AALBORG UNIVERSITY

Building Informatics

Produkt og Procesmodeller (PPM) i byggeriet.
Product and Process models in Construction.

6. Process Models

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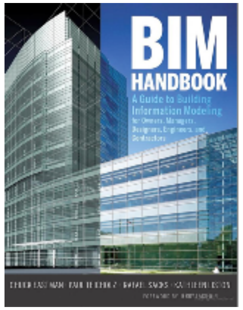
From the BIM Handbook



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BIM for Subcontractors and Fabricators.

7.0 Executive Summary.

Unlike the mass production of off-the-shelf parts, however, complex buildings require customized design and fabrication of ‘engineered-to-order’ (ETO) components, including: structural steel, precast concrete structures and architectural facades, curtain walls of various types, mechanical, electrical plumbing (MEP) systems, timber roof trusses, and reinforced concrete tilt-up panels.

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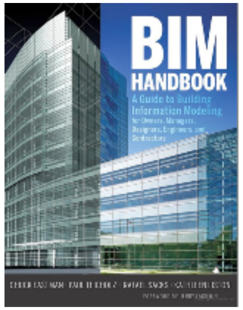
To be useful for fabrication detailing, BIM tools need at least to support parametric and customizable parts and relationships, provide interfaces to management information systems, and be able to import building model information from building designers’ BIM tools. Ideally, they should also offer good information model visualizations and export data in forms suitable for automation of fabrication tasks using computer-controlled machinery.

Our emphasis in red.

From the BIM Handbook



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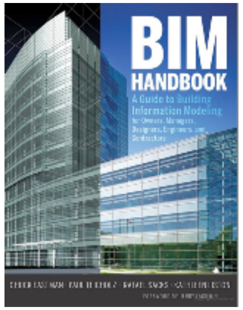
7.1 Introduction.

Drawings are used to coordinate the location and function of various building systems parts. This is the case today for all but the simplest buildings.

In traditional practice, paper drawings and specifications prepared by fabricators for designers fulfill additional vital purposes. They are kept part of commercial contracts for the procurement of fabricator's products. They are used directly for installation and construction, and they are also the primary means for storing information generated through the design and construction process.

Our emphasis in red.

From the BIM Handbook



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7.2 Types of subcontractors and fabricators.

Looking beyond bulk raw materials, building components can be classified as belonging to one of three types:

1. **Made-to-stock components**, such as standard plumbing fixtures, drywall panels and studs, pipe sections, etc.

2. **Made-to-order components**, such as pre-stressed hollow-core planks, and windows and doors selected from catalogues.

3. **Engineered-to-order components**, such as the members of structural steel frames, structural precast concrete pieces, facade panels of various types, custom kitchens and other cabinet-ware, and any other component customized to fit a specific location and fulfill certain building functions

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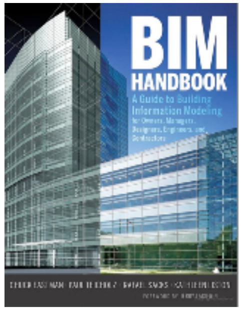
In addition, there are building construction trades that do not function exclusively as ETO producers but offer significant ETO component content as part of their systems. Examples are: plumbing, heating, ventilation and air-conditioning (HVAC), elevators and escalators, and finish carpentry.

From the BIM Handbook



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7.3 The benefits of a BIM processfor subcontractor fabricators.

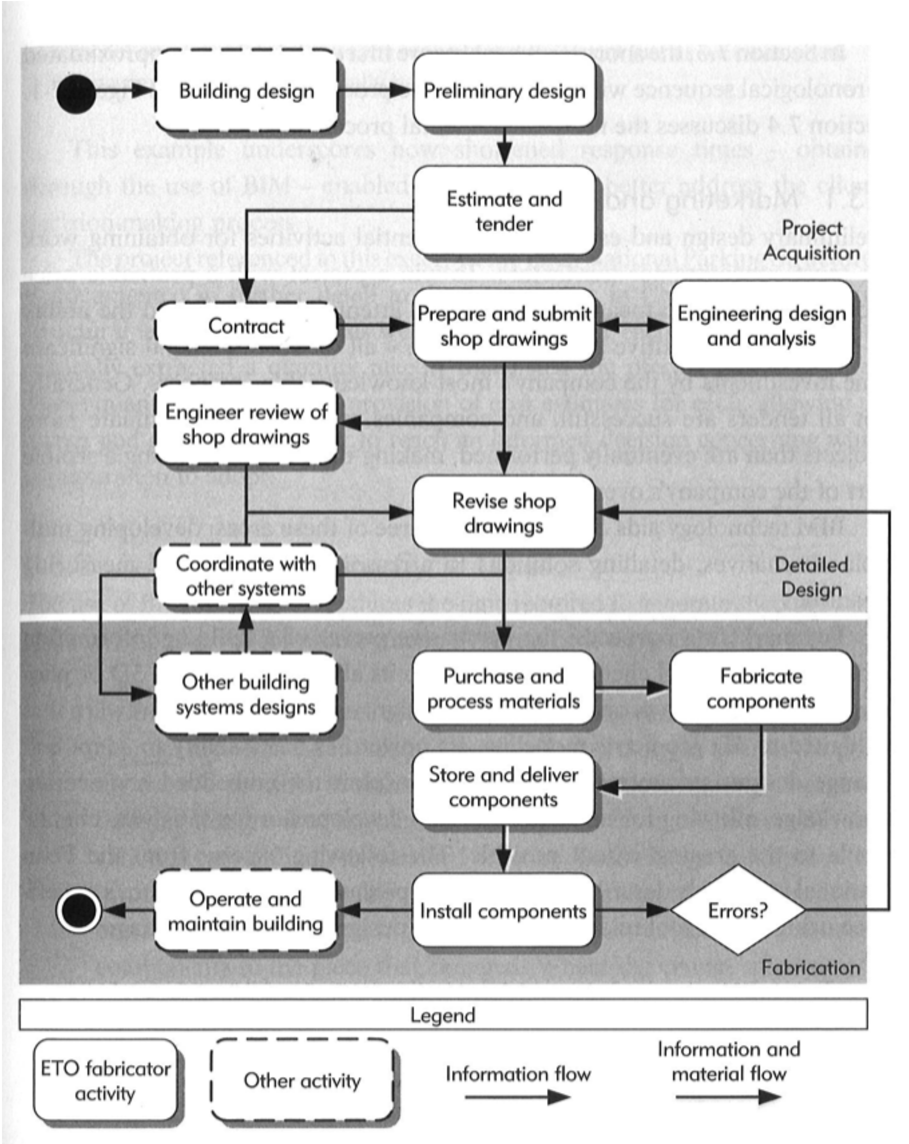
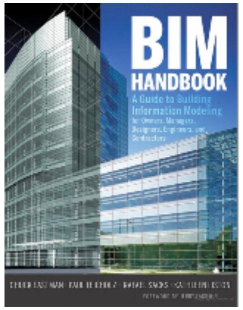


FIGURE 7-1
Typical information and product flow for a fabricator of ETO components.

From the BIM Handbook



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7.3.2 Reduced Production Cycle-Times.

The use of BIM significantly reduces the time required to generate shop drawings and material takeoffs for procurement. This can be leveraged in three ways:

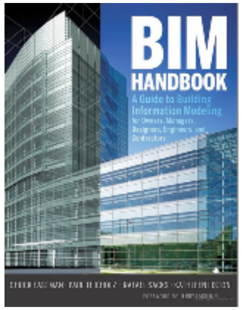
- To offer a superior level of service to building owners, for whom late changes are essential. …. With BIM tools, the changes are entered into the model and updated erection and shop drawings are produced automatically. The benefit is enormous in terms of time and effort required to properly implement change.

- To enable a "pull production system" where the preparation of shop drawings are driven by the production sequence.

- To make prefabricated solutions viable in projects with restricted lead-times between the contract date and the date demand for the commencement of onsite construction, which would ordinarily prohibit their use. Often, general contractors find themselves committing to construction strat dates with lead times-times that are shorter than the time required to convert conventional building systems to prefabricated one, due to the long lead-times needed for production design using 2D CAD. For example, a building designed with a cast-in-place concrete structure requires, on average, two to three months to complete the conversion to precast concrete and produce the first pieces needed. In contrast, BIM systems shorten the duration of design to a point where more components with longer lead-times can be prefabricated.

Lead-time: the time between the initiation and completion of a production process.

From the BIM Handbook



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7.3.3 Reduced Design Coordination Errors

In the introduction to this chapter, we mentioned the need for fabricators to communicate construction intent to designers. …. It allows the team to identify potential conflicts inherent in design. A physical clash between two components, where they are destined to occupy the same physical space, is the most obvious problem. It is termed a *hard clash*. *Soft clashes* occur when components are places to close to one another, albeit not in physical contact, such as rebars that are too close to allow for placing of concrete or pipes that require adequate space for insulation.

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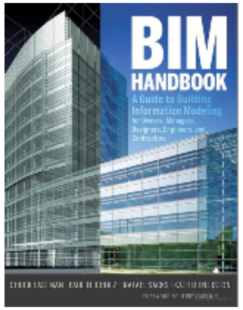
Once the team has decided upon a solution for a conflict identified in the review software, each trade must then make the necessary changes within their individual BIM software. [today's situation].

In future systems it should be possible to report the clash back to each trade's native BIM tool by using the components IDs.

Another significant waste occurs when inconsistencies appear within the fabricators *own* drawing sets. [example mirroring drawing]

From the BIM Handbook



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7.3.4 Lower Engineering Detailing Costs

BIM reduces direct engineering costs in three ways:

- Through the increased use of automated design and analysis software;
- Almost fully automated production of drawings and material takeoffs;
- Reduced rework due to enhanced quality control and design coordination

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7.3.5 Increased Use of Automated Manufacturing Technologies

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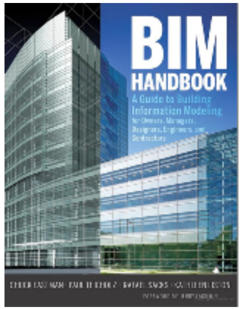
7.3.6 Increased Pre-assembly and Prefabrication

With few exceptions, 2D CAD did not give rice to new fabrication methods, and it did little to aid the logistics of prefabrication offsite. BIM tools, on the other hand, are already enabling not only greater degrees of prefabrication than could be considered without them but also prefabrication of building parts that were previously assembled on site.

From the BIM Handbook



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7.3.7 Quality Control, Supply Chain Management, and Lifecycle Maintenance

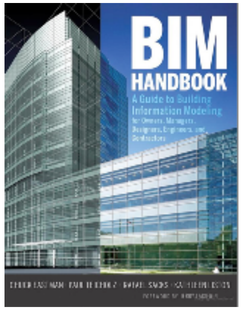
For manufacturers of ETO products for construction, three main areas of application will be:

- Monitoring the production, storage, and delivery of components to site using GPS and RFID systems;
- Supporting the installation or erection of components and quality control using LADAR [laser detection and ranging] and other surveying technologies;
- Providing life-cycle information about components and their performance using RFID tags and sensors

A common thread that runs through all of these proposed systems is the need for a building model to carry the information against which monitored data can be compared. The quantity of data that is typically collected by automated monitoring technologies is such that sophisticated software is required to interpret them.

[See also (Sørensen, 2009)]

From the BIM Handbook



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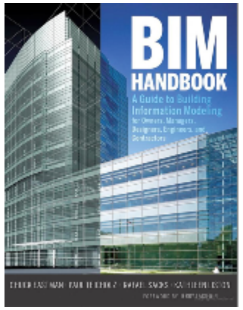
7.4 BIM-enabled Process Change

7.4.1 Leaner Construction

7.4.2 Less paper in Construction
(3D to CNC /computer numerical control/ machine, help man at building site)

7.4.3 Increased distribution of work [virtual workspaces]

From the BIM Handbook



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7.5 Generic BIM System Requirements for Fabricators

7.5.1 Parametric and Customizable Parts and Relationships

(…automate design and detailing… building information models remain coherent, semantically correct and accurate)

7.5.2 Reporting Components for Fabrication

The ability to automatically generate production reports for each individual ETO component in a building is essential for fabricators of all kinds. Reporting may include: preparation of shop drawings; compiling CNC machinery instructions; listing constituent parts and material for procurement; specifying surface finish treatment and materials; and listing hardware required for installation on site etc.

[Our addition: information to support O&M of components]

7.5.3 Interface to Management Information Systems (p. 266)

(… maybe stand-alone applications or part of enterprise resource planning (ERP) suite)

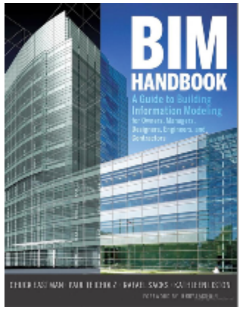
7.5.4 Interoperability

7.5.5 Information Visualization

(… 4D..)

7.5.6 Automation of Fabrication Tasks (p. 267)

From the BIM Handbook



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7.6 Major Classes of Fabricators and their Needs

7.6.1 Structural Steel

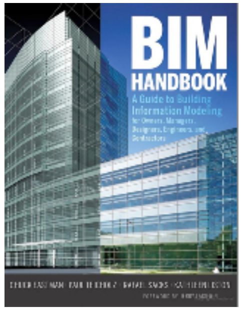
7.6.2 Precast Concrete

7.6.3 Cast-in-place (CIP) Reinforced Concrete

7.6.4 Curtain Wall and Fenestration

7.6.5 Mechanical, Electrical and Plumbing (MEP) (p.274)
(.. Ducts, piping, routing trays and control boxes…. Production and installations logistics)

From the BIM Handbook



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7.7 Adopting BIM in a Fabrication Operation

BIM systems are a sophisticated technology that impacts every aspect of a fabrication subcontractor's operations, from marketing and estimating through engineering, procurement of raw materials, fabrication, shipping to installations onsite, and maintenance. BIM does not simply automate existing operations that were previously performed manually or using less sophisticated software, it enables different workflow patterns and production processes.

7.7.1 Setting Appropriate Goals (p.277)

- What new services can be offered
- To what degree can building model data be imported and how early in process
- Embedding standard engineering details (who, how?)
- Alternative ways of communicating information within company and to consultants?
- Appropriate pace of change. Phasing out existing software
- Need and capabilities of suppliers to whom engineering work is outsourced

7.7.2 Adoption Activities (p.278)

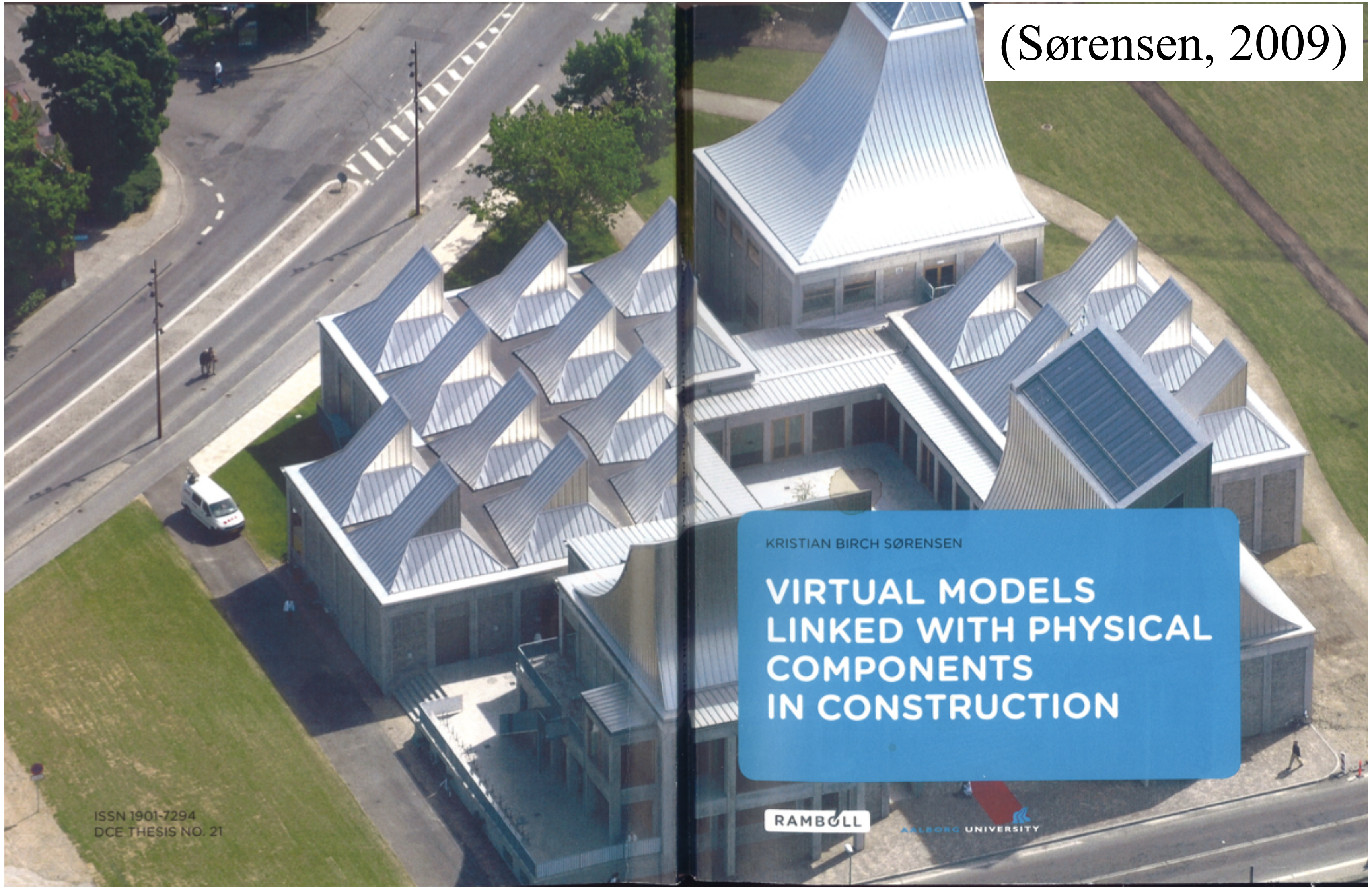
(… training, libraries, software, project ghosting, seminars/workshops other departments)

7.7.3 Planning the Pace of Change (p.280)

7.7.4 Human Resource Considerations (p.281)

(… who, external collaboration..)

(Sørensen, 2009)



Scenario for Future Use of RFID in Construction

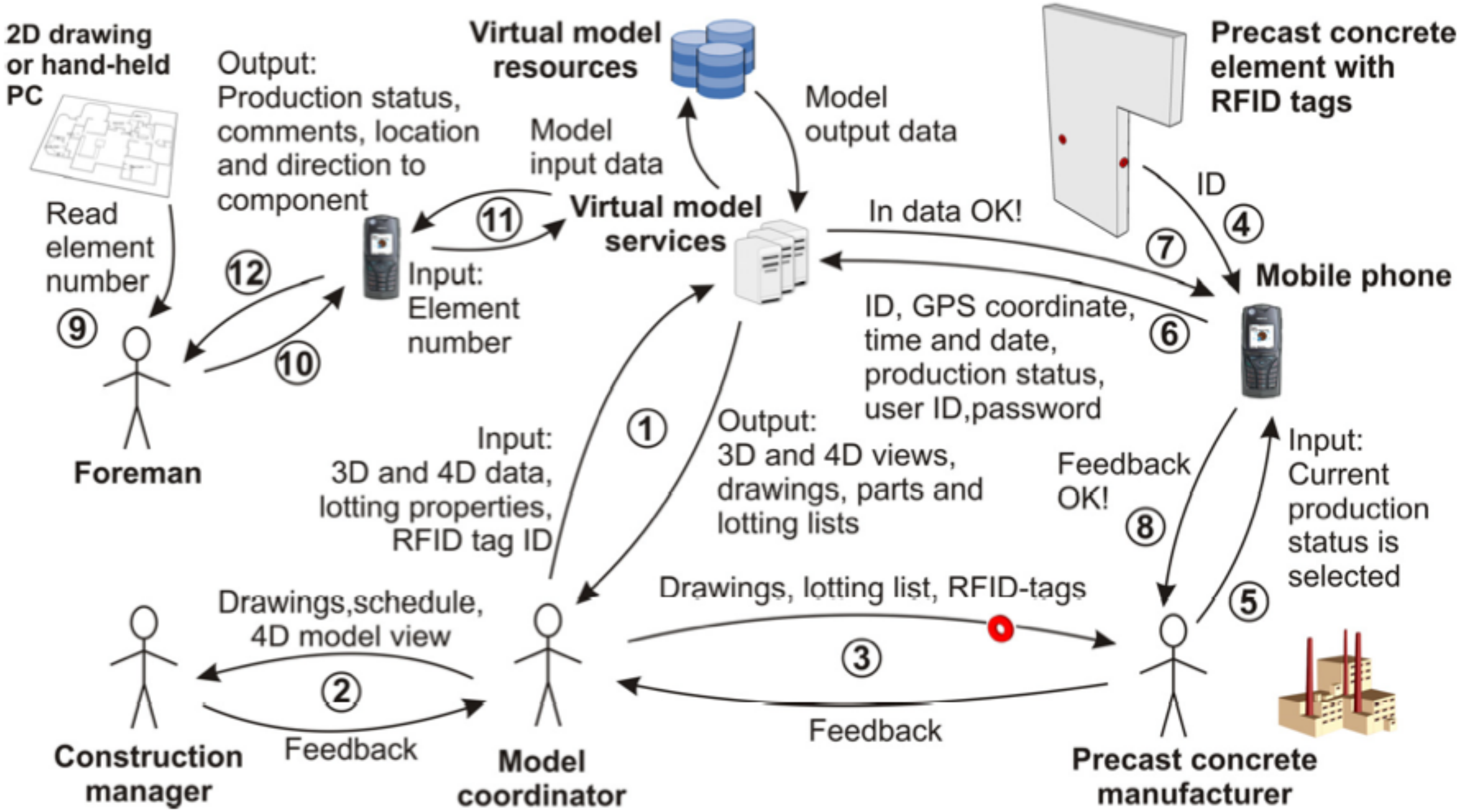


Figure 3 Rich picture illustrating future use of a digital link between virtual models and physical components in construction for model generation and precast element management. The numbered events refer to a possible sequence of the actions.

From (Sørensen, 2009) page 45. Se also (Sørensen et.al.,2009).

REFERENCES

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Sørensen K B (2009) “Virtual Models Linked with Physical Components in Construction”. PhD thesis. ISSN 1901-7294 DCE Thesis No. 21. August 2009. (pp 282).

Sørensen K, Christiansson P, Svidt K (2009) Prototype development of an ICT system to support construction management based on virtual models and RFID, ITcon Vol. 14, Special Issue Next Generation Construction IT: Technology Foresight, Future Studies, Roadmapping, and Scenario Planning , pg. 263-288, http://www.itcon.org/2009/19

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http://it.civil.aau.dk