What's an "Axis Object"?

- Common ancestor for all motor and thermal control objects
  - Almost all the ESP Ruby TLAs inherit behaviours from axes
- Axes are typically defined in configure.rb
  - Or in preconfig.rb or postconfig.rb
  - Always as superclasses (Syringe, Slide, etc.)
- May be added or removed "on the fly"
- Base class is technically "AxisKernel"
  - Axis class inherits from that, adding an AxisMap

AxisMaps

- Simply map named positions to raw, numeric positions
  - Raw positions required for hardware control
  - Named positions much easier for people to understand
  - Also isolate protocol scripts from hardware changes
- Multiple names can be associated with with each numeric raw position
  - The first name is the position's “label”
    - The reverse mapping always uses this “label”
  - Others are aliases

Common AxisMap behaviours

- Reverse map raw position to named position
  - Determine if raw position is near enough named position to be considered “at” the position
- Create a position exactly between two named positions
- Advance to the next named position (or “detent”)
  - Retard to the previous one
  - It's also possible to advance/retard by a decimal number of positions (or detents)
    - This is complicated when the spacing between them is not equal
- There are a few more operations defined in axis.rb

Slide Objects

- Most basic LinearAxis of all the ESP TLAs
- Clamps are Slide axes
  - Think of Slide trombones :-)
  - Not meaningful to talk about units of movement between defined positions or detents (or musical notes :-)
- No notion of empty or full
- However, one can specify movement to a point exactly “between” two defined positions.

Scale Objects

- Scale objects are Slides with notion of measurement units
- Simply some number of raw counts equal 1 logical unit
  - Most be linear across entire range
- Units can be arbitrarily named
  - Call them ml, ul, or “pucks”, degrees C
- Adds notion of a zero point
  - Raw count where number of logical units equals zero.
- Adds notion of a skew
  - With linearly interpolated best fit for empirical measurements
    - Used only for Thermal objects in practice

Pump Objects

- Pumps are Scales with some linear mapping between rawPosition and logical (typically volumetric) units.
- Pumps have no notion of “emptiness” or “fullness”
- Just a constant, prescribed of countsPerUnit

Syringe Objects

- Syringe objects are Scales with measurement units and notion of emptiness and fullness
  - Typically volumetric units

- Adds push and pull methods
  - To move relatively a specified number of logical units

Shaft Objects

- Most basic RotoryAxis object – analogous to a circular Slide object
- Adds dial and dialBetween methods
  - dial to an exact position
  - dialBetwen to predefined positions
- Dial methods usually choose shortest route around circle
  - However, one can specify :via some position
    - Xyz.dial :nastyStuff, :via=>:flushFluid
  - Or, :avoiding some other position
    - Xyz.dial :waste, :avoiding=>:air
  - But not both :via and :avoiding in the same motion
- Shafts may also be advanced or retarded by a number “detents”
  - Advance 1 goes to the next position, Retard 1 goes to the previous position
  - Abc.retard -1.5 moves 1 ½ positions forward
- All Rotary Valves are Shaft Objects

Solenoid Objects

- Inherits from AxisKernel – not Axis
  - solenoids have no notion of position between their endpoints
  - So, there's no concept of rawPosition or an AxisMap
- Each has exactly two named positions
  - Or “states”
- Not usually used directly
  - See Valve Objects instead

Valve Objects

- Solenoid Valves with provision for aliased position names
- Valves are always Solenoids – not rotary valves
  - Which are Shaft objects

Valve::Manifold Objects

- Valve::Manifold is an array of Valves
  - At most one valve is “selected” or opened at any time
  - If no valves opened manifold is said to be “bypassed”
    - In which case is reports its state as :bypassed

- New feature is ability to “alias” the names of the valves themselves within the Valve::Manifold array
  - This is inherently different than aliasing position names
    - But works the same way because users think of the Manifold as one integrated valve.

- It is possible to access individual Valves in a manifold directly

Thermal Objects

- Thermal Objects are Scales
  - With very different underlying hardware!
- The same methods that work on Scales also work on Thermal heaters.
- Uses Scale::Skews to define a mapping between rawTemperature (ADC counts) and logical degrees C
  - That changes depending on ambient temperature
- PID controller is very different at dwarf firmware level
  - P,I,D are augmented by addition damping factors