Stadium Construction Technology Based on Information Modelling of Building Engineering

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***Abstract* — With the rapid economic development and progress of society, there is a need for increasing the number of sports venues. Through the construction and operation management of stadiums, and full analysis of the current situation, it is clear that faced with engineering design and construction problems operators often find it difficult to meet completion targets. Therefore, in order to achieve social and economic benefits of the overall optimization and multi-party major sports venues, the technology must include: i) the full life-cycle management theory and methods, ii) in-depth study of the construction of stadium implementation, iii) operational management for sustainable development, and iv) important stadiums theoretical and practical significant issues. This paper attempts to improve the overall effectiveness and efficiency in the use of large stadia by means of architectural design using concepts of further expansions. We propose BIM-based information management system to include architecture, structure and extension mechanisms.**

Keywords -- Building Information Modeling; Stadium Construction; Engineering Technology

I. INTRODUCTION

With the deepening of reform of higher education, promote college enrollment, consolidation and development of the expansion, mergers, joint and other educational resources, so university and college campuses, especially to prospective universities function gradually, diversified and complex technology trends [1]. Construction of stadiums projects in line with this trend, which is the basic requirement of modern campus planning and construction. According to the requirements of stadiums construction projects feature in the construction must be from people-oriented, diversified and efficient, dynamic continuous three principles hold up their planning and design of the project schedule to conduct scientific establishment and management, to propose more effective project quality and cost control plans and optimization methods, in order to ensure Kazakhstan iron college stadium project within the time planned to complete the construction of high quality [2-3].

From the overview of the origin and development of the stadium, analyzes under the new situation and new problems and challenges of IT innovation brings to the stadium, as well as the impact of large-scale IT stadium faced summarized China's major sports venues under the influence of information technology that may occur the biggest change, and explore issues related to large stadium under the influence of information technology design [4-5]. This paper focuses on issues related to the design of large-scale stadium next explore the impact of information technology, trying to improve the overall effectiveness and efficiency in the use of large stadium by means of architectural design, and on this basis, on the stadium's design was further extended .

The construction sector in the process of development of information technology, the lack of uniform standards for information exchange and information integration mechanism, resulting in the exchange of information and sharing of difficulties between the different stages of life and different construction applications, forming islands of information and information gaps, hindering information technology in the construction sector, thus affecting the productivity of the construction industry. Therefore, the establishment for the building life cycle management system, the development of integrated information management system, improve the construction industry has become an important level of information research and development trends. The latest results of this study the comprehensive application of building information modeling (Building Information Modeling, BIM), information standards and information integration technology, the introduction of international standards for the construction industry IFC (Industry Foundation Classes), proposed BIM-based project information management system and structure, establish a BIM architecture description and extension mechanism.

II. BIM-BASED PROJECT INFORMATION MANAGEMENT FOR STADIUM

Core building life cycle management ideas and concepts are the building lifetime through effective information management for the construction and use of value-added construction project. Effective information management is creating effective and efficient management of information and effective sharing of information [6-8]. The BIM is the

key to effective information management. its structure is shown in figure 1.

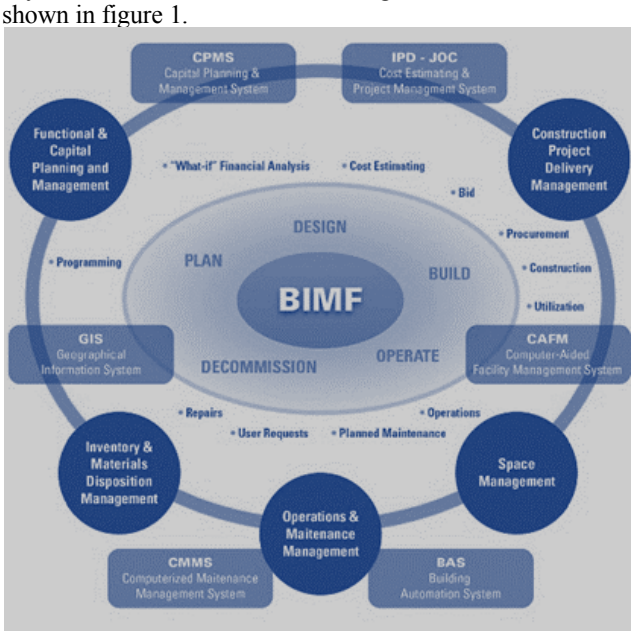

Figure 1. The structure of Building Information Modeling (BIM).

Stadium construction project implementation is highly complex, large-scale features, involving owners, consulting, design, construction, operation, and many other actors, BIM data generated by the complex structure, different formats, different stages of the application requirements for data that are not the same [9-10]. Therefore, how to create a life in the building of BIM information created by the way who is troubled BIM technology to achieve, and how to solve the storage and distribution of BIM data sharing heterogeneous data it is to establish BIM key technical problems.

This paper presents a method to create a stage and applications for BIM information is a sub-information model as the core. The basic idea is that with the progress of the project and the need to create a phased BIM information, namely from project planning to design, construction, operation at different stages, to establish the appropriate data sub-models for different applications. Each sub-information model can automatically evolution, through the extraction of model data on a stage, expansion and integration, the formation of the present stage information model, but also for a particular application integration model data to generate application sub-model, along with progress of the project eventually form For complete information model for the building life cycle. Create BIM information throughout the entire life of the construction project, is the accumulation of the building life cycle engineering data, expansion, integration and application process, is for the construction lifecycle information management and services, as shown in Figure 2.

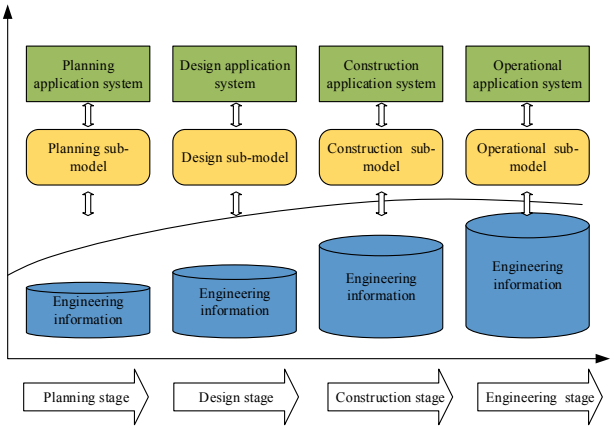

Figure 2. BIM information creation process.

From the planning phase to the design phase to the construction phase to the operational phase, the gradual integration of engineering information and eventually form a complete description of the construction project information lifetime collection. Each stage and each stage of software systems according to their information exchange requirements, the definition of the stage and information exchange sub-models for specific applications. Application system to achieve integration and sharing of data extraction and integration through sub-model.

Design stage, architectural design, structural design according to the planning stage of information to the drainage design, HVAC design, produce large amounts of geometric data, and building and construction professional, construction and to between water supply and drainage, building and HVAC exist Collaborative demand data access. These requirements through different sub-information model and the overall interaction and sharing BIM model.

Construction stage, can be extracted partial information on demand planning and design stage, the application software used for the construction phase, such as 4D construction management, cost estimates analysis. These applications will generate new information and integrated into the overall BIM model.

Operation and maintenance phase, BIM model integrated engineering information planning phase, design phase, construction phase, calls for the operation and maintenance of application systems. Due to the application of BIM makes project information to the various stages of integration and preservation, in order to address the loss of information and information gaps and other issues.

III. BIM Modeling Technology FOR Gymnasium

BIM can support building information management life cycle, so that information can be effectively organized and tracking, to ensure the transmission of information from one phase to another does not occur loss of information, reduce ambiguity and inconsistent information. To achieve this goal, the need for a lifetime of saving for building information

integration platform for BIM and BIM data, tracking and extension mechanism, the various stages of the project engineering information related to organic integration [11-13]. Stadium project includes building components, power distribution components, etc., derived by IFC Product entity. IFC Product is an abstract base type that defines the attributes associated with the geometric representation, as shown in Figure 3.

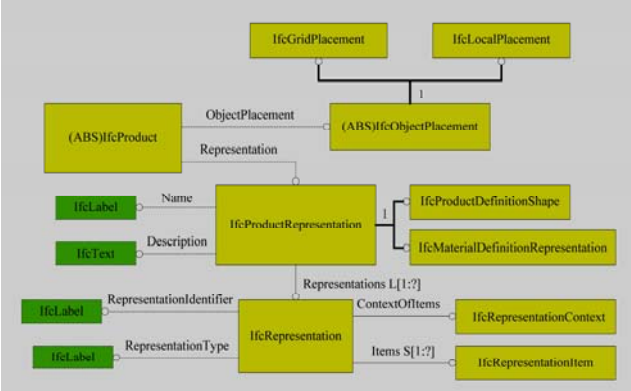

Figure 3 building component and geometric model integration.

Object Placement attribute defines coordinate information IFC Product entities, coordinate information can be used both in world coordinates, relative coordinates, can also be used with respect to the axis of the grid manner described. Building products can be obtained in the final position in the world coordinate system by the coordinate transformation matrix coordinate transformation. Representation property IFC Product entity is defined geometric model of building products, including geometric description of building products and materials defined geometric description. IFC Product Representation Representations property entity of type list, for the same construction products can store a plurality of geometric model data, such as described with a solid model of building products, wireframe and surface models. Each instance of a geometry corresponding to an IFC Representation entity in Representation Type attribute type memory model.

BIM surface modeling for the stadium is by reading the BIM model in the existing solid model data, the three-dimensional geometry processing engine, the final surface model data generated by the integrated BIM process model, shown in Figure 4 . Geometric model of building products in the design phase is usually created in conjunction with the integrated entity attributes, project information in the BIM model. Describe the geometry of the resource application entity IFC model, these entities can not be independent for the exchange of information. The stadium exchange process to a three-dimensional solid model geometry processing engine needs to track Global Id value. So that when the return processing results can be positioned by the Global Id value to the corresponding entity instance construction products, and then the surface model to the newly created integrated BIM model. Create a surface model is divided into three main steps: First, the reconstruction process geometric entities described in the previous section; then, on the entity model were triangular mesh; and finally, the triangular mesh surface data into the model data again integrated into the BIM model.

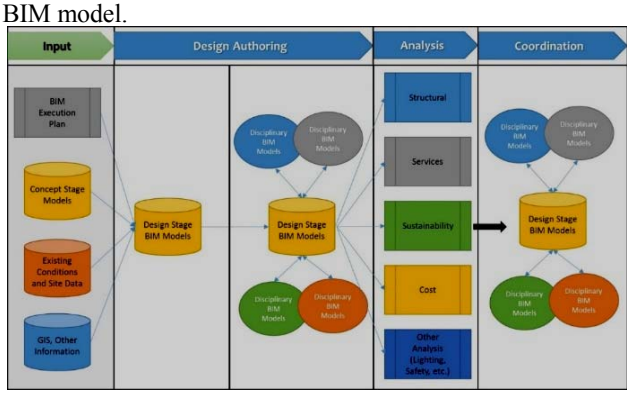

Figure 4. Process of BIM surface modeling for stadium.

IV. BIM SUB-MODEL INFORMATION EXTRACTION AND INTEGRATION FOR STADIUM

Information extraction and integration of BIM is the accumulation of the building life cycle engineering data, expansion, integration and application process, involving interactive multiple construction project participants. Since the process of information exchange with the above characteristics, so its effective management to ensure the accuracy, consistency and completeness of BIM information. To make BMM implementation language-independent, compatible with the BIM model, we use the EXPRESS-G defines the BMM Schema, as shown in FIG. BMM Schema by a number of entities, including BMM Primary Entity, BMM Auxiliary Entity, BMM Property Set, BMM IFD Property Set, BMM IFD Concept correspond to the main entity, auxiliary entities, predefined set of attributes, IFD attribute set, IFD concept. Links between these entities by entity relationship.

Effective management requires the aid of technical means of information exchange process constraints and norms reflect the description of interactive information and definitions. BIM model describes the life of the project covers the construction data, at some stage, or only for a particular application requires the use of some of these data is described with respect to the complete BIM model is described in terms of this part of the data model called the child view. Use sub-model view can reduce the amount of data transmission, save network bandwidth, as interactive data reduction, while also reducing the possibility of data inconsistency. Therefore, a need to provide a method for describing and defining interaction information, this method not only to read but also to meet the natural language provide to the computer for automated processing. Interactive information typically involves the extraction of engineering information, local processing and re-integration process, this process long period, such as HVAC engineering design stage construction design data extracted HVAC design, take a few days. Multiple project participants to access the same data at the same time is a very common phenomenon. Commercial database systems for data recording by locking to solve the

problem of concurrent access, while BIM database requires a reasonable lock to BIM objects, an object involving multiple database records, and the complex relationship between an object reference. Properly deal with the problem effectively concurrent access to be able to ensure data consistency. The parties involved in construction projects have different responsibilities and roles of BIM information with different access rights, including create, view, change, annotate, delete, etc., the need for effective control authority different parties involved, to ensure that the data is within the permitted range access.

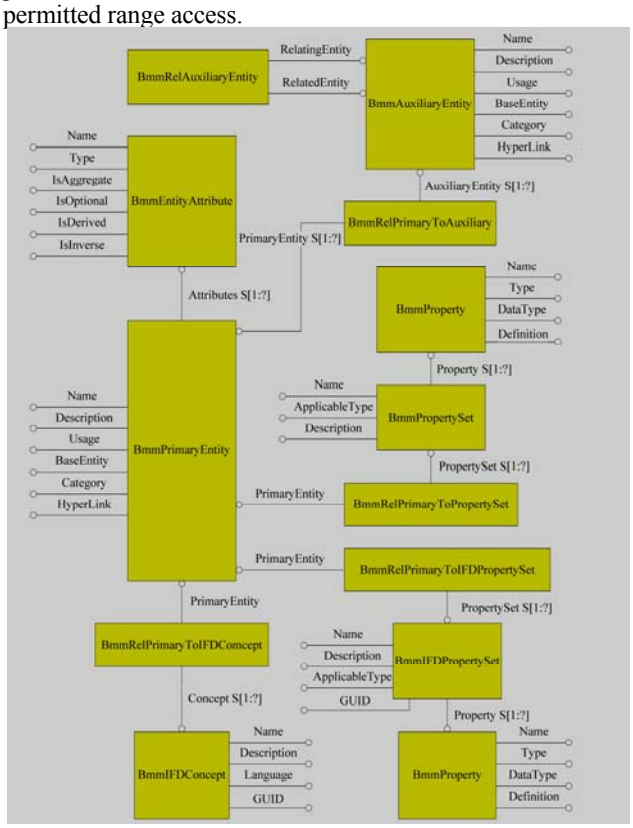

Figure 5. BIM metadata model Schema.

V. CASE STUDY FOR STADIUM BASED ON ENGINEERING BIM

4D construction simulation. In traditional project management process, generally with the Gantt chart or drawing double code network program schedule, but this way is difficult to visually describe the complex process of construction progress between time, spatial relations, it is difficult to articulate the dynamic process of construction, More can not be dynamically allocated during the construction planning construction sites and resources. 4D construction simulation technology for these problems provides a feasible solution. 4D construction simulation technology is based on computer-aided design technology 4Dimension model. Refers to the four-dimensional model is based on three-dimensional space plus the dimension of time. This modeling technique will be applied to the field of building construction, is a three-dimensional model of the construction plans for the construction of the object based on the time factor for its construction, the project will progress vividly show up, form a dynamic simulation model of the construction process, with to assist in the construction program management.

Virtual construction technology based on BIM. Virtual Construction (Virtual Construction, called VC), is the actual construction process on the computer virtual implementation. It uses virtual reality and simulation technology architecture, with the support of high-performance computers and other equipment under the group work on the computer-based simulation construction BIM technology, including the construction activities in the real entity information construction, the construction process can The processes, materials, funds multi-faceted simulation information to find possible problems in construction, development of effective prevention programs or measures in advance, so as to achieve a controlled construction process of the project. Virtual reality construction do not consume resources and energy, the process is carried out by a virtual process, which can provide useful experience for the construction. Through virtual construction technology, owners, designers and construction side prior planning, investment, design and construction can be the first to see and understand the construction process and results.

Stadium construction simulation, perform the following steps: the actual division of the simulation stage of the project, according to the various stages of the project schedule simulation were developed based on a dedicated schedule plan view model, the establishment of secondary model If you need a temporary facility or construction equipment; and Export Import model, organize the collection; import schedules, and to adhere collections; setting analog parameters, simulation debugging; set the camera waypoints, debugging; export simulation. Specifically flow chart shown in Figure 6.

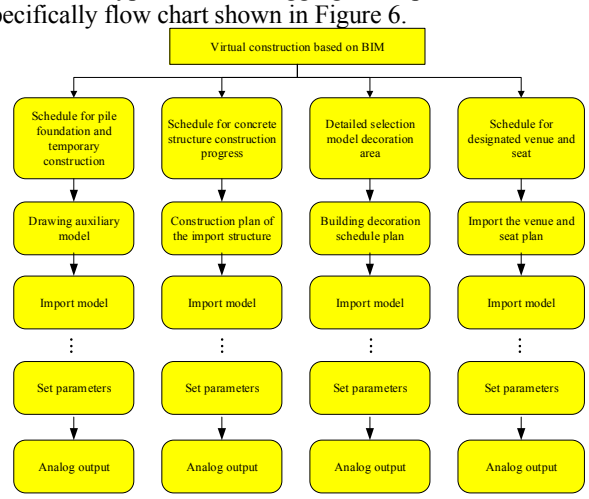

Figure 6. Construction simulation flow chart.

Case Study. For construction projects continue to mature the project management life cycle thinking and the emergence of BIM technology, promoting innovation

construction project information management approach and management tools. Based on the progress 4D BIM concept, the 4D technology and process simulation method proposed by combining the progress of the project management approach to project-level and procedure-level analysis of the combination, the method in achieving 4D-GCPSU and SDESA platform capable of providing image management construction process simulation and vivid 3D animation, thus providing a more effective tool for the progress of the project management. In addition, the use of the stadium project data integration platform developed by BIM information is verified, test the information exchange and sharing design phase and construction phase between different software applications, shown in Figure 7.

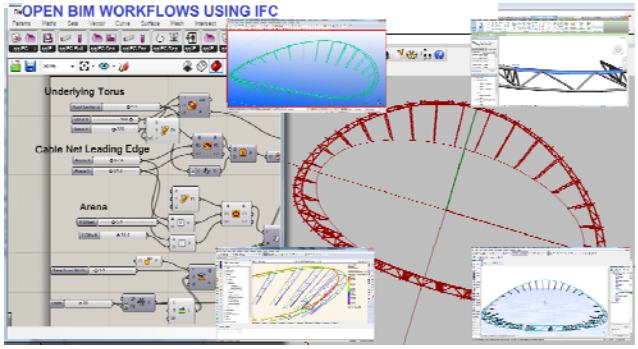

Figure 7. One case of stadium based on engineering BIM.

This case will be completed after the BIM model, external links (direct one-way interoperability) way to create a task, and then use the rules associated with it. And other information will be achieved after the BIM model interoperability and Project management software for real-time interaction in Autodesk Navisworks Manage software. In Autodesk Navisworks reads the Project Gantt chart, according to certain rules and construction associate member, to achieve the implementation of visual simulation work. After creating a task using an external link and read the construction schedule information created Project 2007, and finally use the rules to associate progress information and tasks, BIM-based virtual building model stadium.

VI. CONCLUSION

Construction projects are complex, integrated business activities. The participants involved come from numerous professional and sectors of society. Construction projects including numerous building activities: from the survey, design, construction, to the use, management and maintenance stage, with time spans of decades or even centuries. Implement projects of information-sharing at all stages of life and take advantage of, optimal design of the project implementation process, develop a reasonable plan, accurately grasp the construction process, reasonable arrangements for construction resources and science in site layout, construction industry to improve the level of information and shorten schedule, reduce costs, improve quality, enhance the competitiveness of enterprises in the construction industry, have far-reaching impact. In this paper, follow the development trend of information technology, development of information technology can not meet the demand for information infrastructure construction field stadium, the prevalence of information fault problem, integrated application IFC standard, information modeling, 4D-CAD as well as optimization and simulation theory and technology, research Architectural engineering support life cycle engineering information exchange, sharing and integration management, development BIM information integration platform, has high research value and application prospects.

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