1. FORUM8 Features of VR-Design Studio 14.1 4D Simulation plug-in

The new 4D simulation plug-in provides an easy-to use function to manage the scheduling of events and activities within a construction project and linking this schedule to an interactive 3D VR photo-realistic simulation of the project's development over time and hence enable efficient project management.
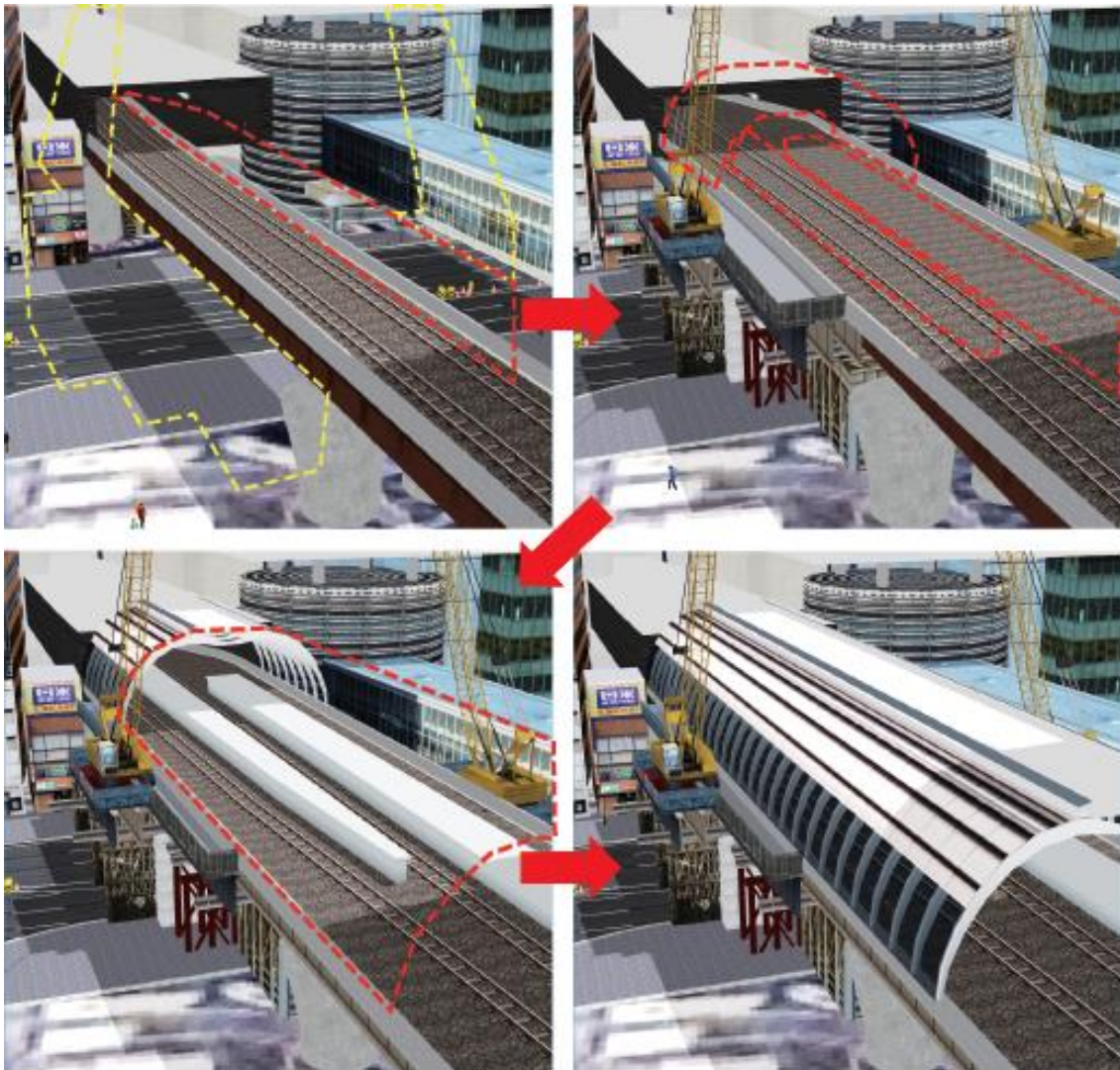

Fig.1 Example of station construction reproduction

Gantt Chart

The Gantt chart enables the user to visually represent the project's schedule by setting individual tasks to be performed against a time line. It also includes a function to set and display work hours and holiday periods.
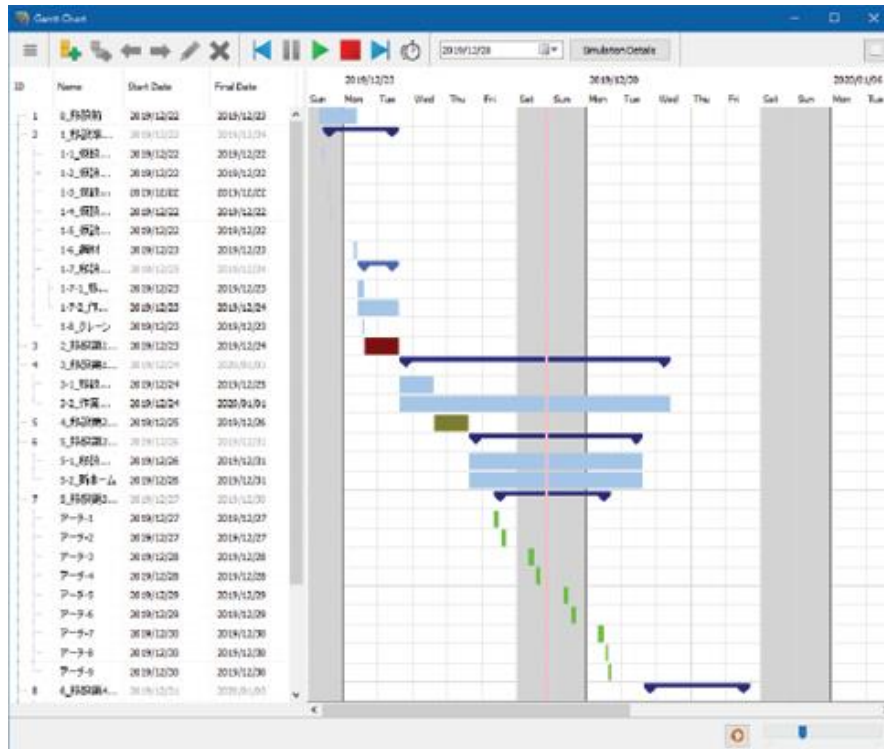

Fig.2 Gantt chart display

The Gantt chart tasks can have subtasks represented by a tree structure. In the Gantt chart display, 'parent' tasks and 'child' tasks are displayed differently, so that they can be easily distinguished. In addition, you can change the display colour of the tasks to easily visualize their individual relationships and contents.

Each task has a start date and time and an end date & time, and can be set by date and time (hour: minute: second). Tools for managing tasks include manipulating the task hierarchy, such as adding tasks, subtasks, deleting or duplicating tasks and editing the 'parent-child' relationship of tasks within in the tree structure.

The zoom function allows you to view different levels of detail in the schedule. The zoom is continuous and you can check the contents of the calendar while zooming in and out smoothly by dragging the slider or operating Ctrl + mouse wheel. At a fine zoom level, an hourly calendar can be displayed. By changing the zoom, it is possible to continuously change to the daily, monthly, and yearly calendar display. This allows you to use 4D features to simulate long-spans for the general planning of work, examine details of work in minutes, evaluate details such as feasibility and optimize procedures for complex operations.
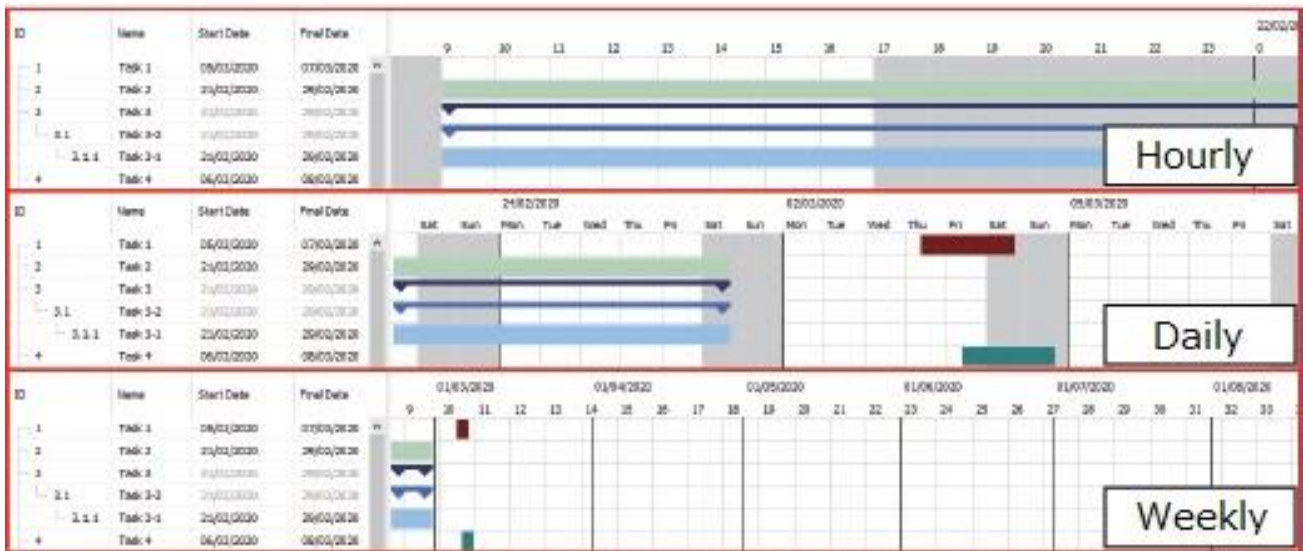
Fig.3 Differences between zoom levels

Resources & Behaviour

To quickly add a 3D model to the simulation, the user can select tasks to simulate and control a specific model. Clicking on a model will bring up a screen where you can assign the model to any task. You can set the timing to show or hide the model from among the schedule start, task start, task end, and schedule end.

For example, in a simulation of a construction site, it is possible to set up a simulation that displays the completion status of each construction stage according to the progress of the schedule.

It also introduced the concept of resources to include working elements such as machines, equipment, workers, moving materials and resources. Resources are assigned 3D models that exist in the project for visual display. Users can define multiple behaviours that change over time for each resource.
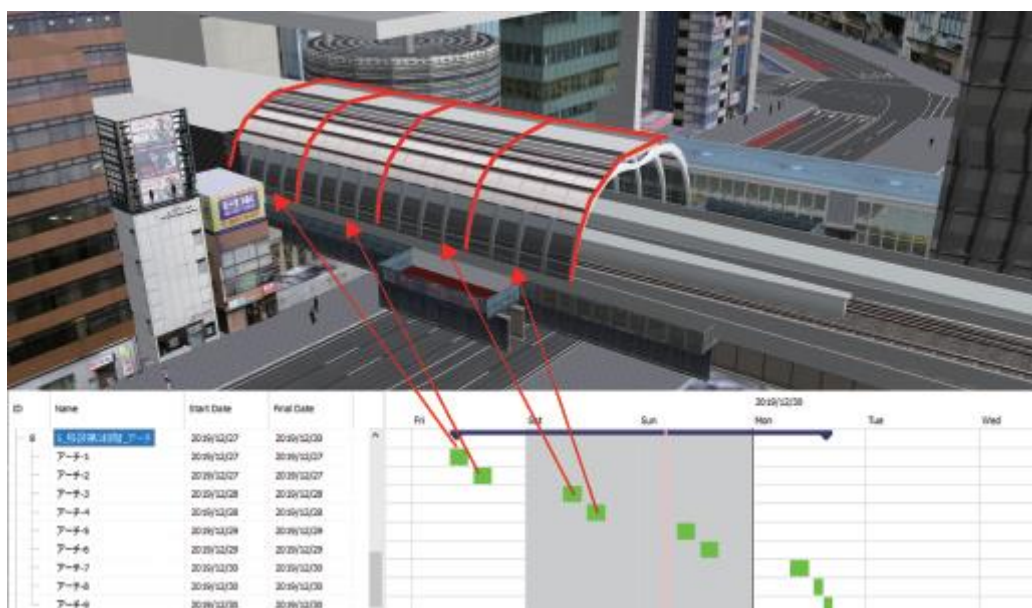

Fig.4 Correspondence between tasks and models

- Move: along a curve (flight path) or set two points and move between them by time.
- Model behaviour: The movement of the parts of the model is controlled by time. It is possible to use predefined movements of the 3D model, for example the rotational movement of a crane boom.
- It can also be used as a temporary object displayed in a certain place without moving for a specific period. An example of the use of temporary objects is to place a sign around the building during construction and remove it after completion.
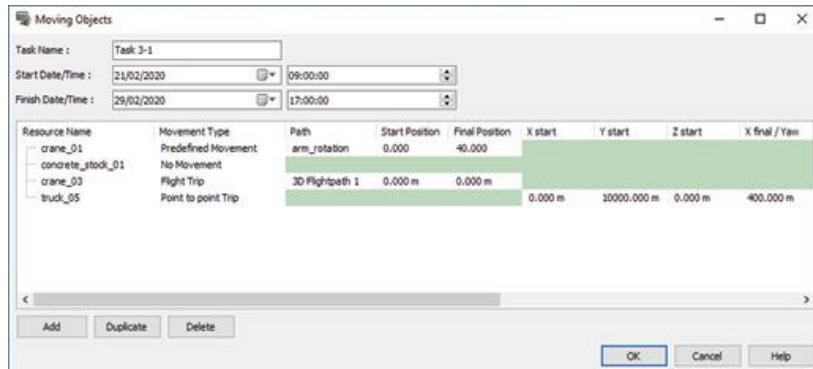

Fig.5 Resource operation settings

A task can have multiple actions with different resources assigned. This allows you to group and configure resource behaviour in one complex task, rather than distributing work across many subtasks. Gantt charts can be created independent of model behaviour, improving readability.

Simulation & Animation

Once all tasks, resources, and behaviours have been set up, you can play back the simulation and watch the project progress. Simulation provides the ability to view within the project period. Simulation progress speed can also be set. Users can run simulations in real time, or run faster than the real world to see long-term schedules, by changing the time scale in the simulation settings.

During the simulation, a time cursor indicating the date and time on the simulation is displayed on the Gantt chart. You can pause the simulation and move it back and forth from the user interface. With a simple click, you can view a specific date and time, immediately check the status of your project, and perform investigations and confirmations efficiently.
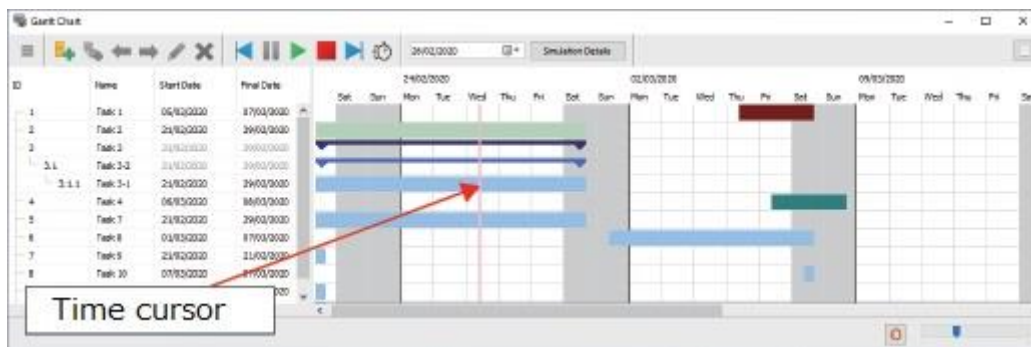

**Fig.5 Resource operation settings**

Export & Import

When the user saves the VR-Design Studio project, the 4D simulation data is saved together with the RD file. It is also possible to save the data created by the 4D simulation plug-in to a csv file. This file contains all schedules, all linked models, resources, and resource actions.

You can also import schedules from the same csv file.

It is possible to link a 3D model file to a csv file, and it is possible to collectively arrange models on a schedule simply by reading a csv file.

This enables cooperation with other applications. For example, it is possible to export a schedule considered in advance in UC-win / Road and pass it to other applications. Conversely, the schedule created with existing software can be imported into UC-win / Road to perform 4D simulation including 3D space, and feasibility and space conditions can be checked.
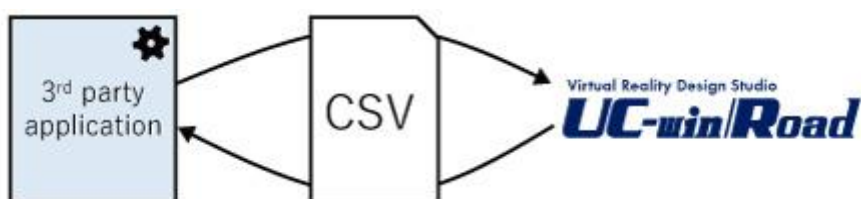
Future Plan

We plan to upgrade 4D simulations to 5D and 6D simulations, as well as continuous improvements to customer requirements. First, we introduce the concept of unit price of resources, so that costs can be easily simulated based on the time to use resources and the amount of movement or uptime of resources.

In addition, by assigning variables freely defined by the user to tasks, the progress of the schedule allows the economy, resources, workload, etc. to be calculated according to the progress of the schedule. We will develop a function to summarize these variables into expressions and create graphs.

We will show the relationship between each element such as resource procurement, moving time, waiting time, etc., and we will work on it so that it can be used for studying and explaining schedule optimization and consensus building, so please look forward to it.