

## BIM & Lean Construction Management

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### Il BIM Execution Planning

Il Building Information Modelling (BIM), e i suoi affini nell'ambito infrastrutturale e paesaggistico (IIM e LIM), danno vita a metodologia assurda sempre più all'attenzione dei decisori politici nei piani strategici di Politica Industriale (ancora poco di quelli finanziari), sotto l'egida della Contrazione della Spesa Pubblica, della Risk Mitigation e della Lean Construction e dei mercati nel Settore delle Costruzioni, ma, per alcuni versi, presenta ancora non poche incognite.

La metodologia, peraltro, presenta livelli di maturità assai differenziati nei diversi Paesi.

Più in dettaglio, nei differenti Paesi non solo la situazione è molto differenziata, così come nelle committenze o nelle società, ma anche il potenziale di crescita appare diverso.

Gli stessi grandi gruppi imprenditoriali manifestano, come nel caso di Lend Lease, alcune perplessità, specialmente sulla capacità di esprimere le proprie richieste da parte delle committenze.

Altri grandi gruppi mettono in evidenza, inoltre, una necessità di sistematizzazione.

La ragione principale per cui questa metodologia, che nasce dall'evoluzione di una tecnologia che combina geometrie e semantiche, ha attualmente generato così tante aspettative è che essa evoca una serie di nozioni (Ciclo di Vita, Collaborazione, Coordinazione, Integrazione, Sistema, ecc.) che costituiscono una delle aspirazioni mai compiutamente realizzate in senso industriale del Settore (non solo nel senso della Digital Fabrication o della prototipazione rapida), tanto che vi sono in letteratura citazioni ormai cristallizzate, come il diagramma sulla produttività comparata dei Comparti Produttivi oppure il rapporto del NIST.

Sussiste, poi, un nesso diretto tra le organizzazioni che hanno adottato in maniera evoluta i sistemi di gestione aziendale e quelle che hanno implementato l'Information Modelling.

Ciò comporta il fatto che l'implementazione dell'Information Modelling richiede una maturità intrinseca che si ritrova, non a caso, in committenze come, ad esempio, Northwestern Medical Healthcare, BAA, Finnish Senate Properties, ByggSøk, Crossrail, Trafikverket, University of Manchester, in società di architettura e di ingegneria come, ad esempio, Arup, Atkins, Buro Happold, Drees & Sommer, HOK, Mott MacDonald, SOM, Thornton Tomasetti, WSP, in imprese di costruzioni come, ad esempio, Balfour Beatty, Barton Malow, Bouygues, CCC, DPR, Max Bögl, Costain, DPR, Hochtief, Laing O'Rourke, Lend Lease, Leighton, MACE, Mortenson, NCC, Royal BAM, Skanska, Suffolk, Turner Construction, Vinci, Ed. Züblin.

Non vi ha dubbio, però, che la dimensione progettuale dell'Information Modelling incontra due ordini principali di criticità che ne condizionano il significato in termini di gestione delle commesse. Il primo attiene alla difficoltà di impostare in maniera efficace la fase del Project Briefing e del Conceptual Design (decisiva in termini di valutazione della fattibilità dell'investimento) il secondo concerne la coesistenza di punti di vista specialistici e irriducibili nella generazione del modello informativo.

Ciò appare fondamentale poiché costituisce un serio ostacolo alla concezione unitaria dell'opera secondo un approccio olistico: i conflitti spaziali che emergono dal Model Checking e la scarsa comunicazione tra ambienti di calcolo e ambienti di modellazione ne testimoniano la centralità.

In altri termini, nell'Information Modelling è insita una aspirazione olistica che non può risolversi semplicemente con una nozione di interoperabilità ristretta allo scambio di informazioni tra gli applicativi nell'ecosistema digitale, ma deve essere gestito attraverso una revisione dei processi e delle logiche che ne prevedono una notevole opacità.

Uno degli argomenti decisivi nella diffusione e nell'affermazione del Building Information Modelling & Management risiede, invero, nella integrazione del BIM Execution and Implementation Planning all'interno del Project Execution Planning.

L'impressione, infatti, è che il metodo stenti a essere considerato tale, a prescindere dagli strumenti, e che, comunque, la Rappresentazione bidimensionale e tridimensionale (parametrica o meno) prevalga sull'Informazione e tanto più sulla Conoscenza e sulla Gestione, come, appunto, si evidenzia da una accurata analisi comparata di molti BIM Execution and Implementation Plan predisposti negli Stati Uniti e in Australia.

In un certo senso, considerando la storia del Building Information Modelling, si ha la sensazione che l'origine geometrico dimensionale delle tecnologie permanga prevalente, anche laddove essa sia machine readable e che, comunque, spesso la geometria resti l'oggetto di attenzione principale. Paradossalmente, le difficoltà incontrate nell'interoperabilità, con IFC e NBIMS, fanno sì che la centralità dell'Information vada a discapito del Management.

Lo stesso Electronic Document Management System (EDMS), ancor più se in Cloud, assume sia una valenza strumentale sia una valenza gestionale, come in alcune piattaforme avanzate di Aconex, Asite, Bluebeam, Conject, 4Projects.

Si tratta, perciò, per le strutture di committenza, per le strutture di progettazione e per i contraenti generali di concepire il ricorso all'Information Modelling sia nella fase di progettazione sia in quella di esecuzione e di gestione (BIM e Field BIM) in maniera coerente, partendo proprio dalla gestione dei dati alfanumerici.

Esistono, in effetti, specialmente nell'edilizia ospedaliera alcuni casi in questo senso in cui il processo, dal Project Briefing al Facilities Management appare quasi compiuto: il Lurie Children's Hospital a Chicago (Mortenson), il Northwestern Medical Center e altri interventi del Northwestern, sempre a Chicago (NMH e Pepper Construction), il Royal Adelaide Hospital ad Adelaide (Leighton in JV con Hansen Yuncken), il Nya Karolinska Hospital a Solna (NKS e Skanska).

In questi casi, infatti, la fase istruttoria alla modellazione informativa per la progettazione è stata direttamente mirata alle fasi successive della Construction e delle Operations & Management, in modo che il BIM Execution Planning, tipicamente indirizzato al Design Team, fosse accompagnato da BIM Co-location e da BIM Orientation presso i Fornitori e i Subappaltatori, come messo in evidenza per altri interventi ospedalieri anche da Jacobs e da Turner Construction, oltre che da Mortenson e Suffolk.

È particolarmente interessante analizzare le configurazioni degli obiettivi delle strutture di committenza nell'Information Modelling.

Ciò poiché la struttura di committenza (e, in teoria, i suoi finanziatori, specie nelle operazioni di PPP), di fatto, stabilisce i riferimenti contrattuali (nel Regno Unito e negli Stati Uniti, rispettivamente con JCTo NEC3 e con AIA o ConsensusDOC), le funzioni, le responsabilità, facendo, da una parte, evolvere ruoli come quello dell'Information Manager e professionalità come quelle del BIM Coordinator, del BIM Manager e affini.

Si ritrova, perciò, una profonda differenza tra quelle entità che hanno definito BIM Requirements e Guidelines e le altre che si limitano a richiedere l'implementazione del Building Information Modelling.

Da questo punto di vista resta Crossrail un esempio paradigmatico sul nesso tra BIM e GIS.

Occorre, però, avanzare alcune questioni preliminari:

- 1) occorre, anzitutto, considerare quali siano gli attori nel processo edilizio che possano trarre i maggiori benefici nel Ciclo di Vita del Progetto e quali abbiano i maggiori oneri. E' probabile che coloro che traggano i maggiori vantaggi siano i committenti (inclusi gli sviluppatori immobiliari) e le imprese di costruzioni (nonché le società di Facility Management) allorché, invece, gli studi di progettazione assumono un ruolo determinante;
- 2) il BIM Execution Plan (BEP) nasce quale documento che riguarda l'Information Exchange Management e, per questa ragione, appare circoscritto ad aspetti che solo parzialmente ineriscono al Project Management. Beninteso, nel BEP si ritrovano alcune questioni decisive in materia di Design o di Construction, come per la definizione dei livelli evolutivi (Level of Detail e Level of Development oppure, nella classificazione britannica, Level of Definition). E' chiaro che l'Information Management in quanto tale è determinante per la buona riuscita del processo di modellazione informativa, nel senso della configurazione dei protocolli e della interoperabilità degli applicativi, ma è altrettanto palese che confinare il BEP a ciò significa limitarne notevolmente il rilievo.

Non per nulla, il ConsensusDoc definisce l'Information Management come *measures that protect and defend information and information systems with respect to their availability, integrity, authentication, confidentiality, and non repudiation. These measures include providing for restoration of information systems by incorporating protection, detection, and reaction capabilities.*

- 3) i BEP appaiono assai disomogenei come contenuti e come analiticità, a dispetto dell'esistenza di alcuni riferimenti obbligati, come i template della Penn State University o quelli della NATSPEC. Per quanto riguarda l'Europa lo sforzo maggiore concerne il Regno Unito con i documenti recentemente emanati dal CPI. Si tratta, però, di una interpretazione che non si discosta molto da quella statunitense che ha influenzato, a sua volta, anche quella australiana.

Nella versione britannica ciò che rileva maggiormente non è, peraltro, il Building Information Modelling Execution Plan, bensì i cosiddetti Employer's Information Requirements che si redigono nella fase di Project Briefing;

- 4) da questo punto di vista, vi sono certamente nel BIM Execution and Implementation Plan elementi legati al Design Management, come le matrici di correlazione tra Responsabilità nel Design Team e Oggetti Virtuali da introdurre nel modello informativo oppure lo scadenziario di consegna degli stessi, ma prevale, come detto, la logica della gestione documentale. Nei fatti, la modellazione informativa si basa sulla configurazione dei livelli evolutivi della progettazione, il che significa che viene sovvertita la logica usuale basata sulla produzione di documenti e non sulle densità di contenuto informativo;
- 5) non esiste probabilmente un caso in cui il Project Execution Plan sia stato interamente tradotto in termini di Project Information Modelling and Management, anche se nei flussi di scambio informativo ciò sarebbe in nuce, come per Arup e Mott MacDonald.

Vi sono altri esempi, come quello di Skanska, in cui i flussi sono stati formalizzati.

In questo caso, vi è un legame diretto tra la struttura dei Level of Detail e dei Level of Development e il Project Management;

- 6) il Building Information Management raramente è declinato in termini di Knowledge Management, come, invece, lo è nel caso dello HMG Ministry of Justice, vale a dire, di rado è oggetto di investimenti sulla capitalizzazione delle esperienze attraverso una BIM Library;
- 7) il BIM Execution Planning, inteso come processo, è assai più decisivo di quanto non lo sia il BIM Execution Plan, considerato come documento: allo Albert Sherman Center dell'University of Massachussets per il BIM Execution Plan Draft sono occorse nove revisioni e diciotto mesi;

## BIM-Based Project Management

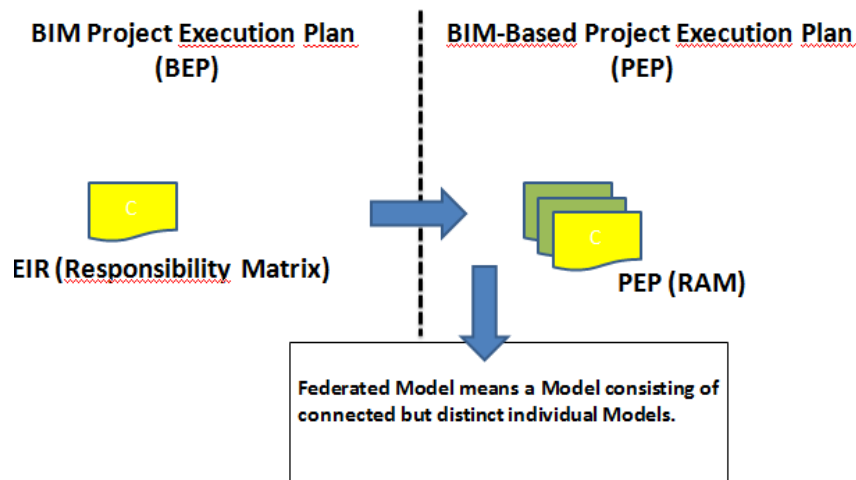


Figura 1: BEP e PEP

- 8) il BIM Execution Planning appare spesso troppo focalizzato sulla fase di progettazione, a discapito di quelle successive, anche se, paradossalmente, solo la norma BS PAS britannica ha introdotto gli Employer's Information Requirements, propedeutico al BIM Execution Planning come trasposizione del Project Brief nell'ambito dell'Information Modelling;
- 9) solo negli Stati Uniti si è prestata una particolare attenzione ai BIM Addendum, vale a dire, alla trasposizione degli obblighi contrattuali in materia lungo la catena di fornitura, anche se in linea teorica ciò permea l'intera norma BS PAS 1192:2. Contrariamente a una impostazione europea, che vede nella progettazione vera e propria il fulcro della modellazione informativa, quella statunitense vede nel coordinamento dei modelli dei subappaltatori un passaggio cruciale: *Subcontractor acknowledges and agrees that Turner shall incur no responsibility or liability with respect to the BIM or the use thereof, including that resulting from errors, omissions or deficiencies in the BIM. In the event that Subcontractor provides deficient information or data that does not represent the Work it will be ultimately providing, that is corrupted, that contains a virus and/or that otherwise damages the BIM, Subcontractor shall bear all costs associated with reconstructing the BIM and to otherwise remediate such deficiencies or their effects.*
- All work on the coordination drawings (including 3D models) shall be performed by competent draftsmen in a clear legible manner utilizing standard industry conventions. All trade contractors shall be responsible for providing their coordination drawing files according to the established coordination schedule. It is the responsibility of each contractor to supply a sufficient number of draftsmen so as not to delay the BIM 3-Dimensional coordination process and shop drawing submittals.*
- 10) una delle domande cruciali è come detenere le economie che si conseguono nella modellazione informativa e come nel BIM Execution Planning esse possano essere assegnate.

In primo luogo, ciò significa che è richiesto, nel bene e nel male, uno sforzo maggiore nelle fasi iniziali e precoci della progettazione, come evidenziato da MacLeamy e contestato da Holzer: *in his original graph, MacLeamy shifts the curve denoting main investment or effort to the left, but he does not consider that, by doing so, the project duration beyond procurement is likely to diminish. This occurs due to added benefits during construction*

*where the contractor can rely on a better integrated documentation set with clashes resolved prior to going on site. Upon examination of the graph, questions emerge as to how far MacLeamy bases the graduation of its curves merely on informal observations at work, or on any quantifiable data from within design practice. In case of the former, the significance of the diagram is likely to be overstated by its users. In the case of the latter one should question the validity of that data used to produce it.*

In secondo luogo, l'approccio all'Information Modelling nella gestione del BIM Execution Plan presuppone una capacità di analisi rapida delle alternative.

In terzo luogo, ovviamente si pone la questione sulla identità dei soggetti che trarranno i vantaggi.

- 11) la struttura degli onorari è connessa alle prestazioni che possono essere prestate grazie alla modellazione informativa in Germania e nel Regno Unito e al modo in cui nel BIM Execution Plan esse possano essere descritte;
- 12) la Clash Detection e il Model Checking sembrano essere aspetti rilevanti percepiti dagli operatori per l'Information Modelling nel BIM Execution Planning, ma i conflitti e le interferenze analizzati sono prevalentemente di natura geometrica, mentre non pare molto praticato il Code Checking (specialmente laddove i rule set esprimono contenuti non geometrico dimensionali) se non per i processi autorizzativi a Singapore con Corenet oppure a New York City con DOB;
- 13) la condivisione dei contenuti introdotti nel modello informativo attengono al sistema di responsabilità e di tutela della proprietà intellettuale e sul Federated Model. E' di particolare interesse osservare come il ConsensusDoc definisca i diversi modelli informativi.

*Il Design Model è definito come a Model of those aspects of the Project that (a) are to be modeled as specified in the BIM Execution Plan prepared pursuant to this Addendum and (b) have reached the stage of completion that would customarily be expressed by an Architect/Engineer in two-dimensional Construction Documents.*

*Il Construction Model è a Model that (a) consists of those aspects of the Project that are to be modeled as specified in the BIM Execution Plan prepared pursuant to this Addendum; (b) utilizes data imported from a Design Model or, if none, from a designer's Construction Documents; and (c) contains the equivalent of shop drawings and the information useful for construction.*

*Il Federated Model è assumibile come a Model consisting of linked but distinct component Models, drawings derived from the Models, texts, and other data sources that do not lose their identity by being so linked, so that a change to the component Model in a Federated Model does not create a change in another component Model in that Federated Model.*

*Ciò spiega la distinzione con il Full Design Model che è a Model consisting of coordinated structural, architectural, MEP and other Design Models designated in the BIM Execution Plan to be produced by the design team.*

*È da osservare come si precisi che i disegni bidimensionali tratti dal modello informativo possano essere supplemented with independent graphics and annotations specified by the Parties to be Contract Documents.*

*Si specifica, inoltre, che Participation of the Contractor or its subcontractors and suppliers in Contributions to a Model shall not constitute the performance of design services. Unless otherwise agreed in the BIM Execution Plan, a Design Model is not intended to provide the level of detail needed in order to extract precise material or object quantities. In the event of a conflict between the contents of a Design Model and any other Model, the Design Model shall take precedence. If any Project Participant becomes aware of a discrepancy*



*between a Model and either another Model or another Contract Document, such Project Participant shall promptly notify the other Party or Parties to that Project Participant's Governing Contract and the Information Manager.*

La norma BS PAS 1192:2 affronta il BIM Execution Planning in correlazione con due distinti documenti: gli Employer's Information Requirements e il Building Execution Plan (BEP), a cui si aggiunge il Master Information Delivery Plan.

Nel documento britannico gli EIR sono *pre-tender document setting out the information to be delivered, and the standards and processes to be adopted by the supplier as part of the project delivery process*, il BEP è *plan prepared by the suppliers to explain how the information modelling aspects of a project will be carried out*, mentre il MIDP è *primary plan for when project information is to be prepared, by whom and using what protocols and procedures, incorporating all relevant task information delivery plans*, seguito dai TIDP (Task Delivery Information Plan), *federated lists of information deliverables by each task, including format, date and responsibilities.*

Nella norma si accenna al Level of Definition, inteso *come collective term used for and including Level of model Detail and the Level of Information Detail* che, a loro volta, sono rispettivamente *the description of graphical content of models at each of the stages defined for example in the CIC Scope of Service* e *the description of non-graphical content of models at each of the stages defined, for example, in the CIC Scope of Services.*

I documenti AIA E203 e G201 e 202 mettono bene in chiaro come, mettendo in relazione gli Authorized Uses con gli Expected Level of Development for Model Elements, per modello informativo si debbano intendere anche i documenti cartacei, così come per il ConsensusDoc. Ciò illustra perché il BIM Execution Plan debba disciplinare le modalità secondo cui avvenga lo sviluppo progressivo e il grado di confidenzialità di ciascun Model Element dalla fase concettuale a quella capitolare. Non per nulla in esso devono essere specificati i Model Element Author, specialmente laddove, nel cambio di fase processuale, la paternità sia trasferita da un organismo di progettazione a una impresa di costruzioni.

I documenti AIA sono particolarmente importanti, nell'economia del BIM Execution Planning, non solo perché disciplinano accuratamente le esigenze di Loading, Sharing, Storage, Archiving, Retrieving, ma, soprattutto, perché agiscono su una differenza tra Detail e Development che la norma britannica affronta altrimenti.

**The Level of Development (LOD) descriptions identify the specific minimum content requirements and associated Authorized Uses for each Model Element at five progressively detail levels of completeness. The Parties shall utilize the five LOD descriptions in completing the Model Element Table.**

**The LOD framework utilized is designed to accomplish two objectives with regard to Modeling. The LOD framework allows the Project participants to efficiently communicate to one another the extent to which a Model Element has been developed by virtue of the defined minimum model content requirement for each LOD. It also allows the Project Participants to communicate the extent to which a Model Element may be used and relied on by virtue of the identified Authorized Uses of the Model. Accordingly, the LOD framework sets the floor for Model content and the ceiling for Model use.**

**With regard to the first objective, communicating the extent of development, it is important to recognize the difference between the detail of a Model Element and the development of a Model Element. In a model, it is easy to misinterpret the meaning of the level of detail at which a Model Element is developed.**

In a Model, however, it is inappropriate to assume that because a Model Element is depicted in extensive detail, it has been sufficiently developed for its intended purposes. The common use of library objects as placeholders in Modeling serves as a good example of why this is the case. A designer may pull a very detailed light fixture from an available object library and place that object in the Model, but only as a placeholder. The object, therefore, contains extensive detail and is precisely located despite the fact that the designer has not fully evaluated and decided upon this information. In other words, while the level of detail is extremely high, the level of development is extremely low.

Non-graphic information may also be attached to the Model Element. Therefore, even if a Model Element is extremely detailed, if it is identified to only be at LOD 200, it is clear that the detailed information contained in the Model Element has not been fully developed. Rather, the content has only been developed up to the point of being a generic system, object, or assembly.

The second objective for the LOD framework, communicating the extent of use/reliance, is intended to address the fact that the possible uses of a Model (and all the information included in the Model) are potentially limitless. Accordingly, the originator of the Model cannot anticipate all the needs for the Model content that the originator is developing.

This has caused significant concern to design professionals who are leery of their work being used for unintended purposes.

It should also be noted that there is no intended correspondence between an LOD and traditional design phases. System progress at different rates through the design process – for example, design of the structural system is usually ahead of the design of interior construction.

Similarly, there is no such thing as an “LOD --- model”. Models will invariably contain elements at various LODs.

- 14) La multidimensionalità (vale a dire il 4D, 5D, 6D, 7D Modelling: con specifico riferimento a Tempo, Costo, Qualità, Salute e Sicurezza, Ambiente) è spesso assente o scarsamente considerata nel BIM Execution and Implementation Planning, ma essa costituisce la ragion d’essere di un processo dinamico ed evolutivo che collega BIM e Field BIM. Prima di tutto occorre rammentare come tutto il BIM Management presupponga una infrastruttura socio-comunicativa. In seconda istanza, il BIM Management resta un dispositivo di Risk Management.

## BIM-Based Project Management

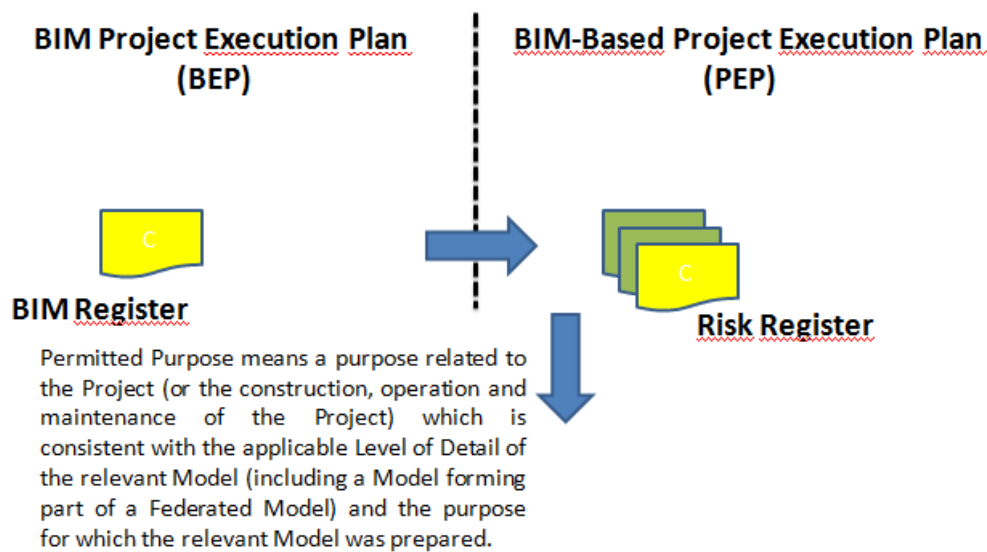


Figura 2: BIM-Based Risk Management

In terza istanza, il BIM Execution and Implementation Planning dovrebbe investire gli aspetti di Semi-Automatic Project Monitoring & Control basati su Laser Scanning e Augmented Reality, oltre che su altre tecnologie.

Ciò implica che il BIM Execution Planning svoltosi nelle sedi della committenza e del Design Team si trasferisca negli uffici del cantiere...

... e in campo.

Questo comporta certamente il ricorso ai tablet e ai Field Management Software come Artra, Dome Connect e BIM 360 Field...

...ma anche ai cosiddetti Smart Board.

Si tratta di un approccio molto interessante perché da vita a una Virtual Company, in cui si agisce in loco e in remoto.

Di fatto, si assiste a una evoluzione del BIM Execution Planning and Implementation nel BIM-Based Project Auditing, Monitoring & Control...

...sino all'Operations & Management.

- 15) Da ultimo, è chiaro che se l'Information Modelling & Management è un processo socio-tecnico esso farà sì che il BIM Execution Planning assuma una veste differente da quella solamente relativa ai Protocolli di Scambio di Informazioni tra Stakeholder, Shareholder, Stockholder.

Tale constatazione si riflette nella configurazione delle Policy dell'azienda.

E' ovvio che per raggiungere un Fully integrated asset data management occorra uno sforzo notevole.

### L'Information Exchange Management e il Project Management

La struttura del BIM Execution Plan, così come proposta in molte situazioni differenti attiene essenzialmente, tra gli altri aspetti, alla definizione degli Authorised Use e dei Permitted Purpose, non solo all'elencazione di software e di hardware oppure alla definizione del File Naming ovvero dei Points of Reference oppure della piattaforma cloud.



È interessante notare come in un BEP si legga che *it is XYZ's goal to create a "social" BIM environment, using BIM for collaboration, problem solving, and transparency for the benefit of the entire Project, and not just an "anti-social" BIM environment where each party uses BIM in a "vacuum" in their own way for their own purposes. As such, XYZ expects each member of the Project Team who is creating a BIM to share their models with the other members of the Project Team (as described throughout this document) in the spirit of collaboration for the benefit of the entire Project.*

Come già osservato, le dinamiche evolutive del processo di BIM Planning sono tali per cui *the BIM Execution Plan is a "living document" that will be modified from time to time as different subconsultants and trade contractors join the project team and as it becomes necessary to further hone the BIM uses, processes, and/or infrastructure for the Project.*

Per questa ragione, il processo assume connotazioni fortemente interattive sia nella fase di progettazione sia in quella di costruzione: *the Design Team will provide a BIM Room to facilitate BIM collaboration and coordination during the design process (both AAA and BBB will provide a BIM room in each of their offices – room and location can be flexible). Once construction begins the General Contractor will provide a BIM Room to facilitate BIM collaboration and coordination during the construction process (both Hunt and Holder will provide separate on-site BIM rooms). The General Contractor will also require each Trade Contractor involved in the BIM coordination process to have their lead coordinator (and lead detailer, if appropriate) located on-site through the construction coordination process. The BIM Room shall serve as a collaborative BIM work environment, providing the necessary space to accommodate personnel for the A/E team, general contractor, trade contractors, and Owner, as well as the hardware and software (overhead projector, screen, workstation, etc.) necessary to facilitate BIM collaboration.*

Ancora più rilevanti sono gli Addendum riferiti ai Subappaltatori, per cui si pone l'esigenza di coordinarne l'operato senza evitare di delegare a essi i compiti e le responsabilità relative: *Coordination Model: the coordination model will be reconciled by each contractor to find the best collective solution to the coordination of all items.*

1. *Each trade contractor will supply a 3D Trade Contractor Model for their own scope of work separated by areas as directed by XYZ.*
2. *Each trade contractor will supply the 3D Trade Contractor Models with all clashes resolved and representing what was installed in the field for their own scope of work at the end of the coordination process. Trade Contractor models will be provided as follows:*
  - a. *One complete model representing the project as a whole.*
  - b. *One model per floor (or as designated by XYZ).*
3. *Each trade contractor will be responsible for working in harmony with the other trade contractors to resolve coordination issues. If there is not a resolution agreed upon by all then the Construction Manager will make the decision for them.*
4. *A lead trade contractor may be appointed to control the process.*
5. *Trade contractor models will be color coded to provide delineation between systems.*
6. *2D coordination drawings will still be required in certain areas as directed by XYZ.*

*3D Trade Contractor Model – computer generated 3D drawings used for coordination, conflict resolution, fabrication, and as-built.*

1. *Each trade contractor will be responsible for producing a model/models to represent the work of the contractor in accordance with the work breakdown structure to be provided by XYZ.*
2. *If the trade contractor does not have the in-house capability to produce the required model/models, the contractor may utilize the service of an outside entity to provide this service.*
3. *In the event that the trade contractor wishes to exclude the preparation of the model/models from their scope of work, they must do so at bid time and must receive approval from XYZ. The*

*trade contractor must still provide electronic shop drawings files as directed by XYZ to support the coordination process in (.dwg) file format.*

*XYZ will engage a third party on behalf of the trade contractor in order to convert the information into (a) 3D model/models for coordination purposes. Any and all costs associated with this work on behalf of the trade contractor will become the responsibility of the trade contractor. This does not excuse or exclude the trade contractor from any of the coordination process as described in this specification.*

*4. All elements must be drawn to scale and shall be a true representation of what is to be installed in the field in all three dimensions.*

*5. All 3D models submitted must be compatible with the NavisWorks Manage 2012 software. If object enablers are required that are not readily accessible free of charge, the subcontractor is responsible for providing them to XYZ.*

**a. Each subcontractor shall be responsible for the development and dimensional accuracy of its work in the 3d construction/installation model. Maximum 3d construction model tolerance shall be 1/16".**

**b. Each subcontractor shall 3d model to a minimum Level of Detail as outlined herein. If there are assemblies that are not listed herein and will affect other subcontractor's Work, those assemblies shall also be modeled or modeled as "stay out space" to reserve physical space so that coordinated installations are maintained. All subcontractor's 3d model content will take precedence over subcontractor's non-3d modeled content should a conflict arise during installation.**

**c. Each Subcontractor shall include all "halos" for code required clearances (such as above electrical gear) or services access "halos" before the start of Construction Installation Model Preparation.**

**d. Each Subcontractor shall include installation "halos" for equipment where necessary. (ie. 6" above recessed 2x4 lights for room to install, room to pull wire at junction boxes, etc)**

**e. Every subcontractor team member who models or coordinates shall have a stand alone copy of Navisworks Manage 2013.**

**f. Each subcontractor shall have internet access with enough bandwidth to view and participate in coordination sessions via Webex or similar online collaboration meeting software if required.**

**g. Each Subcontractor will have a modeler present at coordination meetings onsite for the first half of the coordination. The modeler can attend via on line meeting for the second half.**

**h. Each Subcontractor will have a Superintendent/Foreman present at coordination meetings on site for the second half of the coordination.**

**i. Each subcontractor shall issue their 3d model on a floor by floor basis, by quadrant or as otherwise directed by the XYZ Information Manager.**

**j. Each subcontractor shall post their models by 5pm each day to the site regardless if changes have been made or not.**

**k. Each subcontractor shall utilize and make available detailers Monday through Friday. If behind schedule detailers will be made available on weekends and holidays at no added cost to the project.**

**l. Each subcontractor shall develop their 3d model in layers that represent their typical installation sequence, i.e duct mains, terminal boxes, distribution, air outlets.**

**m. Each subcontractor shall resolve clashes in accordance with the establish priority of systems noted herein.**

- n. Any existing system discovered during excavations will be the responsibility of the subcontractor whose scope of work that system would fall into to include in their model. The existing item only needs to be modeled at the location where it is unearthed.
- o. The XYZ Information Manager will issue a coordination schedule and periodically issue updates to the schedule. Each subcontractor shall provide sufficient resources to maintain the schedule, and shall provide additional resources when the XYZ Information Manager determines that the schedule is not maintained.
- p. The XYZ Information Manager will issue deductive change orders to the subcontractor or subcontractors who cannot maintain the coordination schedule. The deductive amount will be the equivalent amount required for the other subcontractors and XYZ to work the necessary premium time to maintain the coordination schedule. The offending subcontractor or subcontractor's will also be required to work premium time with the non offending subcontractors at no additional cost to the contract.
- q. The XYZ Information Manager shall have the sole discretion to permanently remove an individual or individuals that he determines as counterproductive to the team or the coordination process.
- r. Each subcontractor is required to attend Webex coordination sessions or face to face coordination sessions unless excused by the XYZ Information Manager. Should a subcontractor not attend a coordination meeting or webex session, the XYZ Information Manager will issue a \$500 deduct change order per incident.
- s. Each subcontractor shall pre-coordinate their work with the work of others prior to any coordination session. Coordination sessions are reserved only for coordination issues that involve three or more trades, un-resolvable clashes between two trades, design coordination, or design input.
- t. The XYZ Information Manager will maintain a master Navisworks .nwf file and the most updated subcontractor models and contract models. The Information Manager will also set up the collision tests and issue Navisworks .nwd files updates are issued from each trade. The .nwd file generated by the Information Manager is a tool to assist each subcontractor with coordinating their work and their work with others and to bring efficiency to the coordination process. These .nwd files shall not be relied on solely and do not relieve the subcontractor from their coordination requirements outlined in their contract. Each subcontractor shall use their own Navisworks Manage to ensure their work is coordinated with others.
- u. Each subcontractor shall continue to coordinate and adjust their models until either the Information Manager's master .nwf file reports zero clashes or the remaining clashes reported by the .nwf file can be agreed to amongst the subcontractors. These agreements will be recorded in the .nwd and the master .nwf file so they can be referenced throughout the life of the project.
- v. Each subcontractor will be required to supply all required object enablers for both 32 and 64 bit processors.
- w. Once the respective engineers of record release final equipment schedules, each trade contractor shall be responsible for obtaining final cut sheets of the equipment, with or without a purchase order in place, so that the equipment can be modeled properly and that others can rely on the modeled equipment.

Da questo punto di vista, si pone come centrale il tema dello Storage, dell'Up Loading e del Down Loading degli Information Model, Federated o Single che siano.

Once the Architectural/Structural models are posted on the XYZ BIM Server, each trade is required to download and use these files to create their system models by sequence or geographic area dictated by XYZ's representatives. The process is to create and upload system models to the BIM Server as frequently as required by XYZ for other trades to use while modeling their systems.

XYZ's BIM coordination process in many respects follows a traditional sequence of drawing/modeling those systems with the most constraints on their routing and then following with those trades that have more flexibility in their placement.

Each Subcontractor is required to have access to the software needed to draw in 3D and is required to compile the multiple model drawings and for the subcontractor to run their own clash detection analysis. It is the option of each subcontractor to purchase the software. It is also required that the superintendent for each trade also be equipped with a laptop and a Navisworks license in attendance at coordination meetings prepared to make live, real-time changes to the "Shop Model" in the meetings and in order to review the finalized, signed-off coordinated models prior to and during the fabrication/installation process.

Each Trade is required to run the clash detection analysis for their respective trade system against the Architectural/Structural design models to ensure that there are no conflicts between the architectural/structural elements and their system(s).

It is expected that the weekly Coordination meetings are held to address difficult areas that are not able to be coordinated between the multiple trades themselves. At these meetings, the resolution will be collectively agreed upon, and a trade will be identified as having to "move". This trade will adjust the respective model and repost it for the following week's meeting. All trades are responsible to update and post the changes agreed upon at the meeting within 1 week after the coordination meeting.

Coordination is the responsibility of all contractors. XYZ will call meetings, as required, which contractors must attend. Failure to attend will result in work by the absent contractor on sheets reviewed at meeting being declared improperly coordinated and will require the contractor to relocate work as shown by XYZ, or to field run the work not coordinated. No extra compensation will be paid to any contractor for relocating any duct, pipe, conduit, or other material that has been installed without proper coordination between all the contractors and the trades involved. If any improperly coordinated work, or work installed that is not in accordance with the approved coordination composites, necessitates additional work by other contractors, the cost of such additional work shall be assessed to the contractor responsible as determined by XYZ. Errors in coordination will be resolved by the contractor at his own expense. Where agreements cannot be reached, XYZ will furnish a resolution. The contractor will bear the expense of said resolution.

Sotto questo profilo, il processo di BIM Execution and Implementation Planning ha una caratterizzazione intensa nel BIM Kick-Off Meeting o Preliminary Coordination Meeting, con particolare riferimento alla cronologia di intervento dei diversi subappaltatori.

The Trade Modeling Sequence indicates the Subcontractor modeling succession in order to complete the coordinated project model and is relevant to the overall duration of BIM modeling. The overall duration of BIM modeling for the project is not a source of delay for the completion of contractual requirements as dictated per the Subcontract Agreement and/or the construction project schedule, and should not be construed as such.

Each Subcontractor is required to include the cost of renting at least two (2) standalone licenses for Autodesk Navisworks software from XYZ at a cost of \$200.00 per license, per month. Before

licenses will be issued subcontractor agrees to execute the "Autodesk Exhibit B Software Use Agreement." The NavisWorks software is required to compile the multiple model drawings and for the subcontractor to run their own clash detection analysis. It is the option of each subcontractor to purchase the software. It is also required that the superintendent for each trade also be equipped with a laptop and a Navisworks license in attend coordination meetings prepared to make live, real-time changes to the "Shop Model" in the meetings and in order to review the finalized, signed off coordinated models prior to and during the fabrication/installation process.

Each Subcontractor is required to maintain a fully coordinated and updated Navisworks model that contain all trade contractors models.

Each Trade is required to run the clash detection analysis for their respective trade system against the Architectural/Structural design models to ensure that there are no conflicts between the architectural/structural elements and their system(s).

Each Trade is required to post to the XYZ BIM Server, up-dated 3D DWG, and NWD drawings/models at least once per week, prior to the clash detection analysis run by the BIM Coordinator / Gatekeeper. (Day and time to be determined). This will continue until the area is completely coordinated.

#### Coordination Meetings

1. A Mandatory Kick-Off Meeting will be set up to discuss and determine;
  - a. Introduce the trade coordination team.
  - b. Update of what information is already available from the A/E and structural contractor.
  - c. Distribution of the "base model" and access to the File Sharing application site.
  - d. General review of the available above ceiling space.
  - e. Establishment of "zones" for space allocation per trade as guideline.
  - f. Required attendance of bi-weekly coordination meetings.
  - g. Meeting schedule and breakdown of floors into manageable areas.
  - h. Drawing posting deadlines.
  - i. Sign off schedule and signature lock on sign-off reports.
  - j. Color coding requirements.
  - k. Layering and file naming conventions.
  - l. Method for handling on hold or shelled space.
  - m. Material fabrication and delivery times after sign-off for each area.
  - n. Use of and adherence to signed-off base model during installation.
2. Each trade contractor is required to take part in regular coordination review meetings. The time and place for these meetings will established by XYZ.
3. The purpose of the coordination meeting is to identify and resolve probable interferences between building systems.
4. Trade contractor shall supply a Trade Contractor Modeling Manager or person authorized act on behalf of their organization to solve coordination issues which may arise between trades.
5. If conflicts are identified and a resolution is agreed upon it is the trade contractor's responsibility to have the necessary changes made in their model and republish said model to the File Sharing site in time for the next meeting. It will be established in the kick-off meeting the required timeframe that these models will need to be resolved and re-submitted for the next coordination meeting.
6. Each trade will upload electronic drawings, which must be compatible with NavisWorks software, to the File Sharing site with their pre-determined color-coded drawings for use at the trade coordination meetings. This will occur by 5:00 PM on Fridays prior to the meetings. Each

trade shall review the clash report and coordinate the easy fixes and work together to resolve the clashes. The coordination meeting shall focus on clashes that cannot be resolved by one trade alone.

7. When an area/floor is clash free and ready for sign-off, the VDC Manager/BIM Coordinator will bring one copy of the closed clash report for the area for contractor signoff.

This closed clash report will reference a dated NavisWorks file which will be housed on the File Sharing site.

8. Above ceiling space allocation (zones) for each trade will be established by the group and adjusted to meet actual installation and coordination requirements. These zones are to be used as guidelines for routing prior to the trade coordination meetings.

9. All trades will attend the scheduled coordination meetings, bringing any shop drawings or other materials required to solve potential conflicts. XYZ will facilitate these meetings. If a dialog is required concerning architectural, engineering or structural matters XYZ will request attendance by the appropriate discipline. Notice shall be given to XYZ at least 48 hours in advance of the coordination meeting if a trade knows of a conflict that will require the participation of the lead architectural/mechanical/electrical designer or others that do not normally attend the coordination meetings.

10. At the meeting, the published clash report will be reviewed to identify the areas of concern, discuss possible solutions for conflicts, and decide on the solution that is the least impact to all trades. If any outstanding conflicts cannot be resolved at the meeting, the drawing sign-off can be delayed until the next coordination meeting. However, it is expected that the coordination schedule will be maintained despite the delay in the signoff.

The sign-off represents each trade's confirmation and assurance their work is coordinated and the field installation of their work will not be in conflict with any other trade.

11. During the installation of each trade's work, Skanska will refer to the signed-off report and the 3D model to resolve any conflicts. Each installing firm agrees to install all work per the signed-off drawings, without deviation. If a deviant installation takes place without prior approval from all detailing parties, it will be the responsibility of the installing contractor to remove the work and install it as shown on the signed off drawings. If a conflict does arise during installation that was not foreseen or solved during the coordination effort, each of the detailing firms will work together to find a solution that is the least impact to all trades. The cost of this work will be evaluated as the problems arise, however, the party responsible for the conflict will be responsible for the cost of the fix, including the additional detailing time of all parties involved.

12. If the electronic drawings of an individual firm are not posted to the File Sharing site as scheduled, they will be responsible for any additional meeting time and/or the cost of delaying the process if sign-off dates are not met due to the delinquent posting.

13. Coordination will include all work shown on the contract drawings at the time the base architectural model is created. Any new design work issued after the start of coordination will be dealt with as change order work and the coordination schedule will be adjusted.

14. The VDC Manager/BIM Coordinator will verify the architectural background on the composite plot is accurate with the current contract documents. All updates to background drawings provided by the A/E will be issued electronically with all changes redrawn to actual locations. If any changes are made to an area after a drawing is signed off for coordination or any updates are not issued electronically by the A/E, the cost of the changes to the coordination drawing and schedule will be assessed in a change order scenario.

15. RFI responses required to be incorporated into the coordinated drawing for the upcoming



meeting shall be clouded within each trade's detail model to denote that the area is incomplete. All RFI that will potentially impact the trade coordination will be distributed to all the parties involved.

16. Trades not attending any coordination meeting, or failing to post their electronic drawing files on the provided File Sharing site by the designated date and time, will relinquish the right to make changes to other trades' routing in an effort to coordinate their own work, and will execute their discipline without impact to the work coordinated at the meeting.

17. A representative of the A/E may be attending the coordination meeting and will be authorized to assist in the resolution of clashes from a design perspective to expedite the process. If changes to the building design are requested, the RFI process must be followed. When submitted, the RFI must clearly state the problem, possible solutions and benefits to the project.

Di fatto, pertanto, gli elementi salienti del BIM Execution and Implementation Plan sono quelli relativi alla relazione tra livelli evolutivi e obiettivi.

Rimarchevole è, inoltre, il fatto che la relazione tra livelli evolutivi e scopi, che origina i Deliverable da programmare in termini di consegna ufficiale, dia luogo anche a una previsione di impegno di risorse umane.

Analogamente, occorre prevedere la natura e la frequenza delle riunioni di BIM Management.

Naturalmente, però, occorre correlare il fabbisogno di ore-uomo necessarie alla modellazione informativa con quello relativo al Model Checking e alla sua valorizzazione: *at the end of the Project, ABC should provide XYZ with a total estimated Owner savings through the BIM clash detection process. This savings can be tracked and calculated by assigning an estimated value to each clash on the Coordination Log that was resolved through the BIM clash detection and resolution process.*

In questo senso, i temi sono così riassunti: *it is recommended that the Design Team and Construction Team use Solibri or Autodesk Revit Model Review software for:*

- *Automated checking and analysis of the building design*
- *Highlighting potential design issues in the 3D visualization model*
- *Classification of design issues into three groups based on severity*
- *Enabling user to define customized rules and standards for model checking*
- *Automated space analysis and measurement*
- *Zone management*
- *Defining escape routes of the building*
- *Verifying accessibility rules*
- *Model version comparison*
- *Conformity between Architectural and Structural models including reasoning for walls and slabs modeled with beams and columns in structural model*
- *Report and optionally correct inaccuracies and inconsistencies within model(s)*

Uno degli aspetti salienti della prassi statunitense è la correlazione degli oggetti da modellare con la loro caratterizzazione e la loro paternità.

Differente è la versione britannica.

Come si può evincere dall'analisi condotta, l'ambizione della modellazione informative è inclusiva degli aspetti alfanumerici, a eccezione, nel caso che segue, delle specifiche capitolari: *all information needed to describe the "detailed design" should be graphically or alphanumerically included in and derived from these models only, except for the Specifications. Documentation of*

*the models should not happen outside of the BIM authoring software (Revit). However, this does not imply that the model itself is a contract document.*

Al contempo, tuttavia, vi è una sistematica riluttanza ad ammettere il modello informativo quale riferimento contrattuale: *Design Models are not intended to provide the level of detail needed in order to extract precise material or object quantities.*

Il BIM Execution and Implementation Planning disciplina, perciò, tutte le fasi della modellazione, che ovviamente trascende la progettazione, sino a giungere al Federated Record Model: *the Trade Contractor Construction Models should reflect the exact geometric properties of the materials and/or systems in the model, along with the exact material properties and performance data. This includes, but is not limited to, the size, manufacturer, make, model number, and serial number (where applicable) for each component in the model. As each Trade Contractor completes their scope of work, both AAA and BBB will require all Trade Contractor Construction/Fabrication/Shop Drawing Models (ie. Construction Models) to be updated to Trade Contractor As-Built Record Models. These As-Built Models will capture all as built differences between what was actually installed in the field and what was represented in the Construction/Fabrication/Shop Drawing Models, and will also include the actual size, manufacturer, make, model number, and serial number (where applicable) for each component in the model to reflect the content that was actually purchased and installed.*

Parimenti, però, prima di arrivare ai modelli informativi più dettagliati è opportuno utilizzare alcuni accorgimenti: *in order to maintain smaller model file sizes it is allowable to “strip” and object within the model by replacing, for instance, a manufacturer’s equipment product model with a simpler object of accurate dimensions that includes connections / tie-in points, as long as the spec data from the original product model is maintained within the BIM, and can thus be accessed and quantified from the BIM.*

## **Le sperimentazioni del BIM Task Group Britannico nel BIM Management**

Il caso britannico appare, in termini sistemici, senz'altro il più interessante, almeno a livello continentale (a prescindere, dunque, da Australia, Canada, Corea del Sud, Hong Kong, Singapore, Stati Uniti), anche se alcune recenti azioni governative in Francia (all'interno del Plan Construction Durable) e in Germania (a opera di Zukunft Bau), oltre che in Olanda e, ovviamente, nei Paesi Nordici, mostrano segni di attenzione.

Elementi cruciali della road map britannica sul Building Information Modelling accoppiato al cosiddetto Green Soft Landings, sono quelli improntati a una gradualità nell'evoluzione dei Level of Maturity e nell'estensione agli Enti Locali.

La norma BS PAS 1192:2, che sorge dalla norma primigenia del 2007 sul CDE (Common Data Environment), propone, peraltro, un Information Delivery Cycle piuttosto esaustivo nei risvolti sul processo decisionale o sulla catena della fornitura, ma altrettanto macchinoso e, in questo, abbastanza distante dall'approccio, anche riduzionista, ma fortemente pragmatico, riscontrato nei casi statunitensi.

Vi sono, nel documento, da una parte distinzioni sofisticate, come quelle tra Client o Employer oppure tra Information Manager e BIM Coordinator, ma pure vi si trovano terminologie originali e non allineate a quello di uso più comune.

Il caso britannico del BIM Trial Project promosso dal Ministry of Justice, in qualità di Early Adopter, per l'ampliamento del carcere minorile di Cookham Wood a Rochester nel Kent, primo di una serie di interventi diversificati (Chelmsford, Oakwood, Aberystwyth) e primo di altre serie nel settore della Mobilità, in quello della Difesa e in quello della Sanità, è particolarmente significativo.

*Il Ministry of Justice created a collaborative culture so as to bring together the consultants, Tier 1 and Tier 2 contractors at the earliest stage and to develop cost savings innovations and improved efficiency prior to start on site. The Cookham Wood Trial Project combines collaborative working under Two Stage Open Book with the adoption of BIM, Project Bank Accounts and Government Soft Landings. A fully integrated team have worked to a tight timescale to commence delivery on site of a new build Young Offenders Institution that to date has exceeded cost saving targets.*

Le risultanze del Trial sono così riassunte dal Ministry of Justice:

*Ministry of Justice set a target of 10% cost savings between selection of Interserve and commencement on site. Taking into account value indicators of similar projects, cost savings achieved (as analysed by the client and cost consultant Sweett Group) show a cost saving of 20% from the rate of £2,910 per square metre anticipated for a comparable project and the rate of £2,332 per square metre achieved in relation to Cookham Wood by the time of establishing the agreed maximum price. These savings have been achieved through the following means:*

*Joint working by Interserve with Tier 2 subcontractors in developing innovative proposals at the point of selection.*

*Further joint working by Interserve and its Tier 2 subcontractors with the client and its consultants throughout the contractual preconstruction appointment. Additional information provided at the point of selection and throughout the preconstruction phase through the use of BIM.*

Si possono evidenziare una serie di fattori:

- *il caso di studio appartiene a un programma di interventi teso a sperimentare formule appaltistiche e contrattuali innovative, contestualizzando il BIM in un quadro ben più ampio, così come ha recentemente fatto il Governo Britannico nel documento *Construction 2025*. Di fatto, il Ministry of Justice aveva chiaramente in mente il senso del BIM Execution Planning: *a contractual BIM implementation plan for the project defining different levels of design maturity for each project phase, who will develop the content, to what standards, who will be authorised to use it, for what purpose, how it will be coordinated, who will own what and how information incompatibilities shall be resolved. This is to include the means and protocols for the communication of information between parties. This is to be reconfirmed for each project phase below;**
- *il caso di studio venne scelto mentre la sua impostazione originaria della progettazione, di carattere tradizionale, era già stata impostata, richiedendo alla struttura di committenza di tradurre in poche settimane il progetto in termini di modellazione informativa: *tender package included the native model developed by the design team, 2D cuts and COBie drop 2a. Tenderers had to return the developed model, 2D cuts and COBie drop 2b. The short tender period does not allow for fully integrated design development (eg Architectural, Structural, MEP, and Fabric). Clearly BIM supports this, but to extract full BIM value at tender period needs a different approach (or procurement route). This is clearly compounded by the requirement for a full COBie Data Drop at Stage 2b.**
- *in ogni modo, è palese che , così come per i casi statunitensi, il ricorso alla metodologia in fase di avvio della progettazione sia difficoltoso: *MoJ have been reviewing this and are developing a new Clients Information Requirements document to replace the Employers Requirements used at Cookham Wood;**
- *è palese, nell'impostazione del Ministry of Justice, una cura particolare per il Lean Management e la Lean Construction che ne spiegano molte motivazioni: *Ministry of Justice have developed consistent systems for preconstruction phase working, for lean programming and for measured performance and those systems were applied to the Cookham Wood project;**

- il tema del ruolo degli Employer's Information Requirements, e, perciò, dell'Information Modelling nelle fasi del Project Briefing appare ancora irrisolto: *the Employers Requirements could contain zoning/adjacency instructions, alongside a description of how the asset is to be used in the future, with the COBie data allied to this. MoJ have been reviewing this and are developing a new Clients Information Requirements document to replace the Employers Requirements used at Cookham Wood;*
- la pretesa valenza dell'Optioneering per il Building Information Modelling non è scontata: *there was poor understanding of how to achieve economical use of the BIM model and change control. The procedures need to be documented;*
- la sperimentazione è avvenuta contestualmente alla redazione della norma BS PAS 1192:2 per la quale il Ministry of Justice è stato parte attiva, ma, al di là di alcune leggere dissonanze terminologiche, è evidente che il processo ivi descritto, per essere applicato *interamente, avrebbe dovuto essere avviato in precedenza: the Cookham Wood project was converted from 2D to BIM and a number of issues which would not be apparent from a BIM originated project did arise;*
- alla base dello sviluppo dell'Information Modelling vi è una istanza legata al Knowledge Management, alla costituzione di una BIM Library aziendale deputata a codificare e a capitalizzare le conoscenze o le esperienze individuali: *the demographic of the technical team in the MoJ is such that much knowledge will "retire" over the next few years. As much of this knowledge must be transferred into the libraries as soon as possible;*
- l'interlocuzione con le cinque imprese concorrenti, non prive di esperienze in materia, su cui oggi vale la norma BS PAS 91, ha richiesto un processo di audizioni sia sul metodo (sul BIM Execution Planning) sia sulla gestione documentale (sui sistemi di IBM e di 4Projects, quest'ultimo in relazione anche a IFC e a COBie): *the tenderers were asked to attend a pre tender BIM workshop at the MoJ where the intent of the tender process was explained and preliminary questions were, where possible, answered. This was considered a very useful exercise by all concerned. During the tender exercise a full day tenderer's meeting was held on site, during which more BIM information was given and questions answered. Further assistance was given during the tender process when tenderers were given the opportunity to attend a COBie data extraction training session. The Pre-Tender BIM engagement workshops were very useful. They should be utilised on all BIM tenders until the process and experience is fully developed;*
- a sua volta, la gestione documentale ha imposto una serie di problematiche legate all'upload e al down load di file molto impegnativi in termini di big data: *the evaluation of use of BIM in the tender evaluation report seemed unclear to the Constructors (the marking may be clear but interpretation of quality was not);*
- al di là dell'e-Procurement, il Ministry of Justice, che pure aveva compilato una Process Map per gli interventi BIM-Based molto dettagliata, denuncia l'esigenza di modificare gli assetti e le regole dell'appalto, per quanto sia la formulazione JCT sia quella NEC per ora siano state contraddistinte solo da chiarimenti aggiuntivi. Probabilmente è proprio nei percorsi logici della gara che si annidano le maggiori differenze: *the brief and BIM Clients Information Requirements (CIRs) need to be rewritten in plain English with no ambiguity. Any items which are specific to the design team must be removed from the version which is used for the Constructor tender;*
- il passaggio intermedio tra l'aggiudicazione e l'avvio dell'esecuzione del contratto ha implicato un lavoro comune di affinamento da parte delle controparti (Ministry of Justice e Interserve), coinvolgendo anche i Subappaltatori di rango elevato (Emcor e SCC), ma forse sul versante più di rappresentazione: *use of 3D model in design meetings allows us to focus*

*and visualise the issues quickly and accurately leading to efficient resolution. We also record comments from review directly in the model;*

- i valori aggiunti che sono stati messi in evidenza nel report ufficiale attengono più agli aspetti geometrico-visivi che non a quelli informativi (la pre-comprensione da parte della dirigente del carcere, l'analisi delle sequenze costruttive). Particolarmente rilevante l'impiego nelle procedure autorizzative previste: *the ability to show a 3D animation of the whole site to Medway Council's Planning Committee, allowed them to more easily understand the impact of the proposed scheme at Cookham Wood;*
- il coordinamento della progettazione è specificamente enfatizzato, ma, come nei casi precedentemente analizzati, sembra prevalentemente ribadire le funzionalità principali dei software di Authoring più che un approccio innovativo alla gestione dei dati alfa numerici: *regular sharing of models amongst design team members (work-in-progress models shared weekly), using project protocols to determine exchange method and project extranet to share files. Regular sharing keeps all disciplines up to date with design changes and avoids risk of receiving a large batch of changes late in the process;*
- si riscontra una notevole attenzione ai Data Drop e a COBie, ma sia la questione dei Level of Definition, Detail, Development sia quella del cosiddetto Field BIM non sono più che tanto messe in luce: *Client's strategic purposes – details of the expected purposes for information provided in models: the MoJ need to define what level of information was required at each stage of the procurement process in general, but particularly at tender and that this should be defined to incorporate BIM requirements;*
- in termini di Design Management poco si dice sul grado di Collaborazione e di Integrazione nel Design Team tra HLN, Arup, Faithful Gould, ecc.). Del resto, la gestione degli elaborati dall'Information Model è ancora molto legata ai disegni: *outputs and deliverables are cut straight from model. We estimate this has created significant savings and improvement in accuracy, for example, in the detailing of builders work for the pre-cast elements over and above traditional methods which would have required generating individual 2D plans, sections and elevations for each element;*
- l'insistenza sui Data Drop andrebbe verificata alla luce degli usi effettivi che dei dati raccolti si faranno in seguito, ma, oltre a ciò, si ravvisa una certa insicurezza sulla validità dei Protocolli generali: *the issue of an MoJ specific BIM Protocol document would help to consolidate some of the contractual issues around design responsibility for the BIM information at Drop 2a and 2b. The quality checks in the COBie definitions need to be defined. The CIR should be explicit about which of the ten 'Client's Strategic Purposes' outlined in the COBie-UK-2012 specification the COBie data will be used for. In addition, the tender assessment criteria should define the processes by which the tender return COBie files will be assessed against the tender submission files and the tools that will be used to carry out this assessment;*
- il modello del Two Stage Open Book prevede, anzitutto, la concertazione di Framework Agreement coi progettisti e con l'appaltatore, per, poi sviluppare una azione congiunta anche coi principali subappaltatori, giungendo a un Agreed Maximum Price, come regolato dal contratto sulla scorta del PPC2000: *the Constructors need to manage the process differently, and use different resources and therefore there needs to be more forward planning and adherence to dates. Effective use of BIM may need a review of the procurement process. BIM has the potential to change how designs are managed (BIM Technical Standards Library) and risk profile (clarity of risk through Data Drops). This may lead to review of tender process as BIM maturity increases. ECI commenced when Interserve worked with its preferred subcontractors (including SCC and EMCOR) to develop*



*innovative proposals at the point of selection by Ministry of Justice from a shortlist of framework contractors;*

- il processo di negoziazione nella transizione tra progettazione ed esecuzione appare tra i più interessanti e fruttuosi: *this collaboration continued among Interserve and its subcontractors who worked with Ministry of Justice and its consultants as an integrated team to undertake agreed preconstruction phase surveys, design development, risk management, cost reviews, enabling works and other preconstruction activities that delivered further innovations.* Collaboration between Interserve and its specialist SSC resulted in a pre-cast volumetric cell proposal for the construction of the project. As a result, the construction programme was reduced from 50 to 44 weeks with a saving of £85,000 in time-related site overheads. Additional savings were achieved through Interserve working with Ministry of Justice to review certain works packages and obtain early cost/quality proposals from Tier 2 on an open book basis in advance of start on site;
- il 4D Modelling è stato pure utilizzato, ma senza particolari innovazioni: *the team have linked the model to our construction programme to effectively simulate the construction sequence. This has proved an effective tool to engage new starters during inductions and help them to familiarise themselves with our construction site. It's a great tool to share the build sequence with those who aren't used to reading typical programme charts;*
- assai più interessante appare il ricorso al cosiddetto Location-Based Management System;
- naturalmente, anche per il Ministry of Justice, la gestione del computo metrico attraverso l'Information Model si è verificata come positiva, ma, in generale, si è riscontrata una certa sensibilità alla gestione del rischio con riferimento al Model Checking: *aspects of the design continue to develop even when the contractor has started on site. Interserve have continued to coordinate models during the construction phase and use a Model Risk Register to log, delegate and prioritise issues found to ensure they are resolved in good time.*
- manca spesso l'attenzione alla gestione della catena di fornitura: *the majority of the tender was administered by the Constructors using the 2D information (particularly amongst their Supply Chain). To get the best value out of BIM this needs to change and is again recognition of the challenges of using BIM in the tender environment. This is a larger industry debate about BIM uptake in Tier 2 and 3 supply chain as the BIM capability of the Tier 1 supply chain is dependent on Tier 2 and 3;*
- la centralità dell'Operations & Management non sembra del tutto mediata nella fase costruttiva, di fatto poco esaminata, se non per la definizione del modello informativo As Built, per giungere a quella che sarebbe seguita: *one of the MoJ's key objectives is to ensure that data is fed from the BIM Model into the Estates Facilities Management programme Planet. It is proposed that this be achieved by using COBie (Construction to Operations Building Information Exchange) data, which enables data extracted from the model to be inputted into another programme;*
- una simile centralità è, tuttavia, evidente anche in fase di progettazione costruttiva: *development by Arup and EMCOR of a model for service ducts and cell risers as Ministry of Justice had to be satisfied that these could be serviced by repair and maintenance engineers without reference to a computer. It is expected that this will result in whole life benefits.*



## Il Lean Management

A conclusion della disamina, vale la pena di osservare, come, negli Stati Uniti, in un recente contratto, Turner Construction governava i processi di fornitura BIM-Based, legandoli anche al Last Planning e alla Lean Construction: *Turner Construction Subcontractor agrees to participate in the use of digital/computer based three dimensional models and other related functionality, generally referred to as building information modeling (such models and functionality are referred to herein as BIM) as Turner may determine to be beneficial for use in facilitating coordination, sequencing, scheduling and/or production of as-built depictions of the Project and performance of the Work and as hereafter provided. The Subcontractor's costs of such participation are included in the Price unless explicitly outlined herein. Subcontractor's submissions shall be of sufficient detail to enable accurate and complete clash detection and shall be provided by Subcontractor at a point in time that is reasonably in advance of Subcontractor's shop drawing submittals and the subsequent on site construction of the Subcontractor's Work, and such submissions shall contain such details and follow such procedures as Turner may require.*

Come si può constatare, il BIM Management si sviluppa nel contesto della co-location dei subappaltatori e dei fornitori: *Subcontractor shall participate in such BIM coordination and review meetings as Turner may require and agrees that, as a result of the information exchanged at such meetings, both the digital submission and the Work depicted in the Subcontractor's digital submission may be required to be changed by Subcontractor to achieve coordination with other elements of the Project being provided by others. Such changes shall be accomplished at no increase in the Price or Time of Completion. Subcontractor acknowledges that such meetings will require attendance of personnel that are familiar with both the data entry aspects of the BIM as well as an understanding of the Work to be performed and its relation to other elements of the Project, and subcontractor therefore agrees that personnel conversant in both shall attend all such meetings.*

Naturalmente resta ancora piuttosto prevalente la prudenza che invita alla coesistenza tra soluzioni avanzate e soluzioni tradizionali: *Subcontractor agrees that neither the BIM nor the use of the BIM is in lieu of nor intended to relieve the Subcontractor of its responsibilities under the Subcontract, including to (i) coordinate its Work with the work of others involved in the Project and (ii) strictly comply with the other requirements of the Subcontract Agreement and the Contract Documents. It is expressly understood and agreed that, notwithstanding the requirement for submittals in connection with the BIM, traditional shop drawings and other submissions shall be required of Subcontractor as required by the Contract Documents and no party shall be liable to the other for any claim, dispute, controversy, cost, or expense arising solely out of the use of the BIM. Subcontractor agrees that notwithstanding the fact that it may participate in the BIM process or receive information or materials from others in connection with the Project through the course of the use or development of the BIM, it shall not take any position that the receipt of such participation or information has or will, in any respect, operate to waive, release or otherwise invalidate any of its obligations or responsibilities under the Subcontract or any intellectual property rights (copyrights, trademarks/logos, patents, etc.) that may apply to such information or materials.*

Certamente ai subappaltatori sono affidati oneri non indifferenti: *In the event the Subcontractor discovers any error, inconsistency, or omission in its information or submissions, the information or submissions provided by others or any BIM, it shall promptly report the same to Turner via written notice, which shall contain all relevant specifics.*

Appare, pertanto, palese come, dopo la fase progettuale vera e propria, si tratti di fornire un riferimento ai subappaltatori per la progettazione operativa: *Turner Construction Company may provide at their sole discretion a three-dimensional model representation of project Architectural scope for use as a background during coordination. The model shall include, where applicable, elements such as floor slabs, architectural cast-in-place concrete, catwalks, ceilings, soffits, and plenums, interior partition thicknesses, roof thicknesses, roof penetrations and openings, stairs, soffit framing, and miscellaneous metal supports. Turner makes no guarantees, implied or otherwise, as to the accuracy of this modeled information. Each subcontractor is solely responsible for coordinating the trade's scope of work to the information represented in the two-dimensional contract documents.*

Di fatto, il BIM Coordinator ha il compito assemblare virtualmente parti dell'opera:

- a. *Setting and issuing the schedule of coordination, including milestones, submission deadlines, and target completion dates.*
- b. *Determining the specific modeling conditions unique to the project.*
- c. *Assembling the composite model representing all trades and disciplines participating in the coordination process.*
- d. *Performing clash detections per the coordination schedule.*
- e. *Organizing detected clashes into geometrically contiguous groups.*
- f. *Assigning subcontractor responsibility and annotating procedures for clash resolution.*
- g. *Administering clash-resolution meetings per the coordination schedule.*
- h. *Creating such ephemera as is required by the Turner project team to facilitate the coordination process (e.g. clash matrices, model snapshots, or scenario visualizations).*
- i. *Specifying the location and method of shop drawing and as-built documentation delivery.*

*Turner shall provide to each subcontractor a Schedule of Coordination. This schedule shall specify dates for events including, but not limited to, coordination meetings, model delivery deadlines, and project milestones.*

In questo modo, la risposta dei subappaltatori è assimilata a una costruzione digitale legata a quella effettiva: *All Subcontractors shall generate and provide, in a timely manner, a three-dimensional model of their scope of work in addition to the contractually-required two-dimensional documentation. The 3D Model will represent an "as-fabricated" fully-detailed level of information. Elements included in the model may vary by trade and are enumerated below. Any element not enumerated in the Trade-Specific paragraphs below may be modeled if required to resolve a particular coordination issue determined as the sole discretion of the BIM Coordinator.*

La clash detection assume, quindi, una sembianza fondamentale di condivisione: *Each Subcontractor shall be required to publish in a timely manner their current scope models to the Glue server, according to the Schedule of Coordination set by the BIM Coordinator. If necessary, the BIM Coordinator shall provide training in the use of Glue. BIM Coordinator shall create clash detection logic within the Glue system, and run official clash detections in a timely manner, according to the Schedule of Coordination. The clash results shall be grouped into geometrically-contiguous clash groups, and the BIM Coordinator shall assign responsibility for clash resolution based on the Hierarchy of Systems Coordination, annotating each clash group accordingly. Each revision of the Consolidated Model shall be immediately available to all stakeholders within the Glue system.*

Tale processo di coordinamento investe la questione più delicate, quella inerente non ai conflitti tra gli elementi costruttivi, bensì quelli relativi alla coesistenza tra imprese: *Upon publication of the Consolidated Model and prior to the coordination meeting, each Subcontractor shall, to the best of his ability, resolve the coordination issues identified during the clash detection for which they are*

*primarily responsible. If conditions exist where adjacent trades may be affected by a subcontractor's coordination changes, the revising subcontractor must contact the adjacent trade's subcontractor to develop a resolution for all affected trades.*

*Ciò, però, si risolve ancora nella bi-dimensionalità: Once coordination has been determined to be complete for each zone of the project, each subcontractor is required to submit for approval such two-dimensional, annotated, as-fabricated drawings as are required to make a complete representation of their entire system scope. These drawings must be fully-dimensioned projections including, but not limited to, plans, sections, elevations, and axonometric diagrams. Unless otherwise stipulated by the BIM Coordinator, the drawing scale shall be 1/4" = 1'-0". The number, format, and medium of these drawings shall be determined elsewhere in the subcontractor's contract. Printed copies must be delivered to Turner as stipulated by the BIM Coordinator.*

*Il processo digitale di costruzione virtuale non può, quindi, che risolversi nella Lean Construction: "Ready" means that the trade supervisor, project manager, and detailers have "built the job on paper" or built the details or assemblies virtually in the Building Information Model (BIM), shop drawings, and or built a site mock-up if appropriate to coordinate details.*

*Approcci come il Last Planning™ system o il KanBIM™ system appaiono naturalmente ancora, in parte sperimentali, ma il fatto che stiano divenendo oggetto di negoziazione tra le imprese appaltatrici e i loro subappaltatori dimostra come un profondo cambiamento sia in atto nel Settore e nel Mercato...*