**ToolChanger Documentation**

**Introduction**

Rather than being a full step-by-step guide, this document is mainly designed to serve as a collection of information sources with brief explanations in between. The other information sources linked here explain the various parts of the system well and in more detail than could be provided here, so they should be the primary resources for troubleshooting with this document only filling in the gaps.

**Connecting to the ToolChanger**

The printer can be accessed in two ways, [over USB](https://learn.ooznest.co.uk/Guide/1.+Connecting+your+Duet+via+USB+-+Windows/123) and via the [Duet Web Control](https://duet3d.dozuki.com/c/DuetWebControl) interface. The USB interface is minimal, and should only be used when first connecting the Duet control board (the [Duet 2 Ethernet](https://docs.duet3d.com/Duet3D_hardware/Duet_2_family/Duet_2_WiFi_Ethernet_Hardware_Overview) is currently being used) to a network. The Duet board was [configured over USB to use the static IP address](https://docs.duet3d.com/Duet3D_hardware/Duet_2_family/Duet_2_WiFi_Ethernet_Hardware_Overview) of 192.168.2.1. Then, the ethernet cable was plugged directly into an ethernet port of the control computer, and configured as is described [here](https://duet3d.dozuki.com/Wiki/Setting_up_networking_on_Duet#Section_Wired_direct_connection). With this, the Duet Web Control interface can be accessed by going to 192.168.2.1 in a web browser.

**Using Duet Web Control**

An overview of the various functions of Duet Web Control is available [here](https://duet3d.dozuki.com/Wiki/Duet_Web_Control_v2_and_v3_%28DWC%29_Manual). The most important aspects of it specific to the ToolChanger are the [macro files](https://duet3d.dozuki.com/Wiki/Setting_up_macro_files_for_common_tasks#:~:text=You%20can%20create%20macros%20easily,and%20click%20on%20New%20File.) accessible from the Macros tab and system .g gcode files accessible from the System tab. The macro file do not have a file extension and can only be run from the Marcos or Dashboard tabs. The gcode files in the System tab have the .g file extension and can be run from anywhere using the [M98](https://duet3d.dozuki.com/Wiki/M98) command. This can be from the built-in console, within toolpath gcode files, or even from within other system .g files.

The most important system file is config.g. This is run at system startup and whenever the printer is reset, and sets the configuration of toolheads, heaters, offsets, and more. Looking through it, most of the lines are commented describing what is being configured, and each M command can be googled to get more information on what they are doing. Most relevant to the work being done this summer is lines 127-136 configuring the toolhead offsets. These will need to be modified if the geometry of any of the toolheads are changed, putting their nozzles in different locations.

There are also various system .g files used internally by the firmware of the printer, as described [here](https://duet3d.dozuki.com/Wiki/ConfiguringRepRapFirmwareCartesianPrinter). These are used during various actions such as pausing, resuming, and stopping a print. The files that will most likely need to be changed are the tpre[tool number], tpost[tool number] and tfree[tool number]. These are called before and after a tool is selected (tpre and tpost) using the command T[toolnum] and when a tool is dropped off using T-1 (or when directly switching from one tool to another, e.g. if T0 is selected, sending the command T2 will actually execute T-1 and then T2. So the sequence of .g files called will be tfree0.g, tpre2.g, tpost2.g.). Opening up and reading these files, the tool pickup and drop-off locations in the tpre and tfree files will have to be changed if the tool geometries are changed, as well as the Z safety distances denoted by the WARNING comments. This is all described in more detail [here](https://duet3d.dozuki.com/Wiki/Multiple_tools_and_Tool_change_macros#Section_Tool_Change_Macros).

**Printer configuration**

Currently, there are two plastic [Hemera](https://e3d-online.com/products/e3d-hemera-direct-kit-1-75mm) tools, one syringe-based tool, and one hardware store silicone tube-based tool installed on the ToolChanger. The hemera tools both have 1.2mm nozzles installed, however smaller nozzles are on hand in the cardboard parts bin in the corner of the work bench. Additionally, two other complete hemera kits are also on hand, if one wishes to switch out the other two tools for additional plastic extruders.

From left to right, the tools are T0, T1, T2, and T3 which are hemera, hemera, syringe, and silicone tube extruders.

If a tool geometry were to be changed, it would have to be able to accept a tool plate (the metal part) and the plastic tool receptable (black plastic) in order for the kinematic coupling mechanism to be able to interface with it and for it to be able to be parked to the machine frame. The ToolChanger Github is available [here](https://github.com/e3donline/ToolChanger) with PDFs and the original CAD parts.

**Gcode/Toolpath Generation**

The ToolChanger runs on [RepRapFirmware3](https://duet3d.dozuki.com/Wiki/RepRapFirmware_3_overview) (RRF3). [Here](https://duet3d.dozuki.com/Wiki/Gcode) is its gcode dictionary. A notable feature is its [scripting abilities](https://duet3d.dozuki.com/Wiki/GCode_Meta_Commands), which can be very powerful. Gcodes can be generated using slicers, grasshopper, or the excel-based [FullControl Gcode](https://fullcontrolgcode.com/). FullControl was used extensively this past year to decent results. Example designs can be found in the FullControl folder in the IP Accelerator Dropbox. Note that if a different designer is used, the starting and ending gcodes from the FullControl designs should be copied over to ensure proper starting and ending of prints.