**Project Tasks**

1. Create Machine Spec
2. Create Base for project with SPT code + XTS Starter Code
3. Create Git Repo
4. Program XTS to do golf printing functionality

* Orient Station
* Ball Seat Station
* Print Station
* Vision Inspection
* Kickout Station
* Tray Load Station
* Job management
* recovery

1. Create TC HMI

* Machine Control Page
* Alarm Page
* Ethercat Diag Page
* XTS Diag Page
* What else?

1. Create Video for XTS/TC HMI Product ‘Pitches’

**Engineering Competencies**

1. SPT Framework/PackML
2. XTS programming/hardware/simulation
3. TC HMI
4. Teamwork/Source control
5. Customer product pitch

**Machine Spec**

**Overview**

This machine demonstrates the usage of Beckhoff XTS linear transport system for a custom golf ball printing machine. It uses a Beckhoff IPC running Twincat on windows and utilizes Twincat HMI for a user interface for machine control and diagnostics.

The machine is controlled by loading “jobs” which determine the amount (in dozens) of each player number (1,2,3,4) to be printed, and a print configuration (number of colors, and number of balls to be printed of each color)

**Machine Function**

The XTS track functionality consists of 6 stations: Orient, Ball Seat, Print, Vision, Kickout, and Tray Load.

**Orient Station**

The Orient Station interfaces to OEM equipment that orients a single ball at a time and loads the ball into the tooling on the mover. When a ball is loaded, it will be saved into the “payload” information for that mover that a ball is loaded, along with information about the ball (player number). The Orient station also has a sensor to detect the presence of a ball for recovery purposes. At startup, all movers are routed to the orient station and if a ball is detected at the orient, it is routed to the kickout station for removal. There is a pneumatic system to open/close the ball clamps, along with sensors for opened/closed feedback.

The Orient Station has the following IO:

|  |  |  |
| --- | --- | --- |
| Ball Clamp Opened | Digital | Input |
| Ball Clamp Clsoed | Digital | Input |
| Ball Present | Digital | Input |
| Ball Load Complete | Digital | Input |
| Ball Clamp Open | Digital | Output |
| Ball Clamp Close | Digital | Output |
| Load Ball | Digital | Output |

**Ball Seat Station**

The ball seat station simply functions to ensure the ball is fully seated into the tooling so it cannot lose its orientation during further processing.

The Ball Seat Station has the following IO:

|  |  |  |
| --- | --- | --- |
| Ball Clamp Opened | Digital | Input |
| Ball Clamp Closed | Digital | Input |
| Ball Seat Extended | Digital | Input |
| Ball Seat Retracted | Digital | Input |
| Ball Clamp Open | Digital | Output |
| Ball Clamp Close | Digital | Output |
| Extend Ball Seater | Digital | Output |
| Retract Ball Seater | Digital | Output |

**Print Station**

The print station prints a custom logo or image onto the ball. The printer has four print pads and depending on the job, one, two, three, or four could be used. The print configuration is set when the job is started and cannot be changed during a job run. The job can be configured for the following print cycles (X denotes an unused print position, a number denotes the print color index that position completes)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Color Amt** | **Index Amt** |  | **Print Pos 1** | **Print Pos 2** | **Print Pos 3** | **Print Pos 4** |
| 1 | 1 |  | X | X | 1 | X |
| 1 | 2 |  | X | 1 | 1 | X |
| 1 | 3 |  | X | 1 | 1 | 1 |
| 1 | 4 |  | 1 | 1 | 1 | 1 |
| 2 | 1 |  | X | 1 | 2 | X |
| 2 | 2 |  | 1 | 1 | 2 | 2 |
| 3 | 1 |  | X | 1 | 2 | 3 |
| 4 | 1 |  | 1 | 2 | 3 | 4 |

The Vision Station has the following IO:

|  |  |  |
| --- | --- | --- |
| Print Active | Digital | Input |
| Print Complete | Digital | Input |
| Print | Digital | Output |

**Vision Station**

The vision station uses a camera to inspect the print quality. The results are saved to the payload structure for the mover and the mover is sent to the kickout station or the tray load station if the inspection fails or passes.

The Vision Station has the following IO:

|  |  |  |
| --- | --- | --- |
| Vision Active | Digital | Input |
| Vision Pass | Digital | Input |
| Vision Fail | Digital | Input |
| Inspect | Digital | Output |

**Kickout Station**

The kickout station uses an external device to remove balls from the movers. Balls will be sent to this station when the ball is marked bad at the vision station or is determined at the orient station to have an unknown ball after startup.

The Kickout Station has the following IO:

|  |  |  |
| --- | --- | --- |
| Ball Clamp Opened | Digital | Input |
| Ball Clamp Closed | Digital | Input |
| Ball Removed | Digital | Input |
| Ball Clamp Open | Digital | Output |
| Ball Clamp Close | Digital | Output |
| Remove Ball | Digital | Output |

**Tray Load Station**

The tray load station loads 4 balls per cycle onto a tray. Four movers with printed and inspected balls will be moved to the individual pick positions and when all movers are in place, the external system is commanded to pick the balls. All four ball clamps are opened/closed via one actuator.

The Tray Load Station has the following IO:

|  |  |  |
| --- | --- | --- |
| Ball Clamp Opened | Digital | Input |
| Ball Clamp Closed | Digital | Input |
| Tray Load Complete | Digital | Input |
| Ball Clamp Open | Digital | Output |
| Ball Clamp Close | Digital | Output |
| Load Tray | Digital | Output |

**HMI function**

The twincat HMI operator interface will include four pages for machine control and diagnostics: Machine Control Page, Alarm Page, Ethercat diagnostics page, XTS diagnostics page.

**Machine Control Page**

Job Start, Stop buttons (stop cycle stops)

Printer configuration

Player Number Quantity configuration for job

Feedback on quantity of balls printed/loaded, job completion % etc

**Alarm Page**

**Ethercat Diagnostics Page**

**XTS Diagnostics Page**

**Product Pitch Video**

**Scenes:**

* Machine Introduction (what it’s doing/simulating)
* XTS Introduction
* Twincat HMI Introduction
* PC Based Control Introduction?
* Ethercat Intro?
* SPT/Pack ML?
* TBD

**Individual Responsibilities:**

|  |  |
| --- | --- |
| XTS Base | Cope |
| XTS Station – Orient | Cope |
| XTS Station – Ball Seat | Cope |
| XTS Station – Print | Cope |
| XTS Station – Vision | Daniel |
| XTS Station – Kickout | Daniel |
| XTS Station – Tray Load | Daniel |
| TC HMI Base | Daniel |
| TC HMI Pages TBD | TBD |
|  |  |
|  |  |
|  |  |