontractors to the table during design. Doing so creates an opportunity for savings by designing for the means and methods. These savings can now be realized as the design progresses and allow for value-added, pre-construction program changes to be incorporated into a project, therefore maximizing the owner's investment. ■

Michael P. Cannistraro, P.E., LEED AP, is the Vice President of Engineering at J.C. Cannistraro, LLC. In his current role, he is responsible for overseeing the company's BIM and virtual design operations. A registered Professional Mechanical Engineer in Massachusetts, Cannistraro is a co-chair of the Boston BIM Collaborative, an interest group of the buildingSMART alliance™. He can be reached via email at mikec@cannistraro.com.

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1. SmartMarket Report: The Business Value of BIM. McGraw-Hill Construction. September, 2009, Pg. 17.