Technic Dynamics
Powered Up – In Control

User Manual
v1.70 – 12.07.2022

1. Introduction

When Lego recently introduced a set of models that included a new range of Motors and remote-controlled Hubs (called Powered Up, a successor to Power Functions), they released their own Application that allowed you to control each model.

I liked the new Powered Up possibilities because the devices give you many more facilities than the standard on / off / reverse abilities of the Power Functions motors. Here is what you will find in some of the new models:

The top picture is the control Hub which allows up to 4 devices to be controlled over Bluetooth. Notice that these might not just be motors, they could be lights or sensors. The Large and Extra-Large motors are what are normally used to drive your models. *Importantly, these are SERVO motors with adjustable speeds and positional control.* This means that you have much greater flexibility over how your model runs. Although you should still incorporate gears into your designs, the motor's flexibility lets you decide upon the speed and direction of the resulting mechanism.

2. The Problem

Unfortunately, the Lego Control+ App only lets you control five (currently) different models. If you are used to using Power Functions in your models, then you already know that you want to build things for yourself, test them and the play away…

What happens if you want to control things for yourself using Powered Up devices? Well, I am afraid, you are out of luck! That is why I designed the Technic Dynamics Application. Here are some of its features:

1. Connect to and name as many Powered Up Hubs as you have in your collection. Assign one or more of them to Models that you build using the Designer. Notice, you don't really design a model, you design an interface to it. In other words, you design a graphical layout that lets you control motor speed, for example, and then control it using your phone or tablet's touch screen.

2. Connect up-to 4 devices to each hub and assign them in the Designer so that you have full control over them in the Player.

3. Use different Elements in your design. For example, text headers (Labels), Sliders for proportional control or Gear changers for granular control over a drive, and Switches.

4. Position, rotate and scale all the elements in your design using one or two fingers so that it easier to control your model in the Player.

5. Create multiple Tabs in the Designer for complex models. For instance, you may choose to have a main view for a Crane that allows you drive and steer the model. But a secondary view might let you alter the angle, rotation, and extent of the boom (as well as lowering the hoist, of course).

6. As well as the 4 external ports, there are a number of internal ports in each Technic Hub. These allow for things such a battery level, model rotation and collision detection monitoring.

3. Install the Technic Dynamics Application

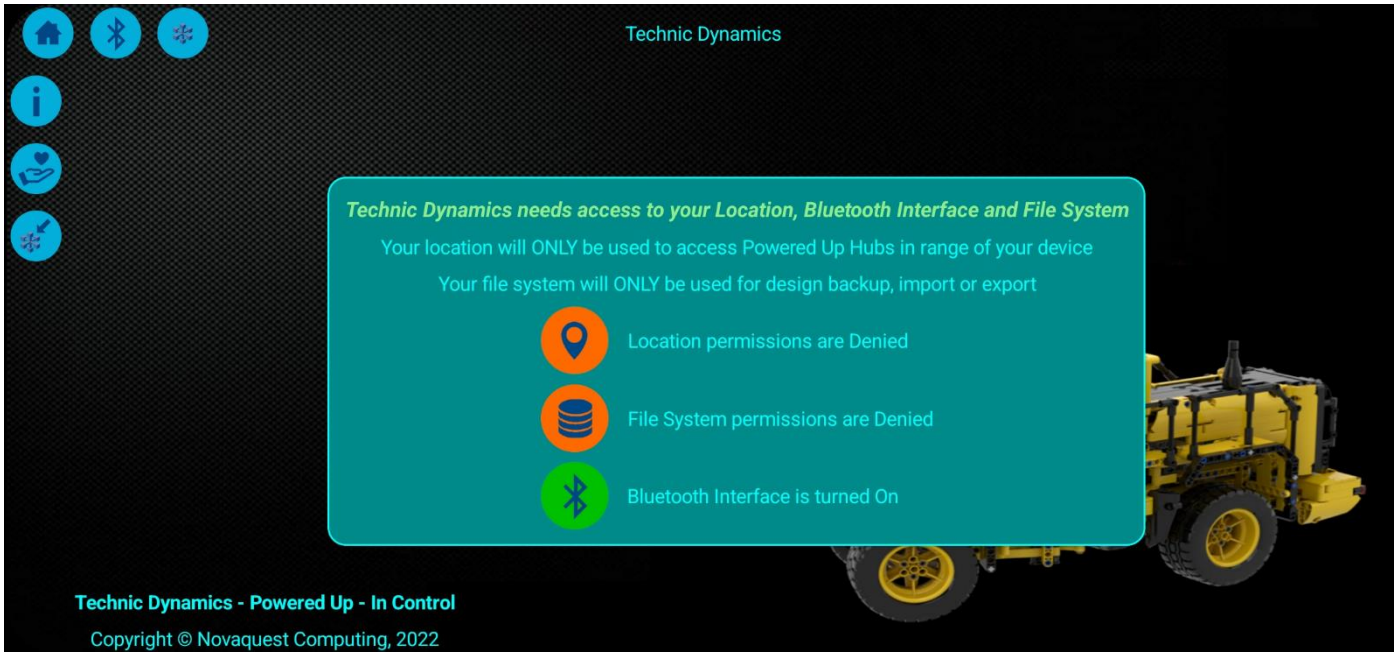
You can download the App from the Google Play Store if you are using an Android device. Plans are in progress to create an Apple version, so please check their App Store soon.

In all cases, please search for 'Technic Dynamics' by Novaquest Computing.

4. Getting Started

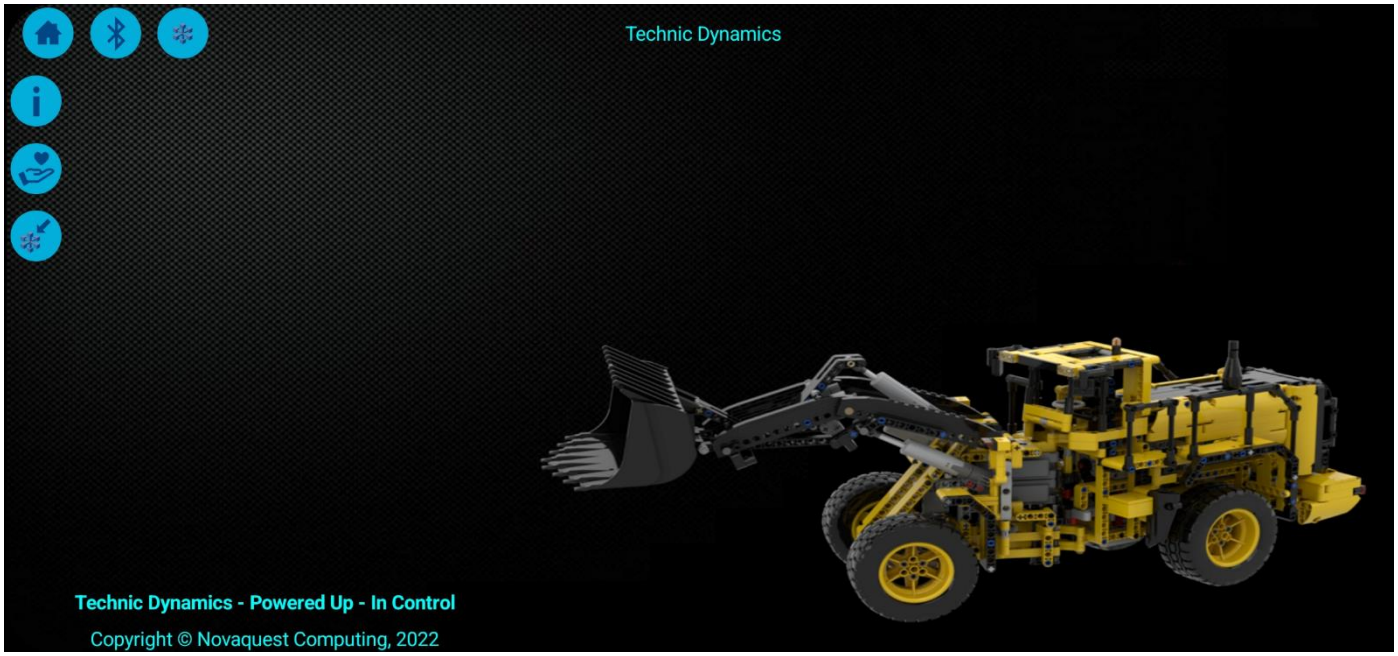
You can start Technic Dynamics by looking for the App after installation:

If you have just installed the Application, you will be asked to confirm permission to access your location, your file system and to turn the Bluetooth Interface on (if it is off). The following view will be displayed at start up:



Tap each image button that is shown in red to confirm your selections. The application will not proceed until you have accepted all three conditions.

Normally, the first view displayed will look like this, and is really for information only:



It has two sets of tappable buttons. Across the top is a standard menu:

Home (this view): 

Hubs (or Connections): 

Models: 

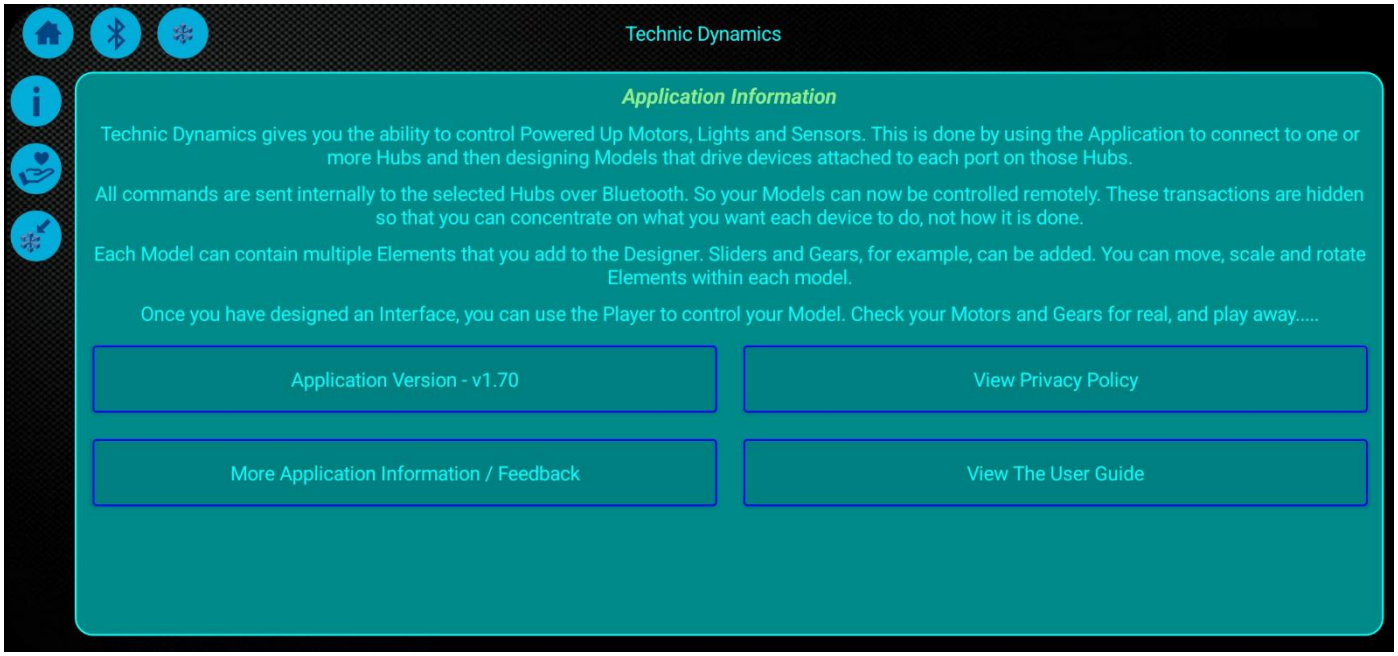
To the left there are three buttons as follows:

Information: 

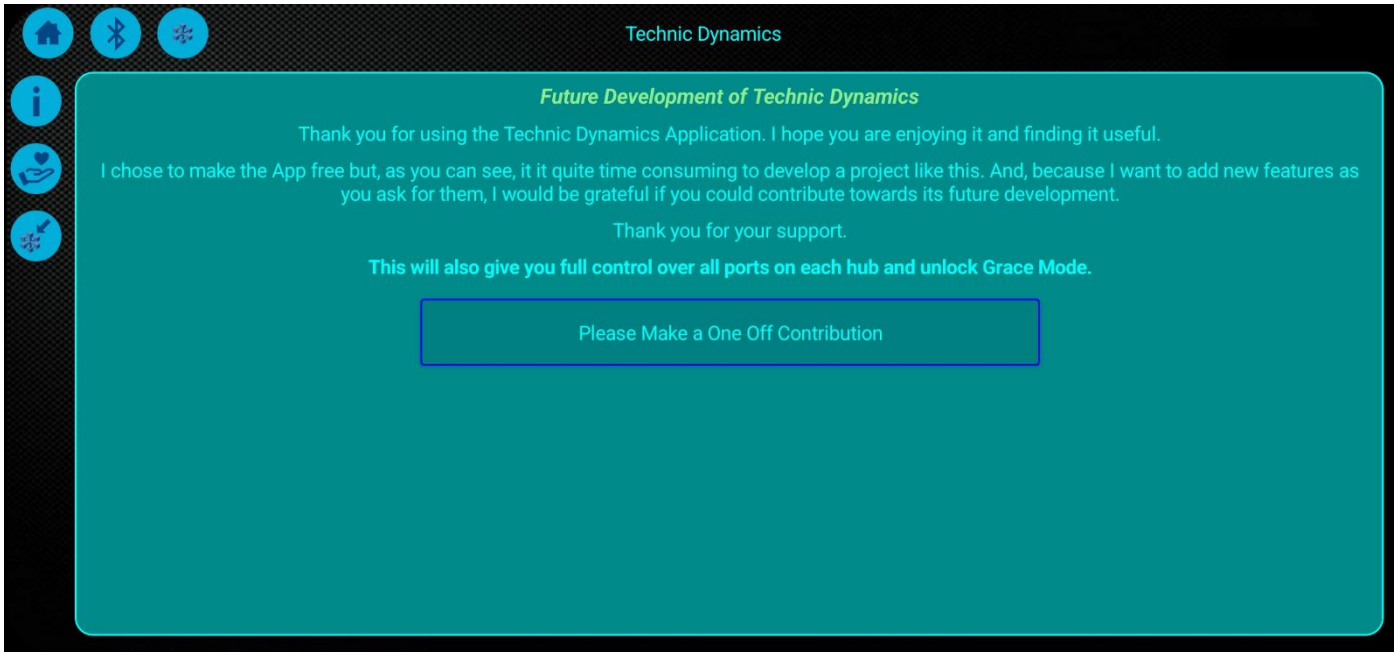
Contribute: 

Purchase Models: 

The first is an Information button. Wherever you see this button you can use it to gather more information about your current selection or activity. In this case, it shows the following (*tap Information again or swipe right to remove the dialog*):



The next button is so that you can contribute to the future development of Technic Dynamics. By default, the application will run five times before reverting to 'Grace Mode'. This is where only a single motor can be controlled per configured hub. Please take your time to consider contributing:

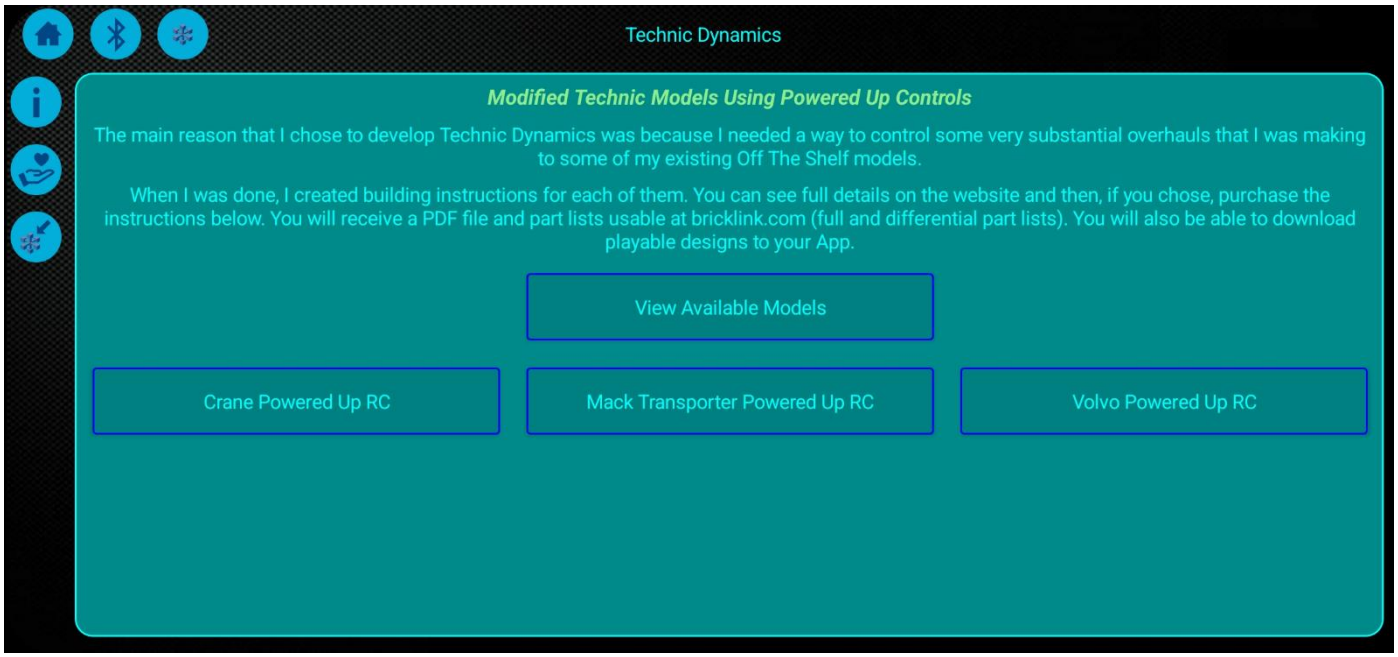


The third button is where you can look at the three Lego Technic models that I have adapted to use Powered-Up motors. Please see my web site for more information (top option). If you chose to purchase, you will get the following for each:

1. Full building instructions.

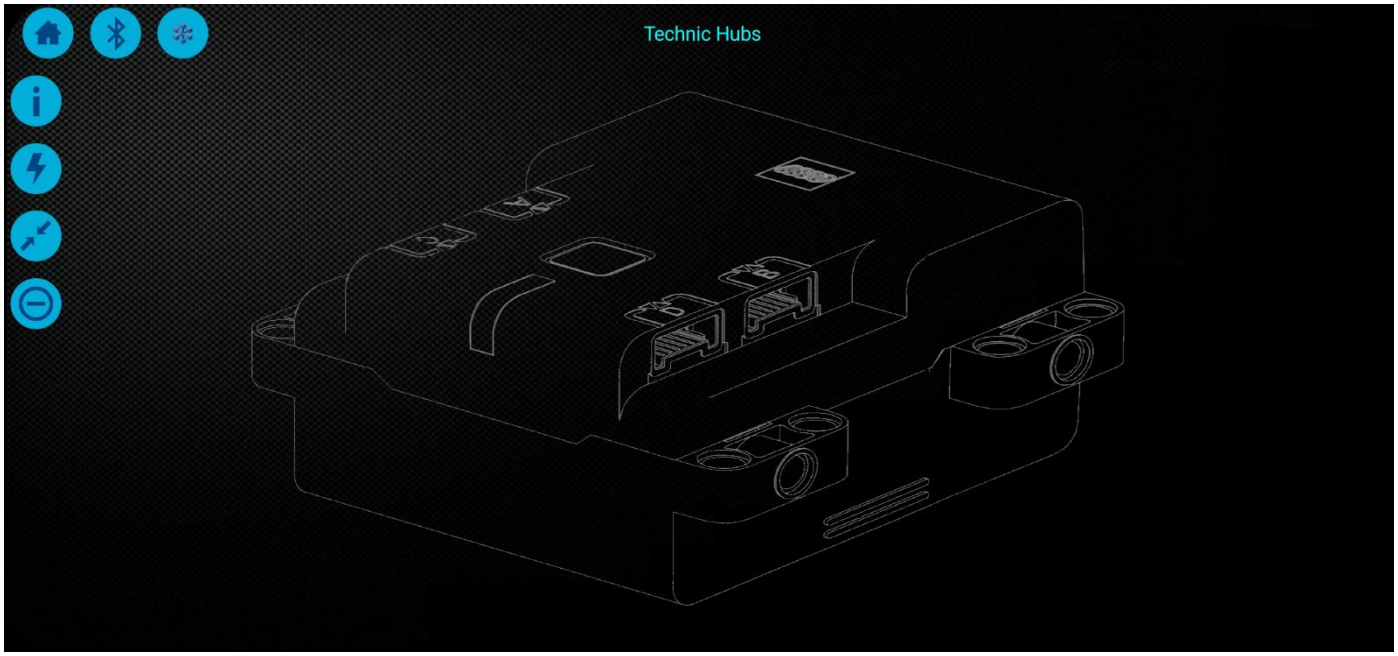
2. Parts lists that can be used on bricklink.com to purchase the bricks you will require (both a full list and a differential list in case you already own the original Lego model).

3. A Model and Hubs that can be imported into Technic Dynamics when you have completed your creation (for control).

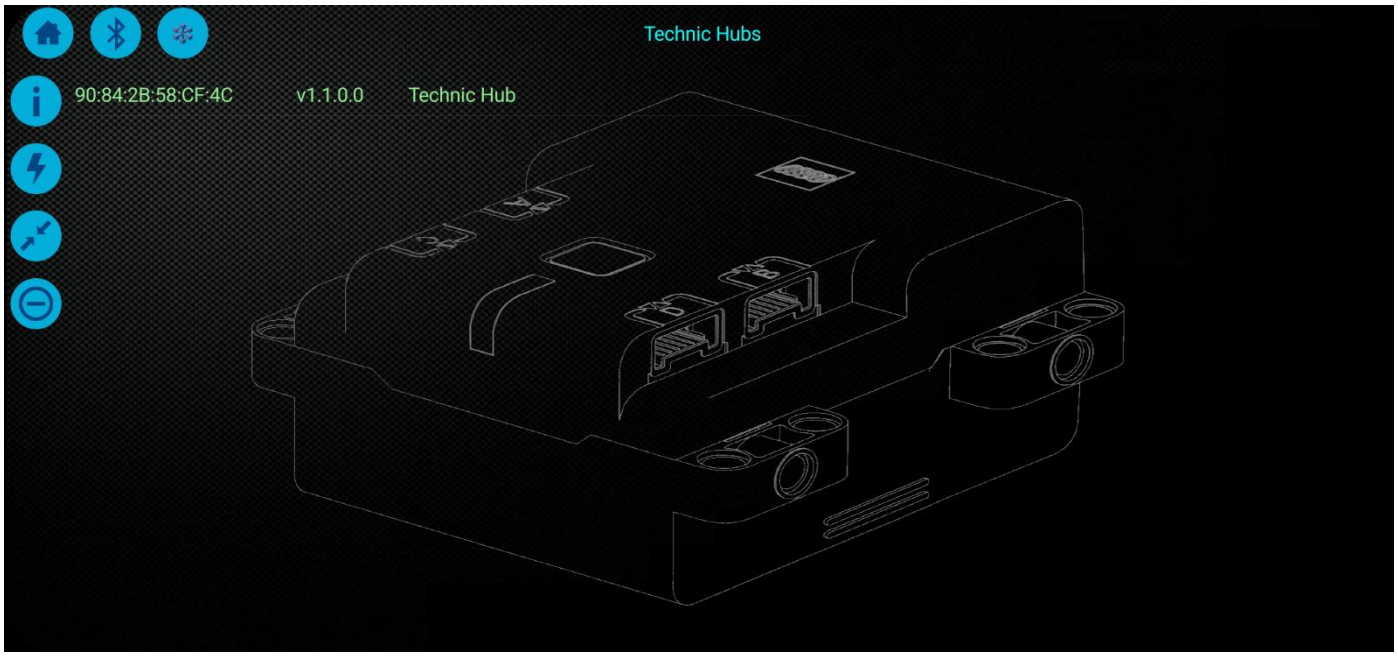


5. Connecting to Your First Technic Hub

If you click the Hubs (or Connections) button in the menu at the top, you will be presented with the following view:



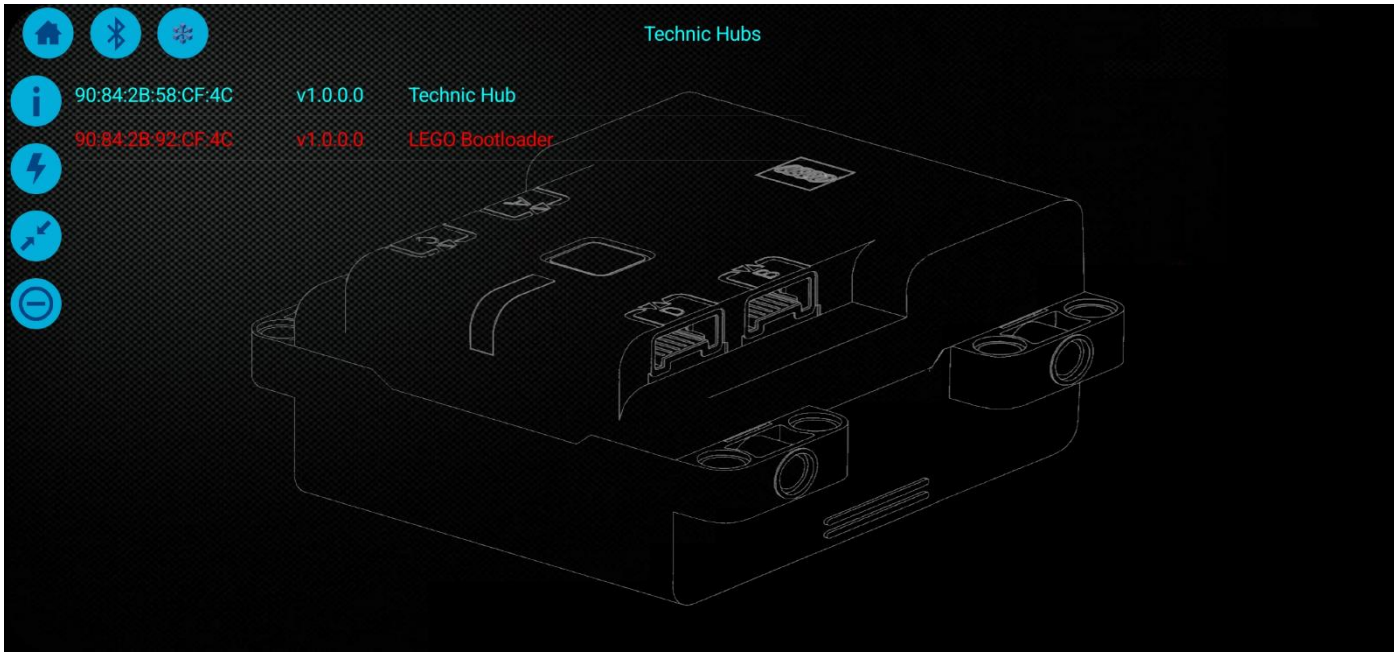
Well, that doesn't look very interesting, does it? But this is where you create a list of Technic Hubs in your collection. So, take a Hub (having installed batteries) and turn it on (by pressing the green button). Wow… as if by magic….



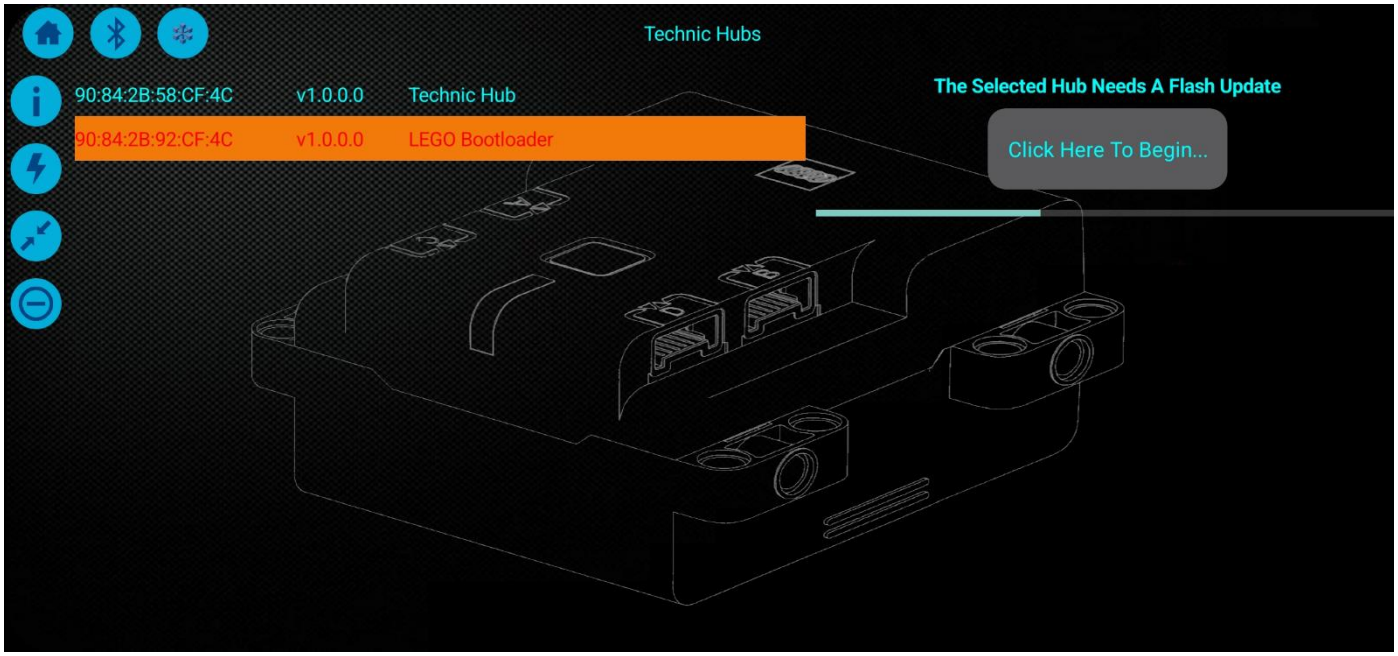
The fact that 'Technic Hub' is connected is shown by Green text in the list. Disconnected hubs are shown using an Aqua text.

Congratulations, you have found your first hub over Bluetooth. If nothing shows up in the list, check the Hub is in range (usually around 10 meters) and that Bluetooth is still turned on in your phone or tablet.

In *exceptional circumstances*, especially for older Hubs, you will be presented with a Red message in the list which means that you must upgrade the firmware in the connected Hub:



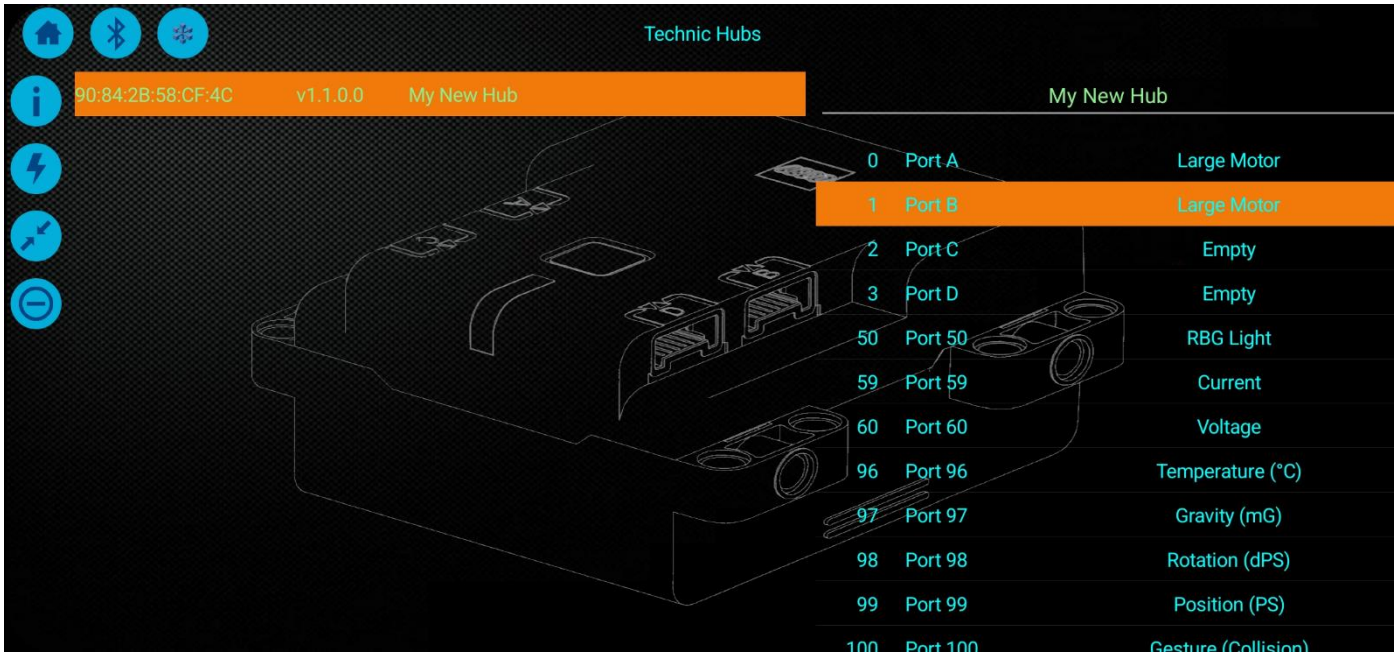
You should select the Bootloader entry in the list and then tap the button on the right to proceed:



Lego have made enhancements and fixed a few problems in various revisions of the firmware. Technic Dynamics will not connect to a Hub that has a revision less than v1.1.0.0. Please follow the instructions to perform the upgrade before continuing (it only takes a few minutes).

If your Hub won't connect but is shown in the list (goes Green and straight back to Aqua), then it has very old firmware. Hold the button down on the Hub for 10 seconds until it flashes various colours. Then follow the instructions above.

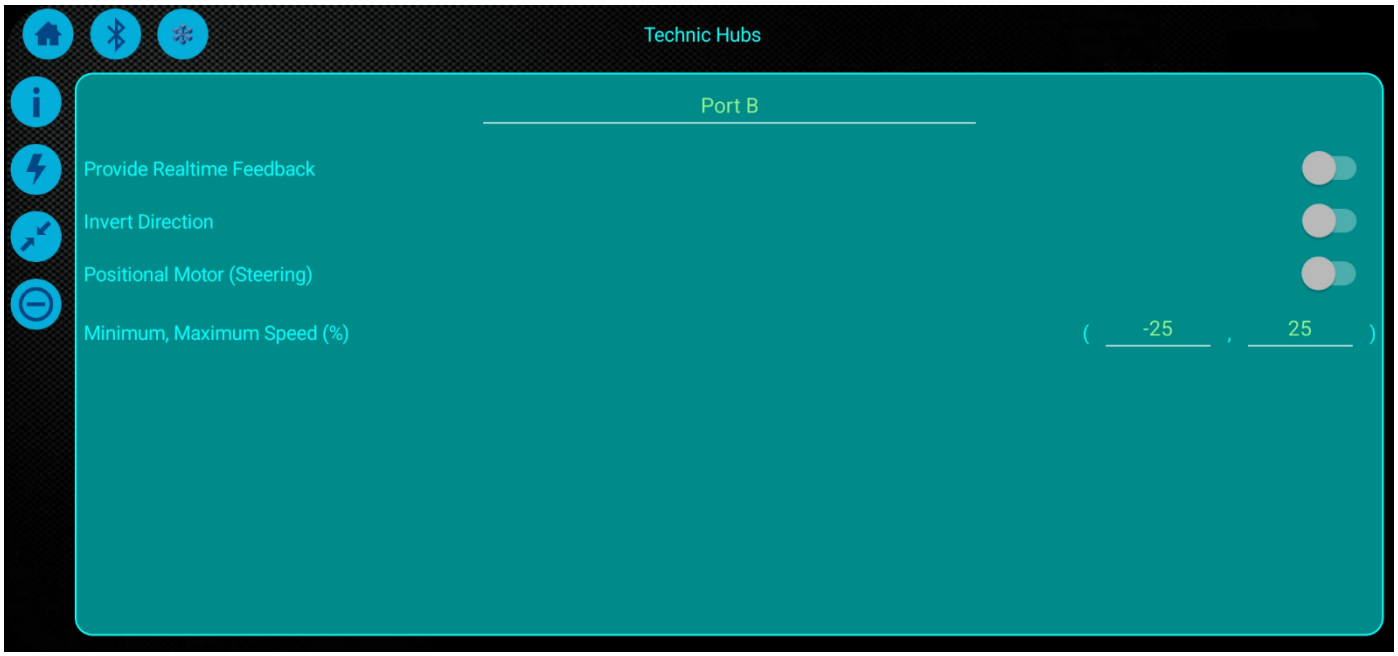
So, now, you have a connected Hub. But what does that mean? Well, as you can see below, you can tap on the entries in the lists to see more detail:



As mentioned earlier, the first 4 ports are the external ports that you can physically connect devices to. Port numbers from 50 onwards are internal and generally used for various hub feedback.

Because we are connected (online) to this Hub, we have the option to change its name in the top right of the screen (just tap the entry field). I've chosen to call this one 'My New Hub'. It will remember its name, even when turned off. This way, you can track Hubs more easily.

For even more Port information, press the information button: 



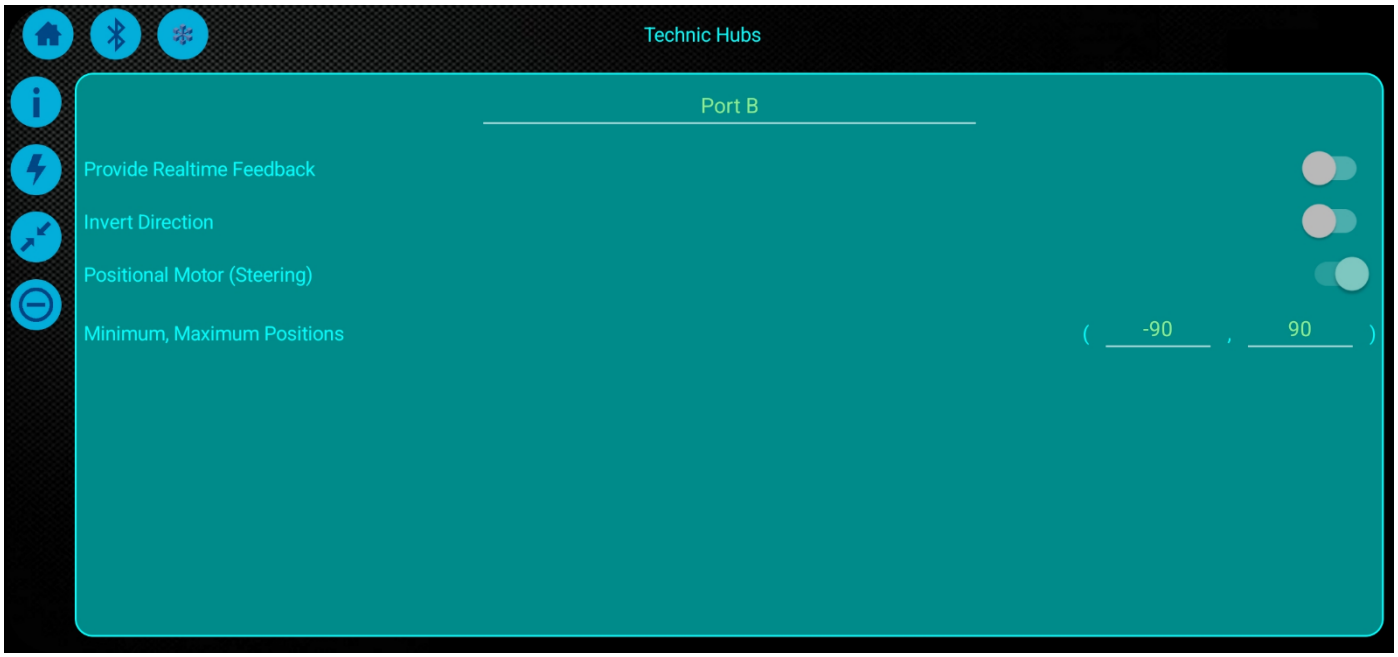
You can remove the dialog by tapping the Information button again or swiping right. Regardless of whether the Hub is online or not, you can alter the Port's name using the entry field at the top of the dialog.

In this view, you can see some quite important options:

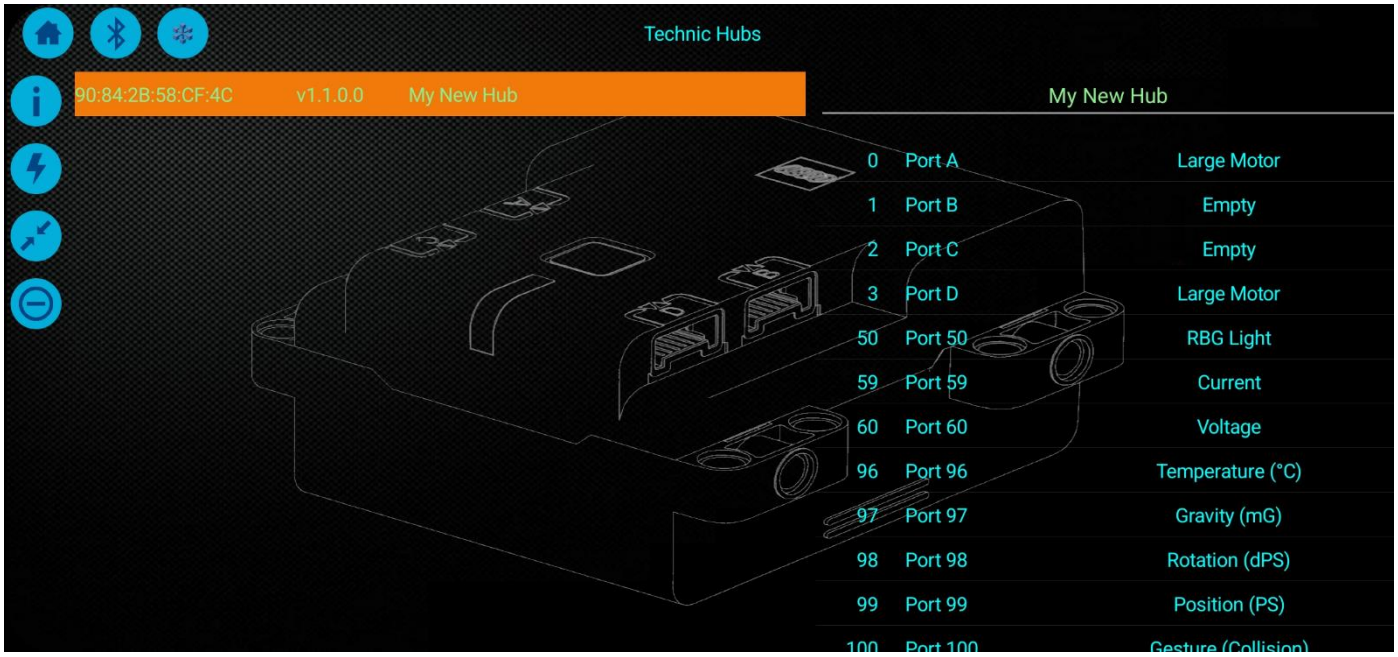
1. Invert direction is useful when a particular motor is running the wrong way, especially when it is driving a vehicle!!

2. Minimum, Maximum Speed (%) are used to limit any potential damage! They are 25% by default to keep things slow while you are testing. Usually, they should be changed back to 100% after testing.

3. Positional motors are usually (but not always) used for steering mechanisms. The values assigned really depend on the gearing between the motor and the destination. Because of this, you should start with low numbers and ramp them up until you have found the minimum and maximum range (especially when a steering unit has physical limits):



Notice that the list below only shows devices that are physically connected to the Hub on Ports 0 – 3. You can add and remove new devices *dynamically if you wish* (by plugging them into a free port), but that is not usual in a finished, wired, model:



The Power button can be used to turn off a Hub remotely. This is useful during Model import procedures (all Hubs must be disconnected for that):

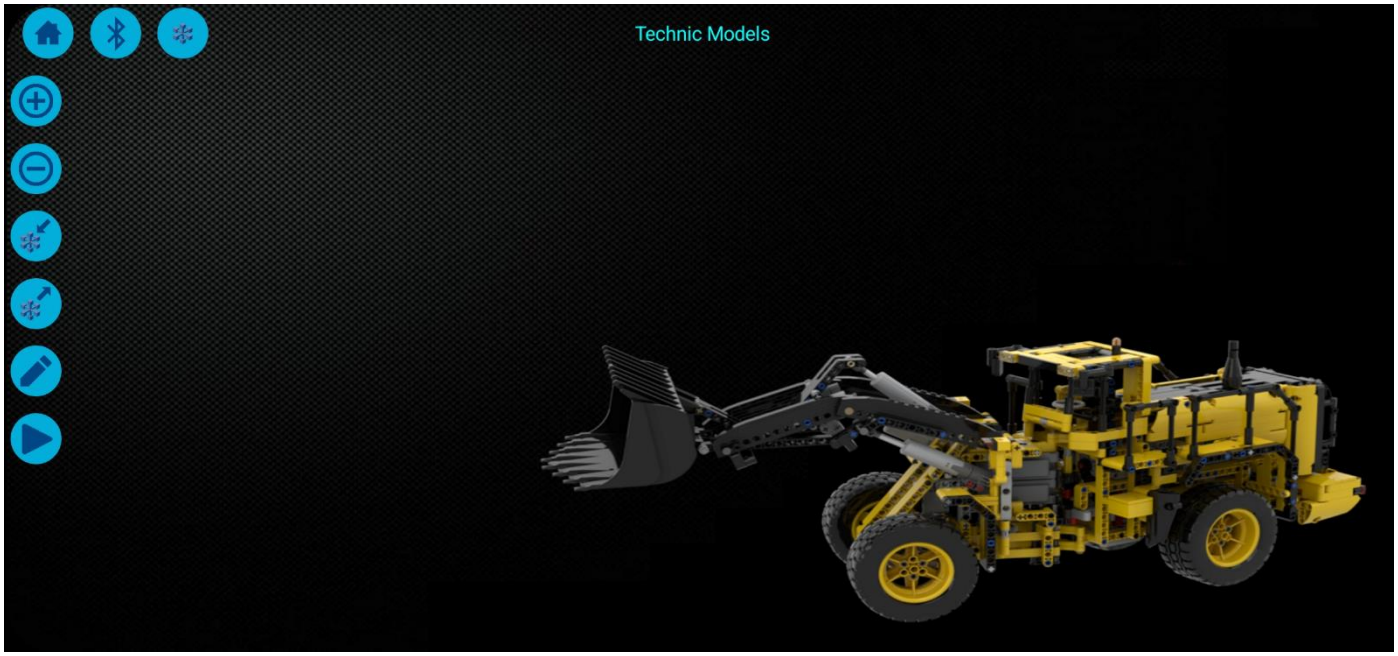
The Merge button can be used to transfer an address on top of an imported Model and Hubs. Take an imported Model and us your own Hubs, but use with caution:

The Minus button can be used to remove a (must be offline) Hub from the list. If you turn it on again, it will re-appear, but it will be set to default settings:

6. Creating Your First Model with The Designer

Once you have one or more Hubs in the connection list, you can create or modify a Model using the Designer.

First you must move to the Models view by pressing this button: 



This view offers some new options via a menu of buttons down the left-hand side:

Add a Model: 

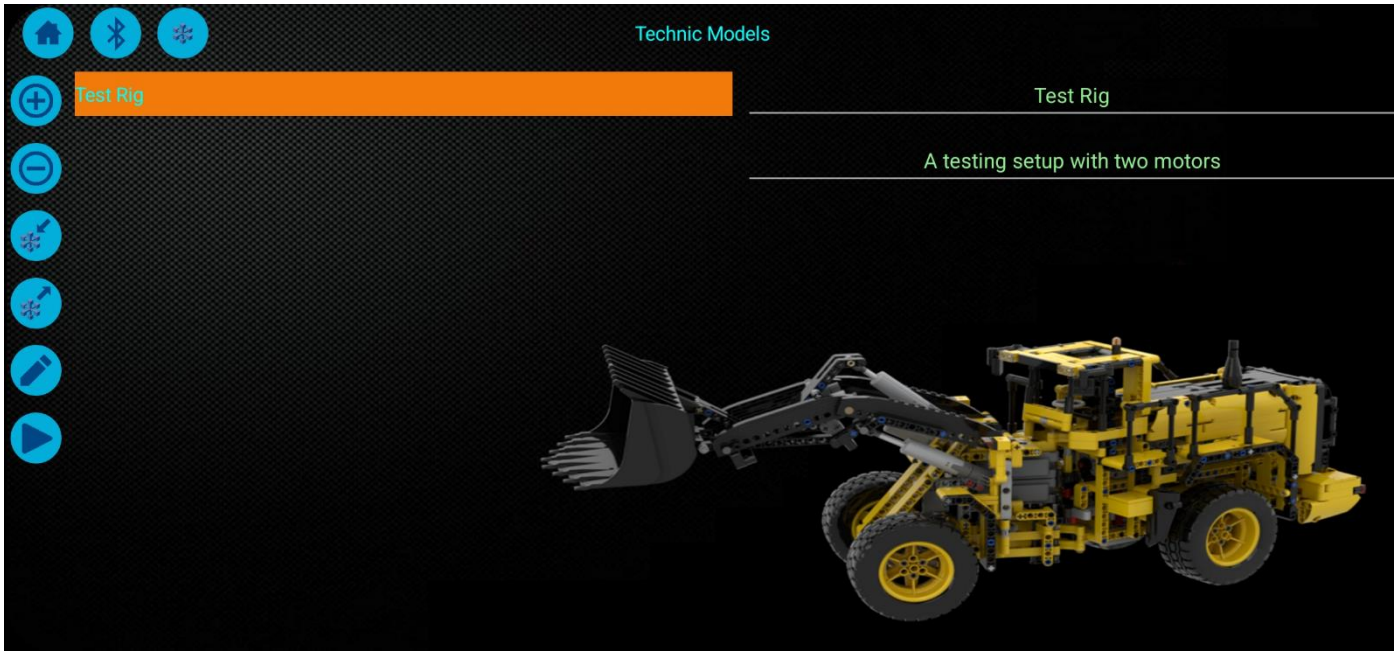
Remove a Model: 

Import a Model: 

Export a Model: 

Edit a Model (Designer): 

Run a Model (Player): 



The first two options allow you to add or delete items in the list. Here you can see that a Model has been added and renamed to be ‘Test Rig’ with a description of ‘A testing setup with two motors’ (using the entry fields at the top right).

So now what? We need to create an interface to our Model. Remember that we had two Large Motors connected to our Hub a few pages back (on Ports 0 and 1). I Decided to make a ‘Test Rig’ as an example. We now need to choose how we want to control those motors using the Designer.

Tap the Designer button to do this:

Two new menus have been added at the top. The left-hand menu allows you to add new Elements to the Designer:

Add a Label Element: 

Add a Switch Element: 

Add a Slider Element: 

Add a Gears Element: 

Add a Gyroscope Element: 

The menu at the top-right has these buttons:

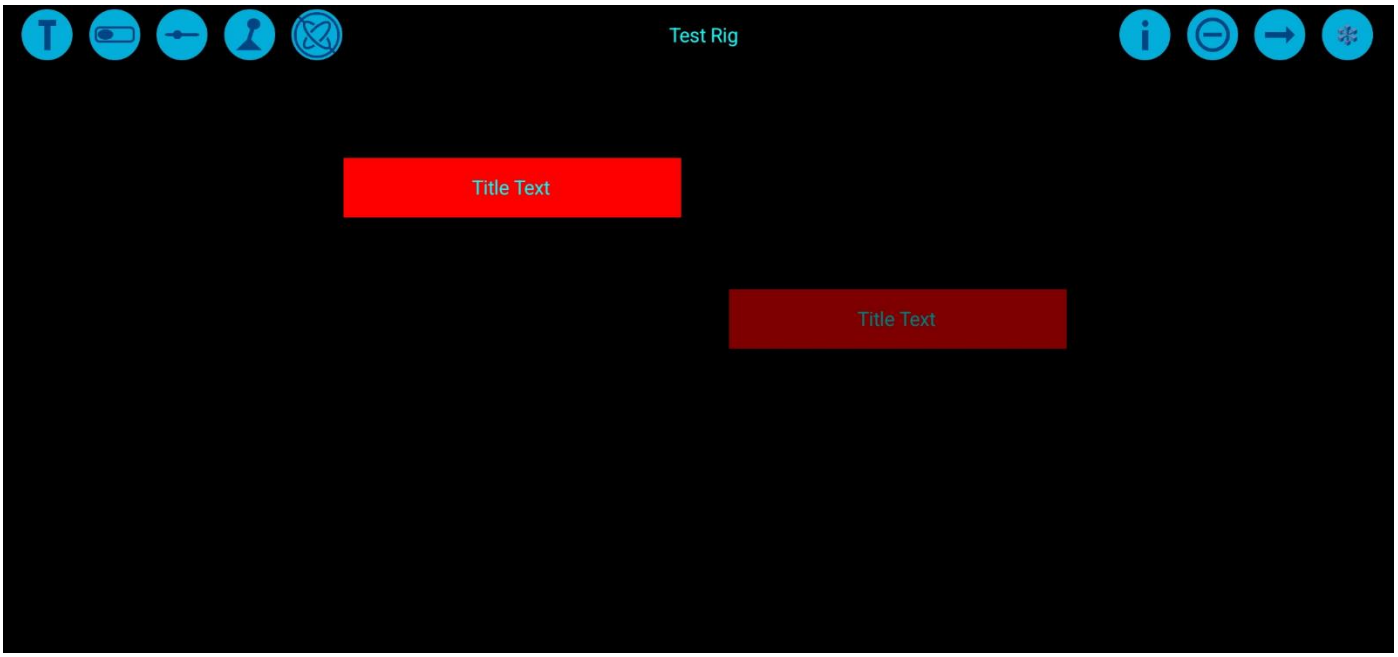
Information: 

Delete selected Element: 

Move to second tab: 

Return to Models view: 

The first thing that we are going to do is add some Label elements to our new Model:

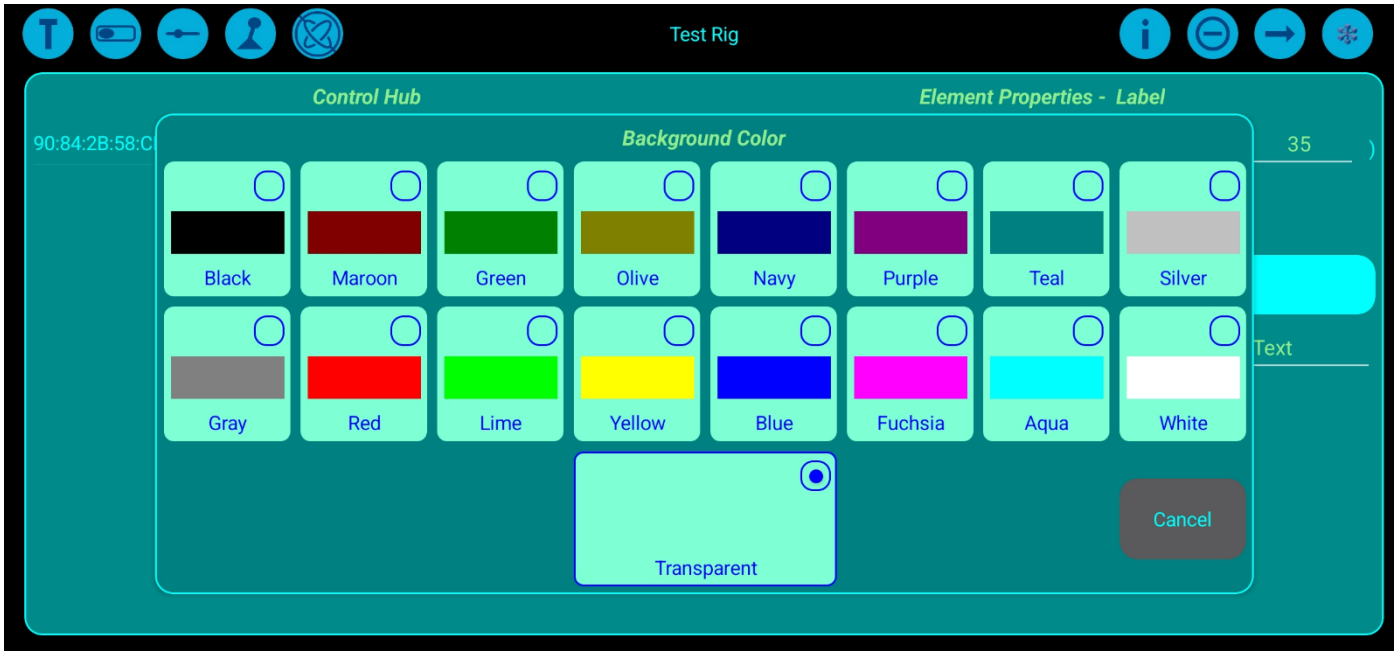


The Label on the right is the second one to be added and is shown in a slightly different way from the one on the left. This change in opacity indicates that it is the *currently selected* Element (the one we are working with). *A single tap on an Element will change the current selection*.

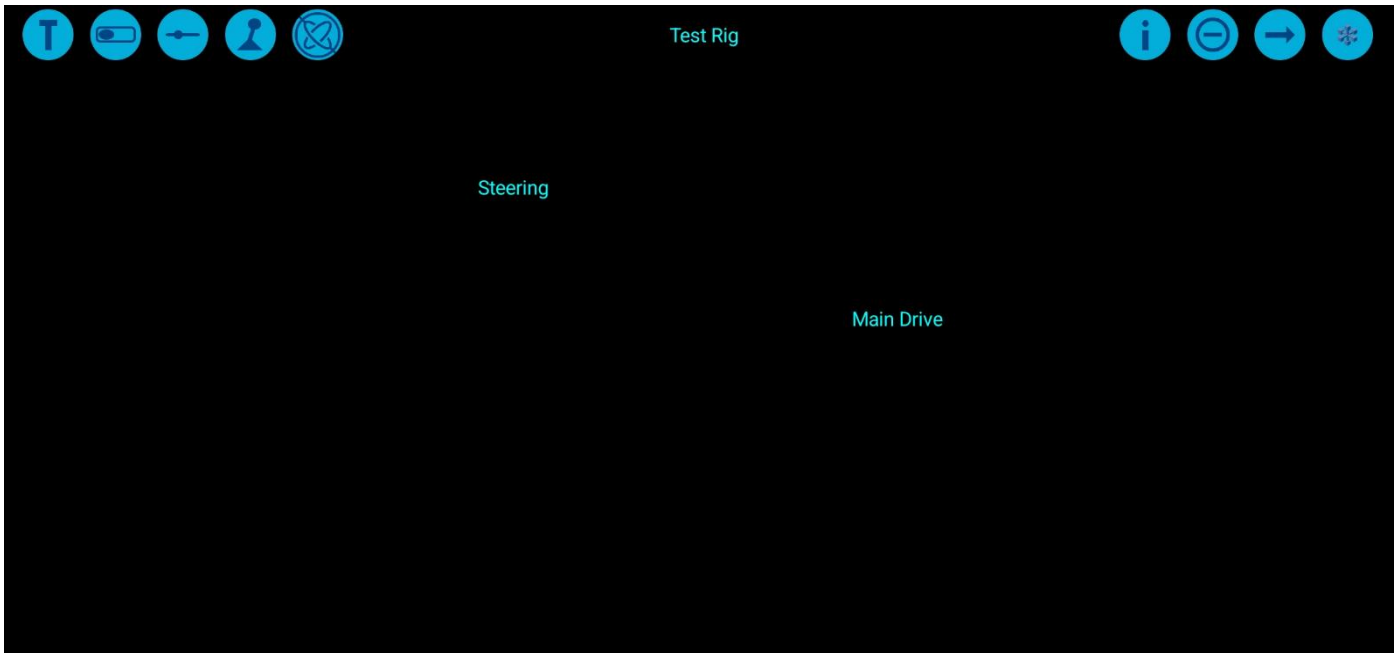
In this example, the Label Elements have been moved to new positions by dragging them with one finger. You can also use two fingers to rotate and scale an Element, which we will see later.

You can change the parameters related to the selected Element (in this case the Label) by tapping the Information button:

There is nothing too special about a Label Element. But we might like to change the colours that it uses, or indeed the text itself. By tapping the colour boxes, a colour picker is shown as below:

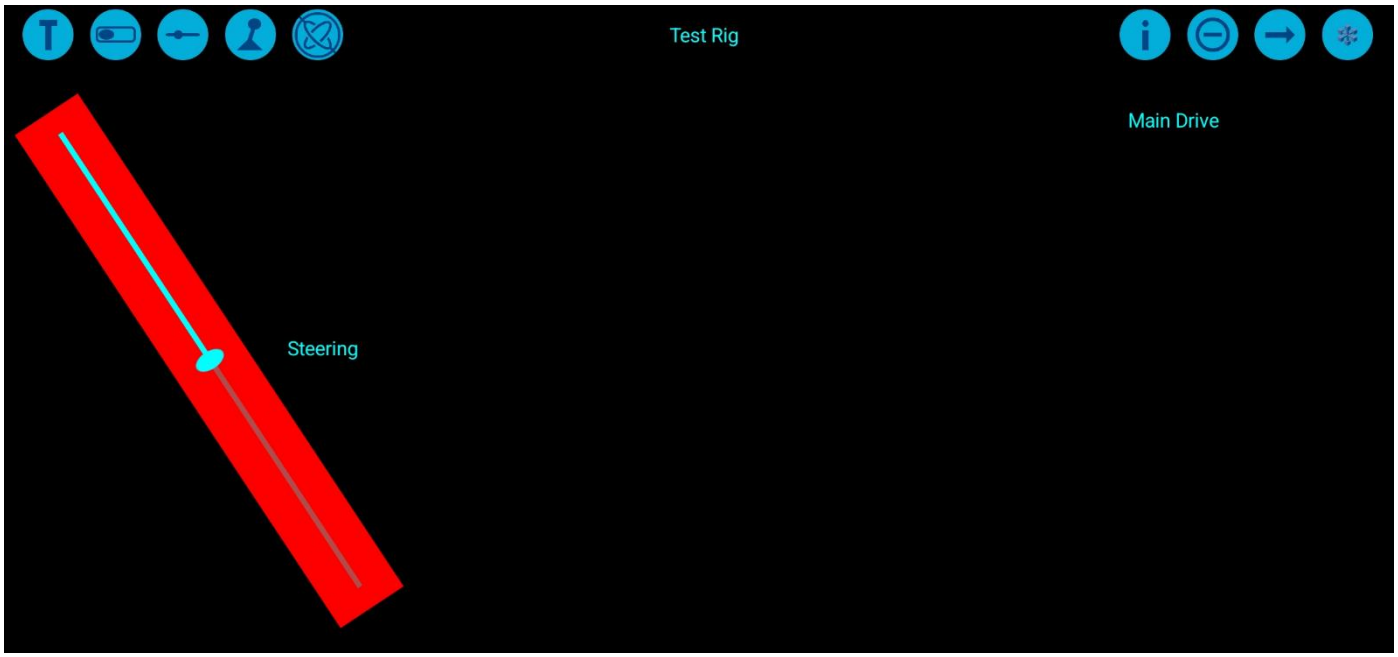


I changed the two Label texts and made their Background Colours transparent:



Next, we need to choose how to control the two motors that are connected to the Ports on our Hub. I've decided to add a Slider for the first Port (Steering) and some Gears to control the other Motor (Main Drive). So first I added a Slider and moved and rotated it. I also moved the Label next to it.

Remember, to rotate and scale an Element, you use *two fingers* and pinch / rotate / move motions (as if you were zooming a photo):

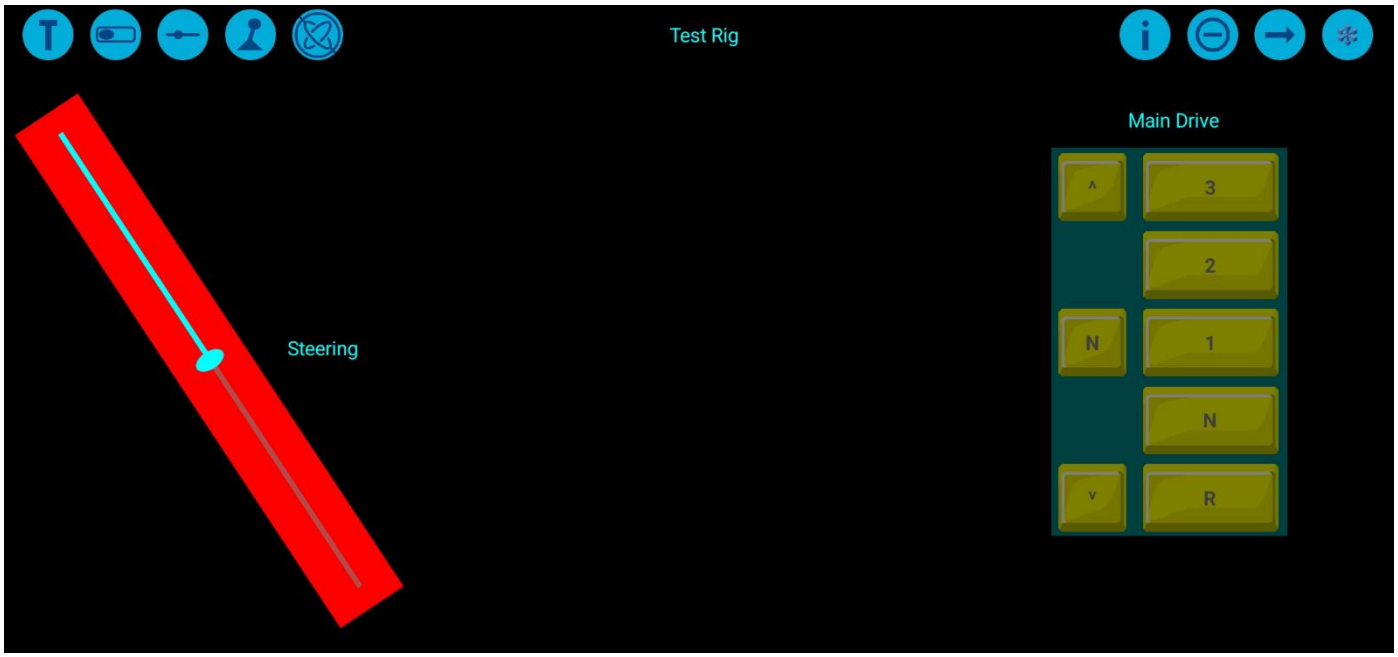


Having tapped the Slider again (to re-select it) I tapped the Information button:

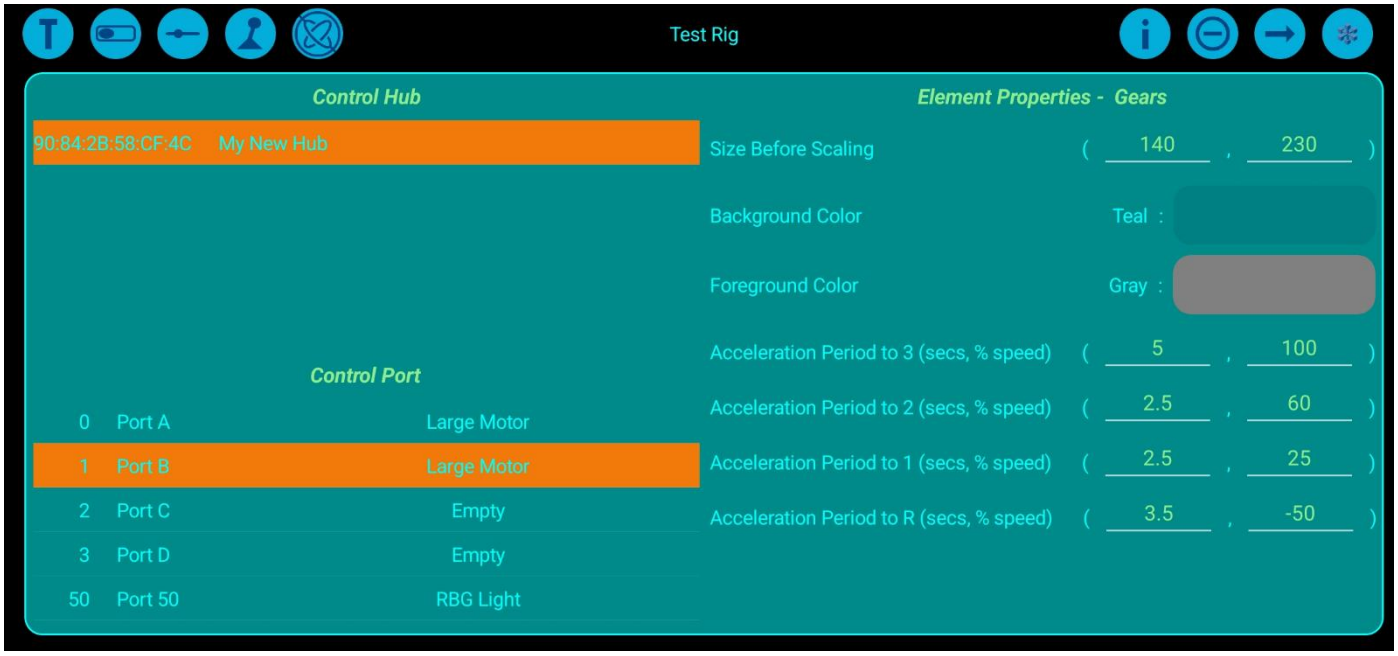
Here we can see *the most important part* of configuring an Element. Notice that I have chosen to select the first Port (0) on the Test Rig. This is how the Application knows where to send commands to when you are in the Player.

The 'Maintain On Release' option allows you to hold a motor at its last selected speed when the Slider is released. If you leave it as above, the motor will stop when you release the Slider (or return to centre if it used for Steering, like this motor will be).

Next, I added a Gears Element in the Designer and moved it under the Label:

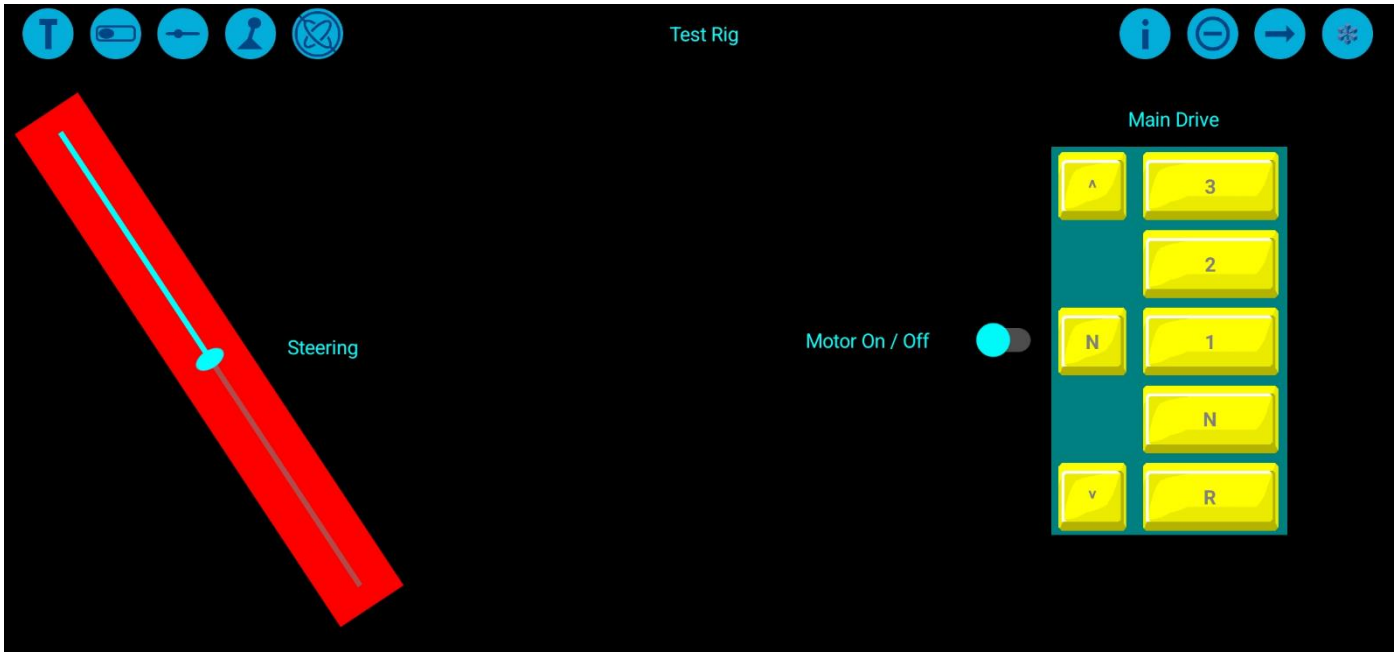


This Element allows you to drive a motor's speed as if you were in a vehicle. You can choose a speed that each gear will run at and a duration that is used to ramp the speed from the last gear. It has an Automatic and Manual gear function in the Player (left and right above).



You can see above that the Designer populates the Element with default values which are usually fine for most vehicles. Obviously, you can change them if you choose to.

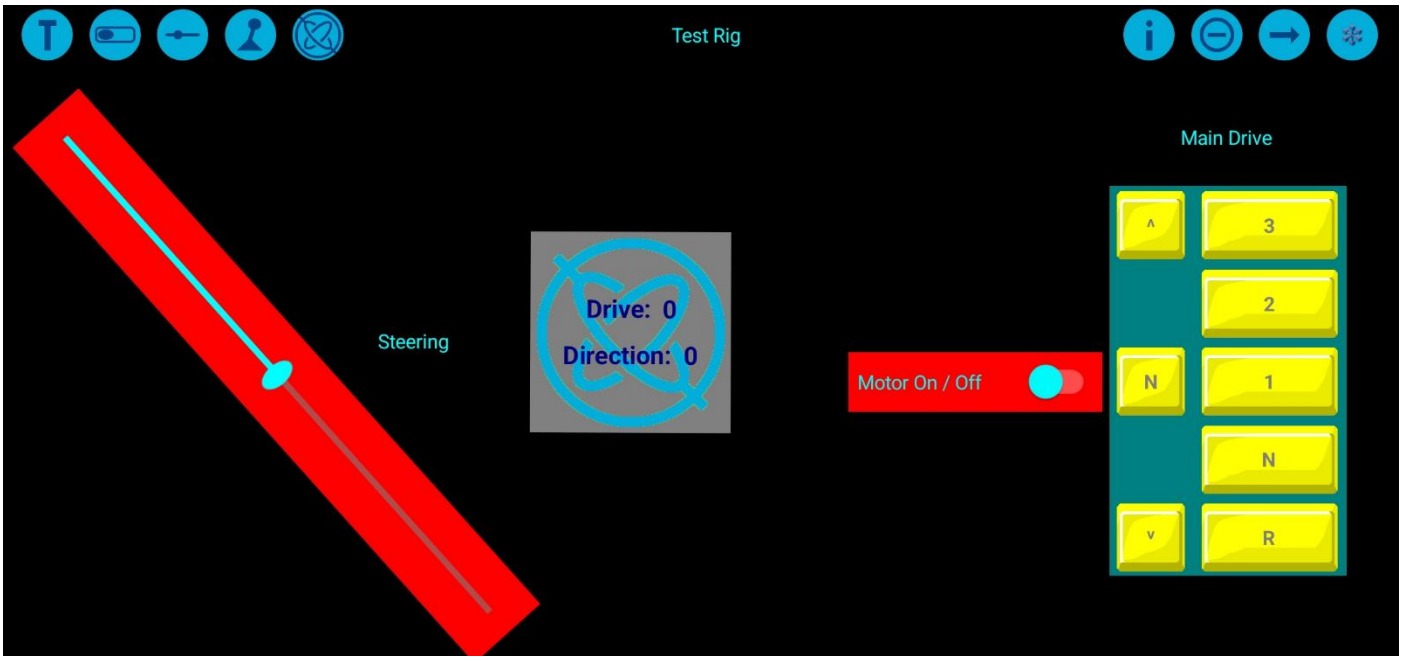
Finally, I decided to add a Switch element for the Main Drive. This allows you to start and stop the motor at full speed. *Note: this is usually used for light elements (on and off), not motors.*



The configuration dialog is similar to all other elements:

A very important addition to the Application in version 1.70 is that of the Gyroscope Element. Instead of using Gears and Sliders to control speed and direction, you can use a single element to do both at the same time. When you tilt the device forward, speed will increase (and visa-versa). When you tilt the device left, the steering will be activated in that direction (and visa-versa).

Here I have added a Gyroscope into the editor:



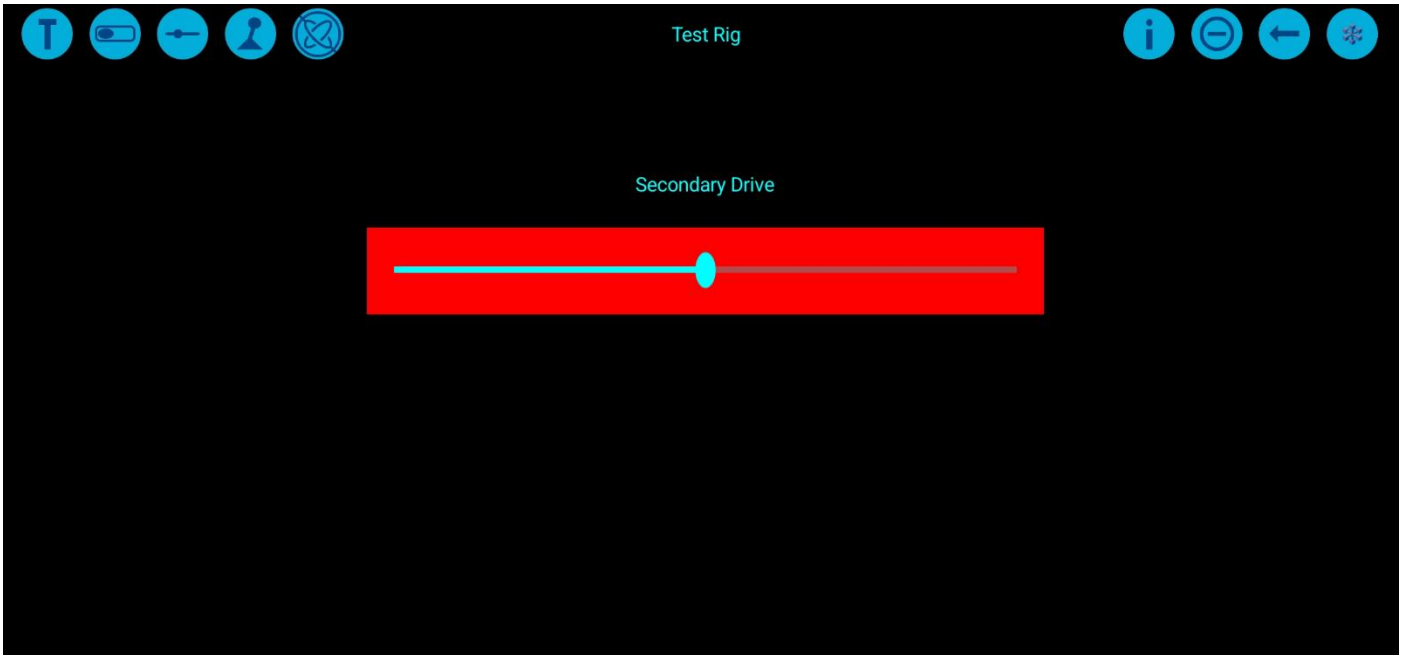
Note: normally, it would be very unusual to have Gears, Sliders and Gyroscopes pointing to the same Control Hub Ports on the same tab. They will interfere with each other.

The configuration dialog is different from all the others because it lets you choose *two* ports that control drive and steering. Also, you can decide if you want to display the element in the player (not normal). If you do, you will get feedback from the device about its orientation:

What happens when you have too many motors to fit the controls on to a single page? Let's explore how to create additional elements on a second Editor Tab. This is very useful when you have lots of elements that won't fit on one page, for example, a drive system for a crane and its hoist system above that is driven by a different hub.

First you should tap this button towards the top right, or *swipe left* in the editor. This gives you a new Tab:

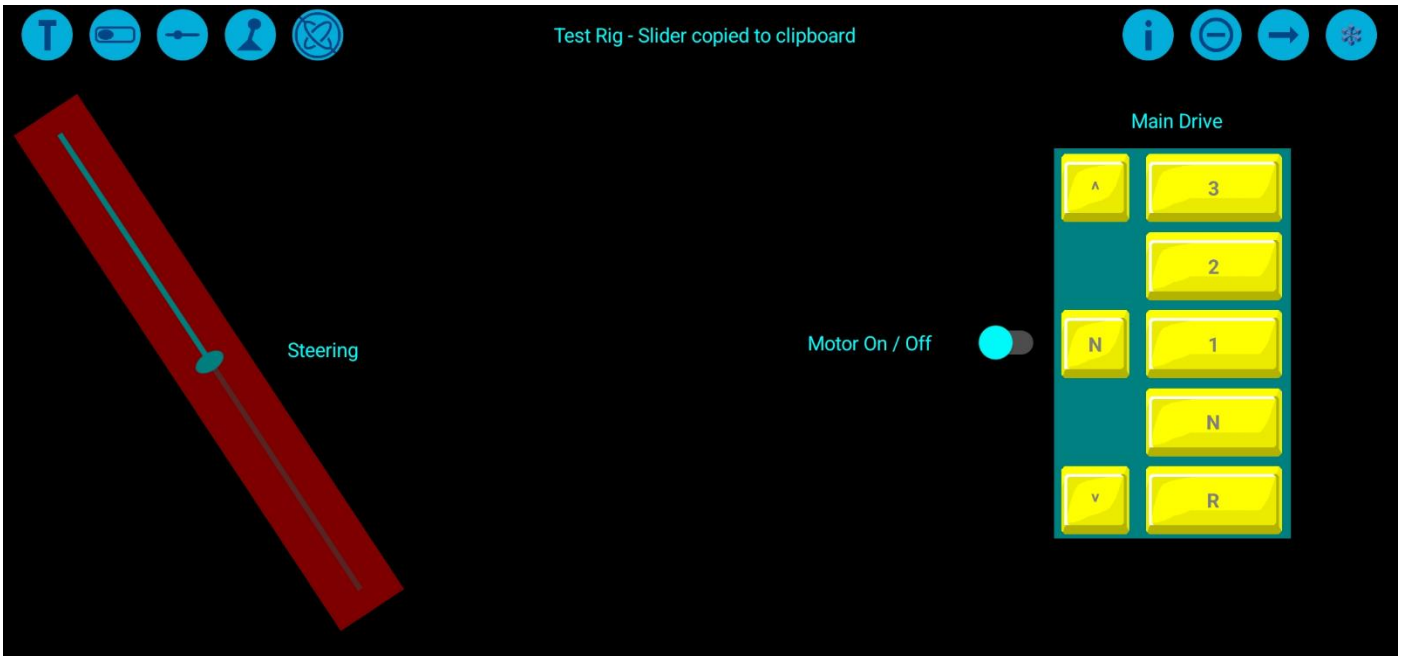
I have chosen to add a Slider element with a heading above it:



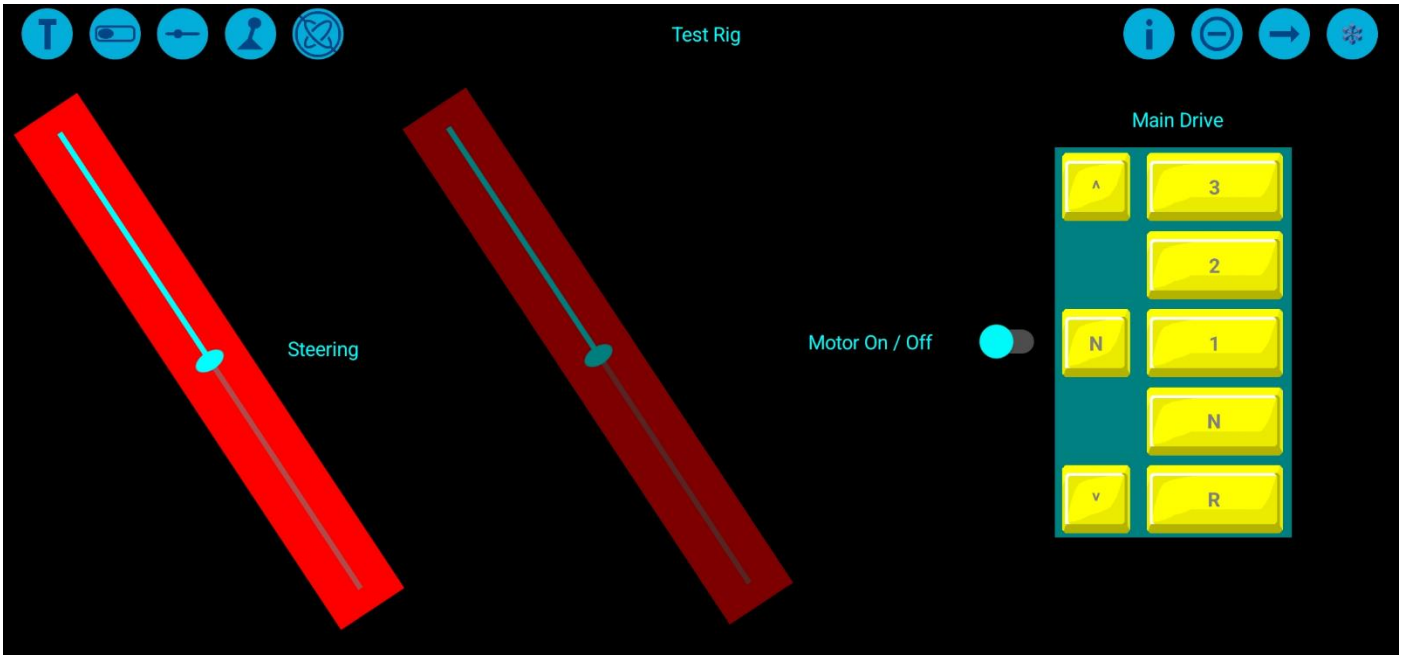
To move back to the first Tab in your model tap this button towards the top right, or *swipe right* in the editor.

The next piece of functionality that has been added to v1.60 of the App is Copy and Paste in the editor. To make a copy of an element, hold your finger down on it and then release. A short message will be displayed in the title bar to confirm the copy was successful (for 2 seconds).

I have copied the Slider shown below:

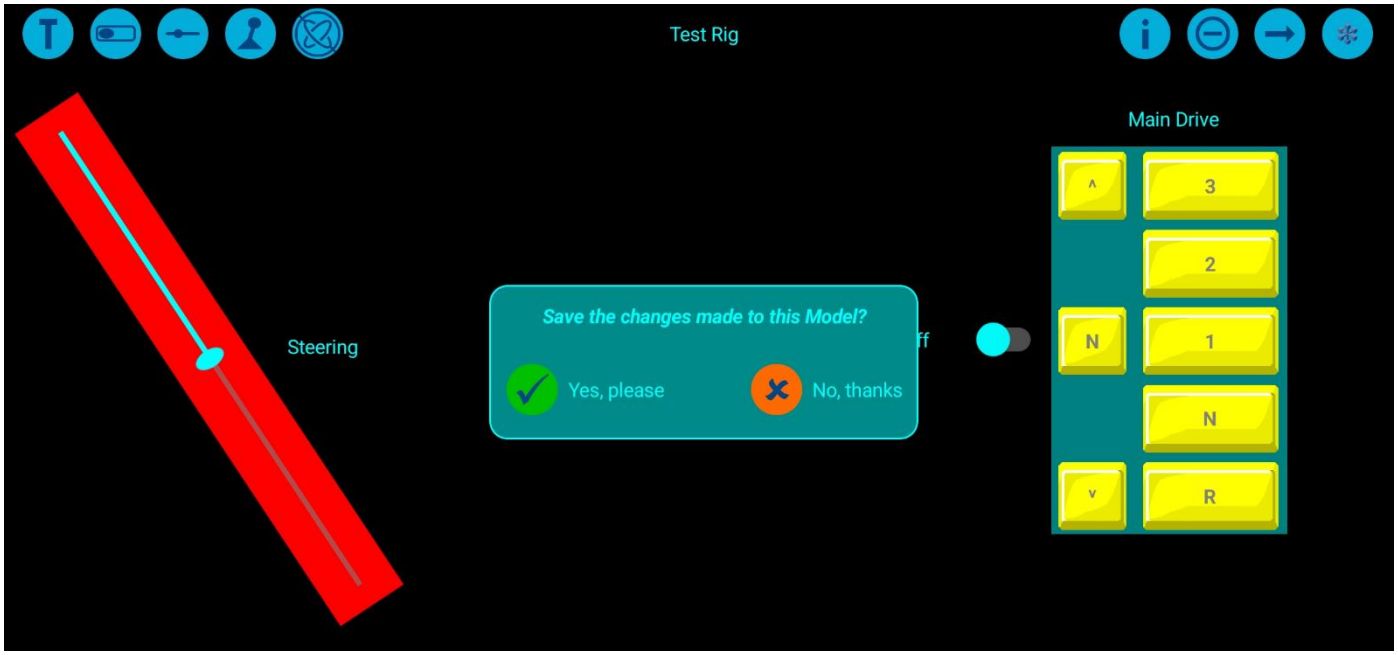


Now, by holding my finger down in a free area of the editor and releasing, the copied element will be pasted to the centre of your finger (and it will be automatically selected):



Note: *You can copy and paste elements back and forth between Tabs.*

The final design is shown below. Make sure you save the Model when asked (having tapped the Models button at the top right):



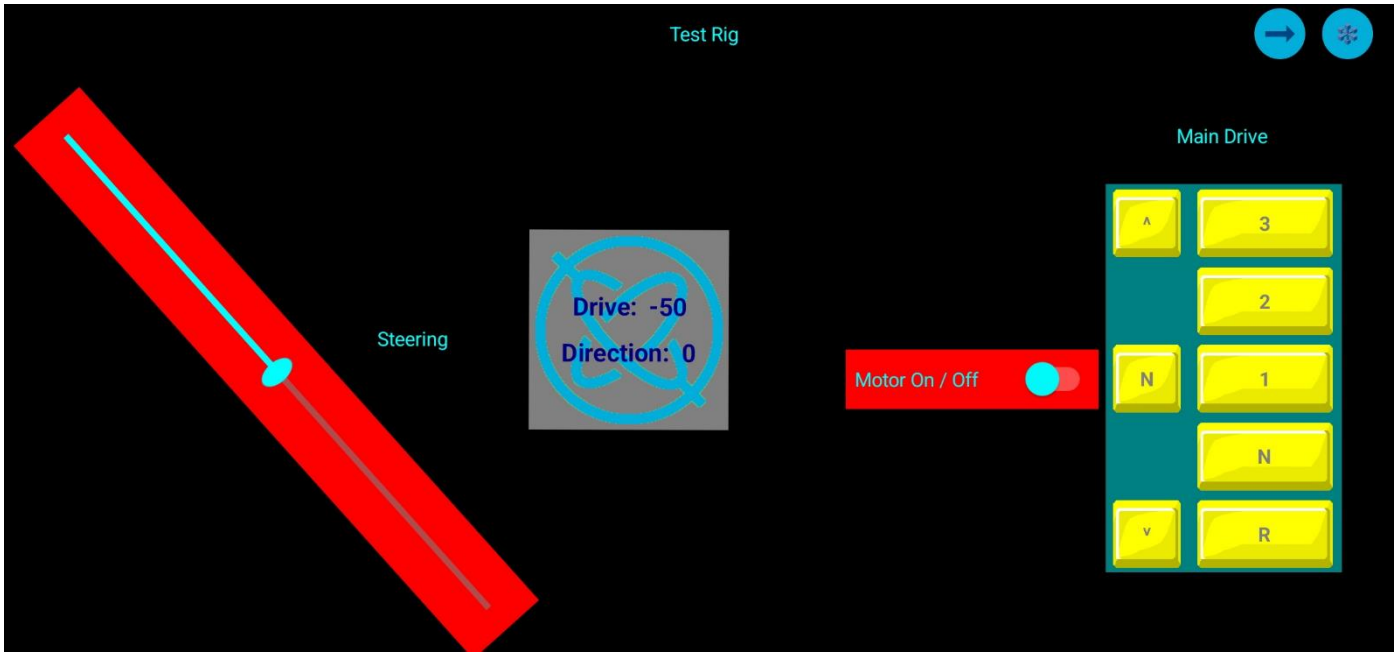
You will find the 'Test Rig' Model when you first run the application. It is delivered as an 'Imported Model' which allows you to assign a Hub that you own to its functions. Please see section 8 below for details of how to do that.

7. Running Your Design using The Player

Of course, this is the most important part of the Application.

Before you choose to play a Model, it is important that all the associated Hubs are online and shown in Green on the Hubs view.

You can then choose any of the Models you have created before tapping play: 



In this example, you should find that moving the Slider will progressively change the progression of the Large Motor connected to Port 0, but only slightly. That's because it is configured for steering in the Hub configuration.

The Gears Element is linked to Port 1, the second Large Motor. You choose the selected gear using buttons on the right (manual gearbox). The up and down buttons on the left can be *held down* to automatically progress from gear to gear (an auto gearbox).

If you are going to crash, press the Neutral button twice for an emergency stop.

The Switch can be used to drive the second motor at full speed and then cause it to fully stop when touched again.

If you tilt the device forwards, the drive speed will increase because of the Gyroscope element. Tilt it left to turn the other motor left. Because the Gears and Slider are attached to the same ports as the Gyro in this example, they will interfere with each other. The delivered Test Rig model doesn't include the Gyroscope because of this (feel free to add it yourself in the Editor).

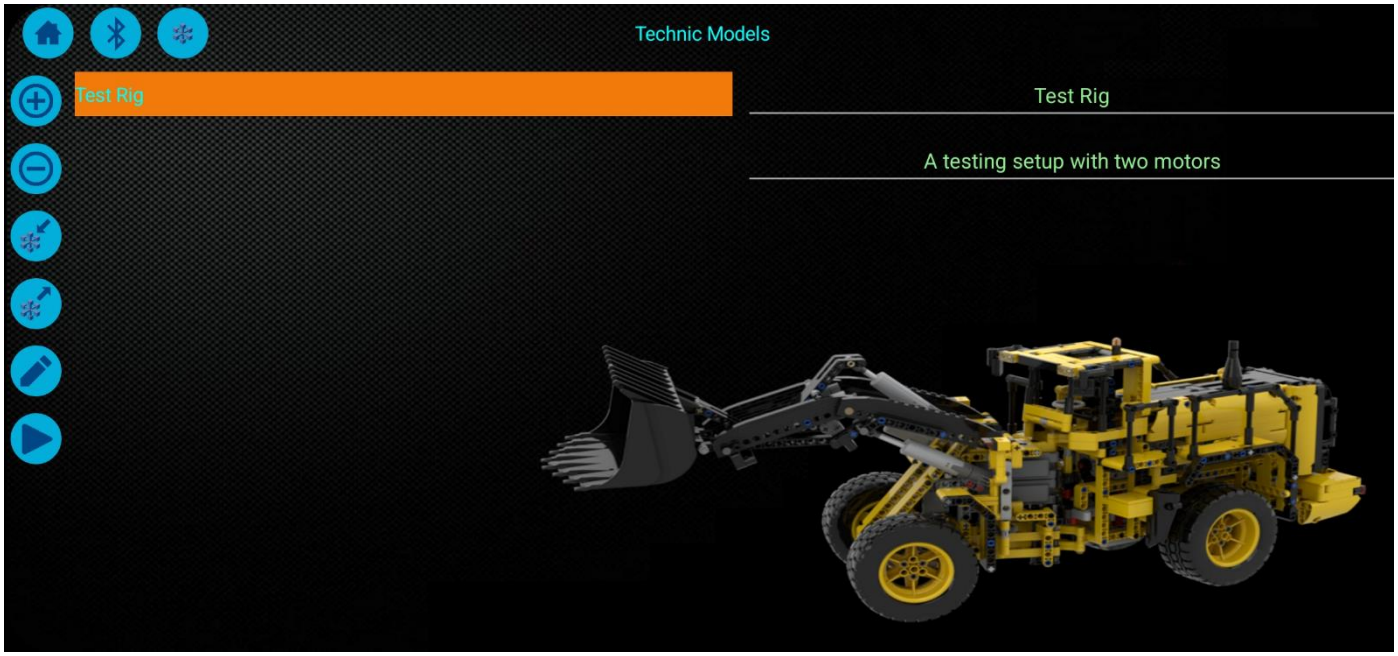
Usually, each Element in a design will target a different Port, and maybe even a Port on a different Hub. For example, the Slider above would normally be connected to a Large positional motor for steering while the Gears would be connected to an Extra-Large motor for drive functions.

You can see more elements in your model by moving to the second Tab (or *swipe left*): 

Move back to the first Tab using this button (or *swipe right*): 

8. How To Export and Import a Model

You will notice on the Models View that there are two additional buttons to the left:

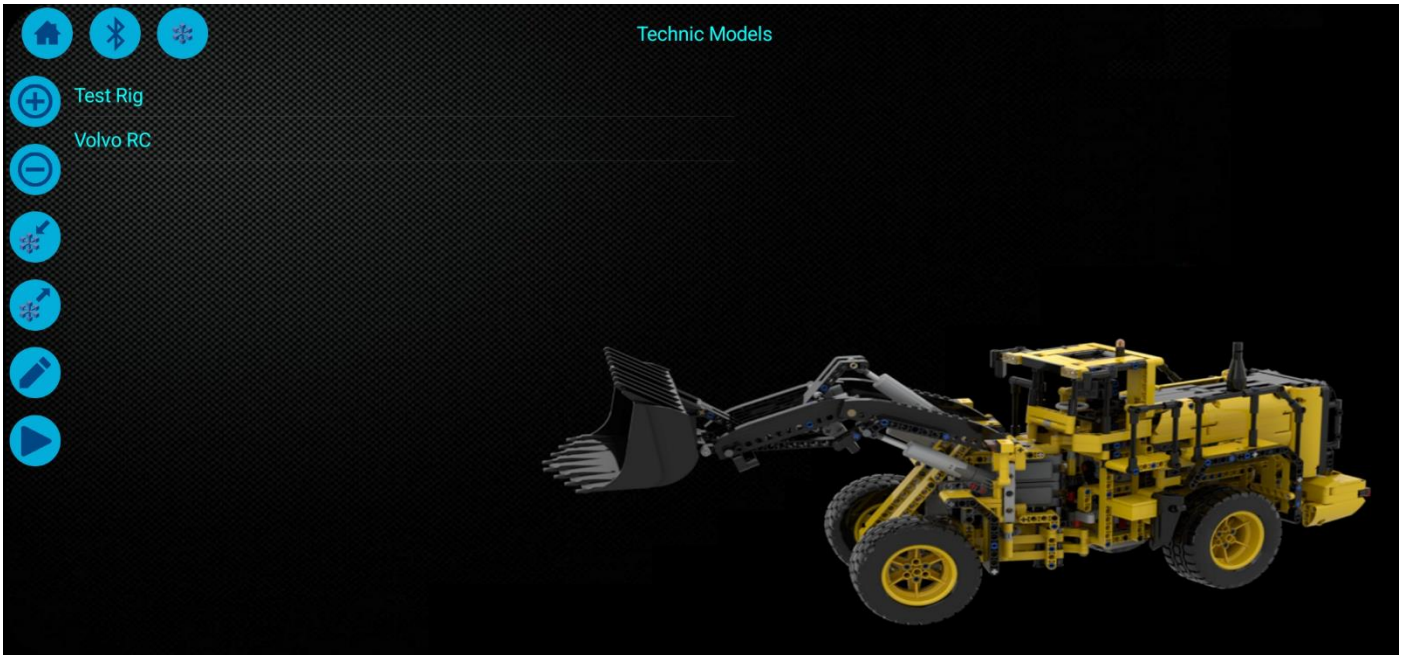


The Export button can be used to export a Model that you have created and then send it to your friends or another device that you own (or just keep a back-up):

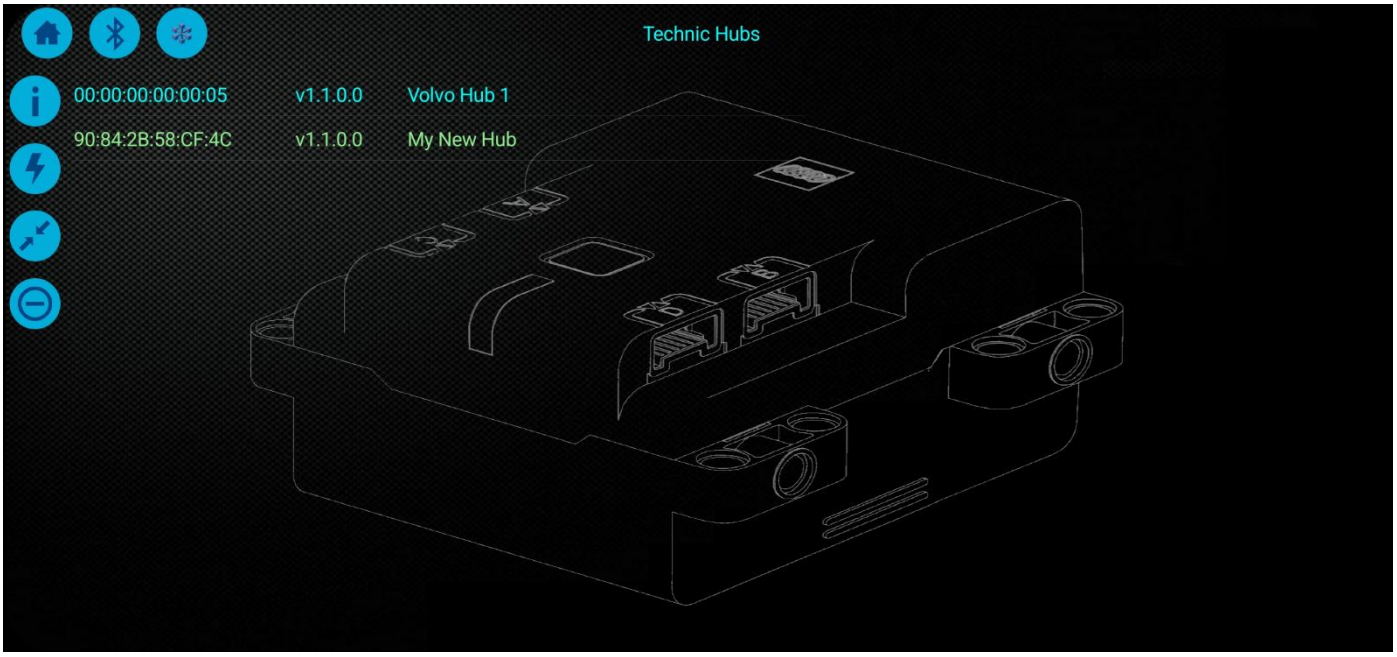
To export a Model, just select it as shown above and tap the button. In this case, 'Test Rig' will be exported. You must choose where to store the file that is generated (in this case, 'test rig.xml'). Then you can decide what to do with it.

The Import Model button can be used to take a downloaded file and import it into the Application. Use this when you have downloaded a purchased Model, for example (or want to restore a backup). The Model and associated Hubs will be imported:

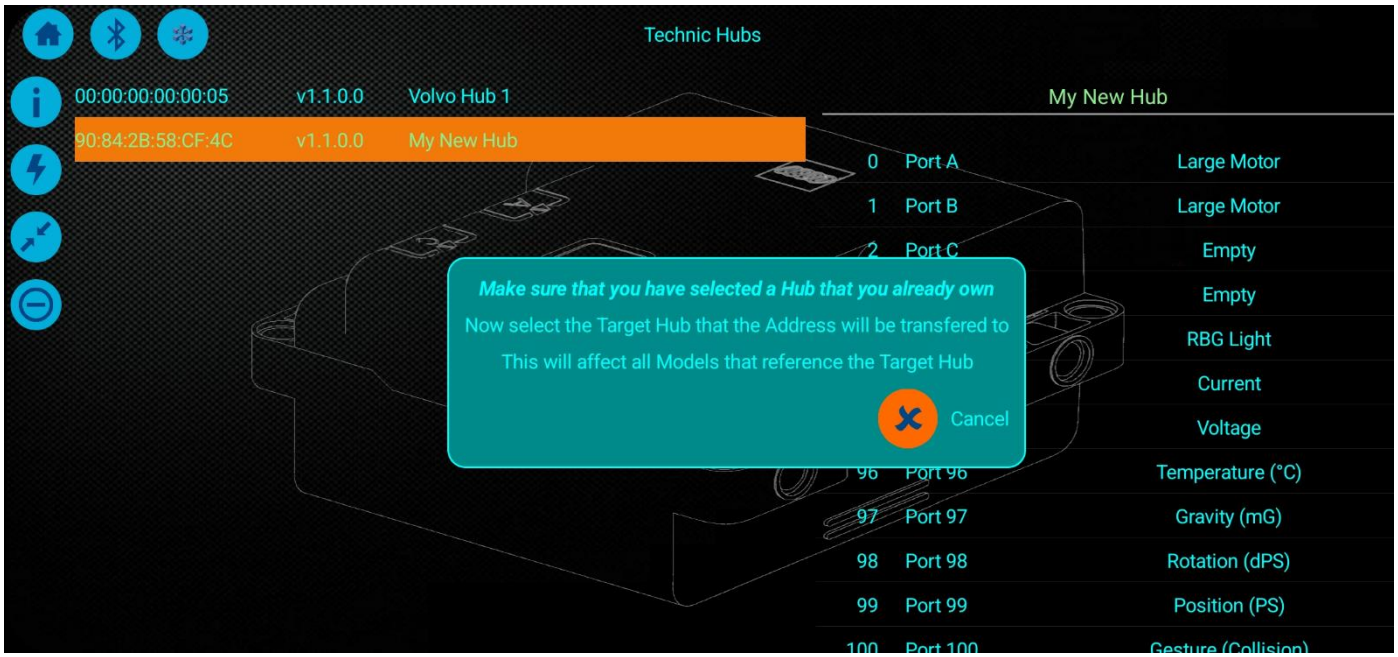
I decided to import the Volvo RC Model that I purchased (via the Home View, Purchases button):



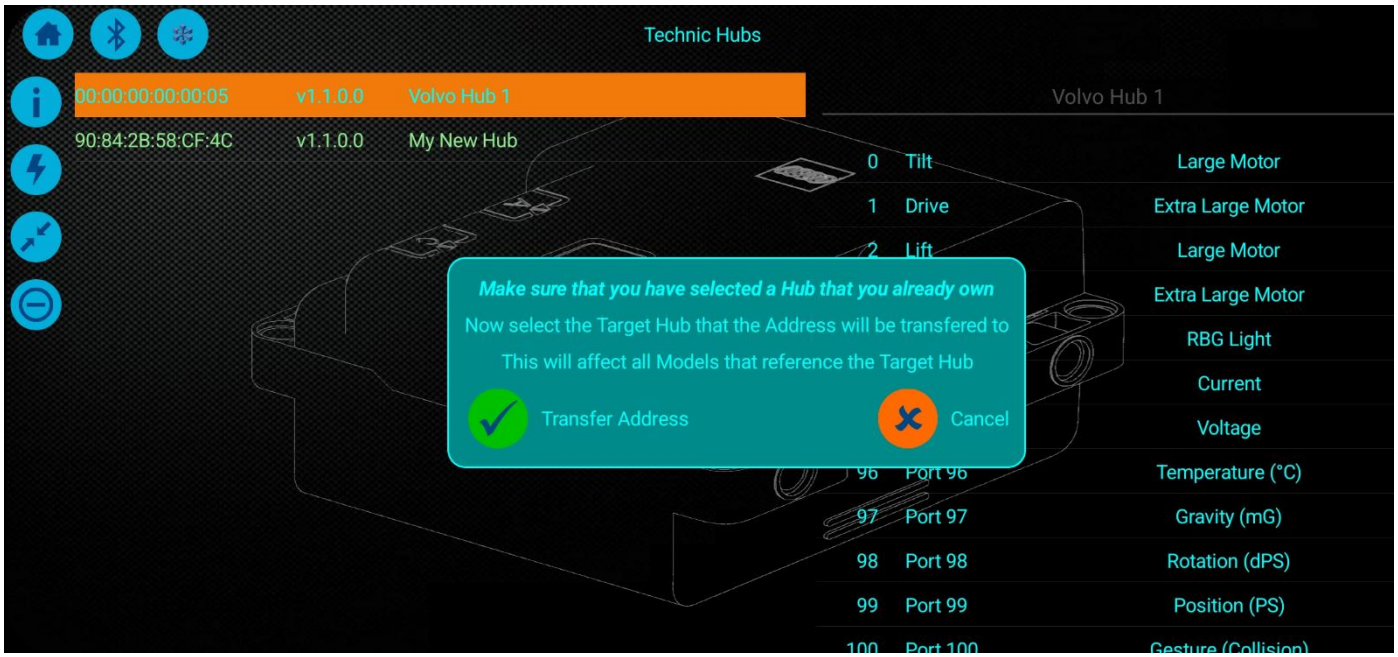
If you return to the Hubs View, you will see another button to the left that lets you assign a Hub's Bluetooth address to a Hub on a Model that you have imported:



You can see above that the first Hub is one that was imported (in this case, the Volvo RC with a default address of 00:00:00:00:00:05). I then turned on a Hub that I own which showed up in Green. Now if you tap the Merge button you will see the following (make sure you select the Hub that you own first):



Now tap the imported Hub so that you can choose to proceed:



After you tap the Transfer Address button, you will probably want to delete the original Hub. To do this, you must first Power it down:

If the Model that you imported is linked to more than one Hub, you will need to repeat this procedure with more Hubs that you own.

9. My Technic Models

I have created 3 rather large models that incorporate a number of the Powered Up Hubs, Motors and Lights. These were the main reasons for writing the Application, because I had no way to control them. They have become *major overhauls* of the original Lego designs, either because no motors were included or the lack of space that I had to squeeze the motors into. Obviously, the gearing mechanisms, as well as many other aspects of each model, have had to be designed from scratch in each case:

Based On 42009	Powered Up Crane RC	2532 Parts	2 Technic Hubs 2 Extra Large Motors 6 Large Motors
Based On 42030	Powered Up Volvo RC	1672 Parts	1 Technic Hub 2 Extra Large Motors 2 Large Motors
Based On 42078	Powered Up Truck RC	1898 Parts	1 Technic Hub 1 Extra Large Motor 2 Large Motors 1 Light Set
	Optional Trailor	920 Parts	1 Technic Hub 1 Large Motor

The instructions and parts lists are available from the Home View of the App by tapping the Purchase button:

10. Future Application Enhancements

At the moment, the Application is version 1.70. This means that I have tested it using the Android devices available to me (and my Windows Laptop for the UWP version).

I would love to hear any feedback or suggestions that you may have. Please email me at:

lgroves@nqcomputing.com

Before the next revision, I hope to add some, or all, of the following to the Application:

- More Elements in the Designer.
- Control over and Feedback from the Internal Ports (50 and above).
- A discussion Forum on my Website

Finally, I really hope that you enjoy using the App. Please tell all your friends about it! The more people that know about it, the better I will be able to make it a success for everyone.

Thanks, Loz Groves.

Novaquest Computing Limited.