WHY IT'S TIME TO ADOPT BUILDING INFORMATION MODELING
Yet, it continues to face numerous historical challenges. Operations can lack efficiency and effectiveness. Deviations on time and/or budget, and significant risk contingencies in calculations seriously impact P&L and operating margins. Project financials and budget control need greater visibility. The complexity, singularity, degree of internationalization and size of projects needs to be better managed. And an increase in PPP (public private partnerships) and PFI (private funded initiatives), especially in the public sector, has added further to project complexity.

How has the industry responded?
Although some companies have not felt the need to move in this direction, the majority have done so. Over about the last ten years or so, E&C has adapted various PLM capabilities used by other industries (automotive, industrial equipment, aerospace) for designing and building new products. That includes processes, systems and solutions, as well as new methods and ways of working in the product development stream. The result is Building Information Modeling (BIM) – a lean framework that integrates technologies, processes and engineers to bring end-to-end efficiency to E&C operations.
Today, BIM is increasingly widespread. Especially as it becomes a mandatory part of public procurement in many countries. In 2016, the UK government introduced “BIM level 2” compliance regulations (4D and 5D Design) for construction companies that want to bid for public projects. More than half of the projects executed in the USA are using BIM. The French government plans to make BIM mandatory in public procurement in 2017. The German federal government announced the creation of a Digital Building Platform and has used BIM in major projects. And Norway, Finland, Denmark and the Netherlands have all implemented BIM strategies for public procurement. BIM is thus quickly becoming a ‘must have’ capability.

With its technological constraints a thing of the past, BIM is both enabled by, and an enabler of, the latest digital technologies. E&C companies can use it as a framework to create digital mock-ups and simulations prior to construction (encompassing structural considerations, HVAC, energy consumption, illumination, services and facilities). They can use it in conjunction with the Industrial Internet of Things and mobility at worksites to assess progress, control procurement and inventory, and manage subcontractors. They can add drones to capture measurements or spot equipment failures and wearables and augmented reality devices to raise worker productivity. They can also coordinate off-site prefabrication, sequencing and 3D printing to leverage new levels of efficiency. Or link up engineers for remote collaboration in real time. BIM is thus one way of driving a digital transformation.

UK CASE

“The Government will require fully collaborative 3D BIM as a minimum by 2016”
Government Construction Strategy 2011

BIM UTILIZATION IN PROJECTS
Source: UK BIM Utilization Survey 2013

No complex management, 2D and poor information exchange.
2D design and potential 3D (not required) integrated with a PDM System (Product Data Management).
3D design integration with planning, project management and cost management.
Full lifecycle integration considering Maintenance and Operations (M&O). Focused on asset management.

LEVEL 0 LEVEL 1 LEVEL 2 LEVEL 3

BIM should not be seen a solution on its own. Rather, it’s a set of processes, tools, technologies and ways of working. It operates throughout a project lifecycle to drive leaner, more integrated operations. And it offers a more structured use of data to increase accuracy, reliability, reusability and speed.

Various levels of maturity exist in the BIM methodology, reflecting different levels of integration in asset lifecycles: from product design to key streams like project execution operations, asset operation and maintenance, and energy consumption control. (See BIM Design Potential Maturity Levels, Page 6).

**FIGURE 2: BIM ASPIRATION: DIFFERENT LEVELS AND JOURNEY**

<table>
<thead>
<tr>
<th>2D/3D</th>
<th>COLLABORATIVE 3D</th>
<th>4D AND 5D BIM</th>
<th>OPEN BIM</th>
<th>6D AND 7D BIM</th>
<th>8D ...</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 3D models only used for concept work</td>
<td>• All stakeholders use 3D as the master for construction</td>
<td>• Use of advanced simulation capabilities for construction planning (4D) and costing (5D)</td>
<td>• Full collaboration of all stakeholders sharing the same model</td>
<td>• Facility Management: Full control of construction lifecycle including Operation and Maintenance (as-built evolution)</td>
<td>• Accident Prevention</td>
</tr>
<tr>
<td>• 2D models used as the master for construction</td>
<td>• No single and shared mockup</td>
<td>• UK’s public sector standard for 2016</td>
<td>• UK’s public sector standard for 2019</td>
<td>• Sustainability</td>
<td>• Decommissioning</td>
</tr>
<tr>
<td>• No collaboration among stakeholders</td>
<td>• UK’s public sector standard for 2016</td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>

Level at which most organizations operate nowadays
The BIM methodology drives agility, predictability, integration and industrialization along the constructive asset lifecycle. It enables a business to keep control of increasingly complex construction projects, by better integrating activities at each phase. It increases the accuracy of estimates, designs and calculations. It also enables new ways of working and new forms of collaboration. It uses dynamic software for 3D and real-time modeling – increasing efficiency during design and execution. It allows the concurrent design of different elements within a build (whether structural, mechanical, or electrical). It offers libraries to increase the reusability of design parameters and bring agility to ideation, design and modeling. It also provides integrated information management and automated documentation.

**CASE STUDY**

**POTENTIAL VALUE REALIZATION THROUGH BIM**

**COSTS**

10–20% COSTS

**REVENUES**

80% TENDERING TIME

±3% BIDDING ACCURACY

**RISKS**

40% TIME SLIPPAGE

Sources: British Government, UK Engineering Association, Stratford University

**THE RESULT?**

Significant advantages for companies that adopt BIM:

- Increased delivery quality and fewer modifications; increased accuracy in design and modeling; better project planning and simulation.
- Lower costs and shorter lead times – a 20 percent cut in conceptual design time; 30 percent in architectural design; 50 percent in tender design; and 35 percent in construction.
- Regulatory compliance, especially on public sector projects.
- A culture of continuous improvement driven by increased collaboration.

On average, workers spend 45 minutes each day searching for and using engineering information – a potential saving of US$2.2 million every year.

- Improved operational margins for the project overall.

**FIGURE 3: BIM DESIGN POTENTIAL MATURITY LEVELS**

<table>
<thead>
<tr>
<th>3D DESIGN</th>
<th>4D DESIGN</th>
<th>5D DESIGN</th>
<th>6D DESIGN</th>
<th>7D DESIGN</th>
<th>8D DESIGN</th>
<th>9D DESIGN</th>
<th>10D DESIGN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product/asset design/modeling. Information model includes project geometry, space relationships, geographic information, isometrics, calculations, as well as quantities and properties of project components.</td>
<td>3D Design + Integration of project planning and activities breakdown schedule information.</td>
<td>4D Design + Project plan/budget breakdown and revenue and integrated cost recognition control activities. Engineers can track and trace deviations end-to-end in the lifecycle.</td>
<td>5D Design + Integration with asset/product operation and maintenance, real estate and asset space and facilities management activities.</td>
<td>6D Design + Integration with environment and sustainability (the asset’s energy consumption).</td>
<td>7D Design + Integration with onsite health and safety (zero accidents) and asset decommissioning activities.</td>
<td>8D Design + Integration with constructive asset lean management, including better integration with resources management – materials, direct labor and subcontractors, and equipment/tools management.</td>
<td>9D Design + Integration with security, emergency and disaster management.</td>
</tr>
</tbody>
</table>
Companies have a variety of choices for BIM software solutions. The right ecosystem architecture for each business will depend on two key factors:

01. **The existing company technologies** and their understanding of 2D/3D CAD and project management solutions.

02. **The business model**, the types of contract they bid for (EPC turnkey projects as primary contractor, construction projects, operations and maintenance, concessions) and the types of asset built (such as residential, civil works, industrial and power plants).
SO, WHAT ARE THE OPTIONS?

FOR A BIM ARCHITECTURE, COMPANIES NEED TO CONSIDER THE FOLLOWING:

2D/3D Design, parametric and calculation, and drawing tools (CAD).
3D representation as a key to support engineering & architecture component for decision-making during the entire project lifecycle. It is equipped with a database with all technical characteristics of the components (structural, mechanical, electrical, supplies, etc.).

Integrated BIM/PLM solutions for 2D/3D and 4D/5D project schedule and costing engine/tool.
Look for solutions that can integrate the 2D/3D design of the asset with 4D (project management) and 5D (project budgeting and revenue and cost control). Seek market-leading PLM solutions that are equipped to support related processes. Also consider niche solutions specializing in BIM for specific assets, such as refineries, power plants and civil works that include CAx in the design work stream.

High Velocity ERP.
Leading ERP solution providers incorporate state-of-the-art in-memory database technologies. Some also incorporate specific functionalities for managing project planning, work and cost breakdown structures, sales and contracts, and sourcing and procurement. Also consider market-leading project management tools that can be easily integrated with ERP and BIM solutions.

Document management.
Ensure integrated and consistent project documentation – contracts, purchase orders, CAD 2D/3D drawings, GIS maps, etc – by storing them in the BIM/PLM solution. Or look for specific documentation solutions from market-leading providers.
The key question: where to begin a BIM journey? For most businesses, the wisest choice will be to start with a “5D Design” level of maturity. That will integrate construction asset design with commercial and operations planning, budgeting and production or progress control, and will form a cornerstone to support operational and financial excellence throughout a project lifecycle. It also represents a solid foundation for targeting higher levels of maturity as the needs of each organization dictate.

The BIM roadmap will be different from company to company. Each will require different building blocks – operating models, technologies, process definition and integration, cultural change management – to set up BIM capabilities. Which of these are necessary in each case will depend on three factors:

01 The maturity level of BIM adoption (technology and solutions adoption; an operating model that can support BIM capabilities; the ability to drive a cultural change)

02 Alignment with business strategy (growth and revenue targets; target country market and asset strategy)

03 Market penetration targets from country to country
A cascaded approach, in which maturity levels are scaled up incrementally for the asset types with the most pressing needs for integrated design and execution, is highly recommended. But bear in mind that BIM and ERP solutions must be tightly integrated to ensure the consistency and integrity of asset and project data necessary for effective change control and risk mitigation.

FIGURE 4: BIM MODEL ADOPTION ROADMAP

* BIM degree of maturity can be extended to the different Business Divisions/Constructive type of assets (e.g. Residential, Civil Works, Oil & Gas, Nuclear, etc.) and Countries; depending on technical and legal/regulatory requirements.
A NEW PARADIGM

BIM is changing the way projects are ideated, planned, budgeted and delivered. It’s both a framework and a methodology for bringing leading PLM practices into the E&C industry. It’s improving efficiency and effectiveness in the end-to-end project lifecycle. It’s increasing accuracy, lean integration and control in calculations, estimates, budgeting and delivery operations. And it’s enabling new levels of efficiency through the reuse of work from similar projects. Most importantly, it’s becoming an essential component of every E&C business as more and more governments around the world make BIM a mandatory part of public procurement. That’s the BIM imperative. Now that the available digital technologies and solutions are mature enough to build solid and integrated BIM architectures for E&C industry companies, **DOING NOTHING IS NOT AN OPTION.**
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