Implementation of a 4D Schedule as a Project Communication Tool

Jared Jacobs
California Polytechnic State University
San Luis Obispo, CA

This report details the project that was completed to produce a preliminary 4D Schedule for the Alma Clark Glass Residence Hall on Western Washington University’s campus. A 4D schedule combines the 3D model of the building and the project schedule and ultimately shows the sequence of construction. The main objective of this project is to explore areas for improved communication strategies within the project team. A 4D schedule provides an added dimension of communication that has the potential, if delivered effectively, to clearly define construction milestones and sequences for an owner to understand. The goal of this project is to have an owner, in this case Western Washington University, understand the benefits of 4D schedules in hopes of making this a required tool on future projects. As this is a preliminary 4D schedule, it only gives a rough picture as to how the schedule will flow. This schedule should be updated through the lifecycle of the project to increase its effectiveness as a communication tool.

Key Words: 4D Schedule, Communication, Project Management, 3D Model, Construction

Project Origination

As a building information modeling (BIM) instructional student assistant (ISA) and captain of the BIM team I have an extensive background in BIM programs and technology. I wanted to apply my knowledge and skills into a senior project that encompassed my passion and drive for BIM. In one of the trips I took to Autodesk University with the Department, I had conversations with Fuzor which is a 4D technology company. I then gained experience with the program over two years at the ASC Reno competition. Over the two years I produced multiple 4D schedule visualizations.

This past summer I had the opportunity to work with Western Washington University as a project engineer intern with Lydig Construction. This project was a Design-Build Contract and there was a collaborative culture when it came to communication. Reflecting on this experience, I wanted to look at opportunities for increased communication strategies and how to better communicate schedule
progress and goals with the owner. Additionally, WWU did not have an advanced BIM plan. These two aspects of the project led me to propose the creation of a preliminary 4D Schedule for the project. Talking with Western Washington University, they feel that this may be a beneficial opportunity for the contractor to prove it a valuable tool.

**Process**

Once I had fully developed the idea for the project, I organized a virtual meeting with Lydig Construction, Mahlum Architects, and Western Washington University. This meeting with the project team was very successful in that it laid the groundwork for my senior project and helped further develop the idea to make sure it would achieve my original goal. I discussed the many benefits of a 4D schedule with the project team and showed an example of a previous schedule I had made during the ASC Reno competition. The result of the meeting was that the project team was on board and looking forward to seeing the result.

**Model Review**

A couple weeks after meeting with the project team, the architect sent over the architectural model for the project. This is the first step in creating the 4D schedule. Fuzor is the BIM software that I chose to use to make this schedule. There are multiple other programs that can be used to make 4D schedules such as Synchro, VICO office, and Navisworks. However, while there are many options for programs, Fuzor offers a variety of assets and is user friendly. Fuzor uses a plug-in with Revit to link the model to its program while simultaneously allowing edits to be made to the model in real time in Revit. Once I had the model in Revit, I ran a quality control check on the model elements to make sure they would allow me to produce the schedule efficiently in Fuzor. In some instances, if model elements were originally modeled poorly, it can greatly impact the scheduling time in Fuzor. For example, model elements such as columns or walls will be modeled from the ground to the roof instead of being modeled on a per floor basis. When one goes to add this element to a specific floor it will not show up correctly in the 4D simulation. Fuzor does allow you to split geometry, which is a great workaround to this issue, but it is time consuming. One of the main challenges faced in this portion of the project was that I was only working with the architectural model. I did not have the structural, MEP, or site models as Fuzor limits the size of models that can be loaded into the software. This was the biggest constraint of the project as it would only allow for a preliminary conceptualization of the schedule since it was missing major components of the project. Although these components were missing, the goal of showcasing the power of 4D schedules as a communication tool could still be achieved.

**Scheduling**

After the quality control check in Revit, the next step was to start developing the schedule. Fuzor allows users to import pre-made schedules into its software to be used for 4D simulations. For this project, I created the schedule in Fuzor. This was the most time-consuming portion of the project. This particular project was broken into three zones with two separate structures connected by a sky bridge. The building layout coupled with the difficult site constraints made the sequencing of events very difficult. I met with the superintendent from Lydig Construction on multiple occasions to discuss schedule logic in order to accurately sequence the project. I organized the schedule into three zones and had a fourth element to capture the sky bridge construction. In each zone, the schedule sub-tasks included the slab and foundation, walls, floors, stairs, windows and exterior enclosures which were metal panels. The overall project was sequenced from North to South. Once the schedule was fully
built out, model elements could then be applied to schedule tasks to prepare for the 4D simulation. This was the second most time consuming portion of the project. Each model element would need to be individually applied to its respective schedule task in order for it to be reflected in the simulation.

4D Simulation

Once all model elements were applied to their respective tasks, I began creating the schedule visualization. Using the fly through feature in Fuzor, scenes could be created by using the schedule scroll bar to move to different times of the project schedule. Fuzor stitches the scenes together to create a seamless video. The ability to fly through the model was critical in that it allowed all portions of the model to be reflected during the animation. Each zone including the bridge construction were showcased in the simulation. After the animation was created in Fuzor, I rendered the video and published it in Adobe Rush, a video editing software. In Rush, I added a title sequence and credits to the Architect and Project team. This program also allowed me to clean up portions of the simulation that were too fast and choppy.

Deliverables

The deliverable for this project is a .MP4 video of the 4D Schedule. The video is just over 1 minute in length and covers the entire schedule of the project. Preliminary 4D schedules such as this one are typically shorter in length as they just highlight the intended construction sequence and give a high level overview for the owner and project team.

Lessons Learned

While this project provided many valuable insights and newfound skills, many challenges were faced during the project. Perhaps the most pressing challenge was the limitation of the software, Fuzor. The fact that there is a 200-megabyte file size limit was a huge restriction on my project approach. When I had first envisioned the project, I planned on having all project disciplines represented in the project simulation, however the structural and MEP trade models were combined to be over 700 megabytes. Further, the architectural model also provided many challenges as it was also over the file size limit. I had to strip down a lot of the model including furniture, fixtures, and finishes to get the file within 200 megabytes. This stripped-down model was not what I had intended but was a result of the aforementioned limitation. Reviewing this issue and talking with Erika Jamerson from Kalloc Tech, the company that produces Fuzor, I discovered that the best practice for issues like this is to lay out in the BIM plan that all models should be separate from design so that they remain within the file size limit. If one has all separate files, each model can be combined in Fuzor. For a larger project such as this one, this would need to be laid out and discussed in the BIM execution plan before design even takes place to ensure this issue does not occur.

After viewing the simulation, I began to think about how this can be applied throughout the lifecycle of the project. As projects are continually evolving, it would be beneficial to have a continually updated 4D schedule to communicate large schedule changes to an owner or project team. Since Fuzor is continually connected to the Revit model, any large changes to the model can be reflected and updated in real time. Once the first animation is created, updating or furthering the animation would be much easier and more efficient since the majority of effort would be completed upfront. Another lesson that was learned during this project was time management. It is very common in the construction industry to have an architect or design team that is very slow to respond. In the case of this project, there were very slow response times and design team turnover that stalled the progress of
the project. After the initial senior project discussion with the project team, it took just over two weeks to receive the model which pushed the start date of the project back. Further, the architect that was a point of contact for this project quit their position and had not returned any questions in a few weeks. These issues combined with the load of coursework taught me that time management is key to finishing a project on time since unanticipated challenges can come up at any time. One of the significant challenges I had communicated with the design team is that the model had no textures applied in Revit which essentially left the model to be rendered with no material in Fuzor. Since this was not an accurate representation of the project, I had to spend a lot of time resolving texture issues manually in both Revit and Fuzor.

Fortunately, this project did not face any challenges related to Covid-19 since all work could be completed virtually. This taught me that digital communication, whether it is BIM or another form, is the future of communication tools not only in the construction industry but in all industries. The power of construction companies to leverage digital tools such as 4D schedules will allow them to win future work and continue building strong relationships in the future.

Photos

Figure 1. Revit Model Import
Figure 2. Model Import into Fuzor

Figure 3. Creating the Schedule
Figure 4. Sequencing Schedule Activities and Model Elements

Figure 5. Creating the 4D Schedule
Alma Clark Glass Hall

Preliminary 4D Schedule

Figure 6. Editing the Animation in Adobe Rush