[00:00-00:15] The construction industry and especially nuclear construction, has experienced huge escalations in overnight construction and schedule delays due to strict quality assurance standards and supply chain delays.

[00:15-00:34] For example, Vogtle electric generation nuclear plant experienced $8.5 billion cost overruns and caused Westinghouse electric company bankruptcy in 2017.

[00:34-00:59] Modular construction is the key to make building components in a controlled manufacturing environment with higher quality. Also, modules can be built faster than conventional methods; therefore, modularization can save time in addition to assurance of high-quality standards, especially for nuclear construction where the construction has to meet strict standards.

[01:00-01:10] Over the past decade, modular construction experienced annual growth of 6%, and it is predicted that the total global revenue of modularization will reach $150 billion by 2023.

[01:10-01:32] To decrease fabrication and overnight construction cost and time, we propose a novel virtual environment for modeling and simulating construction performance using reality capture technologies such as drone imaging and laser scanners.

[01:32-01:37] To create as-built models from the construction site, drone imaging was used, and a 3D as-built model is created based on the images.

[01:37-01:45] This virtual environment allows 3D visualization and navigations in as-built models during construction.

[01:45-02:02] This virtual environment can load multiple as-built models captured at different times and seamlessly switch between them based on the user input to record construction progress.

[02:02-02:25] The BIM is also visualized on top of the as-built for construction progress monitoring and tracking the as-built deviation from as-planned.

[02:25-02:38] BIM can also be connected to the project schedule and create the 4D plan of the construction by color-coding BIM elements.

[02:38-03:07] The images can be shown in CPMS for more checking of the progress.

[03:07-03:21] laser scanner data can be shown in CPMS for interior construction.

[03:21-03:43] On the bottom left window, the BIM elements can be shown separately based on each element ID.

[03:43-03:55] Ultimately, this environment can virtually bring offsite components to the as-built model for inspection and checking the compatibility of the offsite component prior to the shipment.

[03:55-04:10] The offsite component can be selected in the bottom right window, and simultaneously, the user can see the same BIM element in the bottom left corner.

[04:10-04:46] The offsite component's position can then be fine-tuned using CPMS for visual compatibility checking.

[04:46-05:10] The next part is an effort to automate the process of quality assessment between as-built and as-planned models. Artec Leo laser scanner was used to generate the as-built models of the components to start this process.

[05:10-05:54] For testing the designed algorithm, as-built models of six components were compared to their corresponding as-planned models. To account for commonly happening occlusions during the reality capture process, as-built and as-planned models have gone through a voxelization step where each segment in the scan is only compared to its corresponding segment in BIM. CPMS calculates a similarity ratio in real-time on the top right side of the screen. This can be applied to the BIM model and generate a color-coded 3D model, which automatically demonstrates the incompatibilities.

[05:54-06:04] Lastly, compliance of as-built versus as-built components in a coupling system has to be investigated. Combining this with CPMS is the last required step that can automate the process of inspection and quality assessment between manufacturing and project site.

[06:10-06:30] Frame rate and rendered points are also shown in the top right side of the CPMS to show the number of the point in each rendered point cloud.

[06:30-06:52] Combining this method with the CPMS framework can ultimately help the inspectors to automatically perform the quality assessment of as-built versus as-planned prior to the shipment of the module to the site.

[06:52-07:02] In the future, CPMS can help to automate the compliance checking process in a coupling system such as pipe installation and automatically check engineering codes.

[07:02-07:11] Similarly, CPMS can check precast concrete panels and automatically detect any flaw in the panel.