BIM for FM/BIMF

Change on the Horizon

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May 2011

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BIM for FM, and the adoption of an associated Building Information Management Framework – BIMF, will drive productivity gains within the Architectural, Engineering, and Construction (AEC) sector.

The adoption of robust business processes as well as systems integration of industry knowledge domains will be facilitated by information technology. 3D/4D/5D Building Information Modeling (BIM), more collaborative Project Delivery Methods such as Integrated Project Delivery (IPD), and Job Order Contracting (JOC), and several other core competencies will converge to provide an actionable framework for professional collaboration, and increased productivity from capital planning through construction and downstream operations and maintenance.

The success of these processes and technology tools is totally dependent upon transformational changes regarding the ways in which AEC professionals deliver their products and services.

The Drivers for Change

An altered economic and environmental landscape puts significant focus on all aspects of the built environment from planning, design, construction, operations, repair, renewal, and adaptation to maintenance, sustainability, and disposal. Buildings are a major influencer upon the environment, and at the epicenter of a growing worldwide crisis. Approximately forty percent (40%) of the world's raw materials and energy are consumed by buildings.

Within the United States, buildings consume approximately seventy-five (75%) of the electricity and nearly fifty percent (50%) of the total U.S. energy output. At the same time, buildings contribute forty percent (40%) of the carbon emissions into the atmosphere and generate twenty percent (20%) of material waste to landfills. [1]

Local and national economies are intertwined with buildings and infrastructure. On the local level, the financial stability of private and public organizations can be directly impacted by the quality of construction and facility management practices. Capital investments are required for new buildings and ongoing operational and reinvestment cost components are even greater, representing approximately eighty percent (80%) of a buildings total cost over its life. In many cases the annual expenditures required to operate and maintain the physical plant are second only to salary/benefit costs. Across multiple sectors: education, heath care, defense, research, manufacturing, transportation, and utilities, service quality is directly linked to the facilities in which they are housed.

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On a global scale, the stability of economy and environment can be linked to buildings and physical infrastructure (bridges, roadways, and utilities for example) in terms of competition for limited capital resources in a time of tumultuous economic change.

Historically, the United States AEC sector has been notoriously unproductive primarily as a result of the curriculum training and practices of architects and engineers which oftentimes lacked a quantitative cost engineering perspective. A recent change is that building owners are insisting on improved business process integration and collaboration and the use of IPD (Integrated Project Delivery) and JOC (Job Order Contracting) as well as collaborative software tools. These initiatives offer "transparency and collaboration for productivity" which until now has proved elusive to stakeholders.

The implementation and consistent use of standardized information, robust business processes, and easily deployable technologies greatly improves AEC sector practices and performance metrics from initial concept through construction, operation, repair, renewal, and deconstruction/replacement.

4D/5D BIM (Building Information Modeling) integrated with more efficient Construction Delivery Methods such as IPD and JOC, and other complementary facility management processes/technologies are underway to restructure the AEC industry.

Economic Impacts of An Unproductive AEC Sector

As shown in Figure-1, the AEC sector in the United States has historically been singularly unproductive. Construction productivity has decreased over the past forty (40) years, while productivity in virtually all other non-farming sector industries has increased significantly [2]. Also, thirty percent (30%) or more of construction projects don't meet budget or schedule [3].

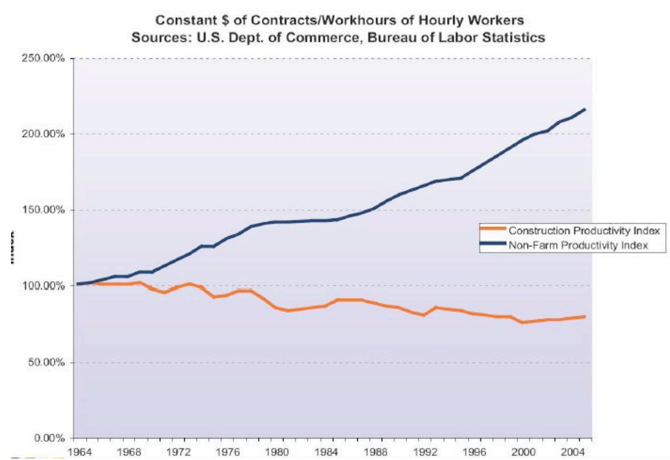

Figure 1 – Construction Productivity

Reengineering practices commonplace in other industries have been slow or nonexistent in the AEC sector. A government study estimated the financial loses attributed to the lack of interoperability between facility design, engineering and associated facility management technology exceeds $15B annually in the United States [4]. Building owners and operators paid the bulk of these excess costs which included cost overruns spanning initial design, construction, and ongoing facility operations and [i]management. While $15B is a considerable sum, it is dwarfed by the estimated ten-to-forty percent (10-40%) of non-value added labor and material waste associated with the approximate one trillion dollar U.S. construction industry [5].

With technology, the centralization and communication of information for architects, engineers, contractors, and owners combined with the implementation of robust business practices will enable the AEC industry to significantly improve productivity [6].

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The current and potential impacts upon global climate, change as well as associated political issues, represent a clear and present danger to which the construction industry is a contributor, and to which its stakeholders can and must respond.

A Framework for Change

The AEC's sector transformation from disparate management practices and scattered silos of information will be greatly aided by the adoption of 3D/4D/5D object-oriented BIM software, common interoperability standards, integrated construction delivery business processes such as IPD and JOC, supporting technologies, and the growing awareness of life-cycle and total cost of ownership practices.

Many currently view BIM as a 3-dimensional representation of the built environment, primarily for use during the design and construction phases. This narrow focus is inconsistent with the definition of BIM which is "*Building Information Modeling is the process of generating and managing information about a building during its entire life cycle."* The National Institute of Building Sciences (NIBS) notes the following about BIM. "The scope of Building Information Modeling (BIM) directly or indirectly affects all stakeholders supporting the capital facilities industry. BIM is a fundamentally different way of creating, using, and sharing building lifecycle data." BIM is a digital software system and an open standards-based collaborative business process targeting life-cycle facility management. It includes: 3D (visualization); 4D (time-scheduling/life-cycle analysis); and 5D (cost-estimating/capital planning), which serve as a common, centralized repository/portal for all life-cycle building related information, from concept thru deconstruction.

The combination of standardized information and facilities management processes enables facility life-cycle and total cost of ownership management. BIM's expansion to incorporate all facility life-cycle phases necessitates standardized business process, taxonomies, and data architectures. Interoperability and standardized content at all levels of granularity from building models to systems, subsystems, components, and individual units are required.

Exemplary efforts in this area include COBIE, IFC, and Ominclass. COBIE (Construction Operation Building Information Exchange), Industry Foundation Classes (IFC), OmniClass™ Construction Classification System (OmniClass or OCCS) are data models, definition, rules, and/or protocols intended to define data sets and information pertaining to capital facilities throughout their lifecycles. COBIE, for example, is a specification for capturing design and construction information for facility managers and operators in a digital format. The standardized data architecture was developed to replace the current *ad hoc* process of leaving disparate piles of paper documents and digital files behind after a construction project is completed. All of these standards promote the exchange/sharing of accurate and reusable building information.

Figure 2 - Building Information Management Framework (BIMF) illustrates the roles and integration of several of the complementary knowledge domains, processes and technologies that are components of a 4D/5D BIM strategy. These components include: master planning, capital planning and management systems (CPMS), design, cost estimating, procurement, construction delivery methods (IPD, JOC), construction, construction management, operations, maintenance, repairs, computerized maintenance management systems (CMMS), space planning and utilization (CAFM-computer-aid facility management), and deconstruction.

BUILDING INFORMATION MANAGEMENT FRAMEWORK – BIMF

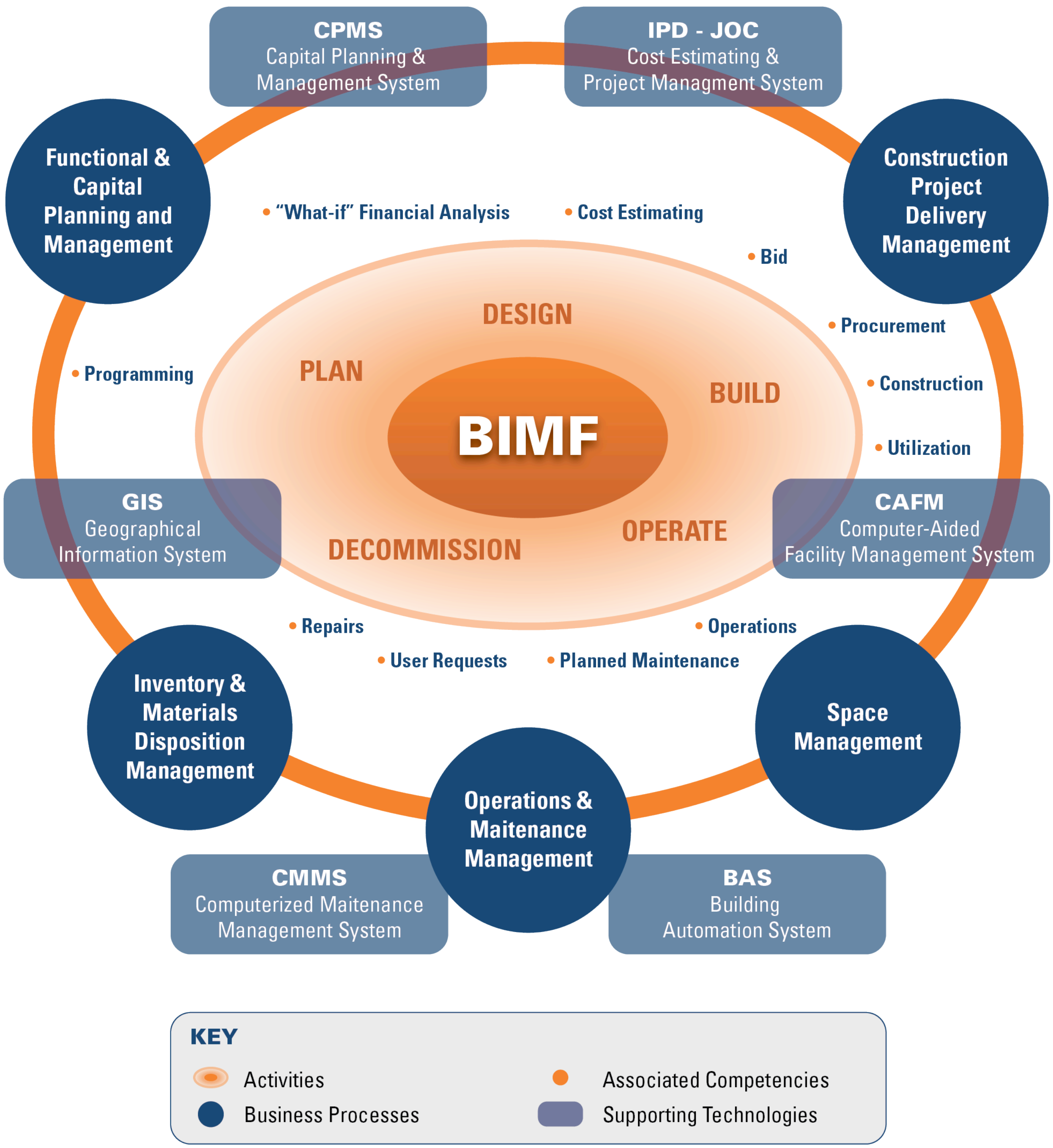

Figure 2 – BIMF - Building Information Management Framework

Collaboration among a wide range of constituencies and shareholders of the built environment it enhanced by the integrated approach. Various parties involved include: architects, engineers, contactors, construction managers, cost estimators, project managers, real property managers, appraisers, brokers, mortgage bankers, facility assessors, facility managers, maintenance and operations staff, safety and security professionals, owners and C-level executives, middle managers, oversight regulators and advocate organizations, and the general community.

Specialized skills and software tools complement, communicate with, and are components of 3D/4D/5D BIM enabling virtual "real-time" facilities management. The goal is to integrate domain specific competencies, information, and technologies necessary for any organization to gain requisite visualization into the life-cycle practices of the entire planned and built facility, at any time.

The level of expertise achieved in each competency or core area will determine how well a particular organization can effectively manage the entire capital planning platform and building portfolio.

Competency areas include:

- Cost Engineering and functional/department models
- Quantity take-off and cost estimating (materials, labor, time, and equipment)
- Architectural planning and design; systems integration across functions
- Product libraries from building product manufacturers
- Facilities management: occupancy/utilization, conditions, operations, maintenance, repair, and capital renewal
- Life-cycle cost data
- Information visualization and decision-support tools

Newly Emerging Effective Construction Delivery Methods - IPD & JOC

IPD (Integrated Project Delivery) and JOC (Job Order Contracting) offer philosophy and tools for improved performance. They also greatly improve the degree of collaboration and communication of a project(s).

The selection and management of a construction delivery method creates the environment for a project from its early conceptual development, thru procurement, construction, warranty period, and beyond. Research has demonstrated that the level of construction project integration has an impact upon productivity, quality, timeliness, and even the level of sustainability that can be achieved on capital projects [7].

Many traditional construction delivery methods are antagonistic by nature, pitting owners against contractors, and/or contractors against designer, etc. Furthermore, owners are very much aware of the problem, noting that problems encountered are due to the current status quo and "artifacts of a construction process fraught by lack of cooperation and poor information integration [8]."‖

Altering fundamental flaws and selecting collaborative project delivery methods that involve all construction project constituencies from the very beginning of any project offers a pathway to significant improvement.

IPD

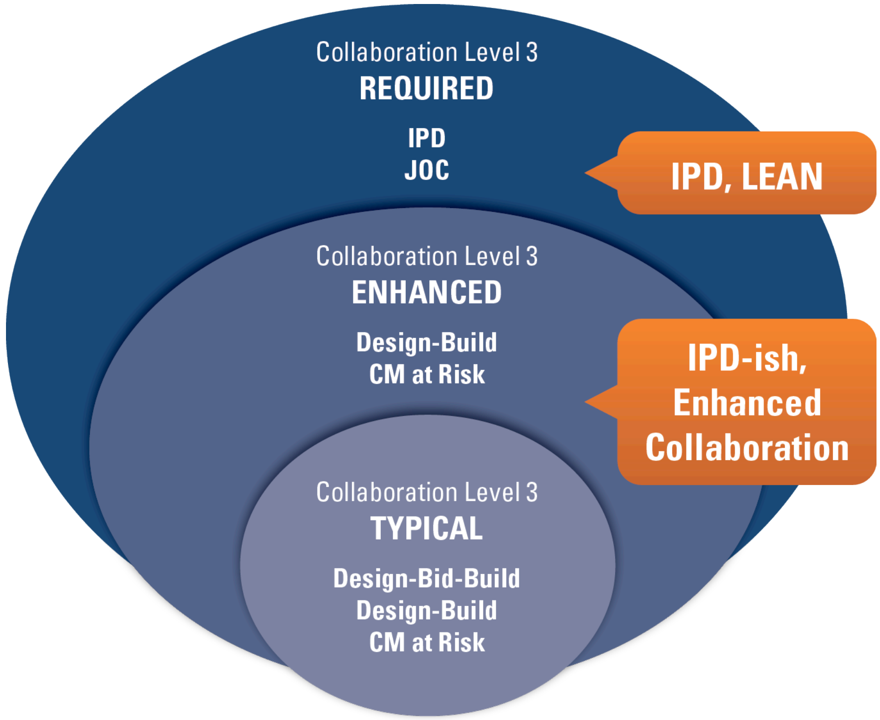

Figure 3 – Levels of Collaboration

Integrated Project Delivery has emerged as an accepted construction delivery method along with Design/Build, CM-at-Risk, and Job Order Contracting (JOC). JOC - a form of integrated project delivery - along with IPD were developed to improve construction delivery productivity and quality. IPD targets major new construction projects, while JOC provides a framework for facility renovation, repair, sustainability projects, as well as minor new construction. Both IPD and JOC are LEAN business processes. LEAN is the adoption of a culture of continuous improvement within an organization through collaboration and constant learning. Thus, LEAN, IPD, and JOC share the same goal: The removal of waste within a process and maximized value at each step of a process.

Initially developed and implemented in limited sectors ten to twenty plus years ago; awareness and broader acceptance of these LEAN practices has only recently begun. A paper titled “Integrated Project Delivery for Public and Private Owners”, was recently published (2010), the result of a joint effort by NASFA-National Association of State Facility Administrators, COAA-Construction Owners Association, APPA-Association of Higher Education Facilities Officers, AGC-Associated General Contractors of America, and AIA-American Institute of Architects. It describes the IPD delivery method as a collaborative alliance among project stakeholders - owners, designers, contractors and other participants - to optimize the project results. IPD pulls together the owner, contractor, designer, and others to achieve higher project results, which in turn increases the overall value to the owner, and everyone involved.

While any construction delivery method may work well dependent upon the parties involved, IPD provides a philosophical framework and structure to improve the odds of success. As illustrated in Figure 3, traditional delivery methods such as design-bid-build typically do not contractually structure or require collaboration. Others, such as design-build, have a limited degree of contractually and/or process required collaboration. IPD is a multi-party contract supporting collaboration among the owner, contractors and A/E. Deployed to its full extend, IPD, like BIM, represents several things: a business process/philosophy, a construction delivery method, and a supporting technology.

A “LEAN” oriented process, IPD, emphasizes collaboration and partnership. It encourages and integrates the design and construction expertise of contractors, engineers, and owners from the conceptual stage of a project life cycle thru project completion.   Risk allocation also significantly differs from traditional processes as overall risk is shared and thus mitigated.

Those involved with the construction sector would likely recognize and acknowledge the importance and benefit of subcontractor, contractor, and supplier input as early as possible, in concert with the owner and design team.   The result of this fundamental systems change shifts the overall approach to a process centric activity by integrating needs, domains, and schedules.

JOC

Job Order Contracting (JOC) and IPD share many of the same characteristics. JOC is IPD implementation for smaller scale construction projects. JOC specifically targets facility renovation, repair, and -minor new construction projects. Initially created approximately twenty-five (25) years ago, JOC, like Integrated Project Delivery, is based upon collaboration and requires early involvement of contractors, sub-contractors, owners, and the A/E’s. Joint Scope of Work (SOW) under a JOC program starts most projects, referred to as task orders. An example of a typical JOC workflow is shown in Figure 4.

Figure 4 – JOC Workflow

Risk is mitigated as SOW’s are jointly developed, discussed, agreed upon, and finalized. As a result, a JOC contract rarely experiences the legal claims/disputes or change orders frequently encountered with traditional construction delivery methods.

Longer-term contractor relationships, greatly sought after by all parties, are common with JOC programs averaging 3-to-5 years in duration.

BIFM, IPD, and JOC necessitate early involvement of a construction manager/contractor in collaboration with the facility owner and the designer. An outline of some commonly shared characteristics between these methods would also include the following:

- **Key Participants Bound Together as Equals** - Contractually defined relationships to establish collaboration and consensus-based decisions.
- **Early Involvement of Key Participants and Jointly Developed Scope of Work** - Participants meet to define scope of work early in the process.
- **Performance-based** - Shared financial risk and/or reward based on project outcome.
- **Transparency** - Maintaining an open environment increases trust and keeps contingency discussion controllable.
- **Common Data Formats and Software Technology** - Building Information Modeling and complementary JOC/IPD cost estimating and project management software integrate document management, visualization, and communications tools. Standards-based information may include COBIE, IFC, MasterFormat, UNIFORMAT, Omni Class, and industry defined metrics.
- **Lean Design and Construction –** Value-based decision making.
- **Co-location of Team –** Use of local resources whenever possible.

Figure-5 illustrated basic differences between traditional construction delivery methods and IPD/JOC.

TRADITIONAL PROJECT DELIVERY		INTEGRATED PROJECT DELIVERY
Fragmented, ad-hoc, hierarchical, controlled	**Project participants**	Team of project constituencies, open, collaborative
Linear, segregated, silo-oriented, limited information exchange	**Process**	Concurrent, project life-cycle oriented, shared information, collaborative
Individually managed	**Risk**	Collectively shared and managed
Cost-based, individually focused	**Compensation**	Performance and value based
Paper-based and/or digital 2D representations, spreadsheets, domain-centric software silos, email, FTP sites	**Technology**	Object oriented, centralized data repository linked with complementary knowledge-based systems, 2D, 3D, and 4D BIM, IPD/JOC software, shared model

Figure 5 – Traditional vs. Integrated Project Delivery

The Benefits of Integrating 3D/4D/5D BIM, IPD & JOC

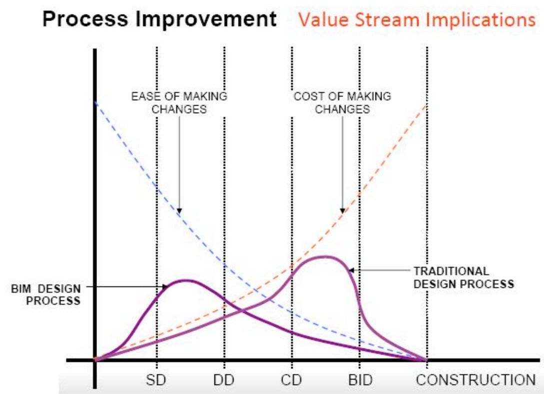

Figure 6– Value Stream Improvements

Most are aware that the earlier changes are defined in a project the least costly they are. Bringing IPD and JOC contractors together with owners and A/Es, at the planning stage, provides the highest level of common understanding of work requirements at the earliest possible time period. The ability to address requirements at the conceptual stage and maintain communications throughout the project lifecycle has significant positive impacts upon cost visibility and cost containment, as illustrated in Figure-6.

IPD and JOC bring valuable information into the process earlier, thus mitigating costly changes later in the construction cycle. The combination of BIM with IPD and JOC enables scalability and significantly increases project success rates. Overall project costs and timelines can be improved by ten percent (10%) to over twenty percent (20%+).

By nature, when IPD and JOC work in parallel with BIM, they enable the effective and transparent transfer of information among all construction project participants; this creates and builds trust and collaboration. For example, contractors provide input about the potential cost, constructability, and value engineering that aids the owners and design team to make more efficient and cost-effective decisions. In addition, the many challenges endemic to traditional construction delivery methods are virtually eliminated such as miscommunications, change orders, adversarial relationships, and legal battles.

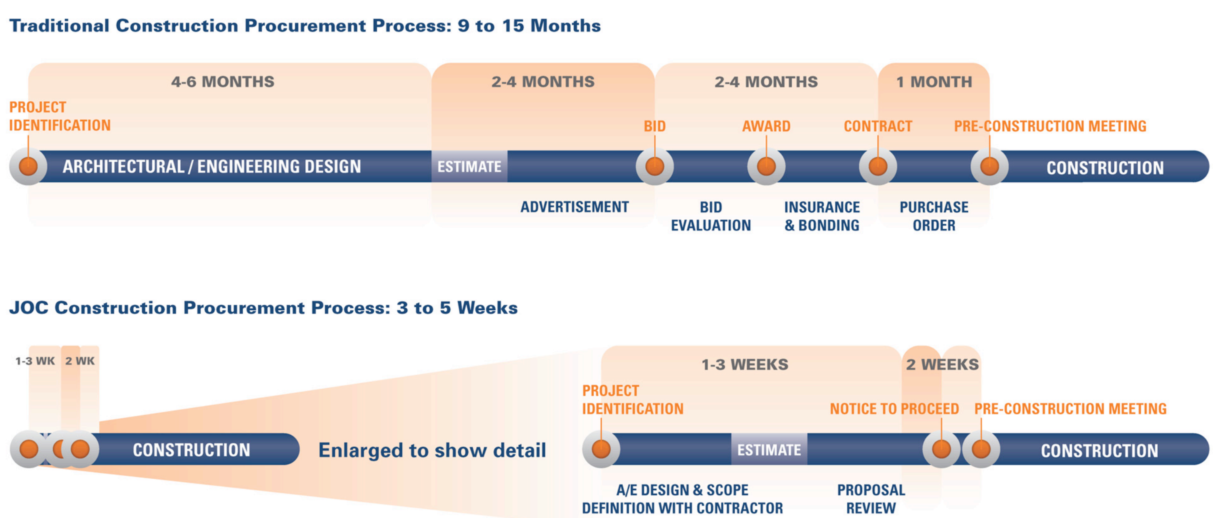

Figure 7– Project Timeline Improvements

Listed below are a few additional benefits with the integration of 3D/4D/5D BIM, IPD and JOC:

- Maintainable designs
- Better defined scopes of work
- Early cost certainty
- Fewer downstream re-designs/change-orders
- Long term relationships build upon trust and performance
- Use of local resources
- Predictable planning
- More accurate schedules
- Improved cost visibility and cost control
- Collaborative vs. territorial behaviors
- Reduced risk
- Fewer claims/dispute/lawsuits
- Higher productivity
- Reduced delivery costs
- Reduced operational costs
- Efficient sustainability project delivery
- Expectations better met by all including Owners, A/E's, Contractors, Sub-Contractors/Trades, Oversight Groups, and the Community

All phases of the construction project lifecycle are considered in an integrated approach. As an example, the use of standardized cost data architectures and unit prices are deployed to improve transparency. From a procurement perspective, collaborative approaches such as Qualifications Based Selection (QBS) and Best Value–Fee Proposal are well suited to collaboration, whereas, Low Bid runs contrary to BIM and integrated project delivery philosophy.

Conclusion

BIM for FM and a "Building Information Management Framework" - BIMF includes a laser sharp focus on integrated functional planning and cost metrics. The framework's value for stakeholders includes: a) transformational change effected by a capital planning philosophy that emphasizes integration of professional practice; b) delivery models that emphasize lean construction practices; and, c) transparent standardized construction and facility operations data and taxonomies that contain cost by providing access to building information whether stored or linked to a building model.

3D/4D/5D BIM, IPD, and JOC are powerful tools that drive project collaboration, quality, productivity, and a better return-on-investment. Electronic sharing of standardized "apples-to-apples" information and more formalized consistent business processes respective of all players involved will help to promote communication, transparency, and collaboration. Standardized model scheme, common data exchange and access protocols, model server technology, cloud technology, intelligent agent technologies, and user-friendly interfaces all work together to realize BIM implementation. Adaptation of the overarching "Building Information Management Framework" assures consistent use of business processes to assure accurate, timely information and better decision-making.

Sharing best practices leads to more effective facilities and infrastructure asset management. 4D/5D BIM, integrated with standardized construction delivery methods, such as IPD and JOC, as well as complementary processes/technologies such as CPMS, CAFM, CMMS, GIS (geographic information

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systems) and BAS (building automation systems), provide tools to capture, store, and share critical building information.

Challenges facing the AEC sector and the planning community at large require behaviors and practices foreign to the professional education of many practitioners. Greater emphasis must be placed upon the skills and tools required to quantify and manage operations of the built environment. In general capital planning must be recognized as being of strategic importance and an ongoing process, with continual reassessment and gap analysis applied. Comprehensive, long-term strategies to acquire, develop, and sustain the built environment and the professional competencies required for sustainment must be adequately defined within various professional curricula. For professionals, BIMF, 4D/5D BIM, IPD, and JOC offer a basis for capital planning and Scope of Work definition, which lead to more effective organization-wide planning and more efficient facility operations.

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