CYNOSURE
CAD OPERATIONS

3D VIRTUAL CONSTRUCTION SIMULATION PRIMER

Virtual Construction Simulation is a powerful tool that allows construction and development companies leverage technology to create a more efficient and cost-effective building process. This paper is an introduction to Cynosure's simulation services and the benefits clients can enjoy.

What is Virtual Construction Simulation?

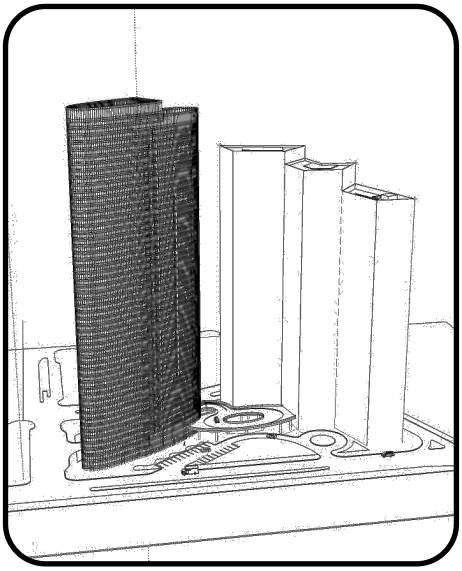
Virtual Construction Simulation (VCS) is the process of creating an entire structure virtually, incorporating technical data and coordinating these data to create highly accurate construction drawings and bill of quantities (BOQs).

Better decisions can be taken based on the developed system analysis. The importance of computer simulation is highlighted in the construction industry because of the complex interactions among various units on the jobsite. It is often necessary to make on-site decisions regarding the on-going daily operations. These decisions have a direct impact on cost, time and productivity. Construction simulation then can be an effective tool that provides a systematic approach to the development of these decisions.

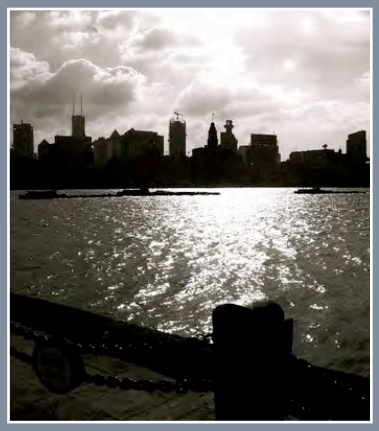
The Simulation Process

The simulation processes can be divided into a general sequence of steps:

STEP 1: Data Collection. During this phase, various technical data in the form of drawings and specifications are collected from different consultants. This information is collected to measure the performance of the system and can be also measured from real field observations, still pictures and movie camera. The quality of the collected data can easily affect what a model can address.



Construction Simulation is the use of computer models in analyzing and planning a construction project



Eric McKinney, CEO of Chong and Partners in San Francisco states that, "architecture is like driving with a blindfold on: upfront, you determine your target and, after driving for a while, you take off the blindfold and find out how close you got to the target".

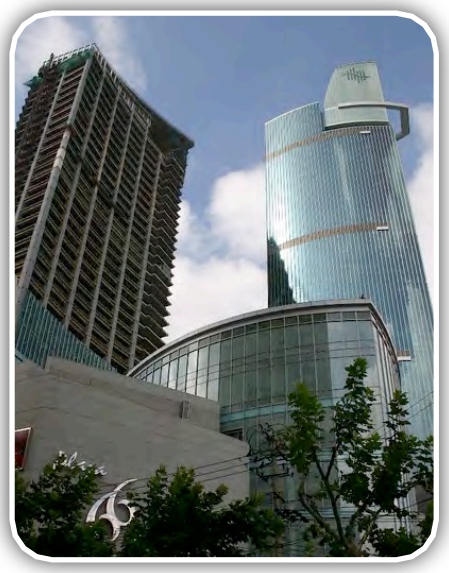
3D Virtual Construction Simulation (3D-VCS) helps solve this problem by turning design and cost estimating into parallel processes.

Step 2: Data Validation. Validation creates credibility for the model. This step starts very early in the model's life and extends until the end. In this step, the model developer examines the validity of the data collected as well as the assumptions made through statistical analysis methods and discussions with subject matter experts (SMEs) including informal validation like audit, documentation checking, inspection, reviews, static validation like cause effect graphing, control analysis, data analysis and dynamic validation techniques like acceptance testing, beta testing, statistical testing, visualization, and animation

Step 3: Modeling the Data. Building a model starts with focusing on a problem. The built model should be easily understandable but sophisticated enough to address the clients needs. However, the model should not be so sophisticated that it exceeds the client's ability to understand and implement the solution. The model should be comprehensive and contain all the necessary information to make it as accurate and realistic as possible. Finally, the model needs to fulfill the simulation's objective and be able to evaluate the system's performance.

Step 4: Coordination and Verification of the model. Entities flow and data input are examined in this part. Verification and validation must be performed through the entire simulation study. They are both continuous processes and the outcome of the simulation model should be considered for credibility. The main benefit of verification is to control change and be able to correct mistakes the client perceives. Of course, this maintains a high degree of coordination to ensure that the modeled data meets the clients needs and address any observed issues

Step 5: Final Output to Construction Drawings and Bill of Quantities. The built model is now an accurate representation of the construction system. Pulling this all together allows the VCS process to output highly detailed and integrated construction drawings. Likewise, the VCS system also allows the client to review and accurate Bill of Quantities. Both these outputs translate directly to an improved and more efficient building process that allows the client to experience profound monetary savings due to a decrease in wastage, mismanagement of resources and design inconsistencies.



THE BENEFITS OF CYNOSURE'S 3D VIRTUAL CONSTRUCTION SIMULATION

Cynosure Cad Operations' 3D Virtual Construction Simulation (3D-VCS) is a cutting edge development in the use of current building design technology. It is a process that aims to ensure specific benefits to actual construction. The benefits can come in the following main areas:

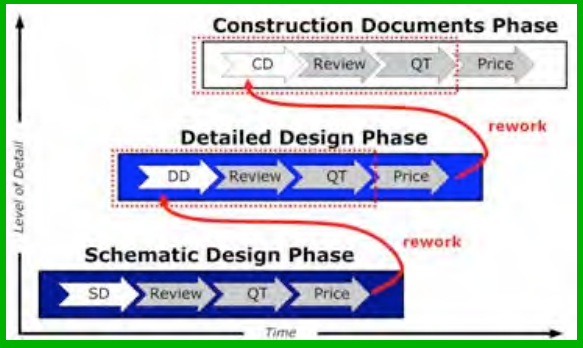
- ☑ The integration of design & estimating
- ☑ The creation of cost calculations
- ☑ The creation, analysis and optimization of schedules
- ☑ Risk reduction
- ☑ Reduction in subcontractor costs
- ☑ Management of contractual issues and claims
- ☑ Winning more business

Design/Estimating Integration

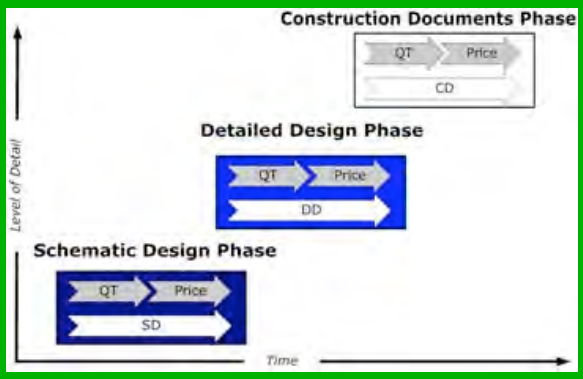
Ultimately, cost drives design, however, the traditional tools do not provide sufficiently accurate and/or frequent information to make good decisions. In current practice, architects are only provided with cost feedback after the construction company involved has reviewed the design, determined the quantities and assigned prices. During this process, the design effort continues, resulting in large amounts of rework in the case of a cost-driven design change. (Fig. 1)

Creation of Cost Calculations

Currently, the use of 3D in Architecture, Engineering and Construction lies heavily in presentation. This is however, not just the capability of 3D Models. Every object in the 3D model can be made so that it stores all the information required to carry out the cost estimation and scheduling of



Actual Construction Process



Cynosure's Enhanced Process

Figure 1: Enchanced Design Process through Construction Simulation

the specified object. Using this way of capturing "real world" objects, 3D models do not have to be highly detailed, thus saving modeling time.

Creation, Analysis and Optimization of Schedules

Planning production to flow continuously with synchronized production rates minimizes the likelihood of trades interfering with each other. There will be less wasted effort, idle time and fewer on-site conflicts.

Risk Reduction

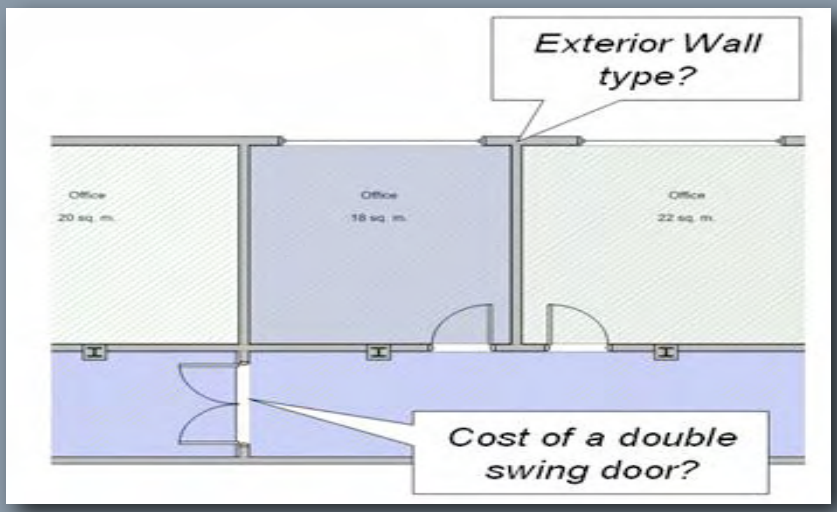


Figure 2. Cost Calculations - 3D Modeling allows the designer to make accurate estimates based on the input into the system

Risk Reduction

There are two main contributors to risk:

- Incorrect information caused by the lack of time to effectively synchronize all data related to project design, cost and time
- Incorrect assumptions generated by the variability of conditions during actual construction

3D Virtual Construction Simulation (3D-VCS) solution addresses these problems in a number of ways:

- Design information is more accurate and comprehensive.
- The synchronization of design, cost and time data is automatically maintained at all stages of design and construction.
- The correct and accurate information allows the project team to constantly monitor, analyze and respond to conditions throughout the project.
- The sum of these benefits provides a far more effective decision support framework than traditional processes.

Reduction of Subcontractor Costs

Almost all of the subcontractors consistently state that they must add extra margins to their bids to accommodate the cost implications of incorrect design data, missing information and coordination errors.

3D Virtual Construction Simulation (3D-VCS) uses proven, leading edge technology and methodologies to improve project planning and control. Construction managers or general contractors can use this process to reduce project cost, risk and time to completion.

Usage of the process directly impacts subcontractors in a number of ways. Most importantly, many of the inefficiencies common on construction projects are reduced or eliminated. These problems include:

- Design Problems
  - Incomplete design documentation
  - Incorrect designs (i.e. cannot be constructed as designed)
- Poor communication between all project members
- Execution Problems
  - Duplication of effort - inability to utilize existing design data, forcing manual re-entry
  - Inability to rely on extensive prefabrication - previously constructed building elements were not built as expected
  - Schedule starts/stops - having to shut down & leave the site numerous times, as opposed to a consistent flow; or paying employees to sit idly on the site & wait until an area is ready
  - Legal claims - resulting from poor communication or the poor performance of other team members

By reducing the severity of these problems for subcontractors, profitability and competi-

tiveness are increased– more projects can be won and more profit made per project. The current practices for estimating job cost and schedule are based on adding allowances for the above problems. These allowances are based on an average amount of problems occurring during a project. If few of the problems occur on a project, the subcontractor will make a high profit. If many of the problems occur frequently, the subcontractor will lose money on the project or even risk bankruptcy due to the magnitude of the loss. 3D Virtual Construction Simulation (3D-VCS) creates a more predictable work environment requiring fewer allowances and greatly reducing risk. Subcontractors who undergo the process are able to reduce bid fees and thus increase profitability.

Competitiveness can be increased by developing a deeper understanding of the process, and by developing the more effective work practices made possible by the new process. These new work practices involve the better reuse of design data, more extensive prefabrication, and even new construction techniques that would not be practical without the precision provided by the 3D Virtual Construction Simulation (3D-VCS). 3D-VCS can consistently reduce a subcontractor's costs by a range of 5% to 20%. The lower range is commonly achieved by simply reducing errors and improving workflow. The upper range of savings has been achieved by using new construction techniques and shorter timeframes. These savings are aimed to reduce bid prices, thus winning more business and ultimately to increase profitability.

Management of contractual issues and claims

Since all project-related data – design, cost and schedule – are synchronized continuously throughout the process, 3D Virtual Construction Simulation (3D-VCS) improves the basis for communication during pre- and post-contract negotiations by taking away multiple interpretable information sources. By using consolidated, accurate and stable information from 3D Virtual Construction Simulation (3D-VCS) as a basis for all tender and contract documents, a more preventive approach can be achieved. This results in a reduction of litigation and arbitration costs.

IN SUMMARY:

The ability to visualize the built environment is a critical skill in design and construction. With recent advancements in computer display technology, it is now possible to place our works within a large-scale, immersive projection display that allows us experience and experiment with a 3D, full-scale virtual prototype of a construction project. This advanced visual communication can significantly improve our ability to comprehend, learn, and gain experience with reviewing designs for constructability and planning the construction of complex building and infrastructure projects.

Ultimately, our goal is to improve engineering in building and infrastructure design and construction. We will achieve this goal through the development of a Virtual Construction Simulator (VCS) that will allow us to immerse ourselves into a 3D construction project, perform a detailed analysis of the design, and develop a plan for constructing the project. The construction plan includes construction methods selection, activity sequencing, activity duration definition, temporary facility locations, and project schedule calculation. Truly, VCS is the logical evolution of the building and construction industry.