JBIM

Journal of Building Information Modeling

An official publication of the National Institute of Building Sciences buildingSMART alliance™

National Institute of Building Sciences: An Authoritative Source of Innovative Solutions for the Built Environment

Spring 2010

BIM and FM:

The Portal to Lifecycle Facility Management

Integration of BIM and RFID in Steel Construction

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CONSTRUCTION PROFESSIONALS OFTEN HAVE TO SELECT from or combine best options to improve the accuracy and certainty of the decision-making processes. For example, steel erectors need to decide on the steel connections, equipment selections, labor arrangements, operation and loading problems. As a combination of all the project data, building information models (BIM) display project data in a designed systematic model that helps with steel construction. Radio Frequency Identification (RFID) tags can support the tracking of component delivery and installation onsite. BIM components that include references to RFID tags can automatically update building product data and construction process data when linked to field scanning devices.

RFID USE FOR BIM DECISION-MAKING

FIGURE 1 shows how RFID can be used in BIM for component tracking. RFID tags can be attached to each construction component and the RFID tag information can be used to represent the component in the BIM model for the construction process.

Steel fabricators use different identification methods for steel members. For example, W12X40 is a marker of column/beam wide-flange shape steel. On projects, wide-flange steel is commonly selected for structural uses. When a user searches for steel components and enters W12x40, BIM tools will show all the members that meet this criterion. In BIM tools, the W12x40 column at the C3 location (the intersection of column line C and column line 3) is not distinguished from the W12x40 column at the B2 location (the intersection of column B and column line 2). RFID technology helps to distinguish the W12x40 members individually. It also enriches and completes the information available for steel members. Each W12x40 steel member is differentiated by its location, date, connection features, and so on. In this case, each member has a special serial number as its ID and is saved in its RFID tag's memory.

An RFID system application in steel structure construction is shown in **FIGURE 2**. The current main purpose for using RFID on a steel structure construction project is to track a steel member's progress and location. In this research, RFID can be regarded as the project information carrier. A passive RFID tag and low radio wave frequency (such as 125 KHz tags) is enough for the current use.

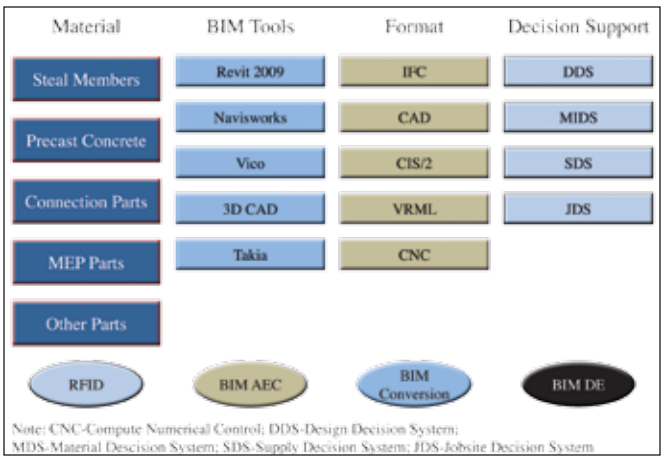

Figure 1. RFID used for BIM components.

RFID is included in this BIM project and impacts the entire project. It makes it more convenient in managing projects, especially when tracking process and erection connection details. In this project, the drawing design had been finished. The first step was to transfer the 2D drawings to a BIM 3D model (see **FIGURE 3**). The transfer process involved the following steps:

1. Transfer a 2D CAD drawing to a 3D BIM.
2. Use RFID to identify each steel member in the project and input RFID to the BIM model.
3. Use RFID to make an optimal project schedule.
4. Simulation and testing RFID and 4D BIM tools.
5. Use RFID to assist the BIM model to control the project.

The RFID database stores and shares each steel component feature and design coding requirement to support the connection design. The design support system uses SDS/2 and Navisworks. SDS2 and CNC control the manufacture, RFID acts as the shop drawing coding system. Other fabrication activities are all under the BIM/RFID Decision Making Model control when using the RFID coding system.

RFID can also help the BIM team to develop the optimal erection plan for the project. This plan should decrease the duration of the project and meet the technology, cost and safety requirements as well.

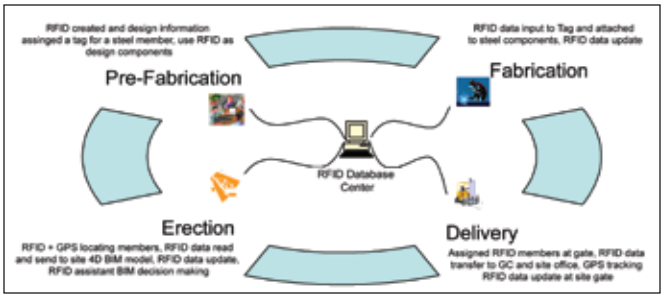

Figure 2. RFID application paths.

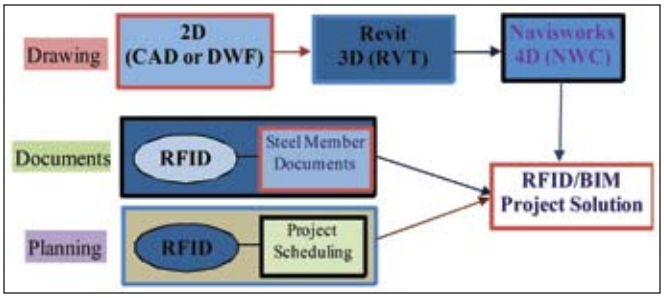

Figure 3. Project files transfer architecture.

USING RFID DATA FLOW FOR THE BIM DECISION MAKING PROCESS

In **FIGURE 4** "DDS" is a system that supports a designer in making a design decision. RFID data layers represent: 1) the design feature layer, including information such as building type, design style and zoning information; 2) the material feature layer, including information such as loading, tension, heat resistant condition and bending features of materials; 3) material layout location layer; and 4) supply chain layer, such as traffic information, weather, road conditions and delivery information. The RFID data flow and BIM components can also be used to make decisions on design, manufacture, supply and installation.

FIGURE 5 shows how a column changes in a simulation of a multiple-floor structural steel 4D model. In **FIGURE 5 (A)** the column with RFID #C10A0301 has not been erected. The information in the RFID tag of column #C10A0301 includes steel features, the mill manufacturer, inspectors, storage, delivery and site location IDs and dates. Other information, such as connection methods and welding methods, may also be included if memory size allows.

FIGURE 5 (B) shows the column has been erected but not connected. At this point more information will be added to the RFID database, such as the installation date, crane operator, superintendent, erector, etc. Information is input to the RFID database system via a wireless PDA reader or manual typing.

In **FIGURE 5 (C)** the column #C10A0301 was connected with beams #B20A0301 and #B20B0301. The added information includes the connected beam information, connected inspection information, erector and connector, crane and operator, safety issues, date and location GPS points, maintenance requirements, bolting and welding methods, bolt size and specifications, etc. The RFID database system is updated and should be inspected in detail by foremen using RFID readers to check the components RFID tags and to determine connecting pieces.

FIGURE 5 (D) shows the building finished with the exterior wall in place. At this point, column #C10A0301 now has all its connection information updated, including its attachment to the walls and roof trusses, girders, bracing, plates and rods. Every connected member and its information may be found by checking its RFID tag and logging into the RFID database system in the BIM/RFID model. This RFID information will be kept in the building facility model to maintain the building lifecycle. The building components can be monitored piece by piece by using RFID records.

Using RFID to simulate the project progress helps the architect, engineer and contractor (AEC) track the progress details of structure steel erection. With the aid of simulation, users could forecast problems to avoid possible adverse situations. They could use the scheduling track to monitor and control changes and buffers in advance to make an optimal plan.

CONCLUSION

Using RFID with BIM makes it possible to develop an effective design-planning-fabrication-erection intranet-based system. RFID gives steel components and events a specificity emblem to transmit their information when saved in the RFID tag. Using RFID tags and the database in the BIM system can help users make better decisions when erecting structure steel. ■

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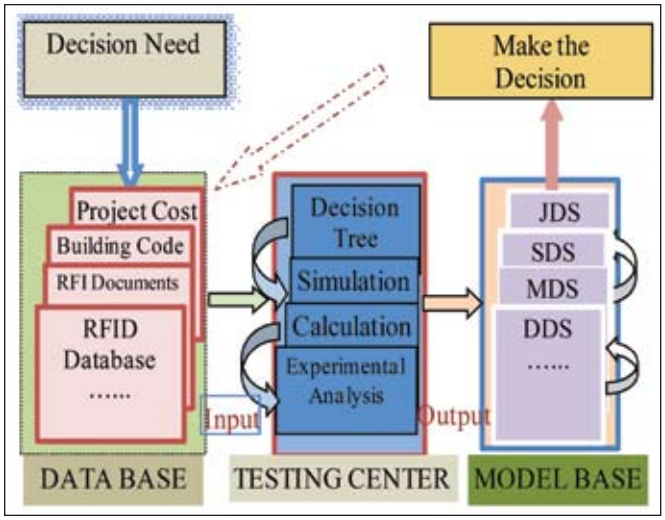

Figure 4. RFID using DATA flow for BIM decision making process.

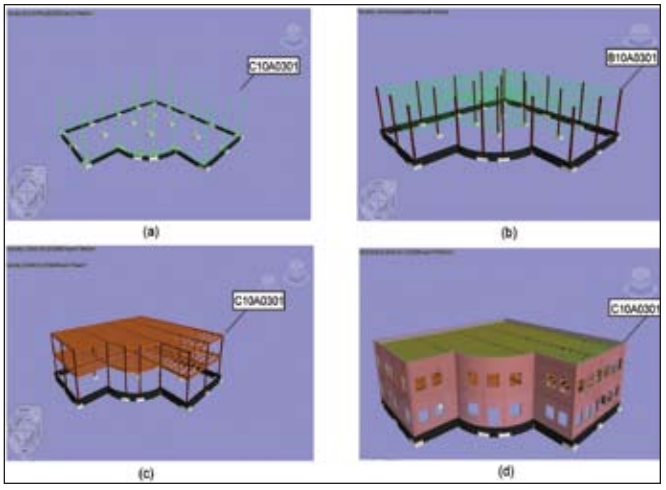

Figure 5. 4D BIM Model shows a column with RFID changes (Revit 2008).