BEST PRACTICE BIM

The BIM Manager's Handbook

Dominik Holzer

ePart 1

THE BIM MANAGER'S HANDBOOK: GUIDANCE FOR PROFESSIONALS IN ARCHITECTURE, ENGINEERING, AND CONSTRUCTION

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Dominik Holzer

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BEST PRACTICE BIM

How does one get Building Information Modeling right in practice? What are the key tasks and challenges faced by BIM Managers in achieving "Best Practice BIM" and how can they master them? By drawing from the experience of some of the world's top BIM Managers, this publication gets to the bottom of these questions. There is much we can learn from their experience, no matter if good or bad. The following exposé consolidates a broad range of feedback from these leading experts and it provides support to those who strive for excellence in their pursuit of implementing BIM.

If we want to understand how BIM Managers can excel in their role, we first need to understand the principles behind getting BIM right. This publication scrutinizes BIM's changing context and looks to see if there is a "BIM formula of success." The past decade has given us the opportunity to see a number of high-profile BIM projects through to completion. We learn from the mistakes we made on the way and we reflect on "Good," or even "Best Practice" BIM. What might be the tipping point for its successful implementation? What are the typical thresholds and benchmarks that apply? Answers to these questions will assist BIM Managers to maximize BIM benefits not only intraorganizationally, but also across the broader project team.

BIM Managers: Breaking Ground

BIM Managers are a wholly new breed of professional. They emerged internationally in less than a decade, most markedly in larger tier 1 architecture and engineering practices. By strengthening integration across disciplines and project phases, BIM Managers become the conduit for facilitating the information exchange between the design, delivery, construction, and operation of projects. They play a central role in deciding where BIM is heading. On a practical level, BIM Managers are the custodians responsible for innovation to occur within their organization and in collaboration across project teams. They empower project stakeholders to understand and engage with the high level of complexity associated with a BIM workflow. They help them to align their skills with the added benefits offered by data-centric and rule-based delivery of projects.

A Role in Transition

Describing what BIM Managers do is a difficult task. What was once associated with responsibilities for overseeing BIM model development is now more and more associated with information management, change facilitation, process planning, technology strategies, and more. Such is the veracity and speed of development surrounding BIM that the job description of any BIM Manager is in constant flux. Given the ever wider group of stakeholders BIM encompasses, there exists an increasing fragmentation of the BIM Manager's role into specialized responsibilities: On one end of the spectrum the role of Model Managers emerges, who assist in-house teams on individual projects, at times complemented by specialist BIM Librarians (or Content Creators). On the other end of the spectrum, Model Coordinators specialize in the oversight of the multidisciplinary integration of BIM. BIM Managers may now also report to Design Technology Leaders or Project Information Managers who directly report to upper management. In some instances, an organization calls for a Strategic BIM Manager (as opposed to providing more technical support on the floor). All of the above descriptions depend on the size and characteristic of an organization. In smaller companies, the BIM Manager may well be tasked to incorporate all those roles, while acting as Project Architect and BIM Modeler at the same time.

There is likely to be a time where BIM Managers become obsolete and their responsibilities will become part of project management in general. A good number of Change Management activities will have been implemented and construction industries globally will accommodate BIM as a matter of course in their project delivery methods.

For now, we still go through a major transition in adopting BIM. BIM Managers need to balance between the possible and the appropriate. Their strategic view will influence which opportunities can and should be aligned with the cultural and professional context of their organization. They also help to map out how such alignment can be achieved. In the end, BIM Managers may not be the ultimate decision makers in facilitating change. They are the ones who provide upper management with decision support in order to do so and they are the ones accountable for BIM implementation "on the floor."

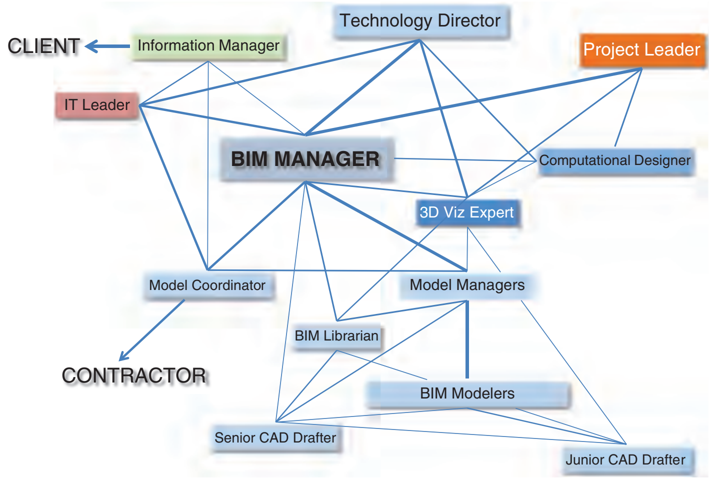

Figure 1–1 Mapping out a possible role distribution surrounding BIM in a larger size design firm.
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What makes a good BIM Manager, or even an outstanding one? In order to answer that question feedback is consolidated here from the world's top BIM Managers to make it accessible to everyone. These managers work for leading Architecture, Engineering, Quantity Surveyor (Cost Engineers or Cost Managers in the United States), and Construction firms. They report on pitfalls and the common mistakes associated with BIM to then highlight what makes BIM tick in practice.

The Rise and Rise of BIM

BIM use has been expanding continuously since 2003,[1] making BIM Management a moving target. Back then, BIM became the accepted industry acronym for a range of descriptions such as Virtual Design & Construction (VDC), Integrated Project Models, or Building Product Models. Until that point, different software developers had branded their tools with these varying acronyms, while essentially talking about the same object-oriented modeling approach that was first introduced to a wider audience by Chuck Eastman in the mid-1970s. Around 2002–2003, it was AEC Industry Analyst Jerry Laiserin[2] who played a pivotal role in promoting the single use of the acronym "BIM" which had been coined by G.A. van Nederveen and Tolman in 1992[3] and which later became the preferred definition of Autodesk's Phil Bernstein. It was the starting point for an industry-wide journey to holistically address planning, design, delivery, and operational processes within the building lifecycle. This journey raises a great number of culturally sensitive and professionally relevant issues: By nature a disruptive process, the adoption of BIM overturns decades of conventions related to the interplay between architects, engineers, contractors, and clients. BIM Managers are drawn right into the center of these changes in practice.

Despite the clarity about BIM's origin, there is no clear starting point to the commercial breakthrough of BIM; conceptually, BIM dates back to the early 1970s with the introduction of mainframe computers.[4] Some of the key BIM software platforms in use today have their origins in these early developments. The increase in processing

Figure 1–2 Detailed facade systems generated via BIM and visualized as a 3D rendering by COX Architects.

COX Architects

power, the drop in price for computer hardware, and the connectivity offered via the World Wide Web gradually led to an increased adoption of BIM in the early 2000s. During that period, a critical mass was reached. BIM software became affordable and it matured to the point where its user-friendliness offered a viable alternative to existing CAD platforms. From that point onward CAD Managers were those individuals most likely tasked with the oversight of the implementation of BIM. With documentation output in mind, CAD Managers were supported by senior drafting personnel who were responsible for generating the contractually relevant 2D plans/sections/elevations from virtual models. The process of BIM modeling remained limited to Architectural Designers and Structural Engineers. The limited scope of BIM existed much to the frustration of Services Engineers and Contractors who had to wait for the availability of BIM tools to serve their purposes until 2007–2008. From 2010 onward, developments surrounding BIM accelerated. Increased software interoperability and an ever-expanding BIM tool ecology resulted in BIM becoming more and more accessible to Quantity Surveyors, Contractors, Facility Managers, and Client Representatives. The ever-expanding list of BIM stakeholders introduced a plethora of opportunities to manage information across disciplines and project stages. Significant consequences followed from this development:

With the broadening scope of BIM comes a diversification of what BIM Managers do: The more information can be exchanged by various stakeholders, the greater the possibilities and challenges for managing that information across those stakeholders. This expansion in scope has by no means occurred in a well-orchestrated fashion. On the contrary, it has evolved organically at different speeds and veracity throughout markets and industry contexts. In some cases there now exists a level of regulation about how information gets shared via mandates or incentives, in other cases the evolution of BIM depends on client demand or simply on the skill level of operators.

One commonality among these diverse propagations of BIM is the fact that until now, there has never been a clear educational pathway toward becoming a BIM Manager. When asking BIM Managers about their background at any conference, seminar, or local user-group session, they will likely represent a broad range of professional affiliations: (Recovering) Architects, Engineering Drafters, Quantity Surveyors, Project Managers, Service Contractors, Specialist Consultants—just to name a few. Some of these experts are self-taught and they have picked up their skills vocationally; others may have attended specialist courses or were introduced to BIM as part of their tertiary education. Others may have learned about BIM from colleagues in practice, and some simply may have picked up BIM as an expansion of the documentation processes they were used to from 2D/3D CAD.

From the early 2010s onward a number of professional bodies and academic institutions have started to offer tiered BIM Management courses with accreditations or certifications. Such courses denote that there exist fundamental, overarching themes that can be addressed in the context of BIM Management. The Singaporean BCA began their local BIM certifications in 2011–2012 as part of their BIM Academy.[5] Around the same time, the HKBIM in Hong Kong introduced entry requirements for their membership.[6] The Associated General Contractors of America (AGC) started their BIM education program[7] with a Certificate of Management—Building Information Modeling (CM-BIM) in 2011–2012. More recently, the UK–based Building Research Establishment Limited (BRE) announced a BIM training and certification pathway that focuses on the UK mandate that targets BIM Level 2[8] proficiency of stakeholders by 2016. What sets the BRE[9] approach apart from others is the split between Task Information Managers (TIM), Project Information Managers (PIM), and Project Delivery Managers (PDM). Less comprehensive, but with global outreach, is the BIM Manager accreditation introduced by the RICS in late 2013–early 2014; it predominantly addresses BIM Management for Chartered Surveyors, but accreditation is provided globally (albeit referring predominantly to a UK BIM context). The Canada BIM Council, CanBIM[10], joins the ranks of other industry bodies by establishing a Certification Program to provide: *A benchmark for individuals to be certified to nationally standardized and recognized levels of BIM Competency and Process Management.*

All of the above courses and accreditations were established by their respective industry bodies within the four years or less leading up to the first release of this publication. Many more are likely to follow. It is fair to assume that few, if any, of the BIM Managers who offer their feedback in this publication gained their knowledge from these courses. Yet this type of accreditation will become increasingly relevant for the second and third generation

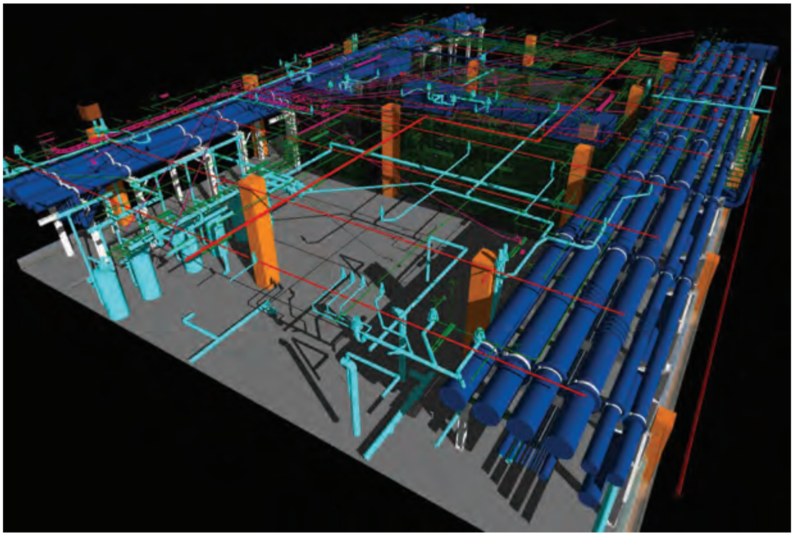

Figure 1–3 The new Royal Adelaide Hospital Construction BIM Services Model by the Hansen Yuncken Leighton Contractors Joint Venture.

Figure 1–4 The new Royal Adelaide Hospital Field BIM used by the Hansen Yuncken Leighton Contractors Joint Venture.

of BIM Managers to follow. How far the essence of BIM Management can be taught in class remains to be seen. BIM accreditation is without doubt an important stepping stone in order to address the epistemological aspect of BIM.

Defining what ought to be known in the context of BIM leads to a clear articulation of competencies and skills to be had by BIM Managers.

Defining Good, or Even "Best Practice," BIM

The term "Building Information Modeling" has remained of such a generic nature that interpretations about its meaning are vast and many. Some see "Modeling" as a verb, describing the activity of generating, assembling, and coordinating virtual building information.[11] Others refer to BIM as "a model" of building information, either in terms of geometric components, data, or a mix between the two. Considering the vast differences in defining BIM itself one needs to wonder if it is possible to define good BIM, or even "best practice" BIM.

The Big Picture

In some cases these documents lead to the generation of national policies or even mandates. An example of such guidelines is the UK Publicly Available Specification PAS 1192 with all its components and additions; another example is the State of Ohio BIM protocol.[12] These documents present the bigger picture of the aspirations related to BIM in local construction industries. They provide useful frameworks and a point of orientation to work toward for practices within a local industry context.

A semantic approach to any BIM definition is better left to the theorists. The work presented here is far more interested in the applicability of BIM as it unfolds in everyday practice. For that reason, this publication focuses on practical outreach and the application of tried and tested approaches to implementing BIM by drawing from the experience of leading BIM Managers around the world. It reports on cutting-edge research and practical use that helps to maximize the results of BIM-enabled workflows. Getting BIM right can never be a linear process as BIM is an ever-moving target. Well implemented BIM always relates to the combination of attitude/mindset and approach to the management of information across collaborators in general. Any attempt to defining Best Practice BIM needs to take into consideration BIM's transformative character that influences the array of stakeholders affected by its application.

We learn from examples and, when talking about the BIM, those examples often reveal a breadth of issues that cut through different, professional, cultural, and market-related contexts.

Reporting from the Trenches

When German Formula 1 driver Sebastian Vettel saw the checkered flag indicating that he had won the inaugural Abu Dhabi Grand Prix in 2009, it is very unlikely that he was aware of the eventful period leading up to the racetrack's construction. The Yas Marina Circuit had just been finished in record time to host the final race of the season. Commissioned by Aldar Properties PJSC, one of the largest developers in the United Arab Emirates,

Figure 1–5 Arup, Aldar HQ Designer's impression and detailed construction model including steel and concrete detailing.
Courtesy of Arup

the racetrack is one of a number of major architectural and urban projects built on Yas Island, just off the Abu Dhabi coast. The racetrack is adjacent to other architectural marvels, planned previous to the financial crisis of 2008, such as the Ferrari World and the Abu Dhabi National Exhibition Centre, which conspicuously display the wealth of this region that is rich in natural oil resources.

Abu Dhabi leaders had high ambitions to present their country and their culture to the world as a modern society. Aldar Properties PJSC wanted to be part of that effort when it came to the development of their own headquarters in 2007. They commissioned an iconic landmark building, an architectural and engineering masterpiece, to grace the Abu Dhabi Skyline.

What followed was the appointment of some of the world's leading experts in design, engineering, and construction in order to facilitate the fast-tracked delivery of the project. Lebanese architecture firm MZ Architects conceived a spectacular, semi-spherical (coin-shaped) concept for the 23-story building—the first of its kind

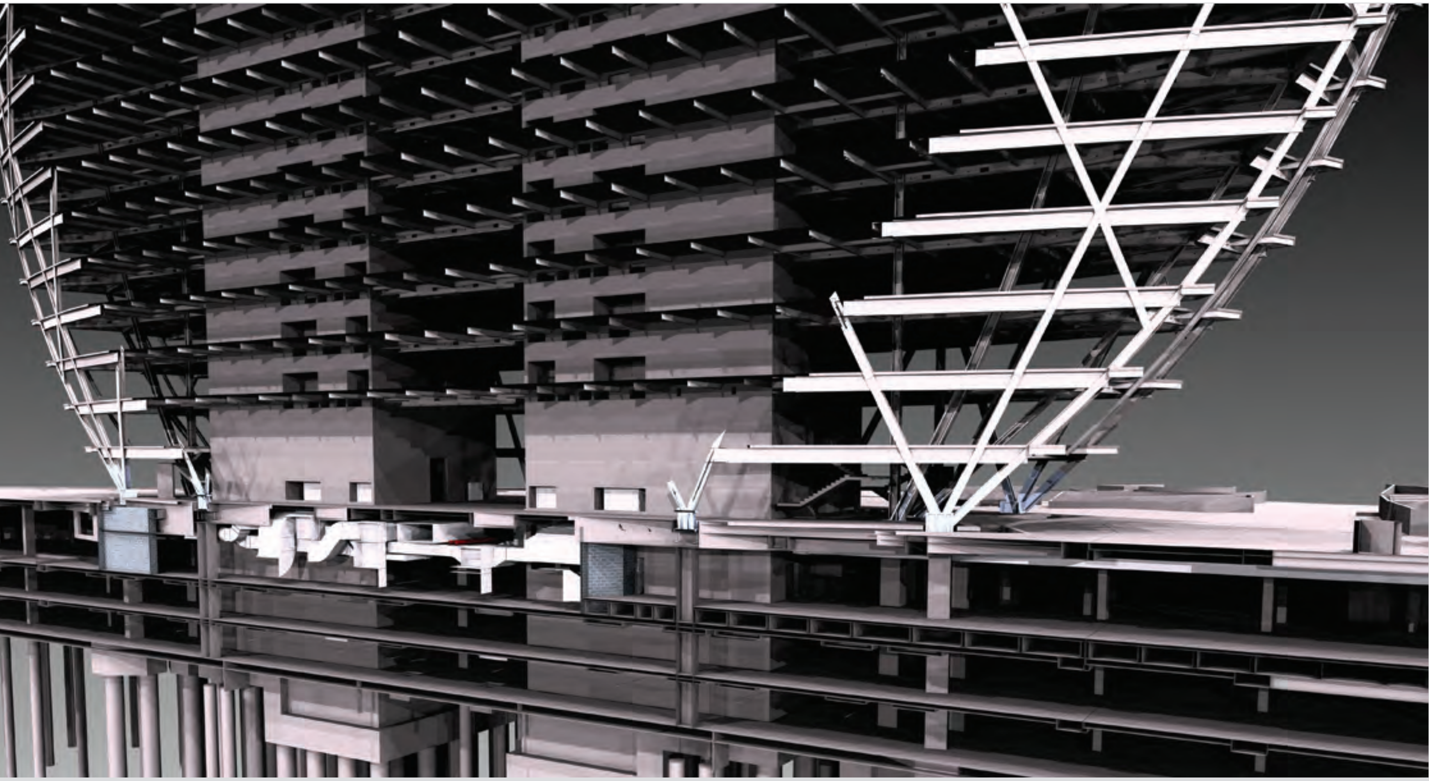

Figure 1–6 ALDAR Headquarters detailed construction model including steel and concrete detailing by Arup.

Courtesy of Arup

in the world. The shape allowed for increased repetition in the facade panels, but at the same time posed challenges to the engineers and contractors as an entirely novel solution had to be found for the detailing and erection of the structure. The nature of the iconic form made steel the dominant construction material, as it was able to accommodate the high-tensile stresses inherent to the spherical shape.

The richness of fossil fuels in Abu Dhabi is not matched by an equal richness in high-grade steel. It cannot be sourced locally in the United Arab Emirates. This became obvious to the Head Contractor (UK–based Laing O'Rourke) and the Engineering Consultant Arup early on in the project. A solution had to be found to procure high-grade steel from the United Kingdom and to orchestrate the entire design, engineering, logistic, and construction process around a unique method for supply chain integration. With production of steel one issue and transport another, the tight time frame of a DnC (called D-B in North America) procurement pushed Laing O'Rourke to look for new ways to make the link between design, engineering, fabrication, and construction. Given the lack of a contractual precedence that would specifically address the issues apparent in the project, Laing O'Rourke put forward a teaming agreement to manage the collaborative workflow of the team using BIM authoring tools. They found a strong partner in Arup's Sydney-based "Regional BIM Coordinator" Stuart Bull and Dubai-based Steve Pennell, who were prepared to shoulder some of the risk of entering unchartered territory. Bull, who is now Managing Director of Ridley VDC, had previously been engaged as a virtual construction integrator on a range of high-profile construction projects globally, ranging from Foster + Partners' City Hall (2002) to PTW, Arup, CSCEC, and CCDI's Beijing National Swimming Centre—the Water cube (2008). Bull knew that the only way to meet the client's tight schedule was to collaborate closely with Laing O'Rourke and the UK steel fabricator William Hare (WHL) in order to produce a virtual shop model that could translate directly into constructible elements. The concept of the virtual model had to be aligned with UK and Abu Dhabi codes and regulations as well as the supply chain integration of various suppliers and forwarding agents. A global collaboration ensued, in order to facilitate just-in-time construction with information being shared between Australia, the United Kingdom, and the Middle East. In reflecting on the key point of difference that allowed for the team to succeed, Bull recalls a week-long design meeting of WHL key project staff in Sydney in order to resolve steel grade, material availability, and fabrication issues on the virtual model collaboratively. The teaming agreement helped to facilitate a highly collaborative and outcome-focused process among stakeholders; it was one of the key factors informing its success, enabling the facilitation of BIM use on the Aldar headquarters.

There were lessons to be learned. In the absence of a dedicated BIM Manager on the project, a Laing O'Rourke Project Manager had to step into that role. Further, there had been no dedicated BIM Execution Plan available on the project and many aspects of the collaboration had to be tested in the heat of the fast-paced project delivery. One of the biggest regrets of the team was the lack of integration of their highly sophisticated virtual construction model with the Building Maintenance Contractor.

The above example highlights that BIM doesn't work (well) when a predominant focus on gaining advantages gets applied by individual stakeholders. Despite the risks inherent to multidisciplinary collaboration, leading examples highlight the benefits of increased collaboration and sharing among project stakeholders, based on trust and respect among collaborating consultants and contractors.

The Aldar HQ example refers to one particular case for a high-profile project, undertaken in collaboration over three continents by highly experienced operators. It was one of the earlier examples where supply chain integration via BIM between consultants and contractors led to a successful outcome. BIM has kept evolving since the completion of the Aldar HQ project, around the time of the 2009 Abu Dhabi Grant Prix. Numerous industry studies illustrate the steady increase in global BIM adoption.[13] According to an annual report issued by the UK National Building Specification (NBS), BIM use there rose from 39 percent of respondents in 2011 to 54 percent in 2014. More dramatically, a Smart Market report issued by the U.S. publisher McGraw-Hill in 2012 illustrates an increase in levels of BIM adoption in North America from 28 percent in 2007 to 71 percent in 2012.[14]

With increasing adoption we also start to understand where we struggle to get BIM right. The following section points out the most common examples of BIM going wrong. It is based on feedback from those who sit in the trenches and who deal with the consequences of badly implemented BIM day by day.

When BIM Goes Wrong—Examples of "Bad BIM"

MAKE MISTAKES FASTER

ANDREW GROVE, CO-FOUNDER, INTEL

What can we learn from BIM gone wrong? What are the key mistakes that repeatedly seem to creep into our projects and that sideline our best intentions when applying BIM in practice?

Column and door conflict

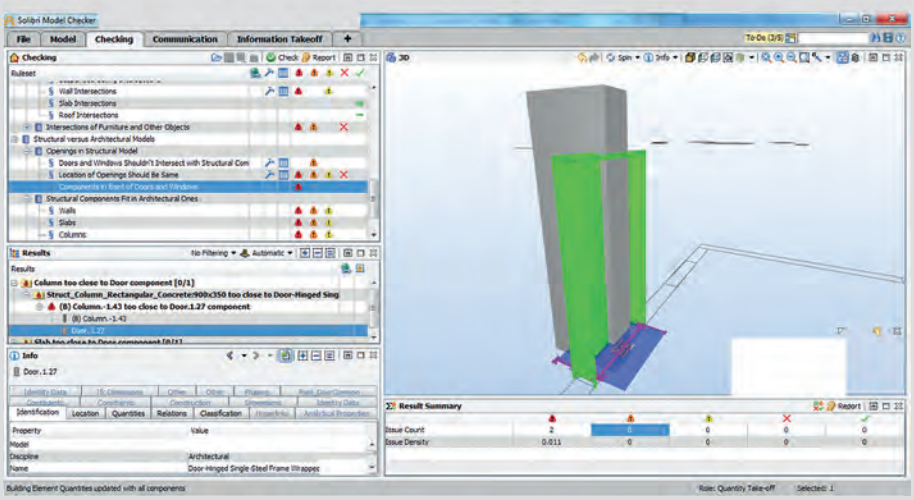

Figure 1–7 Detecting coordination issues in BIM via a model checker by Mitchell Brandtman 5D Quality Surveyors.

It is arguable if "Bad BIM" exists. Let's assume for a moment that the core concepts behind BIM are noble and that they aim at improving how projects get delivered across a building or project lifecycle. Following that thought, BIM cannot be bad as such. It certainly can be interpreted, or applied in a bad way. Its principles can be overlooked, and its goals can be misunderstood or misused.

Anyone who ever worked on a project using BIM will have a number of stories to tell about BIM going sour. In some cases, the apparent shortcomings may have little to do with BIM itself, and they rather depend on the specific project context (for instance, contractual constraints or procurement problems). In others, the shortcomings could refer to a lack of skill or knowledge about how to get the most out of BIM. A good portion of "BIM going wrong" can be attested to the fact that those implementing BIM are often still going through a major learning curve across project teams.

Some common mistakes stand out. It is crucial for any BIM Manager to learn from those mistakes in an attempt to avoid falling into the same. The following hit-list represents a summary of responses from 40 of the world's leading BIM Managers[15] who operate across the United States, Europe, Asia, and Australia.

Pseudo BIM

It may sound implausible at first, but the biggest challenge faced by BIM Managers is what best can be described as "Pseudo BIM." There exists a spectrum of BIM "pseudoness" eventuating in practice. In its worst form, pseudo BIM is used to pretend BIM was applied whereas in reality a traditional CAD workflow was used to deliver a project. The reasons for such deception may be to impress clients (who may not know the difference), or to conform to client/regulatory requirements. Array Architects' Robert Mencarini describes this occurrence as follows: *When some team members think that working in CAD and then creating a model at the end of a phase constitutes true BIM. This isn't BIM and it creates problems.* Instances of this form of dressing up and masquerading are on the decline as more and more clients and/or authorities become more informed about the distinction between Pseudo BIM and the rest.

The most common occurrence of Pseudo BIM is applied by those who use BIM tools simply to produce their 2D documentation. BIM software gets utilized as a means to generate submission documents more efficiently. Multi-disciplinary coordination or data-integration opportunities are not considered by teams who separate geometry from data. The crime committed relates less to any active act of deception, but rather to the cowardice of going out of one's comfort zone—the 2D CAD workflow. The negative effects on other project team members are severe. This form of Pseudo BIM shuts the doors on any form of information sharing beyond simple visual referencing. On a project level this usually plays out as a delay when single seemingly BIM-enabled project partners cannot commit to a BIM workflow. Others have to pick up the slack and gaps in the otherwise integrated approach of project delivery emerge. A common "subcategory" of this form of Pseudo BIM is the "Fall-back." Chris Houghton, Peddle Thorpe's BIM Manager in Melbourne refers to it as: *Hybrid BIM. Too much CAD. Either across the entire project team, or within a single business.* It gets applied by those who commit to using BIM, but who revert to 2D CAD part way through a project. There may be a number of reasons for that to occur. The most likely out of those is a lack of skill or support infrastructure to sustain continuing a BIM approach. It is likely the project leaders who pull the plug on BIM when they lose confidence that imminent submission deadlines can be met.

Considering the level of progress made by most organizations who implement BIM, it is surprising to see the Pseudo BIM Phantom still plaguing the industry. With time these issues are likely going to subside.

Going Solo—Lack of Coordination Across Key BIM Stakeholders

One of the most difficult aspects of pitching a BIM approach to any firm is the fact that organizations tend to search for immediate benefits for their own business or members. It makes sense: Their key purpose is to make a profit or serve their members' interests. Therein lies a fundamental problem: Acknowledging that BIM can increase efficiency intraorganizationally, synergies only really kick in when applied across as a number of stakeholders involved on delivering projects. This circumstance needs to be experienced to be understood. In a project-based environment such as the construction industry, it is difficult for an organization to prioritize multi-disciplinary collaboration over its direct returns on investment. What is good for the project doesn't necessarily appear to be as good for the business.

BIM Managers are not the only ones who are caught up in this conflict, but they are the ones who most directly experience the tension between what would technically be possible and what appears wise from a business perspective. The more acquainted an organization is in delivering projects using BIM, the more likely they will acknowledge the need for collaboration. It is often the more experienced tier 1 or tier 2 design, engineering, or construction firms who push for collaborative BIM, by nature of the scale of projects in which they engage.

Problems emerge when modeling is done by different parties without sharing and overlaying these models for coordination. BIM is not used concurrently during the design phase, and design intent BIMs don't get made available to contractors as a reference during the fabrication and construction phases. Even further, it is still early days for consultant/contractor teams to consider the information needs of Facility Managers. Their work usually starts upon handover of completed facilities and their information requirements are different to those of architects, engineers, and contractors engaged in the design and construction phases. An uncoordinated solo BIM effort results in duplication of information in multiple, often barely interoperable, formats. Potential synergies are not being tapped into and the BIM process becomes inefficient when seen in a holistic project context.

The roots of the problems described above are manifold: Architects fear for their intellectual property and they are concerned about their professional liabilities, engineers see little point in generating models when the design isn't yet completely resolved (as they run the risk of having to accommodate costly changes constantly). Ill-informed contractors may feel inclined to discard design intent BIMs if they don't realize how they add value to their process. Facility Managers don't engage as they are either not on board with the project team yet, or they don't understand how BIM can assist achieving their objectives.

BIM Execution Plan—Lack or Lack of Use

A managed approach to execute BIM goes hand in hand with a focus on collaboration. Many problems related to uncoordinated collaboration emerge if teams don't develop and sign off on what is commonly known as BIM Execution Plans (BEPs), BIM Management Plans, or the like as early in a project as possible. Publicly accessible

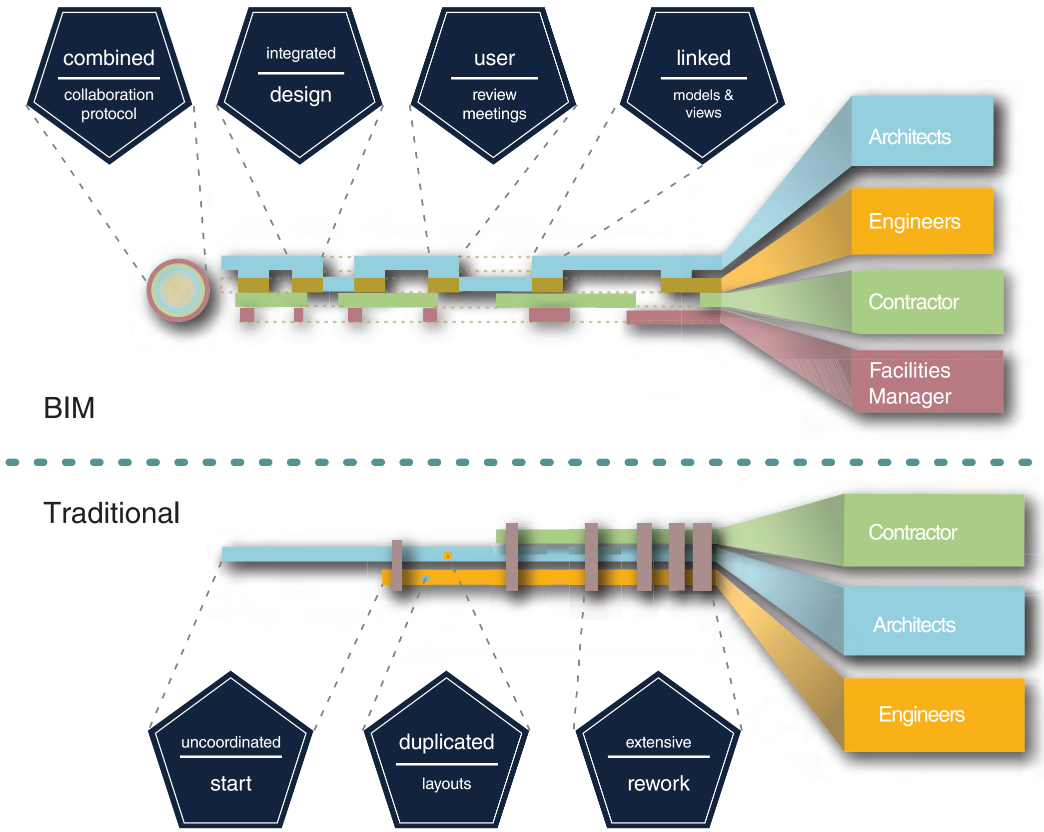

Figure 1–8 Comparing BIM versus traditional methods of delivery: Applying a combined protocol to regulate collaboration among stakeholders.

BEPs templates have been available since 2007–2008 and these BEPs help orchestrate the entire collaborative process when using BIM. Their purpose is (among other things) to allow project teams to agree on the way models and associated information gets shared, how these models are put together, how often they are reviewed and who is responsible for advancing certain components inherent in a multidisciplinary BIM process. Their use—despite the fact that it is increasing—has not yet become standard on all medium- to large-scale construction projects. The absence of a BEP on these types of projects can lead to dissonances among collaborators and a loss in productivity. BEPs are by no means a guarantee for seamless collaboration using BIM, but they increase the chances for teams to work synergistically on declared and common BIM goals. Bad BIM happens when BEPs are either not available, or if they are not understood and adhered to.

No Data Integration

The next aspect of "Bad BIM" refers to an over-focus on geometric modeling to the detriment of associating data to the geometry that is useful downstream. With much attention given to generating 2D design documentation from 3D BIM, questions related to data often remain under-resolved. There is a good reason for that: Traditionally, consultants and contractors are rarely paid for adding any information to their documentation that doesn't directly benefit them. Convincing any team otherwise can be a difficult task if the inclusion of data requires an extra effort that is not covered by their fees. A recent study undertaken highlights the perceived extra effort by consultants of appropriating information from their models that may become useful by downstream parties.

Worse than the lack of data association is the process of developing datasets in parallel to existing BIMs. The two remain disconnected and (often incorrect) information gets mismanaged and doubled up in separate systems with incompatible formats.

Lack of Well-Defined Objectives (Client)

Those using BIM for design, engineering, and construction purposes are likely to be the key culprits for inconsistent approaches to BIM use. Still, clients, Project Managers, and Facility Managers are to blame for BIM going wrong as well. The "mother" of all aspects related to "Bad BIM" may be the lack of clear BIM objectives by clients. Such lack usually originates from an indifferent or uneducated client when it comes to declaring their information requirements at the outset, or at any point later in the project setup. Badly defined BIM objectives from the client side are often the cause for the lack of data integration described earlier. GHD's Brian Renehan laments clients who *over-specify goals, without an understanding of how the data will be generated, managed, and used.* Without declared and realistic BIM objectives, project teams usually tap in the dark as they need to second-guess what the client may be after. Business-savvy consultants and contractors see the opportunities of educating their clients and offering them help to uncover what data they may need at project handover. Others may not even have heard of support documents such as the UK PAS 1192:2 *Employer Information Requirements* (EIR) template, or the Asset Information Model (AIM) that gets created based on a Project Information Model that draws from the EIRs. Bottomline, lifecycle BIM cannot really work without an educated client who can articulate information requirements to the project team. The team may still develop data-rich models, but their usefulness is likely to be limited. The preceding BIM efforts may prove to be useless if clients don't specify what they want to get out of the project. Some clients try to play it safe by asking for "full BIM" or "fully integrated BIM" without the slightest idea how such elusive deliverables may benefit them.

Overmodeling

Stepping back from the client side, there exists another jewel in the crown of "Bad BIM"—it mostly occurs in the interaction between consultants and contractors (but it may extend to the world of Facility Management): Overmodeling.

"Over" may be a misnomer as it only reflects the most common occurrence related to the lack of understanding by a number of BIM stakeholders who are not in tune with the information requirements of their closest collaborators. NBBJ's Sean Burke describes it this way: *Concentrating on making perfect models—at the expense of useful and accurate data.* BIM gone wrong signifies in this context that there is too much (mainly geometric) information embedded in the model. Not only does this represent an unnecessary effort, it may well also make models too heavy to use, thereby jeopardizing the coordination effort across the team. The key reason behind overmodeling is insufficient communication between stakeholders. It becomes particularly problematic in the earlier design phases where an overload of information challenges the flexible design process. As much as a lack of data integration is bad, excessive modeling for the sake of including information (without a clear understanding what the information is good for) is just as problematic. Consultants (e.g., Mechanical Engineers) may go beyond suggesting systems and start to model detailed equipment only for the model to be turned over once the Mechanical Contractors get on board. Recently published guidelines about Levels of Development (LoDs) assist teams in harmonizing their modeling efforts. The definition of LoDs usually forms part of the BIM Execution Plans.

Lacking Tool Ecology

It is tempting to blame software vendors as the major culprits causing this problem. How often have they promised the world about the capacity of their tools? In fact, there is truth to claims that functions within the tools we use become more encompassing. By nature, software developers enhance their products over time in order to gain or maintain market share. When it comes to BIM tools, software vendors are quick to highlight their capacity to serve as sketch-design/conceptual modeling tools as much as they are suited for producing documentation output, 3D visuals, and data export to Facility Management. There may be truth to that, but questions emerge in how far "all-rounders" are the best fit for resolving any design/engineering/coordination/and data integration functions.

Problems emerge when BIM authors try too hard to resolve all design aspects with one model and one single software platform. They may be fixated on one way of doing things (just because it can be) without evaluating the best way of doing it.

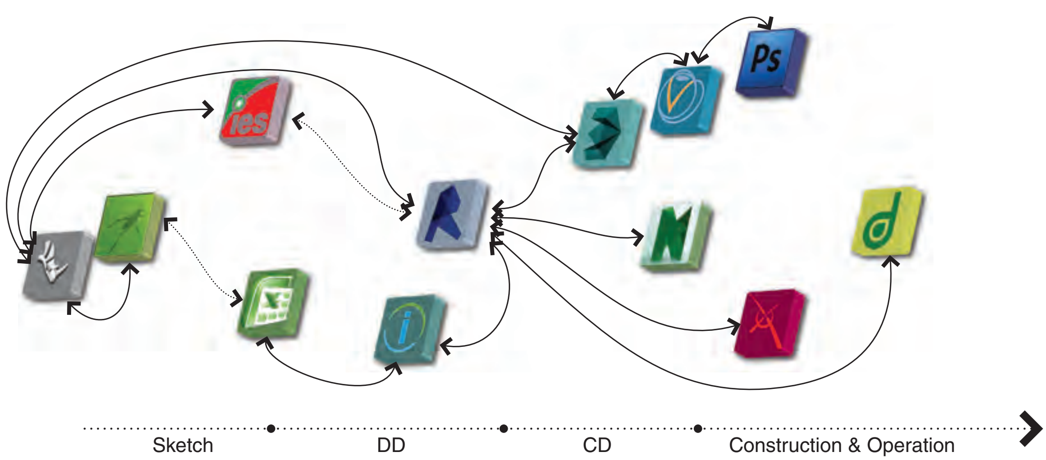

Figure 1–9 Strategic mapping of software interfaces to form a tool ecology associated with BIM delivery and beyond.

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This is where experienced BIM Managers step in. They know when and how to embark on the most appropriate pathway of connecting tools and passing on information in order to fulfill specific tasks. They understand how to establish a tool ecology and fine-tune data and geometry handover processes in order to maximize synergies within given suites of tools or across platforms.

Modeling Without Understanding

More accounts of BIM gone badly refer to modeling efforts where those who author BIMs do not seem to be aware of the consequences of their proposed solution. As much as consultants are usually tasked with the production of "design intent BIM," contractors take over for the production of shop models for manufacture, detailed coordination, and installation. The nexus between intended artifact and the closest possible virtual representation of a construction component can be tricky at times. A spatially resolved model that is well coordinated and clash free is still no guarantee for success. It requires knowledge about constructability and serviceability in order to get BIM on an LOD 400 right. Such an understanding eludes most consultants (and even some contractors) and it comes with extensive site and shop-detailing experience. BIM with best intentions will still not work if those who model don't know how the project will ultimately be built and how certain components will be accessed for servicing and maintenance.

Model Inaccuracy

Parallel to a lack of understanding about what to model are problems related to a lack of knowledge regarding the requited model geometry accuracy. The accuracy associated with the generation of various BIM components and assemblies relates to the project phase and the construction material in question. Design intent BIMs tend to be delivered with lower accuracy than construction BIMs as consultants cannot be expected to know about precise construction tolerances by the various trades involved. Those trades are still liable for correct set-out and dimensioning of the virtual components that ultimately represent the equipment that goes up onsite.

Über-Hacks

One of the first words any BIM Manager learns on the job is "workaround": A way to achieve specific goals in BIM authorship and documentation outside the standard suggestion by the BIM software used. Workarounds are the bread and butter of BIM Managers. There exists a flood of webpages in support of workarounds. A culture of peer-to-peer support and communication has developed related to their use. In principle, workarounds can be seen as a positive option expanding the limits of any given software's tool infrastructure. In many cases, software developers learn from workarounds applied by the users of their tools and they may choose to integrate elements of those workarounds into future releases of their products.

Workarounds fall over when they become too complicated, or when they result in convoluted solutions that only benefit single authors. They may not be scalable across a team and even if one party benefits from a quick fix, others down the supply chain suffer the consequence.

Luckily the richness of examples about unsatisfactory implementation of BIM can easily be matched by positive experience from practice. Respondents who provided their hit-list of "Bad BIM" examples were keen to share their views of successful BIM implementation. What should we aspire to deliver when working in BIM? What approaches to collaboration and project delivery promise increased efficiencies and synergies via the use of BIM? How can we ensure the penny drops and reap the benefits of a BIM workflow?

The Tipping Point—How Do You Become Successful Using BIM?

When the first settlers arrived in Sydney, Australia, to populate the penal colony in the late 1780s, they worked hard to establish a foreshore that would protect them from the prevailing tides and other elements. Back then as today, the sandstone coast of Sydney Cove shifts from rugged bushland to sandy beaches, jumping at times to form steep cliff-edges. Since the days of the early settlers, the coastline framing parts of inner Sydney has undergone a number of transformations. By the mid-1820s the first wharf was built at Walsh Bay followed by the wharfs of Millers Point.[16] Long wharfs that served for docking of trade and transport vessels have for decades been the most prevailing architectural/landscaping feature of an area that is now known as Darling Harbour—and more precisely, Barangaroo. One aspect of these wharfs is the lack of engagement they allow for inhabitants with the water. When the New York–based firm Johnson Pilton Walker in association with Peter Walker and Partners Landscape Architecture won the competition to design the new Barangaroo waterfront in 2009 they knew they wanted to address this issue. Their design surrounding the Barangaroo Headland Park represents the major urban redevelopment program in Sydney of the past 20 years. The team's rugged sandstone topography took inspiration from the naturalistic pre-1836 shoreline in order to allow the public to re-engage with the shore that has been locked away from them for more than 100 years.

The design for the new foreshore by the architects was simple and ingenious: sourcing sandstone found onsite in order to generate a differentiated series of blocks that step down toward the waterline. The arrangement of the 10,000 unique blocks is set in a way to allow the public to navigate different levels of the shoreline while being able to trace and engage with tidal variations in a lifelike fashion. Still, the arrangement of these tidal rock pools could not be arbitrary. Dimensioning, cutting, and transport of individual sandstone blocks, the overarching topography of the terrain, and height-limitations related to pedestrian circulation for easy navigation all formed constraints that needed to be addressed as part of the design. The team was stuck at a point where the ideals of the designers could not easily be broken down into feasible construction components by the contractor. The gap between design aspirations, engineering capabilities, local construction constraints, and cost factors had to be overcome.

As John Hainsworth, BIM Leader at Aurecon, explains: A tipping point was reached with the realization that the definition of the foreshore required a parametric approach to be taken with the input from the designers, the engineers, the contractor, and the stonemason. Not only was it important to rationalize the geometrical aspects of the design, but also the programming of stone-cutting, the QR-coding of the blocks, and the transport and positioning onsite. The geometric concept behind positioning the stepping sandstone blocks by the architects was well defined, but

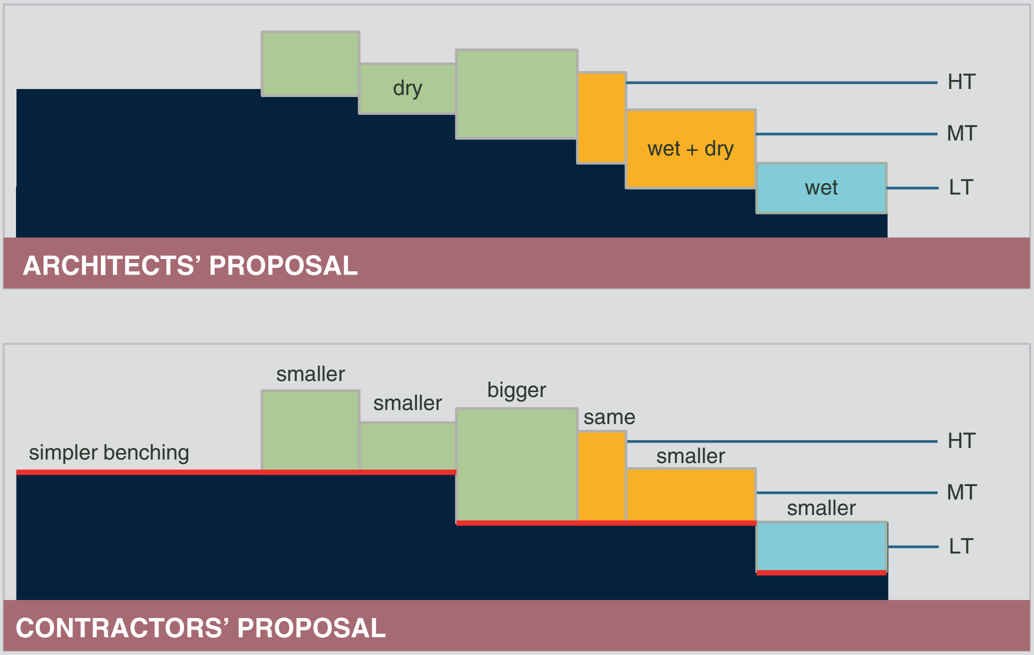

Figure 1–10 Aurecon, Barangaroo Headland Park Foreshore. Section comparing architect's and contractor's proposal for stone block arrangement.

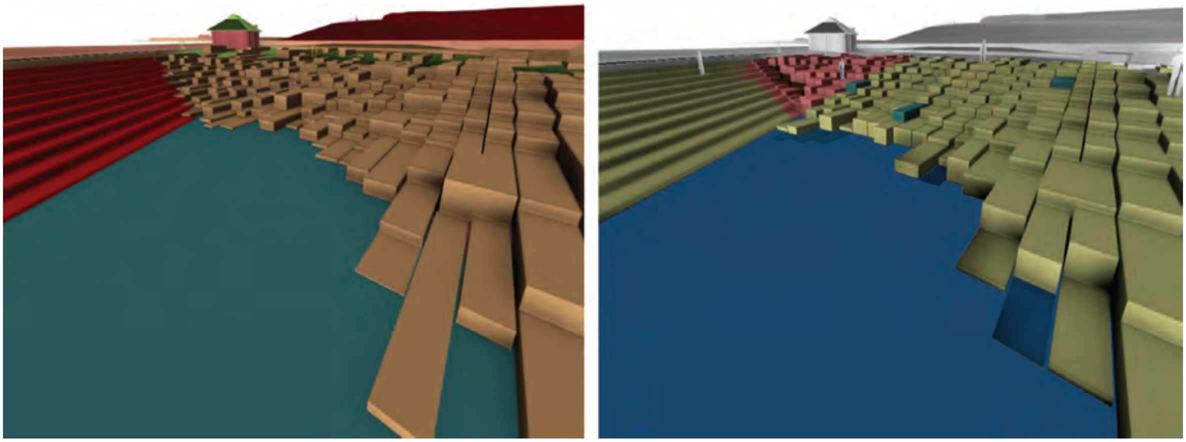

Figure 1–11 Aurecon, Barangaroo Headland Park Foreshore. 3D View comparing architect's and contractor's proposal for stone block arrangement.

Figure 1–12 Barangaroo Headland Park Foreshore, cutting stone blocks from the onsite extraction hole.

© Troy Stratti

Figure 1–13 Barangaroo Headland Park Foreshore, stone blocks in their final position.

© Troy Stratti

the head contractor—Lend Lease—had to overlay it with their own logic in order to make production and positioning feasible. Lend Lease, a great supporter of BIM–related processes, tasked the engineering consultant Aurecon to develop a data-driven BIM approach to resolve the issues mentioned above. Aurecon's model contained a rationalized benching beneath the blocks, but demonstrated a similar upper surface to match the architects' aspiration. The reinterpretation of the desired effect via integrated BIM processes resulted in a solution that was signed off by all major collaborating parties, which led to quick approval. Such success was in no way certain at the outset of Aurecon's involvement. The penny dropped for the team when Lend Lease pushed for a team approach, gathering key parties around a 3D model of the design as often as possible in order to resolve issues collaboratively. That way the team communicated and learned to understand methods for cutting the stone, the associated treatment of waste, and the mechanical treatment of the stone's surface. Buy-in by the client and well-orchestrated supply chain and fabrication integration via BIM by the entire team was the key factor for success.

The difficulties of introducing novel approaches to traditional contexts are well documented and described by Malcolm Gladwell in his book: *The Tipping Point—How Little Things Can Make a Big Difference*. There he concludes by encouraging those who are agents for change to *focus, test, and believe*.[17]

BIM—Getting It Right

How would those who count among the leading BIM Managers explain how to do it right? The responses that the author has solicited as part of the research for this publication from over 40 Design Technologists and BIM leaders draw a clear picture: If you want to do BIM right you need to think about the client first.

The number one aspect of Best Practice BIM is to offer clients a better product and more certainty around the final outcome of their projects. "Certainty" as used here refers to a number of things:

First, BIM delivers clients a better understanding about their project through increased visualization opportunities. BIM also strengthens the design team's abilities to include environmental sustainability concerns early in a project's development. Tighter cost control about the planning and construction process can be applied when using BIM processes in the field. In addition, BIM allows the introduction of more transparency for construction scheduling and sequencing. Ultimately, those using BIM can pass on information from the construction to the operation phase of a facility. These are merely a number of aspects relating to the increased certainties that can be offered to clients via BIM.

The strong focus in client benefits expressed by BIM-enabled consultants and contractors may surprise at first. Those operating in the BIM space rarely represent clients. Still it makes sense if considered as part of the construction industry's push to establish BIM within a lifecycle approach. It also means that Best Practice BIM doesn't work in isolation, but that it requires collaboration across a project team. Next to client satisfaction, seamless design and construction coordination between consultants and contractors is of most relevance to leading BIM Managers. The industry is learning to adopt new pathways to make BIM work not just for companies in isolation, but increasingly also across the consultant/contractor divide. BIM gets used more and more to facilitate construction processes onsite and Field BIM as well as 4D programming are becoming an ever more relevant factor of good (or even best) practice.

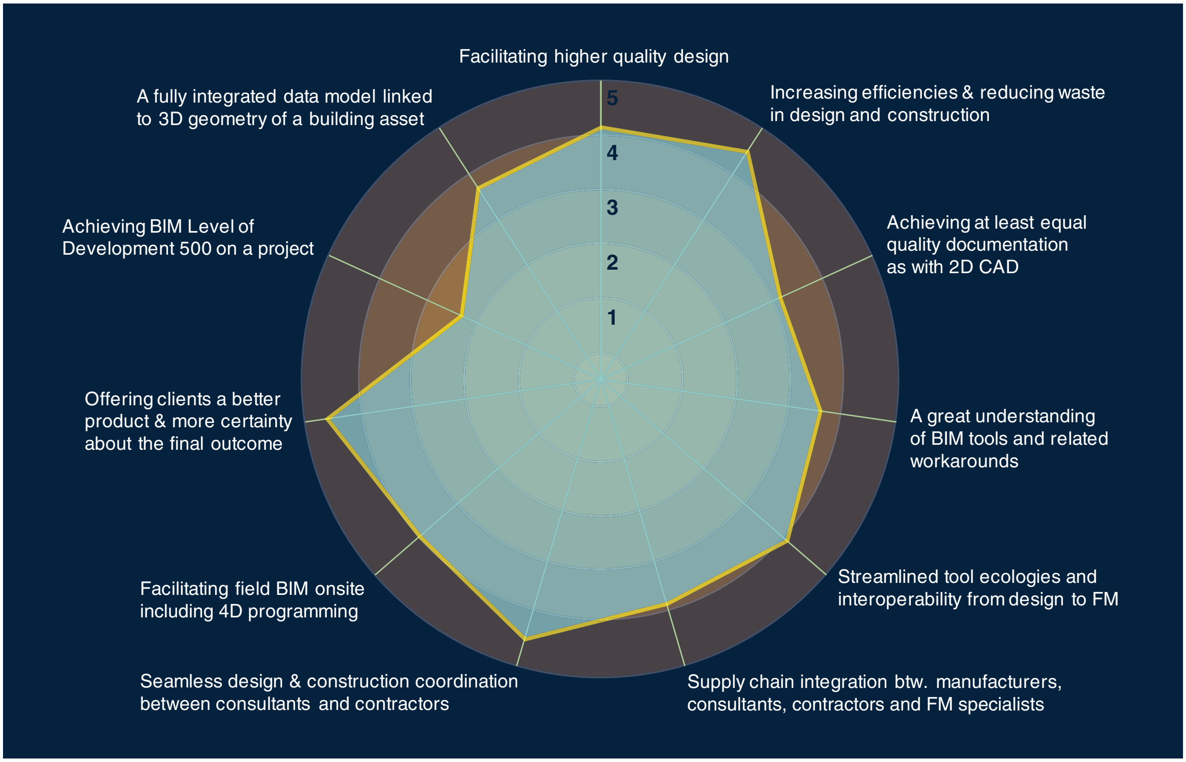

Figure 1–14 Responses from industry experts about what constitutes Best Practice BIM.
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Global BIM leaders are convinced that increasing efficiencies and reducing waste in design and construction is an absolute priority when considering BIM's best practice. Such a response needs to be seen in the light of the decrease in productivity across construction industries over the past 50 years in some western countries. Compared to other nonfarming industries, the dispersed nature of construction is highly inefficient with the doubling up of work and uncoordinated delivery approaches.

BIM experts highlight the need to streamline tool ecologies and to achieve interoperability from design all the way to Facility Management. A traditional project-delivery mindset usually doesn't consider supply chain integration and the alignment of tool infrastructures to facilitate information transfer from conceptual design all the way to operations. Respondents saw overwhelming benefit in BIM's potential for supply chain integration between manufacturers, consultants, contractors, and FM. Respondents supported the idea of a fully integrated data model linked to 3D geometry of a building asset and they highlighted the need for a BIM Manager's understanding of BIM tools and related workarounds. BIM Managers didn't believe that achieving at least equal-quality graphic output as with 2D CAD delivery was a high priority of BIM.

Those who assume that a sound knowledge of technical- and design-related aspects of BIM provide certainty for success in implementing BIM, should think again. As described in the foreshore example, getting BIM right depends on a different set of criteria. The primary driver to make BIM work is to ensure engagement and support of the upper management within an organization or on a project. It often entails changing the mindset of a firm's or a client's leadership in order to make them understand that BIM is more than simply a tool for delivering projects in 3D. Having full support from the top is a key enabler to roll out BIM in a sustained and structured way. If leadership is unaware, not involved, or doubtful about a BIM strategy, decisions get delayed and the implementation effort can easily get bogged down by micromanagement of secondary issues without a clear plan or direction. Another prerequisite for success for succinct BIM implementation is the attitude by the team when it comes to project delivery. The more the team embraces a BIM workflow, and the better they communicate their requirements, the more likely BIM will provide them with tangible benefits. There is no surprise in such a statement. Still, a good number of teams underestimate the value of adhering to a well-conceived BIM Execution Plan in order to tap into the full potential of what BIM has to offer. Understanding BIM as a team sport and adhering to guidelines that were defined in collaboration doesn't come natural to some organizations. It requires a maturing process where—at times—firms put the advantages of the team ahead of their own. Feedback from industry experts suggests that such a maturing process and the implementation of Best Practice BIM typically takes an organization three to four years or more to master.

One of the reasons for this extended adoption period is the lack of clear directives, or "pull" from the client side. Firms push in a direction without necessarily being fully aware of the BIM end-goals by their clients. Clients therefore play a crucial role in establishing overarching BIM goals on projects. By defining what those goals are, clients (while still considering their own benefits) provide teams with an orientation point to work toward.

Benchmarking BIM

What metrics can one apply to measure the quality of BIM? What are the Key Performance Indicators associated with such metrics?

Broader Policies

The quantitative capture of BIM performance has been up for debate for a number of years. On a policy and an industry level, a number of governments or industry bodies have come up with their own breakdown of BIM into defined levels or stages. In some cases (such as with the UK PAS 1192) the lifecycle aspect of BIM is given high priority; in other cases benchmarks are scaled down to more immediate and targeted aspects of BIM that serve to satisfy a department's needs, such as Spatial Programming by the U.S. General Services Administration (GSA) or the Submission of BIM for planning approval/permitting processes by the Building & Construction Authority (BCA) in Singapore. There, the BCA stages the requirements for mandatory BIM e-submissions for architectural and engineering approvals for all new building projects of a certain size.

These guidelines often provide overarching frameworks for BIM Managers and their teams to steer their efforts toward a certain direction. They are an orientation point—a beacon for guiding industries toward higher efficiency in the use of BIM. But there is much more that needs to be considered. For BIM Managers, the key deliverables correspond to their output on a project level. What is it that BIM Managers are most concerned with in everyday practice? How do they measure their success—or lack thereof? The metrics and benchmarks presented here stem directly from feedback given by the 40+ BIM managers who took part in the study leading up to this publication.

Measuring Day-to-Day Performance

The results highlight one crucial factor: A singular formula for Best Practice BIM doesn't exist. Top benchmarks for Best Practice BIM vary from stakeholder to stakeholder and even from project to project. A number of general trends and tendencies still cut across an otherwise diverse set of criteria:

If we believe the feedback from the experts, the most relevant metric for successful BIM is outward looking: Client satisfaction! As Dennis Rodriguez—BIM Enterprise Manager at the global engineering firm AECOM puts it: *A fully integrated data model attributed for the client's use for facility management and operation is essential to the market realization of the true value proposition of BIM.* A key benchmark therefore relates to the quality of data that can be generated via BIM and made available for clients' FM purposes. Toby Maple, National BIM

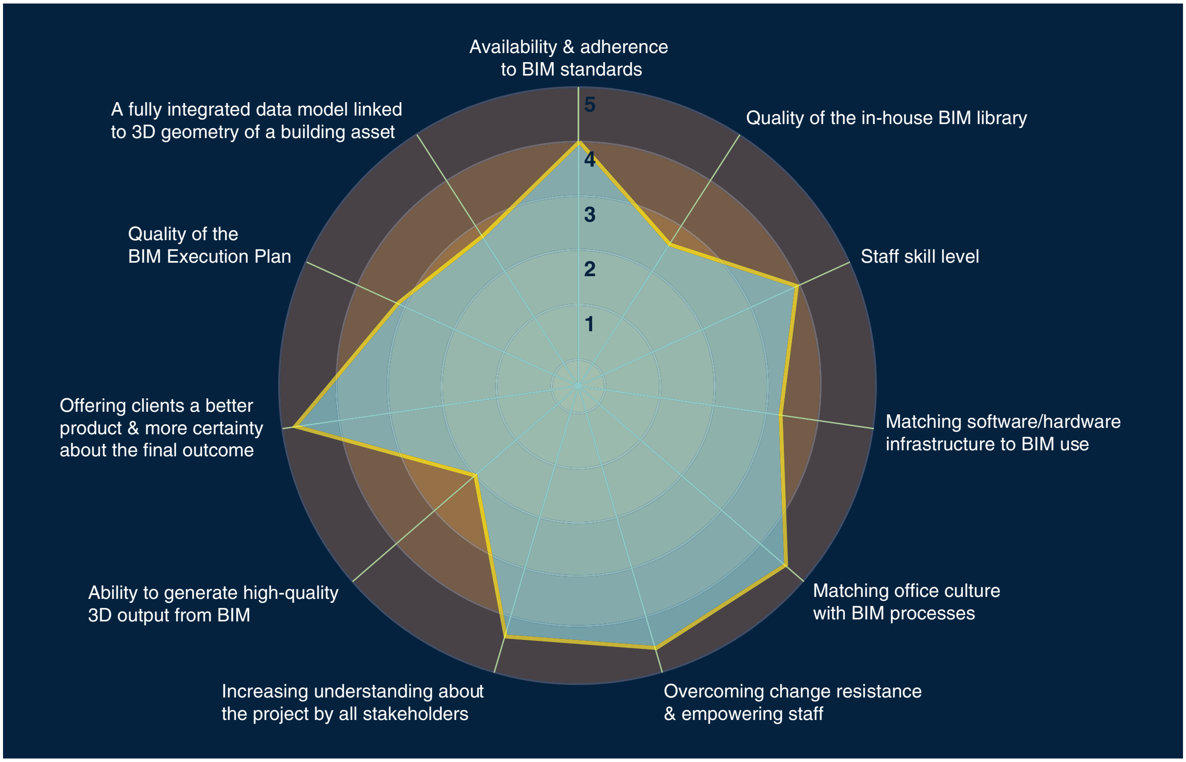

Figure 1–15 Responses from industry experts about the metrics applying to Best Practice BIM.
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Manager at Australia's largest architectural practice HASSELL, adds that an important prerequisite to facilitate such handover is the project team's ability to first: *articulate the "value" to various stakeholders, whether that is for the client, consultant, builder, owner, FM expert, or others*. Based on a number of pilot studies undertaken in the United Kingdom, Mark Bew (Chairman of Building Smart (UK) and Chairman of the UK Government BIM Group) sums up key benchmarks for Best Practice BIM as: *dramatic fiscal and quality improvements*. This promise of BIM aims directly to keep projects on time and on budget. How do teams achieve cost savings while increasing output quality?

Expert BIM Managers agree that the quality of documentation and the smooth delivery of projects in collaboration is a crucial driving factor behind BIM. Improvements in that area can be measured via the reduction of coordination issues and Requests for Information (RFI)s or Change Order Requests. Further benchmarks are inherent to a reduction of waste by avoiding single-use model generation by sharing coordinated models that add value to multiple stakeholders' activities. Casey Rutland from Arup Associates in London points out factors that allow for such coordinated and targeted BIM work to unfold: *Contractual and project management documents agreed and used through appointment*. The adherence to well-configured BIM guidelines such as an Employer Information Requirement document of a BIM Execution Plan represents another benchmark for

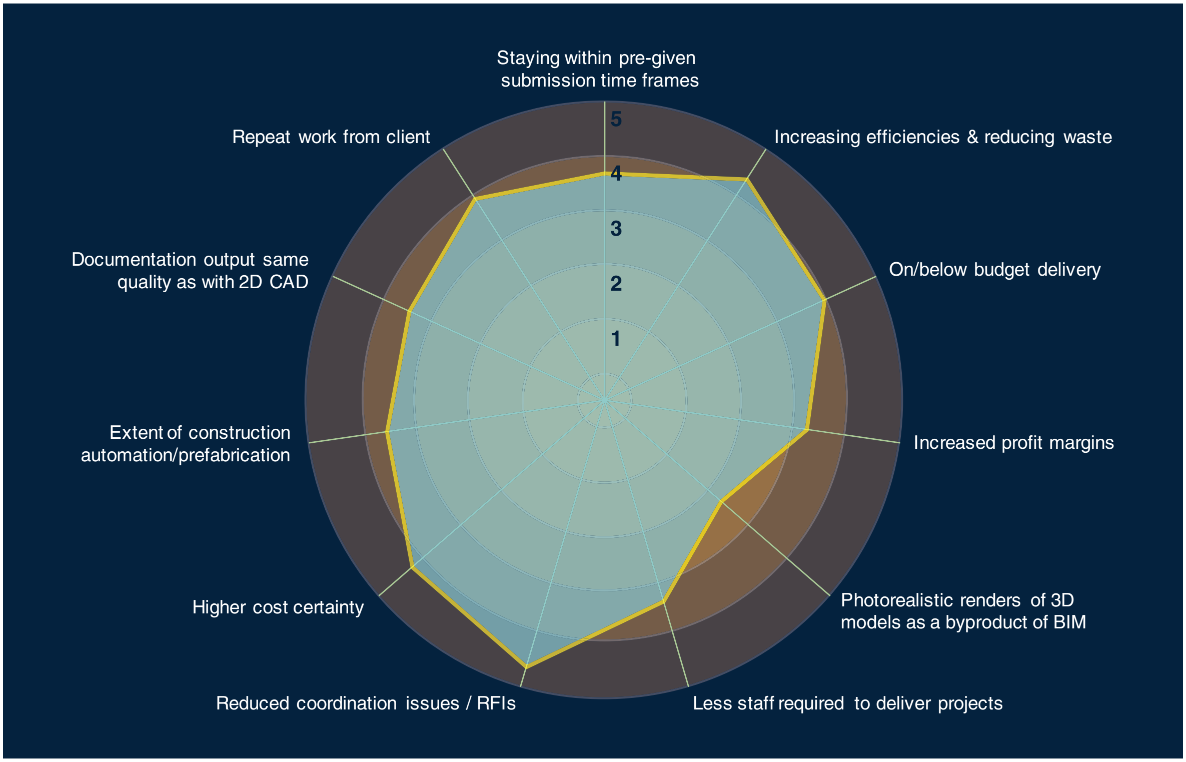

Figure 1–16 Responses from industry experts about the benchmarks applying to Best Practice BIM.

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Best Practice BIM. Hand in hand with the reduction of waste comes higher cost certainty and a reduction of risk. Adam Shearer, BIM expert at YTL in Kuala Lumpur (Malaysia), touches on the risk issue by stating: *Best Practice BIM is about using innovative technologies to predetermine and lower risk to the benefit of the stakeholders and the client*.

Other metrics for Best Practice BIM relate to inner-organizational benchmarks, namely the cultural context within a firm. Overcoming change resistance and empowering staff is seen by experienced BIM Managers as the primary goal within their organization. This revelation points toward a crucial cultural aspect related to BIM: The high importance of Change Management in association with implementing BIM. Despite much attention given to the technical aspect of implementing BIM within and across organization(s), the cultural side tends to be neglected. Such is the relevance of Change Management, that part of this publication is dedicated entirely to the topic. Staff empowerment is a crucial factor of a well-considered Change Management strategy. BIM Managers are specialists and one of their key tasks is to convey and share a portion of their knowledge to others in order to empower them to fulfill their tasks better. How can one measure such knowledge transfer? How does a BIM Manager ensure the empowerment of others with the work he or she does? At times empowerment occurs as part of day-to-day mentoring provided by BIM Managers to others, at other times it is reflected—less directly—in the quality of "back of house" documents such as BIM standards, BIM Execution Plans, and more. Expert BIM Managers assign high priority to the availability of high-quality BIM standards. They are the ones accountable for establishing such standards and they need to ensure that staff adheres to them across an organization.

The diversity of issues listed here reflects the complexity BIM Managers are faced with. On one hand, they are tasked with helping achieve lifecycle goals on a project even though these may stand in conflict with the understanding by upper management of what's best for their organization. On the other hand, they need to have a great understanding of design and construction processes in a highly interactive environment. In addition, they need to be fluent in the use of a range of software applications and understand how to combine their use efficiently. On top of all of this, they need to be great communicators with great people-management and communication skills.

Asked about the most relevant tasks for BIM Managers, exerts report the following:

Overseeing BIM–related process and workflow ranks first, with the facilitation of multidisciplinary coordination and the development of BIM Execution Plans coming second. The third most relevant task for BIM Managers is the link between office/project leadership and BIM authoring tasks. It is essential for BIM Managers to determine standards for information and knowledge management and they need to be strongly involved in assisting their organization in making the right choices when employing new staff.

It is crucial for BIM Managers to grow a culture of support, instead of attempting to provide all the support themselves. When asked about this issue, expert BIM Managers ranked the "provision of assistance on the floor" lowest out of all possible answers. Within an environment that is mainly focused on design exploration and delivery, technology-related aspects often become secondary to some, in particular if all they want is immediate support without considering adding to their knowledge. BIM Managers easily get caught in this conundrum; their role is mistaken for project support which is not the same as managing BIM. Despite any expectation by

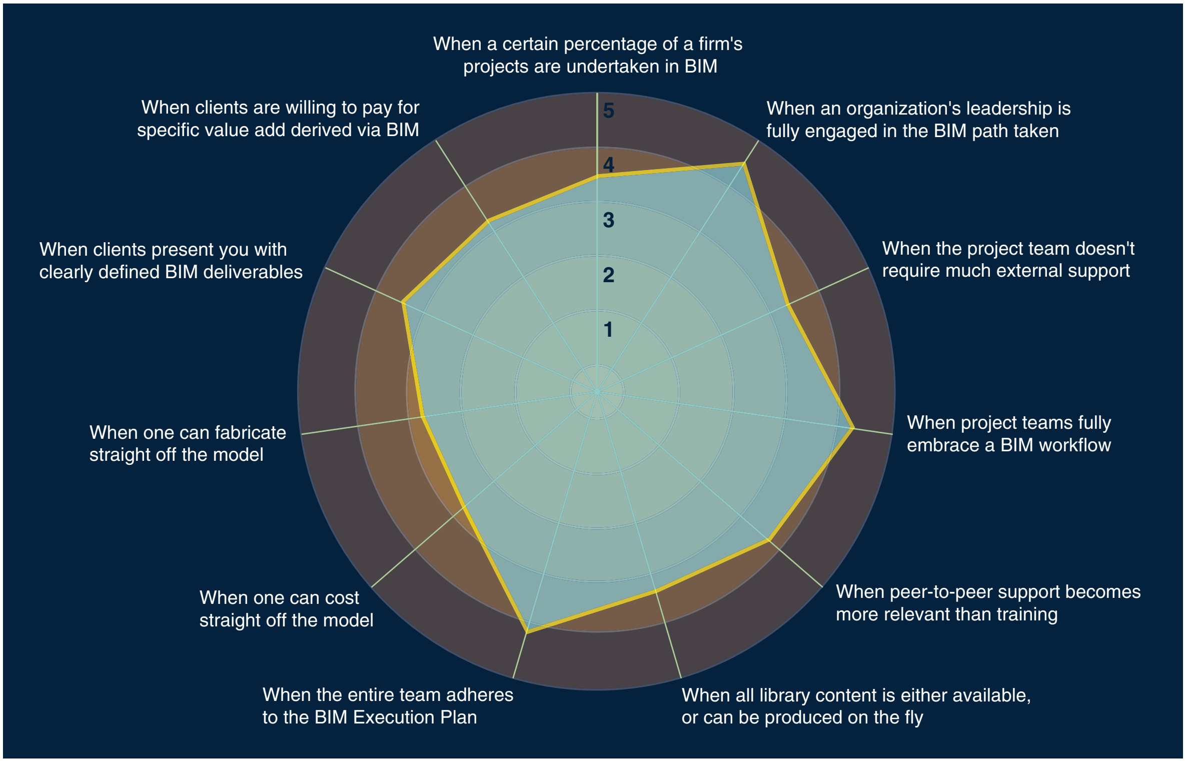

Figure 1–17 Responses from industry experts about the tipping point for achieving Best Practice BIM.

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others and/or eagerness by BIM Managers themselves to "help out," it is the BIM Manager who clearly has to establish and communicate his or her role beyond project support. Empowerment doesn't occur and efficiencies are not gained if BIM Managers keep their knowledge to themselves and get drawn too deeply into project work. This is a problem faced throughout the industry. To a degree it stems from miscommunication between BIM Managers and an organization's leadership. The need to engage an organization's leadership about BIM is clearly expressed by experts who highlight what they perceive as the tipping point for Best Practice BIM.

Key Performance Indicators

There exists a range of Key Performance Indicators (KPIs) for BIM Managers to consider. As much as BIM Managers can seldom measure client satisfaction, it sits within their reach to maximize the quality of their output while aiming for the highest possible efficiencies to get there.

When looking at KPIs for successful BIM, some see a proven track record of successful projects as the most relevant aspect. Once an organization has successfully delivered its first few projects using BIM, the BIM Manager

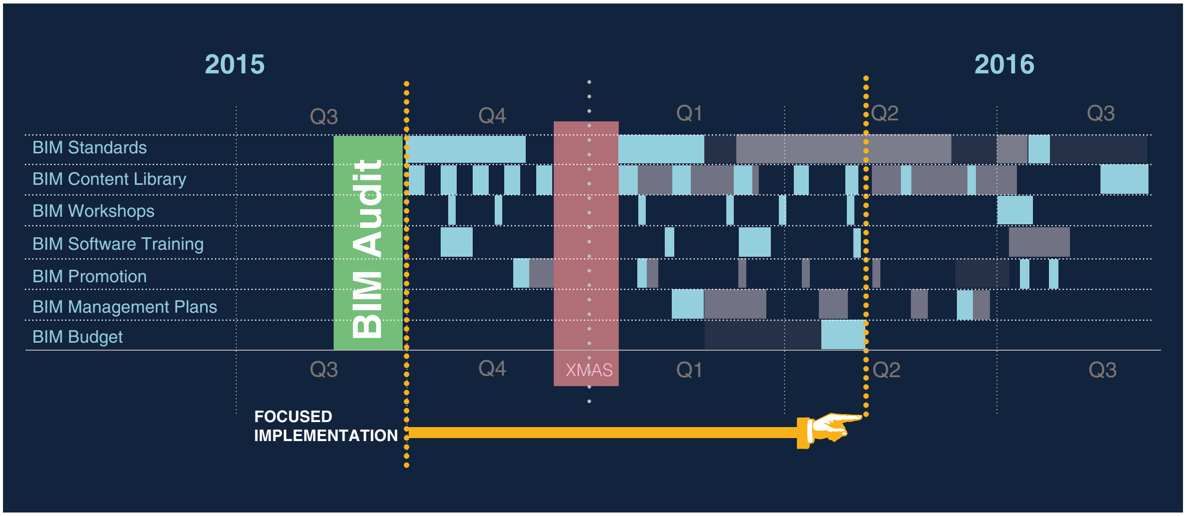

Figure 1–18 Mapping BIM KPIs against timelines for implementation.
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is in a far better position to demonstrate performance based on tangible outputs such as drawing sets, 3D renderings, and data output. Showcasing the finished product after a period of fine-tuning the quality of BIM drawing sets works a thousand times better than trying to explain that the use of BIM may not lead to a decrease of documentation standards.

Another BIM KPI is the interface between the model and the 2D documentation output (or 4D/5D scheduling and costing when considering BIM for contractors). The best practice approach therefore is to ensure that model authors adhere to a clear set of BIM standards, which in return correspond to a well-configured, standardized, and lean BIM object library. If set up correctly, the representation of model information as 2D documentation can then be automated to a large degree via the use of well-structured view templates or filters. Similar arguments can be brought forward for the interface of models with coordination and programming software as well as quantity takeoff. This holy trinity of documenting in BIM—standards, library, and view templates—can be expanded to serve lifecycle benefits. The 2D output becomes a byproduct of increased data integration from specification to documentation, construction, commissioning, and operation and maintenance (O&M). BIM Managers need to use in-house BIM standards as a starting point for producing BIM Execution Plans that help regulate the multidisciplinary collaboration process. The quality of the template documents that feed into those is another KPI that sits in the BIM Manager's corner.

Any BIM standard, or well-structured library or view template, is only as useful as the systems in place to ensure relevant stakeholders adhere to them and apply them correctly in their day-to-day work. BIM Managers need to go through a constant process of monitoring and Quality Assurance (QA). Therefore, a further KPI for them is the level of reporting with their collaborators such as Model Managers or BIM coordinators. Regular

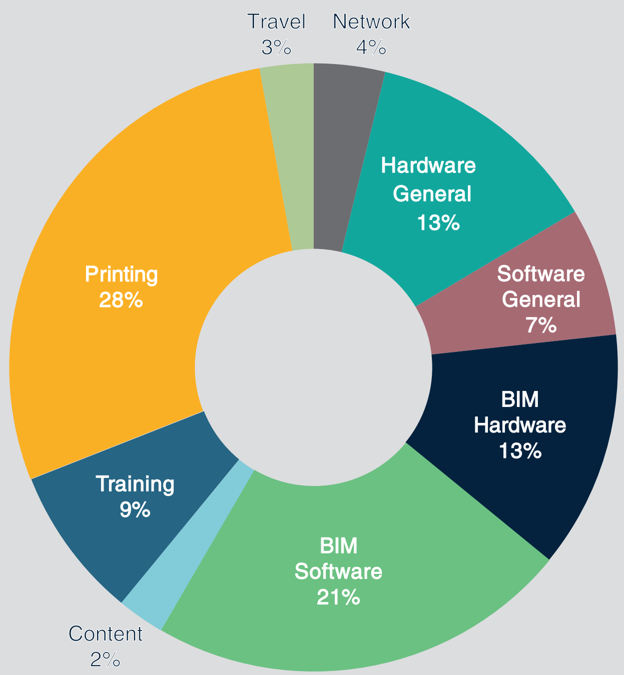

Figure 1–19 Establishing a Design Technology Budget with itemized listing of key cost factors.
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model audits are as crucial as weekly meetings with key BIM stakeholders. Based on these meetings, BIM library content needs to be reviewed continuously and BIM standards should undergo regular revisions.

In the context of BIM, skill development KPIs can be assigned to the level of a BIM Manager's involvement in recruitment, the availability and quality of a BIM induction process for new additions, and the strategy for advancing a colleague's BIM skills to the desired level. In addition, BIM Managers are also responsible for the promotion of an organization's BIM capabilities both inside and outside the firm. Regular newsletters and in-house presentations are important. The generation of BIM Capability Statements for tenders and other forms of promotion are a must. No organization can afford to neglect the public's perception of their BIM efforts. In some cases, BIM becomes a prerequisite for winning work in the first place.

A KPI that sometimes gets overlooked is the Design Technology Budget. Does it exist? Does it separate between capital and operational expenditure? How can it be set up so to become a useful decision-support instrument for upper management? By itemizing and grouping various cost-related expenses associated with Design Technology and IT, a BIM Manager can start to demystify an organization's budget related to BIM. The Design Technology Budget thereby becomes a crucial ally in order for BIM Managers to establish business cases, justify current expenses, and plan ahead strategically.

There is one major set of KPIs that have remained unmentioned so far. They all relate to a BIM Manager's ability to guide an organization through change. Part 2 of this publication is entirely dedicated to the topic of Change Management. The underlying social, psychological, economical, and organizational effects related to the introduction of highly disruptive technology such as BIM will be explained.

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