AUTODESK UNIVERSITY 2014

Modeling vehicle movements to optimise airport design

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CV-6579-P Learn how Autodesk Vehicle Tracking can be used in the preliminary design phase of an airport project. Create and then model the movements of both aircraft and ground support vehicles including push-back manoeuvers. But why stop there? It can also be used to model the movements of vehicles inside airport buildings and help to optimize the design and increase safety. Additional transport links can also be designed by using the "Light Rail" module and traffic flow can be improved by using the "Roundabout Design" module.

Learning Objectives

At the end of this class, you will be able to:

- Learn how to create and modify aircraft and ground-support vehicles
- Learn how to carry out standard aircraft maneuvers
- Think outside the box by modelling vehicle movements in non-standard locations
- Learn how to use additional modules to expand the BIM design process

About the Speaker

Mark is a Technical Marketing Manager for civil infrastructure products at Autodesk currently based in the UK. He started his career in the nuclear industry working with radiation safety and environmental plant management on both operational and decommissioning nuclear power plants. He moved to join Savoy Computing 4 years ago where he and was a technical specialist in supporting the development, training, sales and marketing of AutoTrack swept path analysis software. Since joining Autodesk 1 year ago Mark had been expanding his knowledge of Autodesk civil infrastructure products. Mark holds a BSc in Theoretical Physics from the University of Exeter, England.

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Introduction

What is Autodesk Vehicle Tracking?

AVT is a standalone product that installs against a number of AutoCAD verticals. It primarily is used for analysing the swept paths of road vehicles, light rail vehicles and aircraft. It also incorporates additional tools allowing you quickly design Parking lots and Roundabouts.

How is this relevant to Airport design?

It is commonly said that airports are like mini cities. Therefore as you can imagine, the ability to design the airport layout while taking into account the space required to manoeuver aircraft is of great benefit. However it does not stop at aircraft alone. The management of ground support vehicles (both storage and routing) as well as transporter vehicles used inside buildings

Understanding the vehicles

Vehicles are managed in Libraries. The road vehicles are generally grouped together by country and document of origin. Aircraft have their own Library and are grouped by manufacturer. Light Rail vehicles also have their own Library. All vehicles are locked and cannot be edited. It is only possible to “Edit a Copy”.

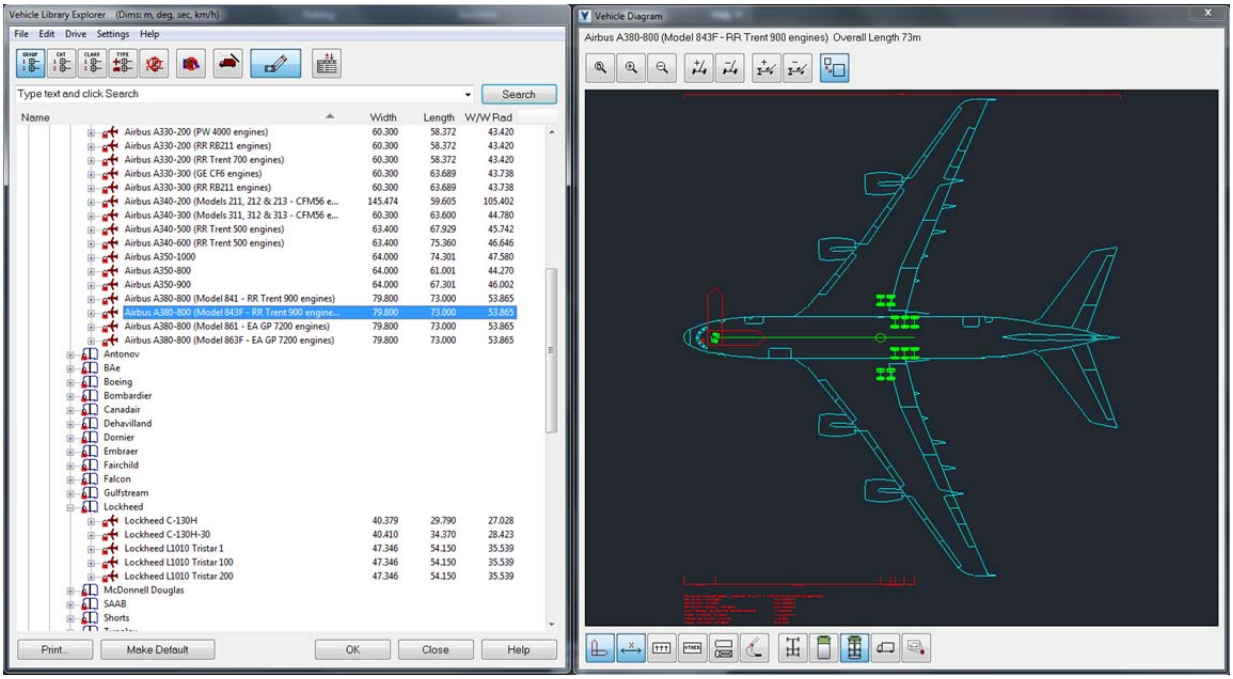
The vehicles have been predefined with a geometry that limits how they move within the drawing. It is not possible to exceed the capabilities of the vehicle however it is possible to manipulate the model in a way that produces unrealistic results.

Aircraft properties often change, especially with regard to the jet exhaust velocity and temperature contours. Don’t forget to check for the most up to date information is applied to the vehicle model that you are going to use in your design.

When a vehicle is used a copy of the vehicle is placed in the Pool. This information is stored within the .dwg file. If the drawing is saved all the Pool information (vehicles, paths, parking layouts, roundabouts) are also saved. This allows other users to view the information even if it is a custom vehicle / standard that was used.

If a custom vehicle/standard is created a new Library must be created to store that information for future use. This is the safest way to manage it in case the drawing is lost or becomes corrupted.

Any vehicle can be driven directly on Civil 3D surfaces.



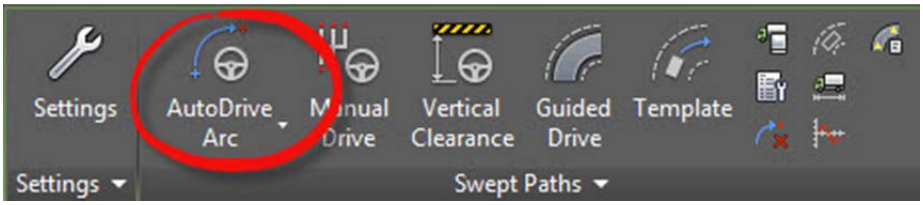
Modelling aircraft movements

Driving aircraft

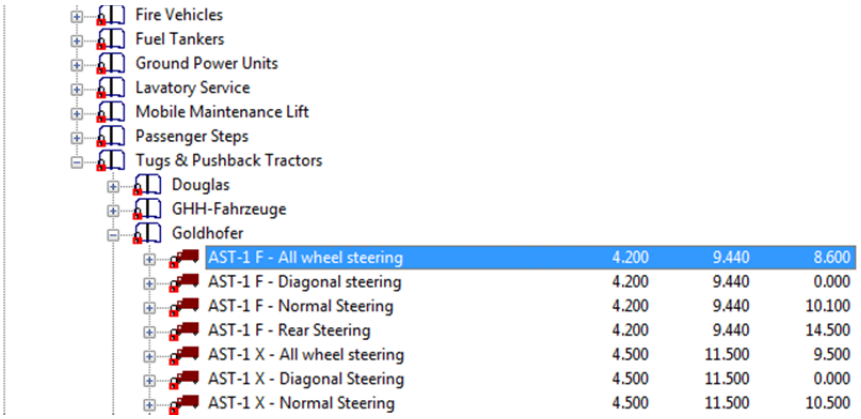
AutoDrive Arc

There are a number of different drive modes available each one specific advantages. AutoDrive Arc is the most commonly used drive mode for most normal road vehicles as it gives the user greatest versatility in generating the swept path. This is where a path is drawn out by clicking in the drawing and placing a series of “Target Points” through which the vehicle will drive. The path once laid out is fully editable.

Select the **AutoDrive Arc** icon to open the pre-loaded vehicle libraries



Select your vehicle and click **Proceed**

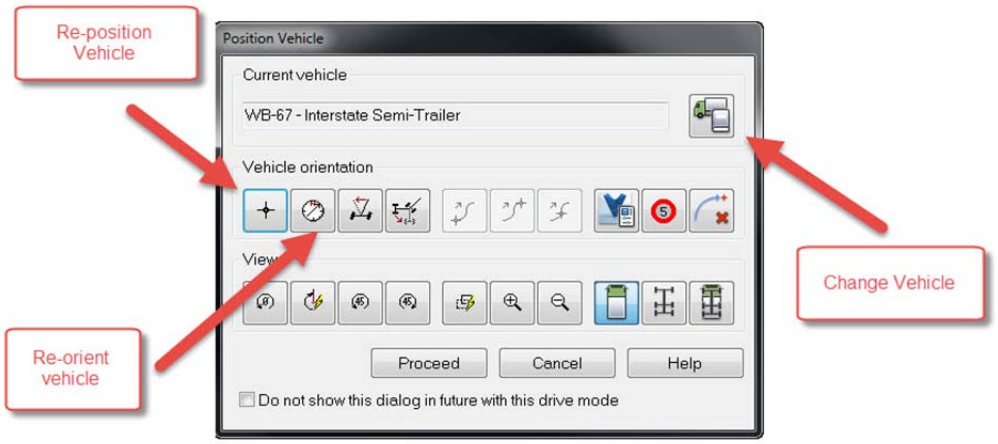


You will be asked whether you want to set the current vehicle as your default vehicle for all future paths. Select either ***Yes*** or ***No***

The Drawing Settings window will appear; here you can change your path settings and units to match the drawing. It should detect automatically by default. If these are ok, click ***Yes*** to continue

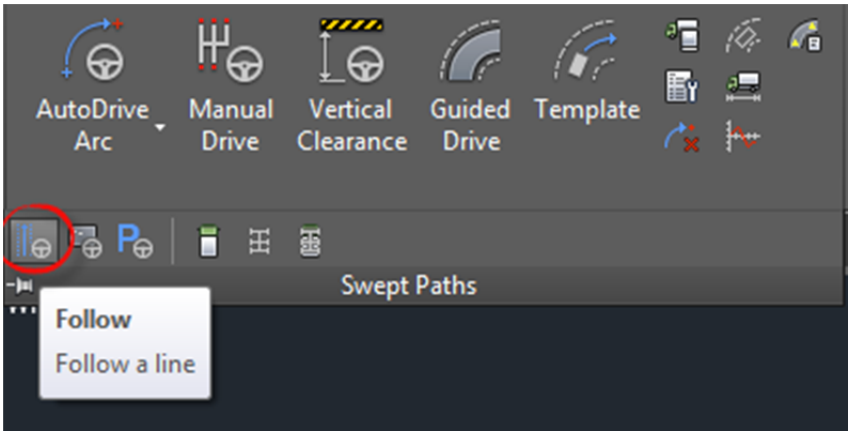
Left click to position the center of the front axle. You can then set the orientation of the vehicle to point in the direction that you need

The Position Vehicle Window will appear with further options to change or define the initial conditions if needed

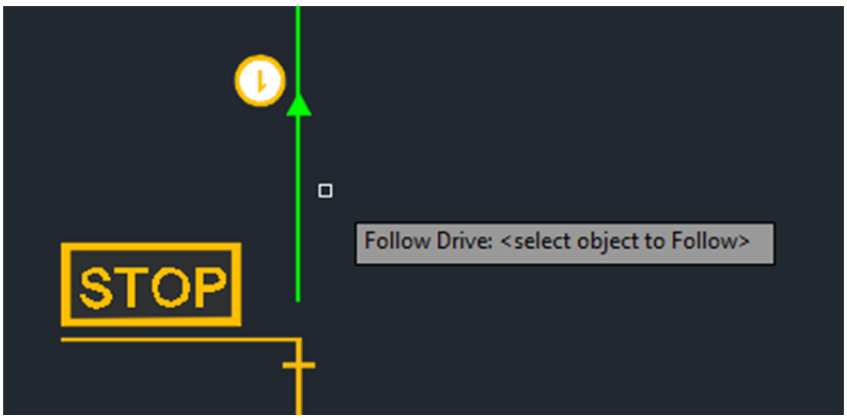


Follow Drive

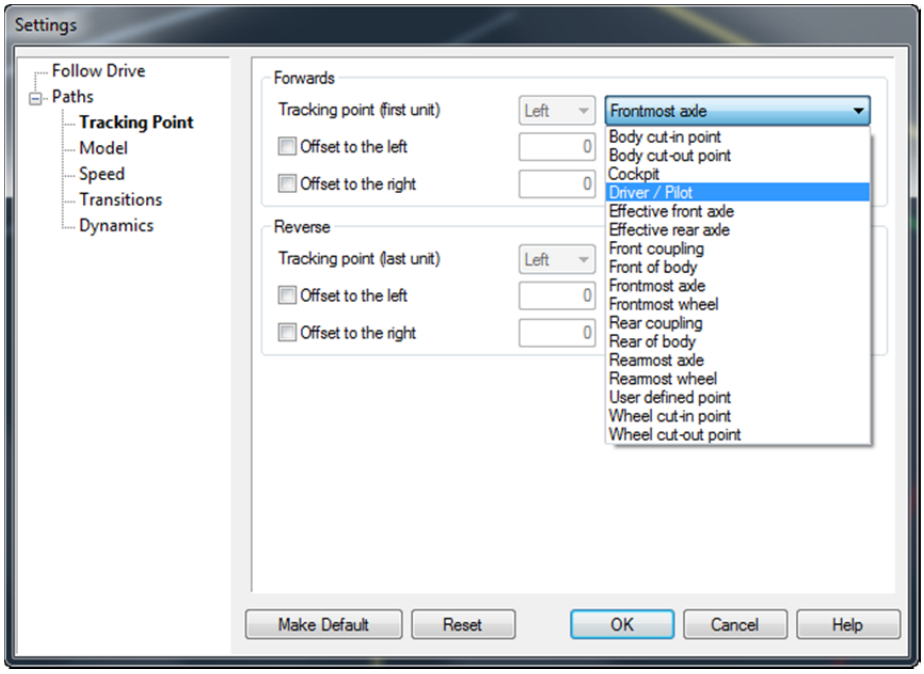
For aircraft I find that Follow Drive mode is the easiest to use, especially when modelling movements along taxi-lines.



You will be asked to select an existing line for the aircraft to follow. The cursor will change to a small square. Select the line near the end you wish to start driving from

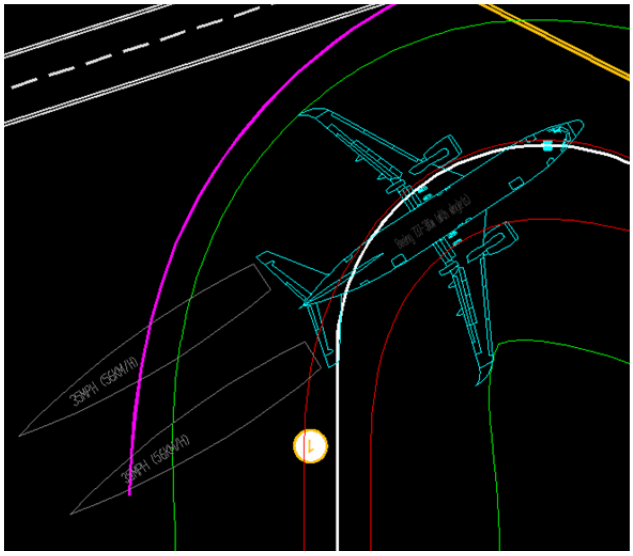


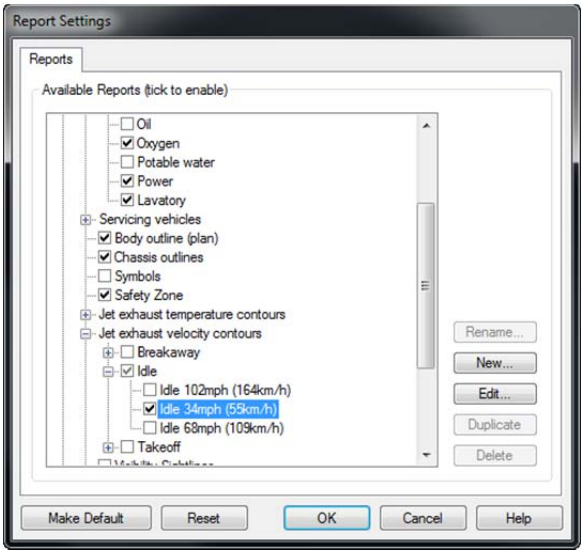
Once the path has been selected you will then set the path properties to be applied to the aircraft. It is here where you can set the point on the aircraft which will track along the line. If you wish your path to be editable once it is in the drawing then you must select the “Create an Editable Path”. It is recommended to set the Target Point spacing to no less than 10m, possibly larger for large vehicles.



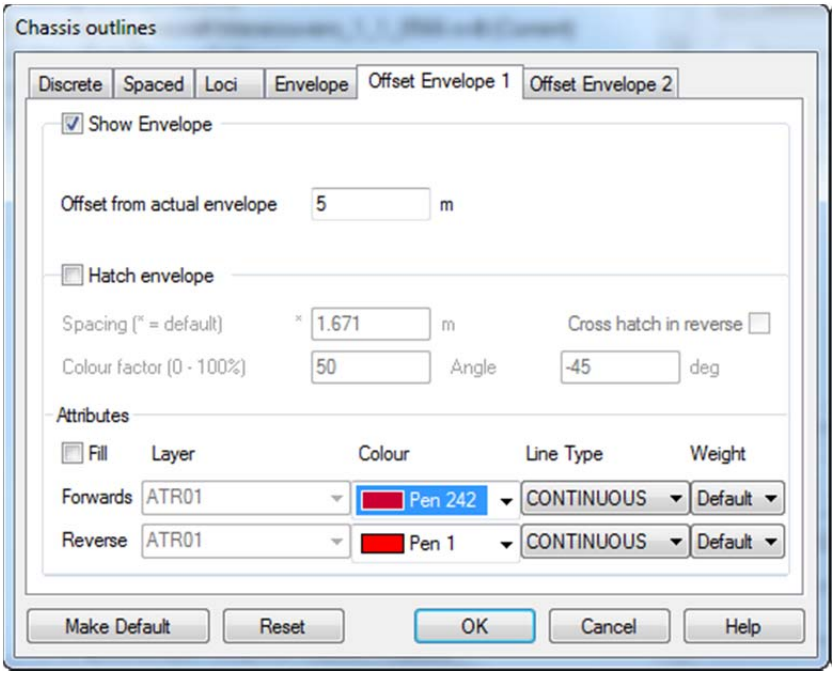
Viewing an aircraft's properties in the drawing

Once a path has been placed in the drawing you can position an outline of the vehicle anywhere you like along the path and use the "Report Wizard" to display various properties associated with the vehicle (eg. Jet blast velocity contours, servicing points, field of vision, etc.)





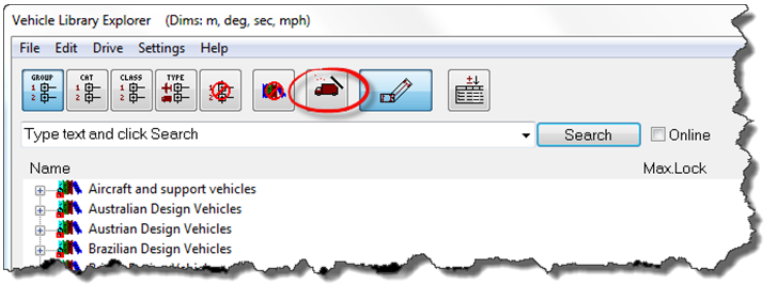
The “Report Wizard” can be thought of as like turning Layer properties on or off for each vehicle path. The lines can also be customized. For example, by default the body path and wheel path envelopes are both displayed. In road vehicles you are concerned with the clearance of the body against any obstacles it may encounter. With aircraft you are interested in keeping a safety buffer around the wheels to prevent them for running off the runway or into obstacles located on the ground. For both of these cases you can set up offset envelopes at custom distances to ensure you always have the clearance you need. You access this via the Advanced Settings within the wizard.



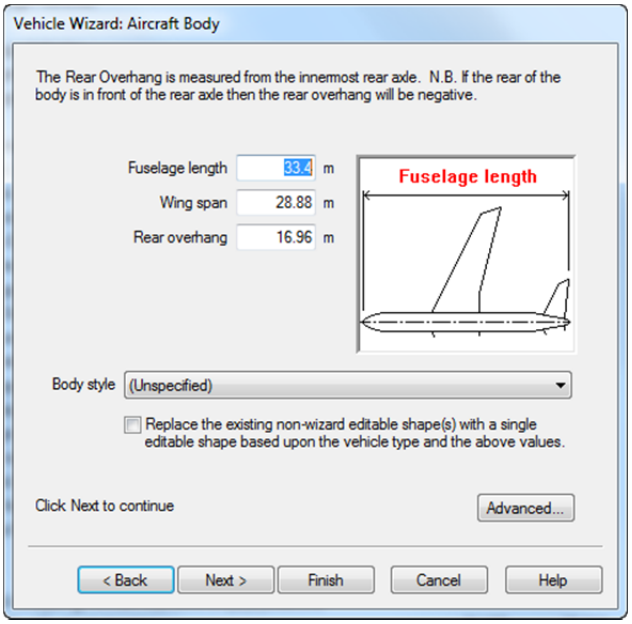
Creating/Editing aircraft

The information displayed in the drawing, as explained in the section above, is defined when the aircraft is created.

Unlike with standard road vehicles, aircraft tend to be more custom in their setup so it is better to create each one from scratch rather than editing an existing aircraft. It is easy to do. Simply open up the Vehicle Library and run the Vehicle Wizard.

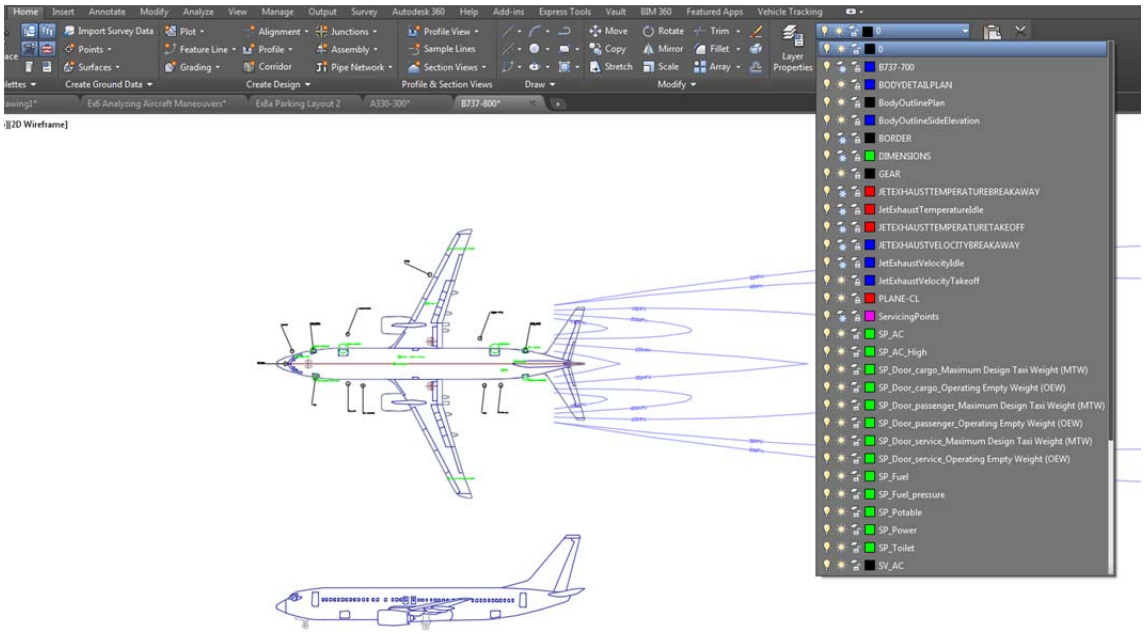


On the first page where you set the vehicle name, ensure you define the Vehicle Type to be “Aircraft”. This will give specific options related directly to creating aircraft. As you proceed through the wizard you will input data as prompted by the small diagram. On the final page you can set the dimensions of a generic fuselage.

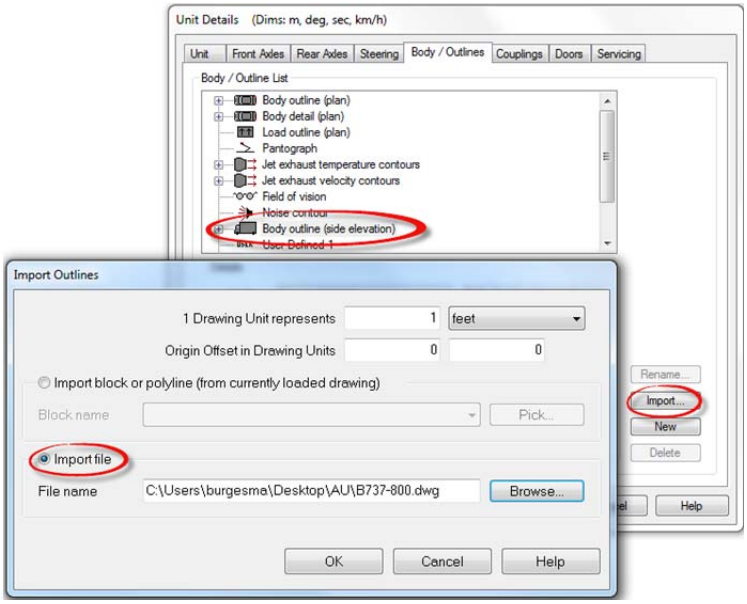


However as I stated earlier, aircraft bodies tend to be rather more complex and varied, therefore a generic fuselage is not always suitable. By selecting the Advance button you can access additional features which allow you more control over how the aircraft is set-up. The concept and features in the Advanced Editor are the same for all types of vehicles. Use the Body/Outlines tab to define custom shapes to be associated with the vehicle. Aircraft have 2 additional tabs for “Doors” and “Servicing” vehicles. Editing and creation of these shapes can be done manually from directly within the editor however there are many of these associated with an aircraft and it can become time consuming to do it in this way.

The easier way is to simply import pre-drawn shapes from an existing .dwg file.

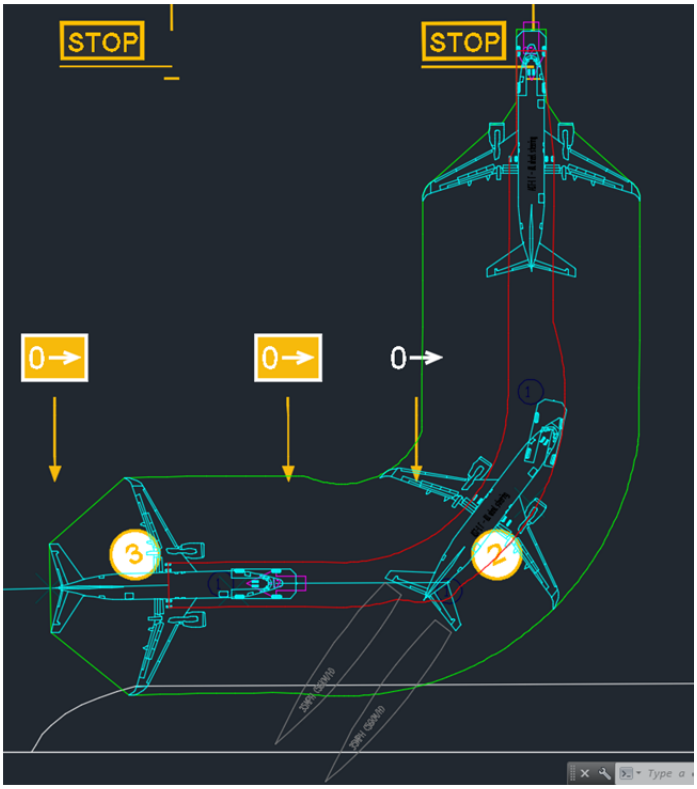


Ensure your aircraft is drawn in plan view facing West. Each feature should be placed on a specific layer (eg. SP_Fuel, JetExhaustVelocityIdle, etc.) therefore when the drawing is imported the features will automatically populate the correct fields in the Vehicle Wizard. Importing is very easy and is done from the Body/Outlines tab. Select Body Outline (Side Elevation) -> Import -> Select Drawing Units and then Import File



Pushback manoeuvers

To model a simple pushback manoeuver you need to attach a tug to the nosewheel of the aircraft. First drag an aircraft and a tug into the Vehicle Library “Pool”. This ensures that you have 2 unlocked vehicles that can be edited. You can attach them by simply dragging and dropping an aircraft on top of the tug. You should do it in this order otherwise the tug will not connect to the correct part of the aircraft. Place in the drawing and drive as normal using AutoDrive Arc or AutoDrive Bearing for greater control especially on a 90 turn.



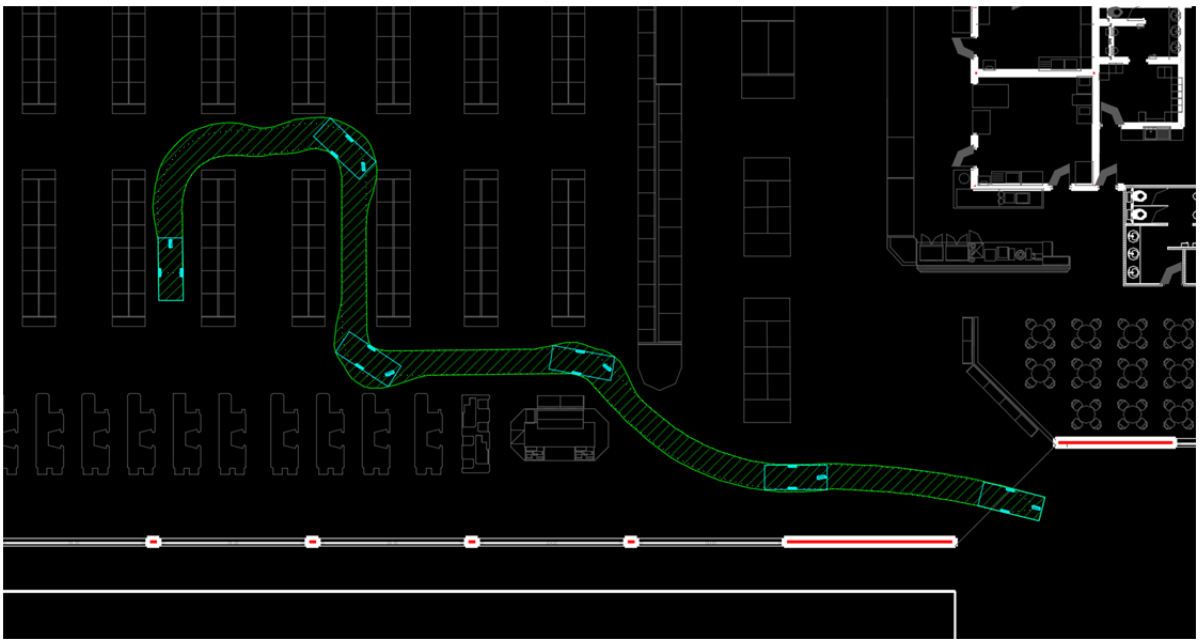
Ground support and other airport related vehicles

There is more to an airport that just aircraft. Yes that is why passengers visit – to get on an airplane. However there are many other vehicles used in an airport. There are a whole host of ground vehicles that support the aircraft directly (power, A/C, food, baggage, etc.), buses which move passengers around the airport and even to the airplanes, emergency vehicles, maintenance vehicles (snow ploughs) and that’s just outside.

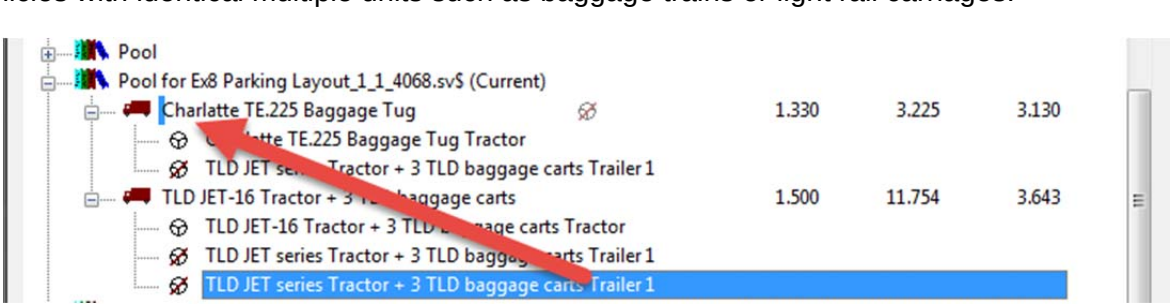
Inside the buildings you will have fork-lift trucks, delivery trucks and mobility vehicles assisting passengers to move around the buildings. In this case you would need to ensure sufficient turning space especially on ramps and suitable clearance in doorways.

Even before the airport is complete there will be a number or cranes, diggers, and other construction vehicles that need to be organised on the construction site and some of the larger ones do occasionally have issues with access that can be mitigated if planned for in advance.

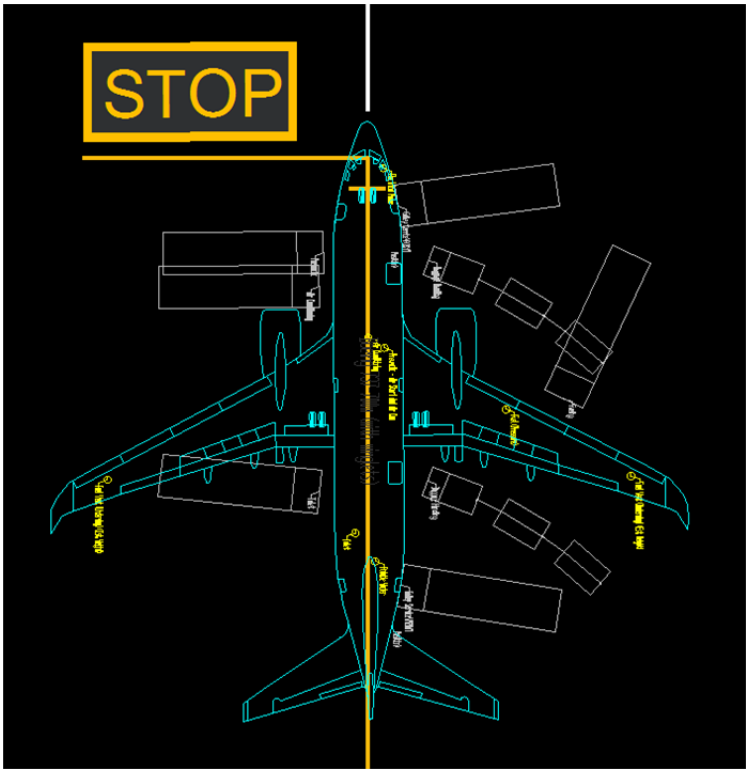
For example here is the path of a fork lift truck negotiating its way through warehouse storage racking. This could be the cargo freight storage warehouse at an airport. By using this type of analysis the spacing of the racking can be optimised and efficiency increased



Most of these types of vehicles are available within the Aircraft and Support Vehicles library and can be driven using AutoDrive Arc. If a vehicle is not available you can create/edit your own. This can be done using the vehicle wizard or units can be dragged and dropped on-top of another vehicle. It will then be automatically attached to the rear. This is especially useful for vehicles with identical multiple units such as baggage trains or light rail carriages.



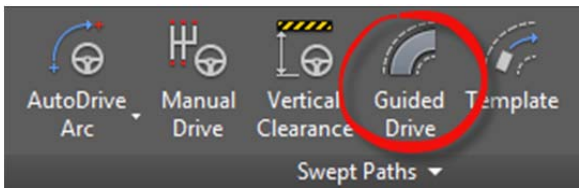
As shown in the screenshot below, most of the aircraft have a layer which can be turned on displaying where ground support units connect to the servicing points. This can help when routing vehicles. These are static images defined in the vehicle setup. You will need to select the corresponding vehicle from the Library and “drive” it. This can be used in the routing of support vehicles to the aircraft



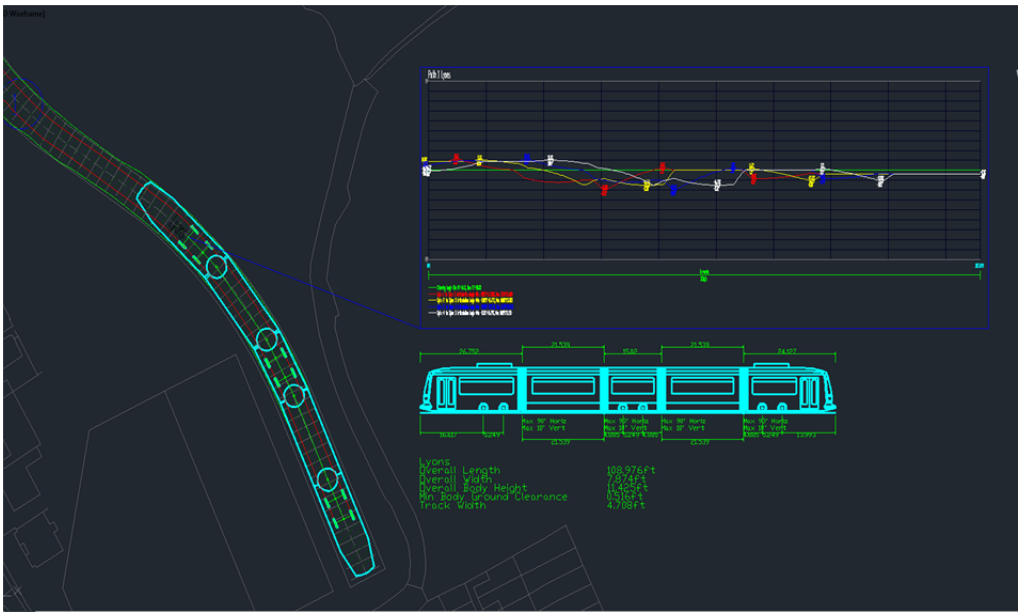
Light Rail

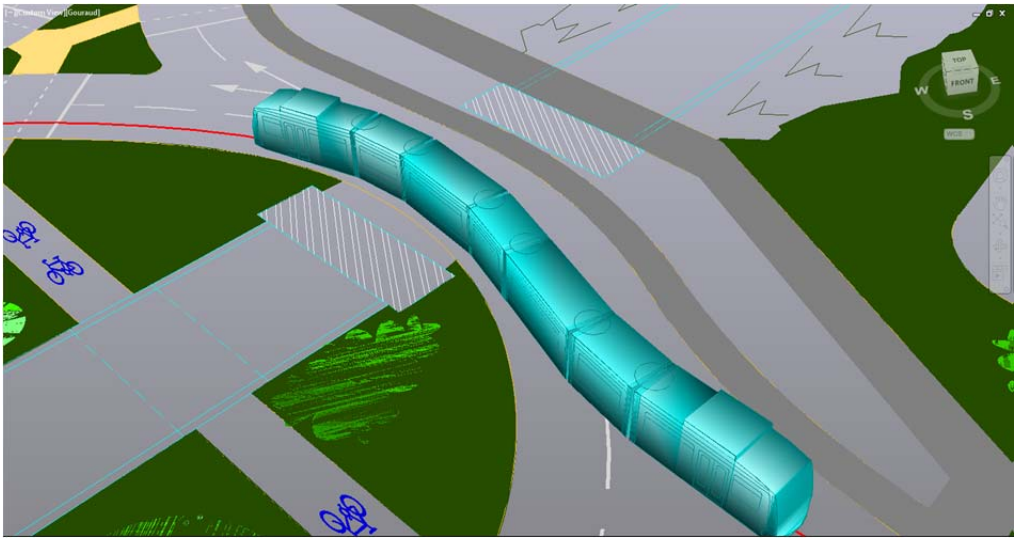
Connections between terminals are now commonly facilitated by light rail vehicles. They can also be used to connect to offsite transport networks. This feature does not model any heavy rail as it does not model cant.

Light rail exclusively uses Guided Drive mode which is very similar in operation to Follow Drive.



Select a vehicle from the “Trams and Rail Vehicles” Library. Then as with Follow Drive, select the line to follow. There are less settings to define (direction and speed) before the path is driven. Clearance envelopes can be added but these are not dynamic. If the vehicle stops along the path because the turn is too tight and exceeds the vehicle capability you must delete the path, adjust the path line and regenerate the swept path. It does not automatically update.

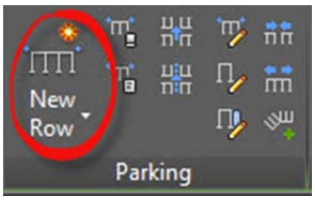




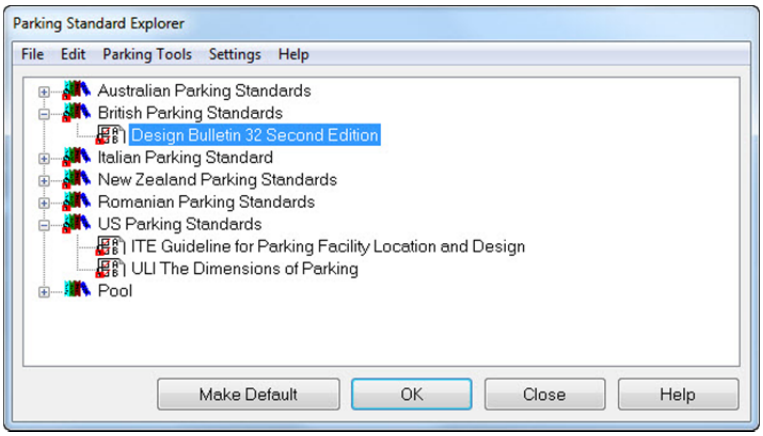
Parking

A major consideration of an airport design/expansion project is the allocation of parking. It can take up a lot of space and therefore it is essential to maximise the efficiency of the design. The rapid deployment of parking bays using rule based design

Select the **New Row** to see the available Parking Standards (if one has not already been selected)



Select the Standard you want to use and select it by double-clicking on it

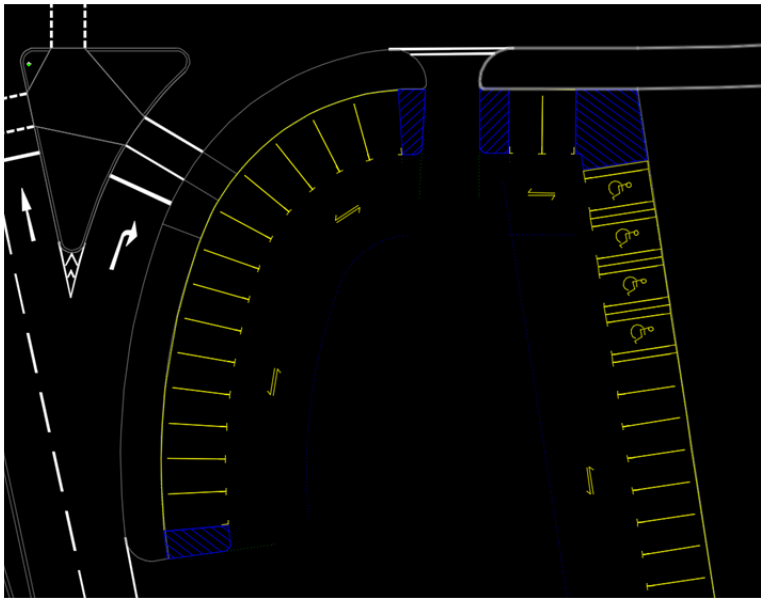


You can the properties for the parking rows before placing them in the drawing. This step is not essential because they can be fully customized later.

To place a parking row, simply click and drag the cursor. Turning **Snap** on helps with aligning your row to existing landscape. Draw out the parking rows using a **left-click** to insert a new vertex. **Right-click** when finished

At this point move the cursor either side of the row and you will see a red arrow used to select which side of the line to place the parking bays. If you position the cursor in the centre of the row it will place bays on both sides. **Left-click** to finalise the bay placement.

The parking rows are covered in grips which allow you to dynamically edit the design (Bay angle, add curvature, etc.). The Edit Parking Row/Bay icons allow you to change the properties (special parking bays, create access roads, etc.)



The Parking tool seamlessly connects with the swept path analysis to allow you to select vehicles and snap them directly into the Parking bays.

Roundabout design

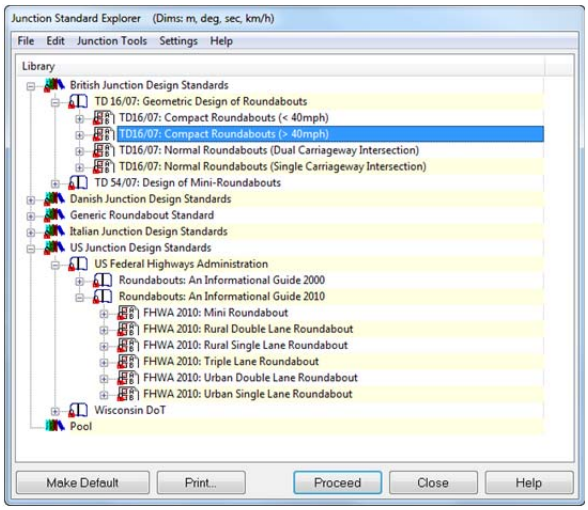
The majority of people arrive at airports via a road network. Roundabouts are generally the preferred intersection design in and around airport campuses because they:

- Can expedite rapid, interactive vehicle movements
- Are relatively compact intersections
- Accommodate many different types of vehicles safely
- Are popular at high volume locations as they can efficiently handle greater traffic flows

It is possible to quickly design a conceptual roundabout in AutoCAD in 2D or an automated 3D corridor model in Civil 3D. Roundabouts can be connected to your existing road corridor and swept path analysis can be carried out using AutoDrive. Some features such as pedestrian crossings and splitter islands can be added directly.

You can even use 3rd party software to connect to the design to add road markings (Line Design Pro) or dynamically link to traffic capacity analysis software (ARCADY) to get real time updates to Level of Service, RFC, Delay, etc.

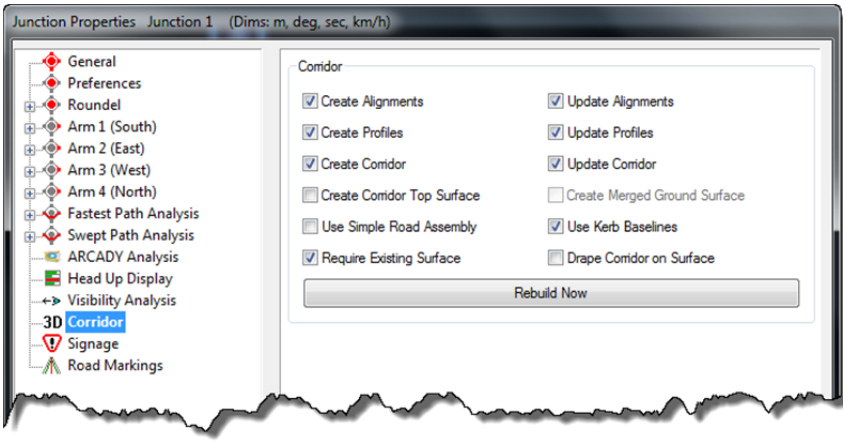
As with vehicles and parking bays, roundabouts have pre-defined standards. Select a roundabout standard and roundabout type, then select the location of the circle…

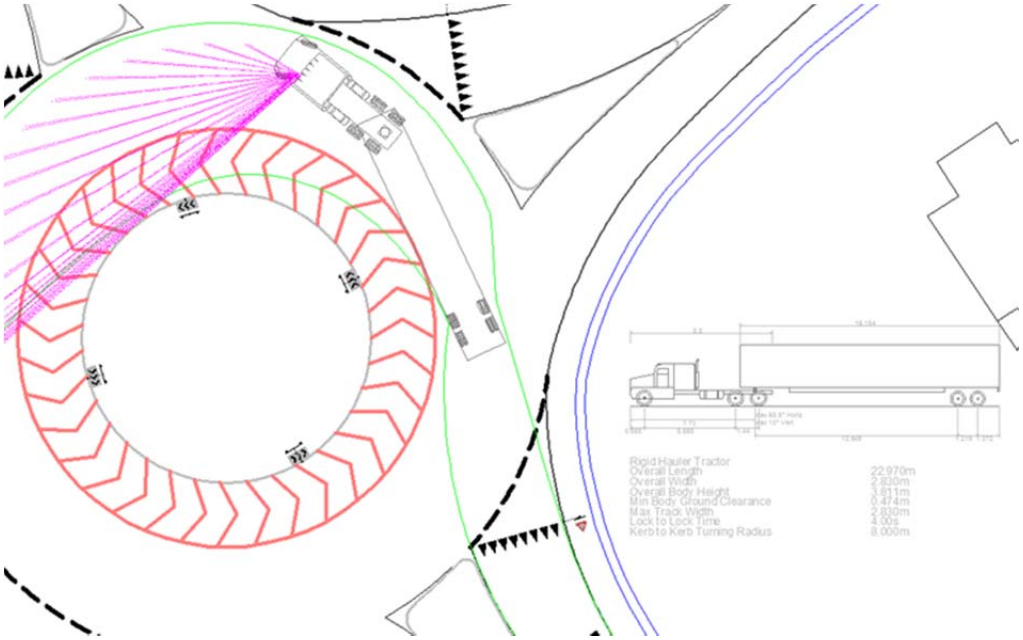


Add roads by selecting the alignments that you want to use for the intersecting roads, then end the command and the roundabout object is complete

Now that you have a roundabout you can use the multitude of grips to improve the design, test alternatives and resolve any issues.

If you are designing on a Civil 3D surface the corridor will be automatically generated. This feature can be turned on or off in the options. I would recommend finalising the design in 2D first and then adding the corridor as this will make the drawing easier to manage.





Summary

Vehicle swept path analysis is often looked over throughout the design cycle of many construction, architectural and site modification projects outside of civil road design. However I hope that I have been able to demonstrate how, if used correctly it can be an effective and powerful tool to assist in the planning, construction, validation and operation of a successful airport.

If you want any further advice or wish to discuss how to apply this type of analysis to your project, please feel free to contact me at mark.burgess@autodesk.com