



Sparrowhawk3D

The Tracks and Chains Package

for CARRARA 4,5 & 6

Beta Version 0.66

The **Track and Chains** package wraps and animates the links on a tracked vehicle or a drive chain. It makes a very difficult or nearly impossible animation task easy. If the motion of the tank needs to change then no key frame editing is required, the Tracks and Chains modifier works out the details frame by frame. Most purchased vehicle models can be adapted to work with the Tracks and Chains package. The Tracks and Chains package is a dedicated plugin and can be used to implement tensioners and suspension.

To install the plugin extract the contents of the compressed zip file into the Carrara\Extensions sub-folder. The plugin must also be installed into the ..\Extensions folder of all render nodes. To remove the Tracks and Chains package Carrara 4 users must delete the Tracks.mcx and Tracks.dta files from the ..\Extensions\ folder. Carrara 5 and 6 users must delete the Tracks.mcx, Tracks.dat and Tracks.txt files.

The package comes in 5 parts each found under a Sparrowhawk3D sub-menu. The Tracks and Chains modifier is used to wrap a group full of links around a group of wheels, each marked with the Sprocket Wheel modifier. The Duplicate Links scene command can be used to produce the required number of copies of one or more links, including any child objects attached to those links. Two scene commands are included which store key framed data so that animations can be rendered in separate batches with consistent results.

You can use the Tracks and Chains Package beta in any project, commercial or otherwise. You may not re-package or bundle and sell the Tracks and Chains Package. Please do not redistribute the beta package.

Overview

The Tracks and Chains package wraps the links of a tracked vehicle or chain system accurately around a group of wheels. This plugin is intended for use with accurately modelled tanks, half tracks, excavators and drive chains with complete working parts. Low detail vehicles and purchased content can be animated so long as the links and wheels are separated from the rest of the undercarriage. The Tracks and Chains package can be used to setup a complete bike chain with gears and derailleurs but the current version is unable to keep the links properly engaged after a gear change (the final version hopes to address this).

All of the wheels in a track or chain system must be in the same group at the same level in the scene hierarchy. The wheel axles must all turn exactly in either the X or Y axis. Every wheel in the system must be marked with a Sprocket Wheel modifier into which its dimensions and properties are entered. Only those objects in the wheels group which have an enabled Sprocket Wheel modifier will be used by the Tracks and Chains modifier. Mark all of the wheels in the group whether they are actually sprockets or not, including all drive wheels, idlers, rollers and road wheels. The track or chain links are wrapped around the wheels depending on their position and order in the group from the first sprocket wheel to the next and then back around from the last to the first. The separate sides of the undercarriage of a tracked vehicle must be treated as two completely separate systems with two Tracks and Chains modifiers, two groups of wheels and two groups of links.

A convention must be followed when arranging and ordering the grouped sprocket wheels. Depending on how each wheel is arranged and set to wrap the chain will pass around the outside of the next wheel or underneath it. If the axles are in the X axis then one wheel is in front of the other if it has a greater Y co-ordinate. A line is traced in the plane of the wheels from the centre of one wheel to the centre of the next wheel in the group. If the next wheel is in front of the previous one and the wrapping mode for that sprocket is set to *around* then the chain will wrap over the top and around the next wheel. If the next wheel is behind the previous one and the wrapping mode is set to *around* the chain will wrap around under the wheel. If the next wheel is in front of the previous wheel and the wrapping mode is set to *across* then the chain will wrap under the next wheel. Incorrect ordering, labelling or impossible arrangements of sprocket wheels will cause unexpected results.

All of the links in the track or chain system must be grouped together at the same level in the scene hierarchy. This group may only contain links and should contain enough duplicate links to fit together closely and wrap around the entire system. The pins of the links must align in the same axis as the wheels. The hot point of each link must be in centre of the pin or where the pin of the previous link will fit into it. The *chain pitch* is the distance from the pin of one link to where the pin of the next link will fit into it and will be measured in the positive axis opposite to the wheel axles. The shoe of a tracked vehicle's link parts can face either up or down in the Z axis. Chain links are typically symmetrical. The Tracks and Chains package allows for the use of alternating link parts with different pitches in which case the links must alternate throughout the link group listing. Usually the links of a drive chain alternate, with the plates of one link fitting inside the next, these links must alternate in the group but do not necessarily require an alternate link pitch.

The links in a drive chain or track system will be arranged by the Tracks and Chains modifier so that they sit on rollers and engage with sprockets. The *pitch diameter* is the distance around the outside of each wheel where the pins of the links will be placed. The pitch diameter of a roller is typically the outside diameter of the wheel plus the height of the link (not including a shoe). The pitch diameter of a sprocket wheel is not the outside diameter but the diameter of the circle made by the pins of the links around that wheel.

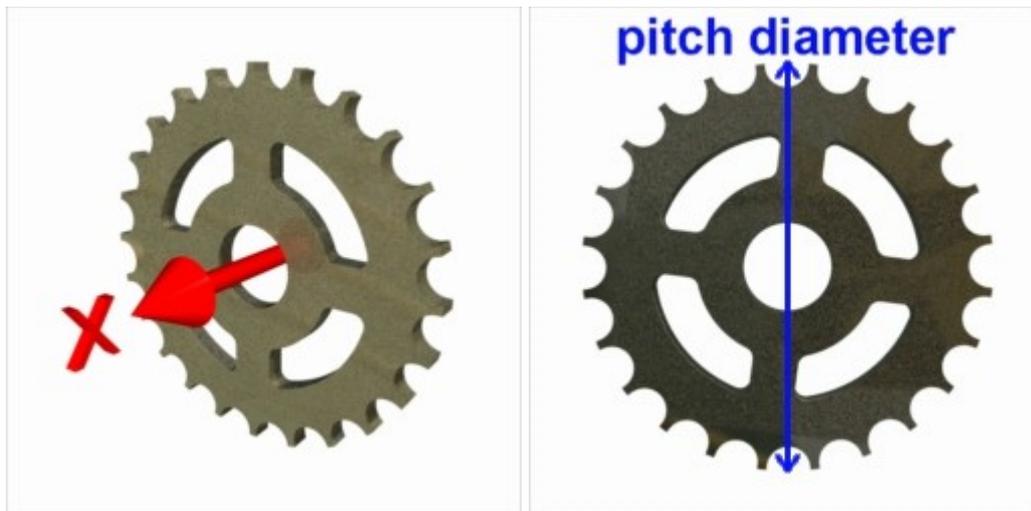
Care must be taken with any scaling of the parts in the system. The dimensions entered in scene units are always measured in the local geometry of the group of wheels. Any changes in the scale of the system will require an adjustment of all the diameter and pitch values. Parts can be scaled to fit and their dimensions must be taken from the size relative to the local geometry of the wheel group. A parent vehicle or the entire system should be scaled at 100% during its setup to avoid error. The whole system can be scaled after it has been setup.

Once the system is setup correctly the tracks of a vehicle are automatically animated as the vehicle moves around in the scene. Separate Tracks and Chains modifiers should be placed on the grouped wheels on either side of the undercarriage so that when the vehicle turns they rotate accurately with the inside track turning slower than the outside. Drive chains are animated by setting the variable rate in cycles per second for the drive wheel which is always the first wheel in the group. The modifier can also be used to animate a bike chain by giving the diameter of a road wheel and moving the system around in the scene.

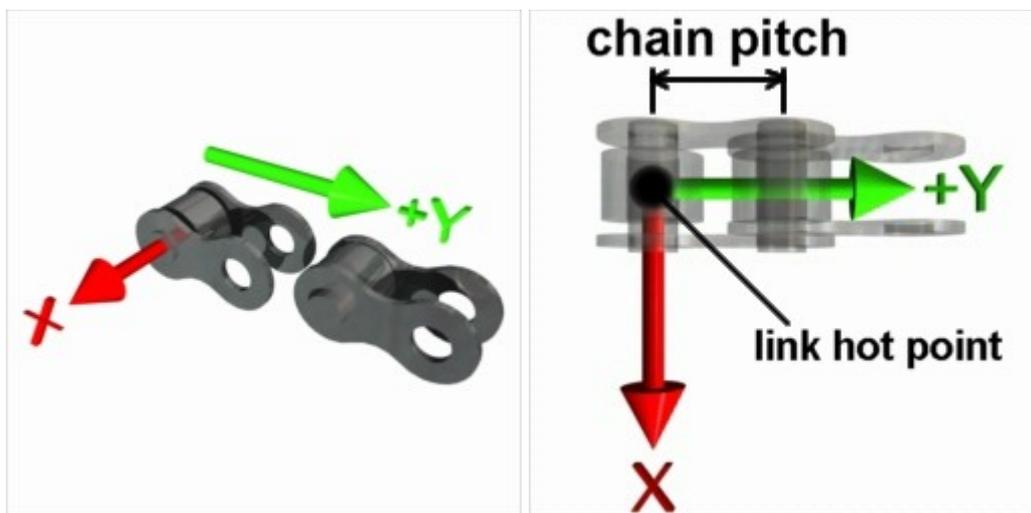
Using the Tracks and Chains Package

Setting up a Simple Drive Chain

Model or import the mesh for the sprocket wheels and links parts, assembling any separate plates, bushes and pins into complete links. Once the drive chain system is setup any rotation of the wheels and arrangement of the links is made exclusively by the Track and Chains modifier. If any of the complete pieces or wheels need to be orientated to get them to line up with the rest of the system or to align them into the X or Y axis, select the part then from the top application menu choose Edit | Group to preserve that orientation. Constraints should not be applied to the wheels or link parts.



In this example a sprocket wheel has been imported from a CAD application. The axle was initially in line with the Z axis. The wheel has been rotated so the axle is parallel with the X axis and then grouped to keep that orientation. Sprockets must be carefully designed so that the chain fits. With the wheel selected switch to the <Modifiers> tab in the Properties tray then add a Sprocket Wheel modifier (found under the Sparrowhawk3D submenu). The most important parameter is the *Pitch Diameter* which is the diameter around the wheel at which the pins of the links will engage with the sprockets.



Link pieces have also been imported and assembled into groups so that the pins are aligned with the X axis and the link itself points in the +Y axis. The hot point of the link is moved to the middle of the pin. The plates of the second link fit inside the plates of the first. Some chain designs have a single type of link with bent plates. When two links are fitted together the distance between each pin is the *Chain Pitch*. Select the link(s) and then choose Edit | Group to get the group of links ready to build the whole chain.

The circumference of the circle formed by the pitch diameter of any wheel should be equal to an exact multiple of the chain pitch. Duplicate the sprocket wheel or set other sprockets up with a Sprocket Wheel modifier and enter the correct pitch diameter. Simple systems with two wheels of similar or the same size should be spaced apart at a multiple of the chain pitch. Systems with many wheels and different sized wheels should be designed and arranged so that the total length of the chain around them is a multiple of the chain pitch. Where alternate links are used the total track length should be an even multiple of the chain pitch.

Group all of the sprocket wheels together then add the Tracks and Chains modifier to that group (also found under the Sparrowhawk3D submenu). By default the modifier will assume that it has been applied to the sprocket wheel group - otherwise use the button to bring up the selection dialog to point it to the wheel group. Carrara 4 users must type in the exact unique name of the wheel group. When a group with at least two objects having sprocket wheels modifiers is found then a valid *Track Length* will be displayed. Select the correct *Axles In* axis for the system, in this example the axles are aligned with the X axis.

Enter in the *Chain Pitch* for the links and then hit the [Calculate] button to get the *Link Count* and the total number of links required. The Tracks and Chains package is not currently able to allow for slack between wheels but by hitting the [Adjust] button when there is a valid total *Link Count* the *Chain Pitch* will be adjusted to loosen the chain a little between each link. So long as the sprocket wheels are spaced so that the track length is close to a multiple of the chain pitch then the system will look okay, adjust the wheels if possible then adjust the chain pitch. If tensioners are to be used then the *Chain Pitch* should not be adjusted.



When the total number of required links is known open the group of links and select the actual link object. Where there are alternate or different links select them both. Now using the top menu choose Edit | Sparrowhawk3D | Duplicate Links then type in the *total number of links*, including the selection. The link objects and anything attached to them will be duplicated to fill the total link count. Return to the Tracks and Chains modifier applied to the sprocket wheel group and use the button to open the dialog box and select the *Links Group*. Carrara 4 users must type in the exact unique name of the links group. If the preview doesn't update after a change then hit the stop button in the sequencer tray.

To get the gaps between the sprocket teeth to line up with the pins and bushings of the links switch to a wireframe side view then select each wheel and adjust the *Spin Correction* value in its Sprocket Wheel modifier. If the system is accurately designed and setup then everything will fit together precisely.

To animate the drive chain switch to the <Advanced> card of the Tracks and Chains modifier. Change the *Mode* to 'Transmission Chain'. The *Cycles per second* value sets the number of times that the drive wheel of the chain system will revolve in one second. The first wheel found in the Sprocket Wheel Group is always the drive wheel. Hit the play button in the sequencer to preview the animation. When the *Mode* is set to 'Bike Chain' enter the diameter of the road wheel instead. When the chain system is attached to a bicycle and moved around in the scene then for every time the bike travels through a distance equal to the circumference of the road wheel then the drive wheel will turn once.

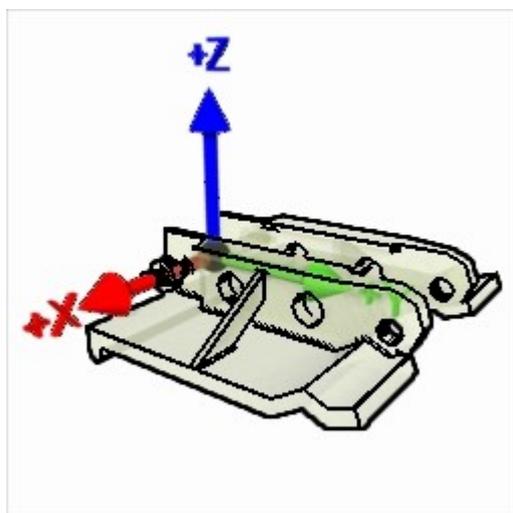
Setting up an Early Tank



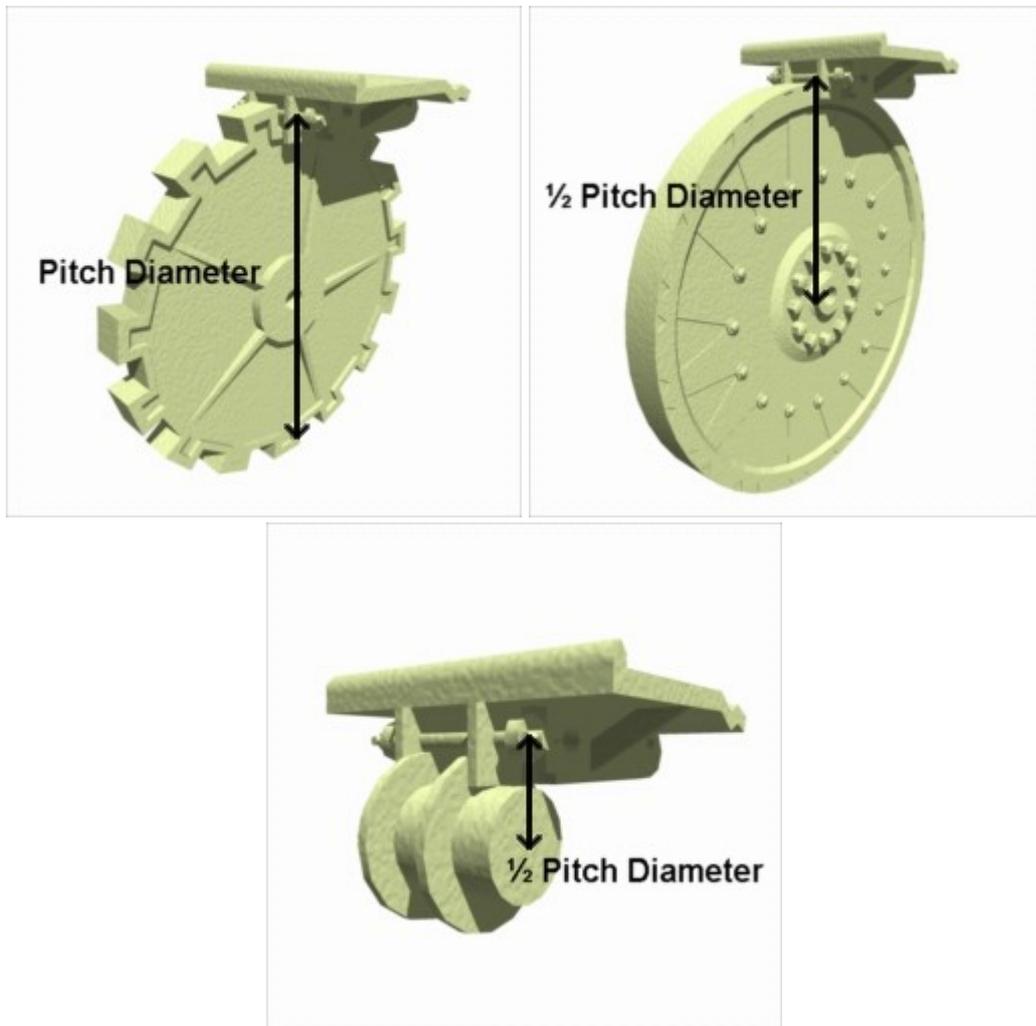
If all of the tank parts are made accurately to scale then the Tracks and Chains package can be used for the final assembly of the tracks. This example shows a model of the Renault FT-17 tank that came into use at the end of the First World War. When converting an existing vehicle or purchased vehicle, parts may need to be individually selected in the vertex modeler, cut from the mesh, then pasted into a new vertex objects. There is no need to manually duplicate the links and arrange them around the wheels when modeling a vehicle intended for use with the Tracks and Chains package.



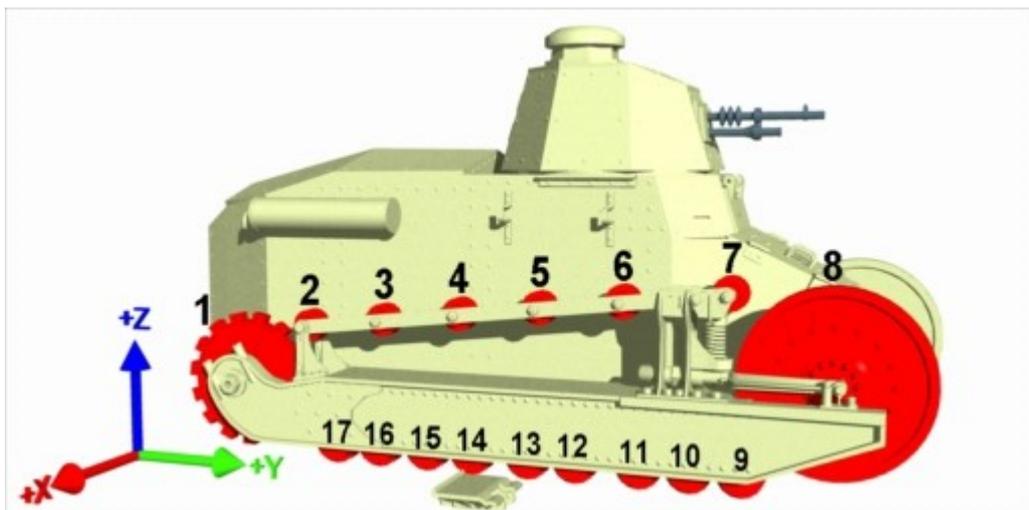
All of the wheels and the pins of the links must have their axles aligned either in the X or Y axis. If the wheels need to be orientated to fit them to the vehicle assembly then group each wheel to preserve the rotation. For this tank the axles are aligned in the X axis and the vehicle faces in the Y axis. The hot point of each wheel should be in the middle of its hub.



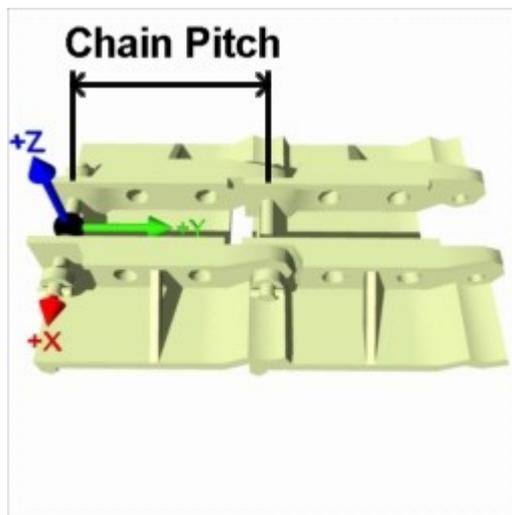
This tank used a single type of link with a bent plate, most modern tanks use more complex track parts with hinges. The hot point of the link must be in the centre of the pin. The axis of the pin must be aligned in the same major axis as the wheels of the tank. The shoe or tread of the link can sit on the ground or face the sky. The pin of the next link will be fitted in the axis opposite to the axes (Y in this example) at a distance of the *Chain Pitch*. Make sure that the link has no rotation currently set in order to arrange it in the tank assembly, if so group the link master to preserve this orientation.



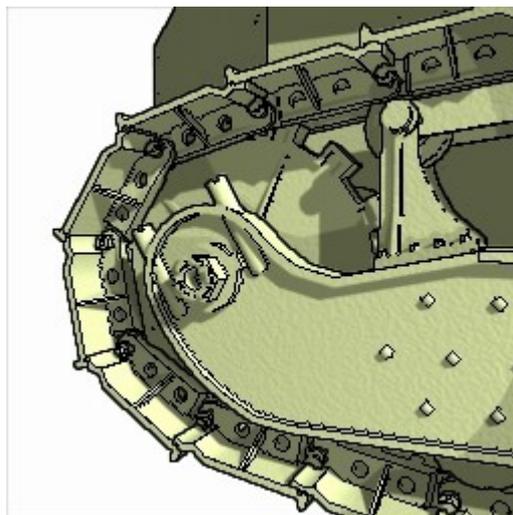
Select all of the wheels on one side of the tank and group them together. Give this group a suitable name such as "Right Wheels" or "Left Wheels". Every wheel in the group must have a Sprocket Wheel modifier added to it. The *Pitch Diameter* must be set correctly for each wheel so that the pins/bushes of the links sit on the outer surface of the wheel and engage with the teeth of a drive wheel. If the pitch diameter is unknown try making a duplicate of a wheel and move it so the hot point is at the origin then after placing the link at the origin raise it up in the Z axis until the pin is resting on the top of the wheel. Double the Z value of the pin in that position gives the pitch diameter.



Tracks and Chains uses the order in which the wheels are listed in the group and how their *Wrapping Method* is set to determine the path the links follow around them. When one wheel is in front of the next the track is wrapped *around* over the top of that wheel. A wheel is in front of another if it has a greater value in the axis opposite to the wheel axles. When the next wheel is behind the previous wheel in the list the tracks are wrapped *around* under that wheel. The track wraps around from the last wheel back to the first. Only those objects that are marked with a Sprocket Wheel modifier (and enabled) are found and used. The sprocketed drive wheel should be the first wheel in the group.



Select the group of wheels and add a Tracks and Chains modifier to it. If the modifier is added to a different object then hit the button and use the selection dialog to find the *Sprocket Wheels Group* (Carrara 4 users must type the name in). Make sure the correct *Axles In* axis is selected for the track system. The modifier will join up a group of links, wrapping them around the wheels and placing the next link at a distance of the *Chain Pitch* from the hot point of the previous link. If there are two types of links switch to the <Advanced> tab and enter in the *Alternate Chain Pitch* value. Enter in the *Link Count* for the track system if it is known. Otherwise hit the [Calculate] button and the modifier will divide the *Track Length* by the *Chain Pitch* to give the link count. Use the [Adjust] button if the links do not quite join up right around the track. The *Mode* (on the <Advanced> tab) should be set to 'Tracked Vehicle', which is the default. Realistically modelled tracked vehicles should have adjustable parts and tensioners.



Select the link object in the scene list then from the top application menu choose Edit | Group then give this group a suitable name such as "Right Links". Tracks and Chains expects all of the links to be in one group and any objects in that group are joined and wrapped around the track in their listed order. If there are alternate links then they must be listed second in order then 4th, 6th etc. Select the link or pair of links then from the top menu choose Edit | Sparrowhawk 3D | Duplicate Links and enter in the total number of links needed including the selected links. Enough duplicates of the selected links arranged in the right order will be added to the group. Return to the Tracks and Chains modifier and then use the button and select the *Links Group* using the dialog (Carrara 4 users must type in the exact unique name). Press the stop button in the sequencer tray to force an update and the links will now appear around the wheels. If the shoes of the tracks are facing the wrong way up or down then switch to the <Advanced> tab and check (or uncheck) the *Flip Shoes* box. The links group does not have to be attached to the vehicle, the modifier will make sure that the links stay wrapped around the wheels. Use the *Spin Correction* on the Sprocket Wheel modifier of the drive wheel to get the pins and gap between the sprocket teeth to engage properly.

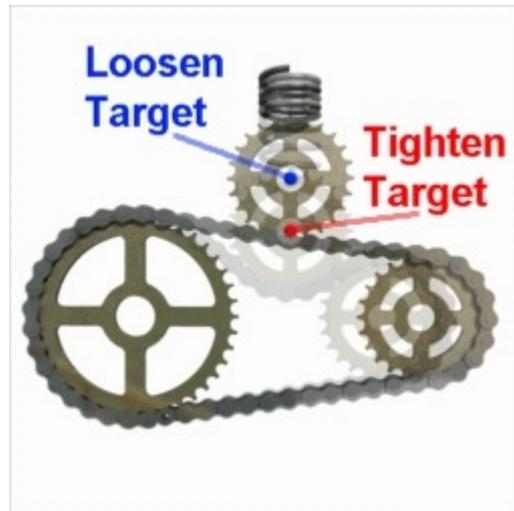
Repeat this process for the other side of the tank. Time might be saved by modelling one side of wheels and using Duplicate With Symmetry on the finished setup, renaming and re-selecting the links and wheels of the other side.

In some cases, due to floating point math inaccuracy, the tracks may incorrectly wrap completely around one or more wheels, appearing like a knot. By slightly moving that wheel a fraction these problems can usually be solved. This is most likely to occur in cases where there is a straight line of rollers or road wheels.

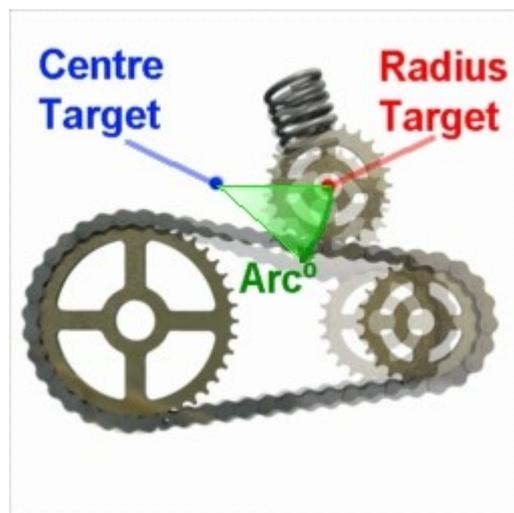
To animate the tank tracks simply move the vehicle around the scene or follow a motion path.

Tensioners

Tensioners are an advanced feature and recommended for users who are familiar with the basic function of the Tracks and Chains package. An accurately modeled tank will have suspension and use tensioner rollers to maintain a tight track. Without tensioners if the road wheels are moved around then the chain will break and the last link will not join up with the first. Two types of tensioners can be implemented, those which push the wheel in or out and those which swing it through an arc. A tensioner requires two target points positioned correctly to work, use target helper objects for this. These target points for the tensioners should be placed into the same group as the sprocket wheels.



The normal straight tensioner wheel will move toward the *Tighten Target* point when the chain needs to be tighter and toward the *Loosen Target* point when the chain is too tight.

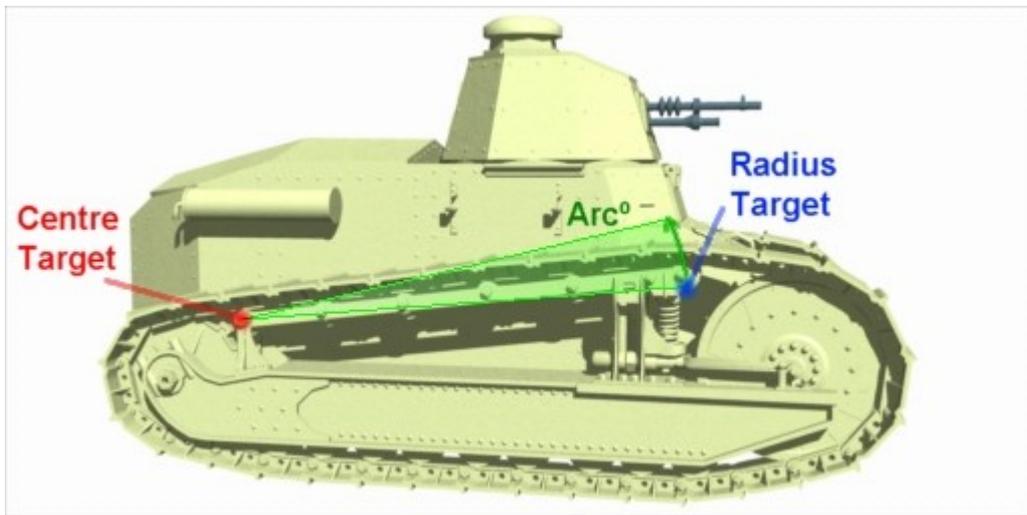


When the *Curved* tensioner option is used the tensioner will swing around the *Centre Target* point at a radius measured from its distance to the *Radius Target* point. The tensioner wheel will swing through an *Arc* away from the *Radius Target* point to tighten the chain. The *Arc* direction (\pm) follows the standard right hand rule for rotations in Carrara.

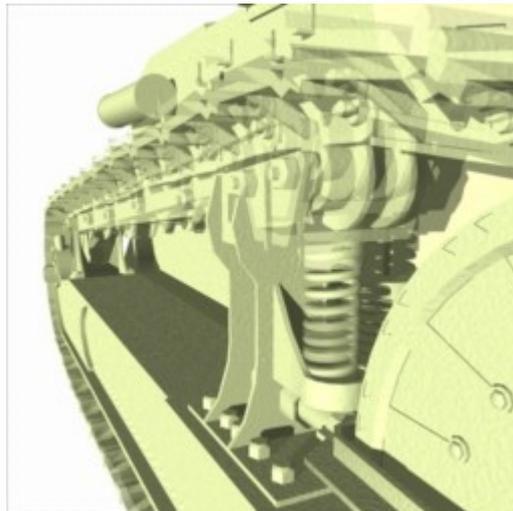
If the exactly and accurately modelled track or chain length is unknown then set the system up without the tensioners enabled or disable them in the Tracks and Chains modifier. The track length should be kept equal to the exact *Chain Pitch* times the *Link Count*. Switch to the <Tensioners> tab and enter that *Required Track Length*. A *Guess count* of 10-25 is usually enough, use 100 for a more accurate result.

Multiple tensioners can be given unequal weighting by changing the tensioner Weight values. A tensioner with a lower weight will not respond as much as a tensioner with a higher weight.

If the tensioners cannot be adjusted to maintain the required length then the chain will break or begin to double wrap around the system.



Getting the suspension system to work for the FT-17 example requires a few tricks. The spring near the large front idler wheel moves the entire top rail and all of the rollers through an arc with its centre on the pin on the support near the sprocket. The roller above the spring is set as the tensioner. The assembled top rail is rotated to be horizontal then has a Point At behavior modifier added so that it points at the moving tensioner. The hot point of the rail is in exactly the same position as the tensioner *Centre Target* so the last roller will remain correctly fitted to its end. Since the rollers on the rail must be in the wheel group all of their pins are attached to the rail, numbered and then each roller is given a Track modifier so that when the rail moves they stay fixed on the pins. When the road wheels are moved up and down the tensioner is raised or lowered and the rail and all of the rollers swing with it. This creates a 'chicken and the egg' problem - one of them has to come first. The tensioner must be adjusted before the rail can point at it - but the wheels, higher up in the hierarchy, must track to the pins on the rail. To implement the system two Tracks and Chains modifiers are used for each track side.

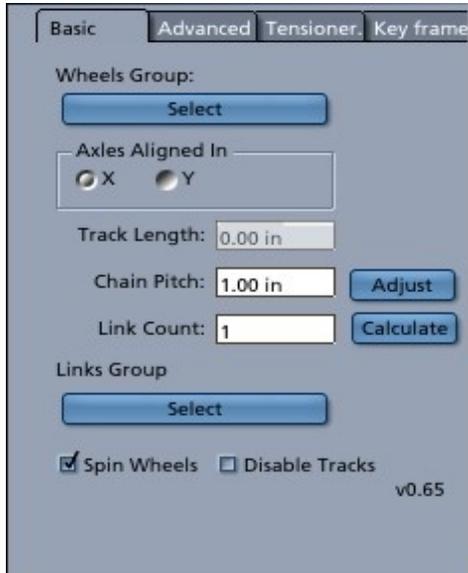


Add a 'dummy' object, a sphere, into the scene then jump this object onto the same position as the wheels group. Hide it then parent it to the vehicle, level with but above the wheels group in the hierarchy. A duplicate of the dummy is made and the second one must be moved lower in the hierarchy than the wheels group. The suspension rail must be higher in the hierarchy than the wheels group and lower than the first dummy sphere. Add a Tracks and Chains modifier to the first dummy sphere higher up in the list and this one will enable the tensioners but uncheck the box to spin the wheels and select a different empty group of links (eg the other dummy sphere object) so that it is tricked out of wrapping the links. Add or drag and drop a Tracks and Chains modifier to the dummy object lower in the hierarchy with the same settings. This modifier will be used to wrap the links and spin the wheels but not adjust the tensioners. Both of the hidden spheres must move with the wheels to correctly track the motion of the tank. Carrara processes objects and modifiers in the descending order of the scene list, but every object is moved first according to its key frame data. The first dummy sphere adjusts the tensioners according to the changing position of the road wheels. Next in the list the rail will point at the tensioner and then after that any of the road wheels are tracked onto the pins of the rail. Finally the Tracks and Chains modifier is called on the second dummy sphere which wraps the links around the moved wheels and spins them. A Sparrowhawk3D Spring Primitive is inserted lower down into the scene list and set to work between two target points, one at its base and the other is attached below the moving tensioner. A tricky setup but the tank can be freely moved around and its road wheels can roll over bumps and the tensioner will keep the track tight.

The Tracks and Chains UI

The Tracks and Chains modifier can be found under the Sparrowhawk3D submenu in the modifier list. The modifier uses the motion of a tracked vehicle or bike so it should be applied to the group of wheels.

Basic Settings



Hit the button to bring up the dialog and select the *Wheels Group* containing the set of wheels for one track side or chain system. Carrara 4 users must type in the exact unique name. Every wheel in the group must have a Sprocket Wheel modifier added to it. If the Tracks and Chains modifier is added to a group of wheels, and two or more objects are found with Sprocket Wheel modifiers, then the *Wheels Group* does not have to be selected. Constraints should not be applied to the wheels in the group.

The track or chain system must have all the wheel *Axles Aligned In* either the X or Y axis. The pins of the links must also be aligned in the same axis. Any rotation of the wheels in the group will be controlled exclusively by the Tracks and Chains modifier.

When there is a group of wheels found a valid *Track Length* will be displayed in scene units. This is measured in the local space of the wheels group and any scaling of the group or parent objects will be ignored. The value cannot be changed by the user.

The *Chain Pitch* is the distance from one link pin to the next and is used by the modifier to space the links around the wheels. If there are alternate links enter the *Alternate Chain Pitch* in the <Advanced> settings card. The *Link Count* gives the total number of links to be wrapped around the tracks. If the chain pitch is known but the link count is unknown then hit the [Calculate] button to give the nearest round number of links that will fit in the system. $\text{Link Count} * (\text{Chain Pitch} + \text{Alternate Chain Pitch}) = \text{Track Length}$. If the links do not exactly wrap around the track and tensioners are not implemented then hit the [Adjust] button to loosen up the system so that the last link joins up with the first. Hit the [Adjust] button to give the recommended chain pitch if this is unknown when constructing a system. The *Chain Pitch* is given in scene units and must be at the correct scale for the local geometry of the wheels group.

Hit the button to bring up the dialog to select the *Links Group* which must contain all of the links and only links. Carrara 4 users must type in the exact unique name. Alternate links must be listed in alternating order. The links will be wrapped around the wheels, their position and rotation is then controlled exclusively by the modifier. Constraints should not be applied to the links. If there are not enough links in the group then the chain will animate and function but it will not join up the ends. If there are too many links in the group they will continue to wrap around in the same place as the first set of links.

When the *Spin Wheels* option is ticked all of the Sprocket Wheels in the group will be rotated at the correct speed and direction to match the motion of the tracked vehicle, bike or the cyclic rate of a transmission chain. This parameter can be key framed.

Check the *Disable Tracks* to leave the links where they are currently positioned and stop any animation. This parameter can be key framed.

Advanced Settings



Select the appropriate *Mode* for the Tracks and Chains modifier to function in. A 'Tracked Vehicle' will be animated when the object the modifier is applied to is moved around in the scene. When using the 'Transmission Chain' mode animation is controlled by the *Cycles per second* which gives the rate at which the drive wheel turns. The drive wheel is always the first wheel in the group. The positive or negative cyclic rate follows the right hand rule. In 'Bike Chain' mode the chain is still animated by motion but the *Road Wheel Diameter* must be entered in scene units. When the bike travels though the circumference of the road wheel the drive wheel of the system makes one revolution.

Change the setting of the *Flip Shoes* checkbox if the tracks of a vehicle are facing the wrong way up/down.

For systems needing two types of links with different pitches enter the *Alternate Chain Pitch* in scene units. The second link in the group is always the alternate link. Leave the alternate chain pitch set to 0 if there is only one type of link or if the links have the same pitch.

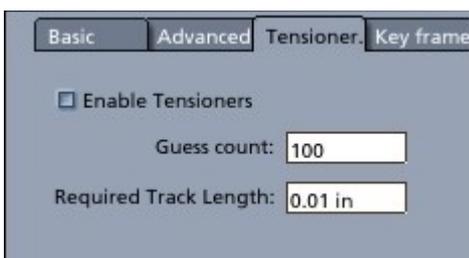
When the Tracks and Chains modifier is operating in 'Tracked Vehicle' *Mode* enter a *Travel per Second* value in scene units to animate the tracks without moving the vehicle or in addition to/against the motion of the vehicle. If the value is equal to the track length then the whole track will make a complete revolution in one second. Use this to animate a vehicle stuck in mud with the tracks slipping as it fails to move. This value can be key framed.

Use the *Track Offset* value to move the links around the track as an alternative to adjusting the spin correction parameter for a sprocket.

Adjust the *Traction* to simulate different ground conditions. When the *Traction* is less than 100% the tracks will spin faster due to loss of traction. Values greater than 100% can be entered in by clicking on the number.

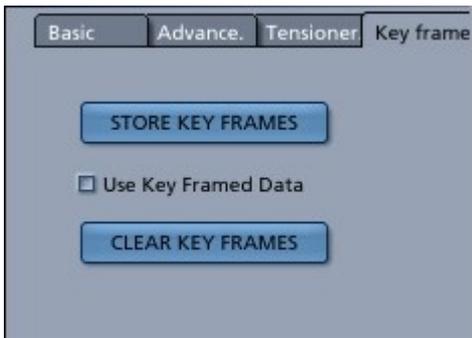
Check the *Manually Align Tracks* option to move the chain off the group of wheels. Normally the group of links is kept wrapped on the tracks by moving the hot point of the link group to the hot point of the wheel group and matching the rotation.

Tensioners



Check the *Enable Tensioners* box to use the advanced tensioners feature. Enter the *Required Track Length* in scene units and the modifier will move any sprocket wheels that are enabled as tensioners to maintain a constant belt length. The *Guess count* value sets a limit on the number of attempts that are made to find the right position for all the tensioners, using a very high value may slow down the Tracks and Chains modifier. Set the *Required Track Length* to the exact multiple of the chain pitch times the total link count.

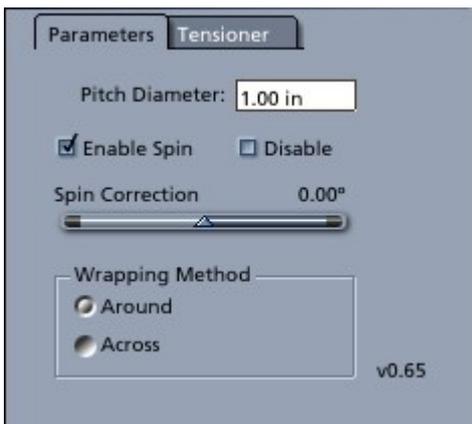
Key frames



The Key frame data feature is only needed for separate batch queue rendered movies which are to be joined later. Key frames do not have to be stored for normal function and animation of the modifier. Adjust the animation frame rate in the sequencer then hit the [STORE KEY FRAMES] button to store data. When the *Use Key Framed Data* option is checked the Tracks and Chains modifier will ignore any other animation parameters. Hit the [CLEAR KEY FRAMES] button to remove the key frame data.

The Sprocket UI

Parameters



Every wheel in the track or chain system must have a Sprocket Wheel modifier added to it. It can be found under the Sparrowhawk3D modifiers submenu.

The most important parameter is the *Pitch Diameter* which tells the Track and Chains modifier how far around the centre of the wheel to wrap the pins of the links.

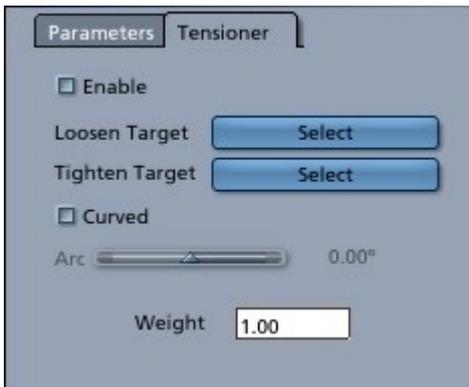
The next most important setting is the *Wrapping Method* which tells the Tracks and Chains modifier whether to wrap the links *around* the outside of the wheel or to pass *across* the wheel on the opposite side. When the next wheel is in front of the previous wheel (in the axis opposite to the axle) the chain will wrap over the top of the wheel and *around* the outside or *across* the gap and then pass under the wheel.

Unchecking the *Enable Spin* box will prevent the Tracks and Chains modifier from turning the wheel when the system is animated.

When the *Disable* option is checked the Tracks and Chains modifier will ignore the sprocket wheel and the chain will pass by or through it. This feature can be used to implement selectable gears.

Adjust the *Spin Correction* to rotate the sprocket wheel around its axle. This value can be key framed and used to orientate the sprockets a particular way or to make a particular wheel slip during animation.

Tensioner



Tensioners are an advanced feature that allows the Tracks and Chains modifier to automatically adjust and move one or more sprockets to maintain a constant *Track Length*. Check the *Enable Tensioners* box to activate a sprocket wheels set as a tensioner (note that this property can be key framed). Use the object selection dialog box to choose the target points. Carrara 4 users must enter exact unique names into the field. When the *Curved* option box is checked the target labels change and the *Arc* range of the curve can be set. The positive or negative rotation through the *Arc* from the *Radius Target* follows the right hand rule. A tensioner with a lesser weight will be brought into action slower than a tensioner with a higher weight.

Storing Key Frame Data

The Tracks and Chains modifier animates the links and spins the wheels frame by frame. When rendering most animations there is no need to use this feature.

If there is too much detail in the scene and the rendering must be done in batches then the final animation of the tracks will be inconsistent. When a render does not start and run continuously from the first frame right through the position of the chain links is lost because the vehicle is assumed to be stationary when the modifier is first called. When separate animations are joined up the tracks will jump at the cut. Using the pause and resume feature of the batch queue will avoid the problem. Otherwise this feature can be used to store key frame data for consistent results.

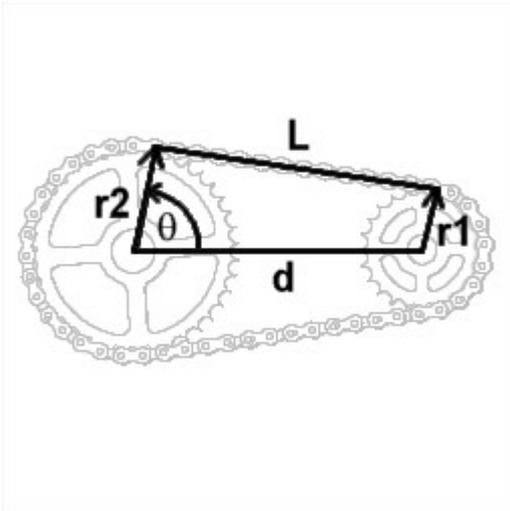
Select the object which has the Tracks and Chains modifier then switch to the <Key frames> tab. Adjust the frame rate in the sequencer tray to set the number of keys required. Hit the [STORE KEY FRAMES] button to generate the key frame data setting a % of the current scene's frame rate for the accuracy. When the *Use Key Frame Data* box is checked the modifier will ignore any motion or travel/cycles and use the stored values to animate the tracks or chain. Hit the [CLEAR KEY FRAMES] to remove the frames. Newly stored key frames will clear and replace any existing frames.

Key frames can also be stored and cleared for multiple selections with Tracks and Chains modifier by using the commands from the application menu. These are found under the Edit | Sparrowhawke3D sub-menu.

The key frame data stored is simply a single value recording the absolute travel of the track. Key frames are not generated for the individual wheels or links.

Design Notes

Use the following formulae when working with the Tracks and Chains package.



for wrap Around

$$r_1 = r_2$$

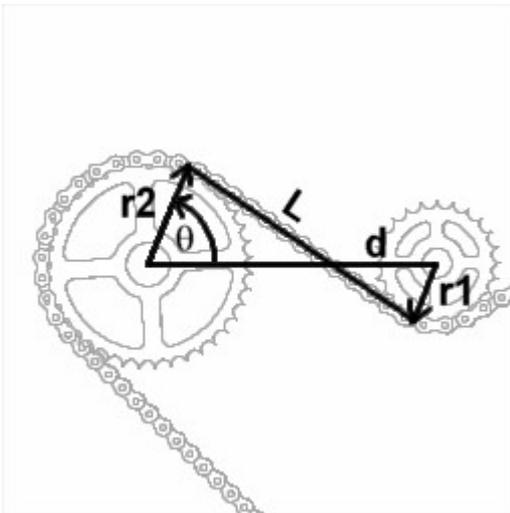
$$L=d$$

$$\theta=90^\circ$$

$$r_2 > r_1$$

$$L=\text{sqrt}(d^2+(r_2-r_1)^2)$$

$$\theta=\text{acos}((r_2-r_1)/d)$$



for wrap Across

$$L=\text{sqrt}(d^2-(r_1+r_2)^2)$$

$$\theta=\text{acos}((r_1+r_2)/d)$$

Tips and Tricks

- After changing the parameters for a sprocket or rearranging the wheels force an update in the preview by hitting the stop button in the sequencer.
- Wheels or links seem to be going the wrong way ? select a wheel with the rotation tool or select one of the links then hit play to be absolutely sure.
- The modifier can be used on a bike chain with many gears and a spring loaded derailleur (a very complicated setup but possible) however it is unable to keep the chain exactly lined up with the sprockets after a gear change.
- Use the package on a conveyor belt or escalator and get items to track a particular link to move them along it.
- Some tanks have 'slack' tracks. Place some invisible sprocket wheels with small diameters above the road wheels to change the path of the track.
- Be careful when applying a fractal or procedural texture and use local or uv space on the links and vehicle.
- Use Track and Chains together with the Wheels modifier on a half track vehicle.
- Try using the package on a chain saw by using a series of hidden wheels that make out the shape of the blade.
- Get mud to stick to the tracks by parenting lumps to some of the links or tracking to target points placed on the links.

Notes Regarding the Beta Version

- The Tracks and Chains package has been thoroughly tested but not applied to an extensive range of tracked vehicles and tanks.
- There is a known issue with links incorrectly wrapping right around certain wheels arranged in a line. Slightly adjusting the position of a wheel will easily fix this in most cases. The code is able to detect and deal with problem cases but due to floating point math inaccuracy wheels may appear to line up but are not quite in a perfect line.
- Beta 0.66 fixes:
 - Duplicate Links scene command number entry field made integer rather than text
 - Hot point of links group correctly matches and jumps onto the hot point of the wheels group

Planned Improvements

- Add an option for use in the Bike Chain mode that stops the gears spinning when the bike is going backwards
- Add zoomable sliders to the user interface for the Spin Correction value of Sprocket Wheels
- Allow the user to set a different vehicle direction axis from the wheel axes
- When in bike or chain mode change more of the UI labels to make parameters even more clear
- Add tool tips to the UI
- Fix 3D view auto-updates
- Fix rare straight line wheel floating point math errors
- Tracks and Chains systems to align in Z axis
- Allow for slack in the system so that a completely functioning bike chain can be maintained with the pins/bushes fitting exactly into all the sprockets. This will require a major rewrite of the wrapping algorithms used by Track and Chains. If done this feature will be part of a 'pro' version.

Support

Sparrowhawk3D is an amateur project so I can't make any promises regarding support, however I'm keen to improve my simple practical plug-ins and share them with the Carrara community.

For comments, feedback and suggestions email me, Jeremy@Sparrowhawk3D.com.