snowbank brewing

fort collins, colorado

brewery automation for small craft brewers and homebrewers

how does brewery automation help a brewer?

- maintain/improve product quality
- free up time to experiment*
- increase operational efficiency
- standardize operations between brewers
- lower operational costs
- increase enjoyment of the brew day

are there any drawbacks?

- missed knowledge and experience
- cost
- can be taken to extremes

it is best to learn how to do things manually then automate

automation in brewing

it's like having a friend helping you brew every day

(a good friend)

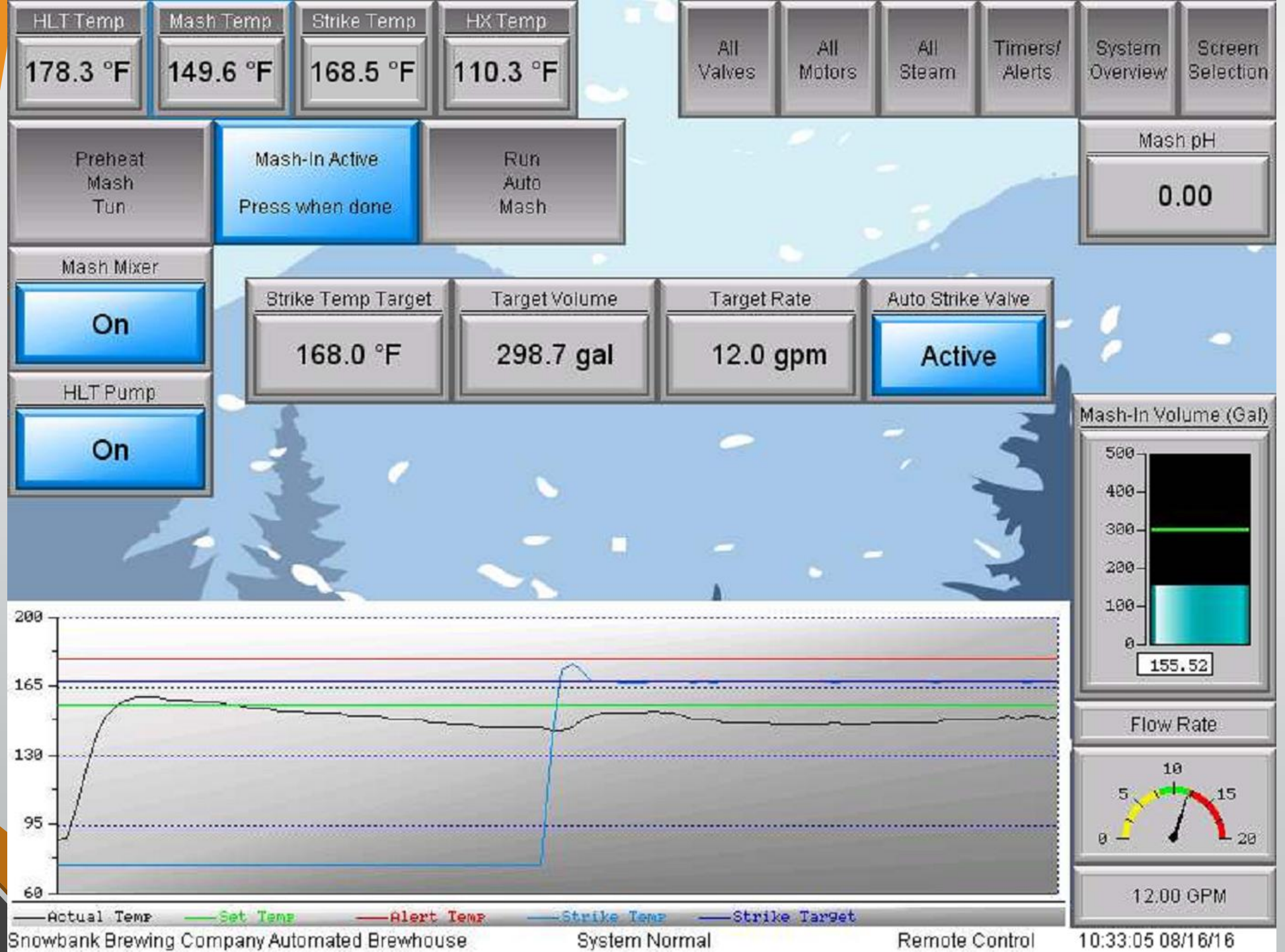
(who knows what they're doing)

why use automation?

- As simple as a timer or stopwatch
- Can be used for simplifying a single task
- As complex as replacing a user entirely

what can you automate for brewing?

- Manage temperature control
- Run pumps
- Open and close valves
- Coordinate entire processes
- Gather and report data


HLT Temp
178.3 °F
Mash Temp
149.6 °F
Strike Temp
168.5 °F
HX Temp
110.3 °F
All Valves
All Motors
All Steam
Timers/ Alerts
System Overview
Screen Selection
Preheat Mash Tun
Mash-In Active
Press when done
Run Auto Mash
Mash pH
0.00
Mash Mixer
On
HLT Pump
On
Strike Temp Target
168.0 °F
Target Volume
298.7 gal
Target Rate
12.0 gpm
Auto Strike Valve
Active
Mash-In Volume (Gal)
500
400
300
200
100
0
155.52
200
165
130
95
60
Actual Temp
Set Temp
Alert Temp
Strike Temp
Strike Target
Flow Rate
10
5
15
0
20
12.00 GPM
Snowbank Brewing Company Automated Brewhouse
System Normal
Remote Control
10:33:05 08/16/16

what are the options?

discrete components

- PID Controllers
- Relay logic and safeties
- Pushbuttons and switches

integrated systems

- Prefab systems
- Homebuilt controllers
- PLC-based systems


EMERGENCY STOP
ACTIVATE SYSTEM
119
L1 Volts
118
L2 Volts
20.1
System Current Draw
SSR Heatsink Temp
JLD634
10.4
SET
HLT Control
ENABLE
READY
HEATING
FAIL
Hot Liquor Tun
Transfer Pump
162.2
5.0
Mash Control
Mash System
AUBER
00
90.0
Boil Timer
61.7
Boil Control
Boil Kettle

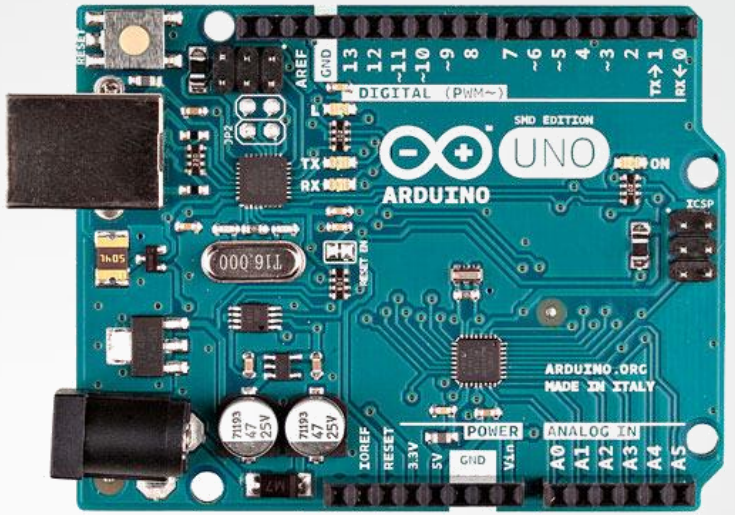

Nubble Tide Brewing Co.
Power
Emergency Stop
Hot Liquor Tun
Mash Tun
Boil Kettle
HLT Heater
Water Pump
Wort Pump
Boil Heater
The Way Beer Should Be

Blichmannengineering.com

ebrewsupply.com

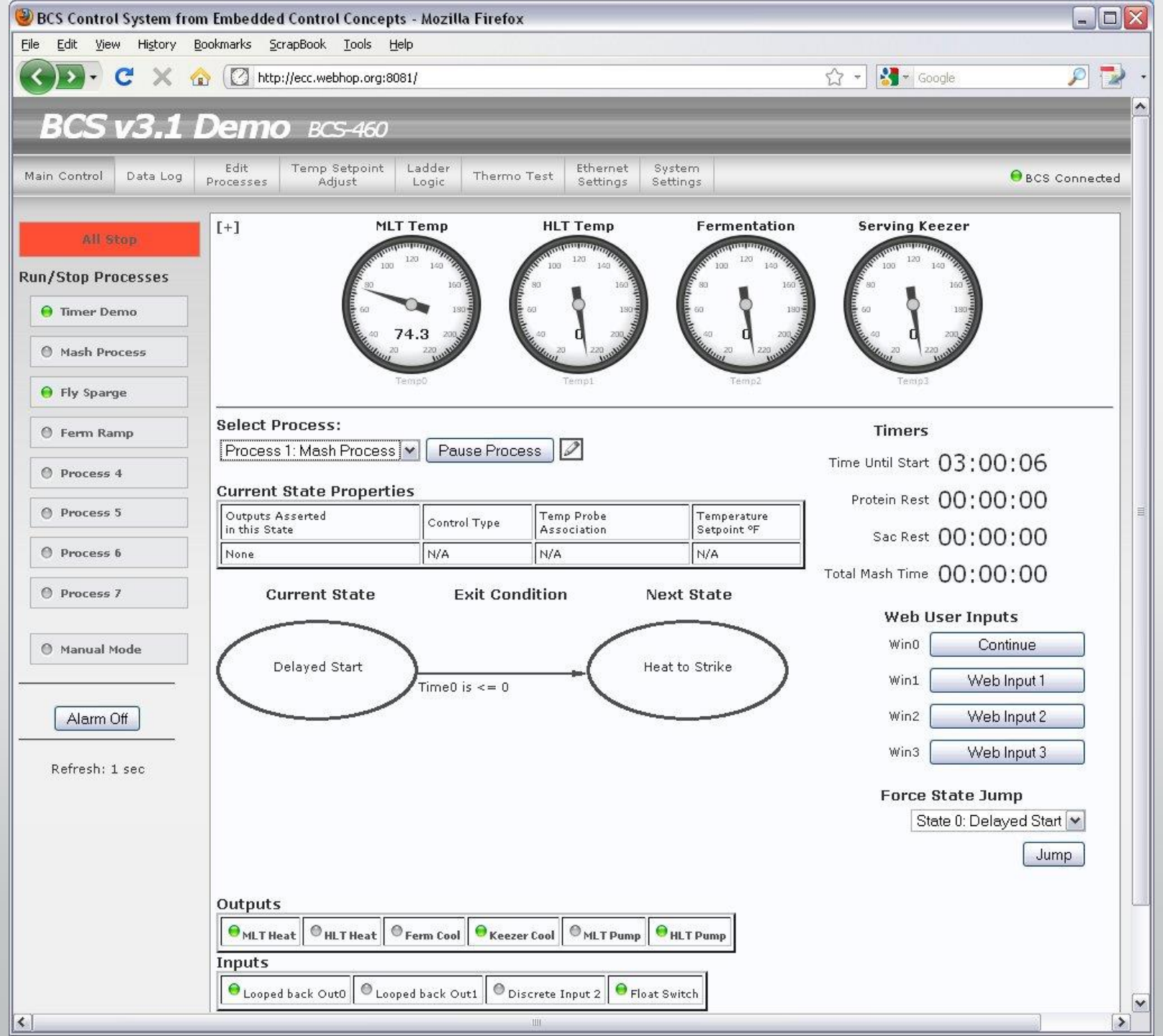
Theelectricbrewery.com

embededcc.com

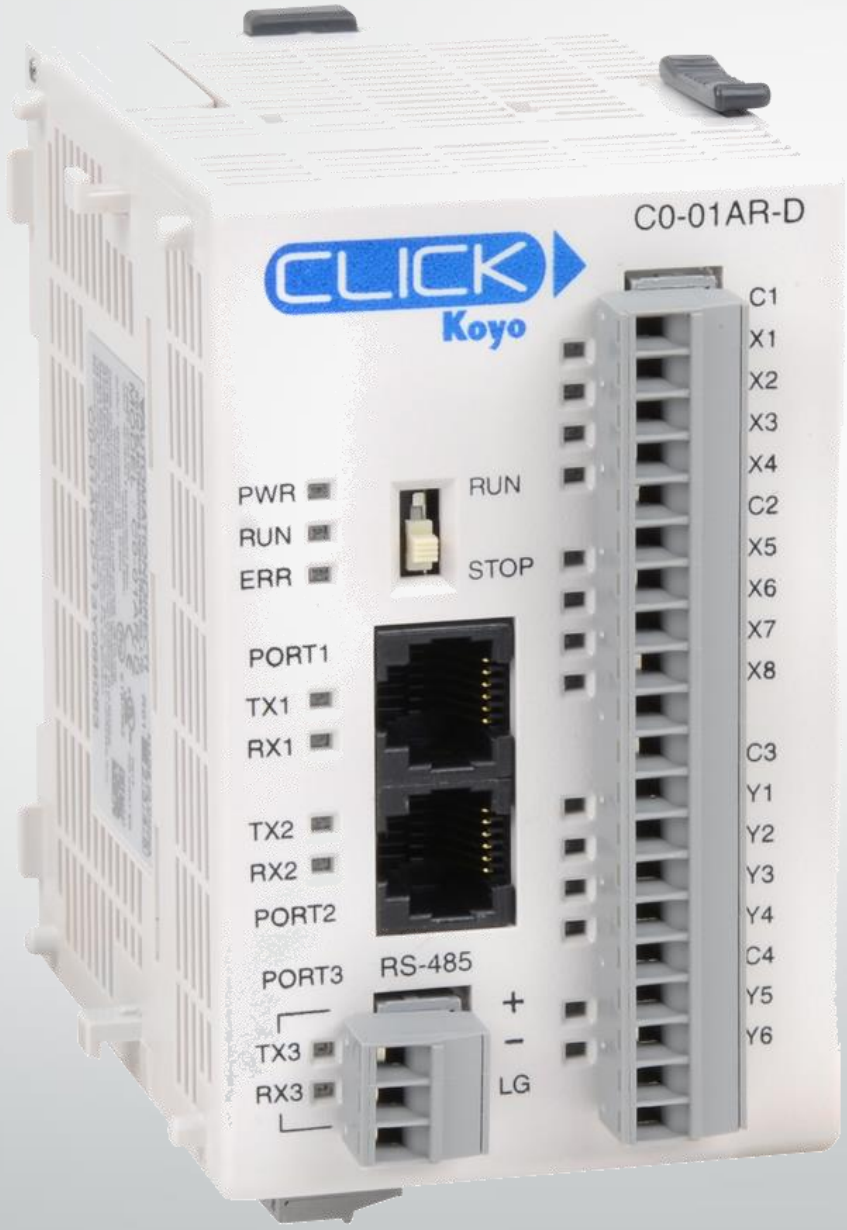


arduino.org

raspberrypi.org


BCS Control System from Embedded Control Concepts - Mozilla Firefox
File Edit View History Bookmarks ScrapBook Tools Help
http://ecc.webhop.org:8081/
BCS v3.1 Demo BCS-460
Main Control
Data Log
Edit Processes
Temp Setpoint Adjust
Ladder Logic
Thermo Test
Ethernet Settings
System Settings
BCS Connected
All Stop
Run/Stop Processes
Timer Demo
Mash Process
Fly Sparge
Ferm Ramp
Process 4
Process 5
Process 6
Process 7
Manual Mode
Alarm Off
Refresh: 1 sec
[+]
MLT Temp
HLT Temp
Fermentation
Serving Keezer
74.3
Temp0
Temp1
Temp2
Temp3
Select Process:
Process 1: Mash Process
Pause Process
Current State Properties
Outputs Asserted in this State
Control Type
Temp Probe Association
Temperature Setpoint °F
None
N/A
N/A
N/A
Timers
Time Until Start 03:00:06
Protein Rest 00:00:00
Sac Rest 00:00:00
Total Mash Time 00:00:00
Current State
Exit Condition
Next State
Delayed Start
Time0 is <= 0
Heat to Strike
Web User Inputs
Win0 Continue
Win1 Web Input 1
Win2 Web Input 2
Win3 Web Input 3
Force State Jump
State 0: Delayed Start
Jump
Outputs
MLT Heat
HLT Heat
Ferm Cool
Keezer Cool
MLT Pump
HLT Pump
Inputs
Looped back Out0
Looped back Out1
Discrete Input 2
Float Switch

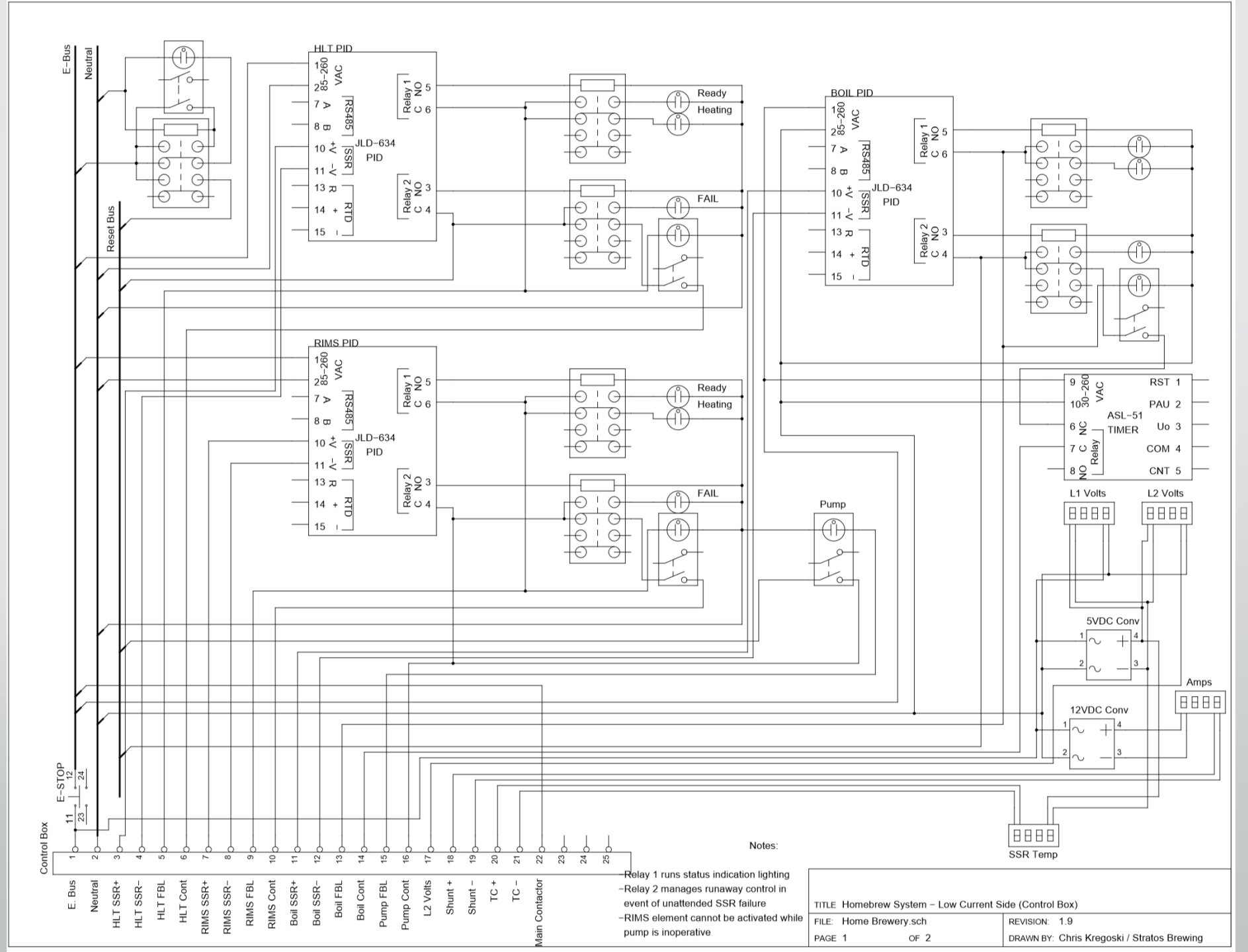

Next: 3.0
Waiting: -
Errors: -
BCS: auth example
Control Enabled
Mash Temperature: 64.3
32
212
HLT Temp: 64.3
32
212
Heat Exchanger: 64.2
32
212
Fermentation Tmp: 64.5
32
212
MLT Heat
HLT Heat
MLT Pump
HLT Pump
Ferm Heat
Ferm Cool
Monitor
Processes
Settings


C0-01AR-D
CLICK
Koyo
C1
X1
X2
X3
X4
C2
X5
X6
X7
X8
C3
Y1
Y2
Y3
Y4
C4
Y5
Y6
PWR
RUN
ERR
RUN
STOP
PORT1
TX1
RX1
TX2
RX2
PORT2
PORT3
RS-485
TX3
RX3
+
−
LG

what does it take?

discrete components

- Need to be able to understand basic circuits (SAFETY FIRST!)
- Need to be able to build a plan
- Need to be able to use tools


E-Bus
Neutral
Reset Bus
HLT PID
RIMS PID
BOIL PID
JLD-634
PID
85-260 VAC
RS485
SSR
RTD
Relay 1
Relay 2
Ready
Heating
FAIL
Pump
ASL-51
TIMER
30-260 VAC
Relay
RST 1
PAU 2
Uo 3
COM 4
CNT 5
L1 Volts
L2 Volts
5VDC Conv
12VDC Conv
Amps
SSR Temp
E-STOP
Control Box
E. Bus
Neutral
HLT SSR+
HLT SSR-
HLT FBL
HLT Cont
RIMS SSR+
RIMS SSR-
RIMS FBL
RIMS Cont
Boil SSR+
Boil SSR-
Boil FBL
Boil Cont
Pump FBL
Pump Cont
L2 Volts
Shunt +
Shunt -
TC +
TC -
Main Contactor
Notes:
-Relay 1 runs status indication lighting
-Relay 2 manages runaway control in event of unattended SSR failure
-RIMS element cannot be activated while pump is inoperative
TITLE Homebrew System - Low Current Side (Control Box)
FILE: Home Brewery.sch
REVISION: 1.9
PAGE 1 OF 2
DRAWN BY: Chris Kregoski / Stratos Brewing

what does it take?

homebuilt controllers

- Everything from the discrete component method still applies
- Need to make control power work with operation power
- Need to be able program

FF_Brew_System | Arduino 1.6.7

File Edit Sketch Tools Help

FF_Brew_System

```
  delay(1500);
  lcd.setCursor(0,0);
  lcd.print("HLT RIMS BOIL P1");
  lcd.setCursor(0,1);
  lcd.print("OFF OFF  OFF  OF");

}

void loop(){

  // Read Button States
  HLT.SwitchState = (1-digitalRead(HLT.SwitchPin));
  RIMS.SwitchState = (1-digitalRead(RIMS.SwitchPin));
  Boil.SwitchState = (1-digitalRead(Boil.SwitchPin));

  /*HLT.SwitchState = readpin(HLT);
  RIMS.SwitchState = readpin(RIMS);
  Boil.SwitchState = readpin(Boil);*/
  Pump1.SwitchState = (1-digitalRead(Pump1.SwitchPin));
  Pump2.SwitchState = (1-digitalRead(Pump2.SwitchPin));

  // Read Alarm States
  HLT.AL1State = (1-digitalRead(HLT.AL1Pin));
  HLT.AL2State = (1-digitalRead(HLT.AL2Pin));
  RIMS.AL1State = (1-digitalRead(RIMS.AL1Pin));
  RIMS.AL2State = (1-digitalRead(RIMS.AL2Pin));
  Boil.AL1State = (1-digitalRead(Boil.AL1Pin));
  Boil.AL2State = (1-digitalRead(Boil.AL2Pin));

  //Active Control
  if (HLT.SwitchState == 1) HLT.ActiveState = setMode(HLT);
  if (RIMS.SwitchState == 1/*&& (Pump1ActiveState == 1 || Pump2ActiveState == 1)*/) RIMS.ActiveState = setMode(RIMS);
  if (Boil.SwitchState == 1) Boil.ActiveState = setMode(Boil);
  if (Pump1.SwitchState == 1) Pump1.ActiveState = setPumpMode(Pump1);

  //RIMS Pump Lockout -- Not needed if RIMS automatically turns on pump.  Needed for dual-pump setup.
  //if (Pump1ActiveState == 0 && Pump2ActiveState == 0) RIMSActiveState = 0;

  //Set indicators
  HLT.ActiveState = setIndicator(HLT);
  RIMS.ActiveState = setIndicator(RIMS);
  Boil.ActiveState = setIndicator(Boil);

  //Crappy "debounce"
  delay(150);

  digitalWrite(FailLight, LOW);
  if((HLT.AL2State == 0) && (RIMS.AL2State == 0) && (Boil.AL2State == 0)) digitalWrite(10, HIGH);
}
```

1

Arduino Nano, ATmega328 on COM6

what does it take?

PLC-based controllers

- Still requires planning and electrical knowledge
- Easier to interface to the real world (pumps, heaters, sensors)
- Much easier to program
- More robust

Do-more Designer 1.4.3 - Brewhouse PLC 101816 - [Outputs]

File Edit Search View Tools PLC Debug Window Help

Open Save New Backup Edit Mode Accept Undo Cut Copy Paste Find Find Next Browse Previous Next Output 100% Options On The Web Tip Help

Read PLC Write PLC New Online Do-more/Sim Data Debug Trend Memory Status All Status No Status Forces Value Mode Info Configure Devices Check PID Overview PID View

Project Browser

- Programs
  - Administration
  - Autovalves
  - Boiler_Control
  - BoilTimer
  - CO2_Meter
  - Data_Monitoring
  - Ferm_HMI_Convert
  - Fermenter_Ctrl
  - Fermenters485
  - GS_Drives485
  - HLT_Autofill
  - HMI_Inputs
  - Inputs
  - Keg_Cleaning
  - Outputs
  - Preheat_Mash_Tun
  - RunMash
  - StrikeValve
  - Target_Monitor

Launchpad | Project Browser

Data1

Native

	Element	Status
1	FV1_Name	DIRTY
2	FV2_Name	Moraine
3	FV3_Name	CRANKNB
4	FV3_PV	320
5	FV3_SV	320

$Main Outputs

Show Device List

1
HMI_V1_Out AutoValve_MashIn Runmash_Lockout Lockout_V1 V1_Output OUT
Autovalve_V1_Out HMI_Task_RunMash
Runmash_V1_Out HMI_Task_RunMash

2
HMI_V2_Out AutoValve_Sparge Runmash_Lockout Lockout_V2 V2_Output OUT
Autovalve_V2_Out Grant_Mode HMI_Task_RunMash
Runmash_V2_Out

3
HMI_V3_Out AutoValve_Sparge Runmash_Lockout Lockout_V3 V3_Output OUT
Autovalve_V3_Out HMI_Task_RunMash
Runmash_V3_Out

4
HMI_V4_Out AutoValve_VorIf AutoValve_XFtoWP MashDrum.Run Lockout_V4 V4_Output OUT
Grant_V_4 Grant_Task.RanThisScan Grant_P_Msh
Autovalve_V4_Out Grant_Task.RanThisScan
AutovalveSprgOff SprgOffV4

For Help, press F1

Instr Toolbox Accept F2 F3 Sh+F2 Sh+F3 = ! < > Delta Out Set Reset Browse ^w Edit Mode

Show list of devices

Run Term Stop S P D Devs OK Warning Online/Administrator/Snowbank Run 05700/65536 H2-DM1E

what does it cost?

discrete systems

- Fully featured kits can start around $1000
- Building your own? Cheaper is possible!
- Building your own? More expensive is probable!

what does it cost?

prefab systems

- ebrewsupply starts at $1500
- Blichmann Tower of Power can be <$750
- Many more options available, but expect to pay at least $1000 - $2000 for a good system

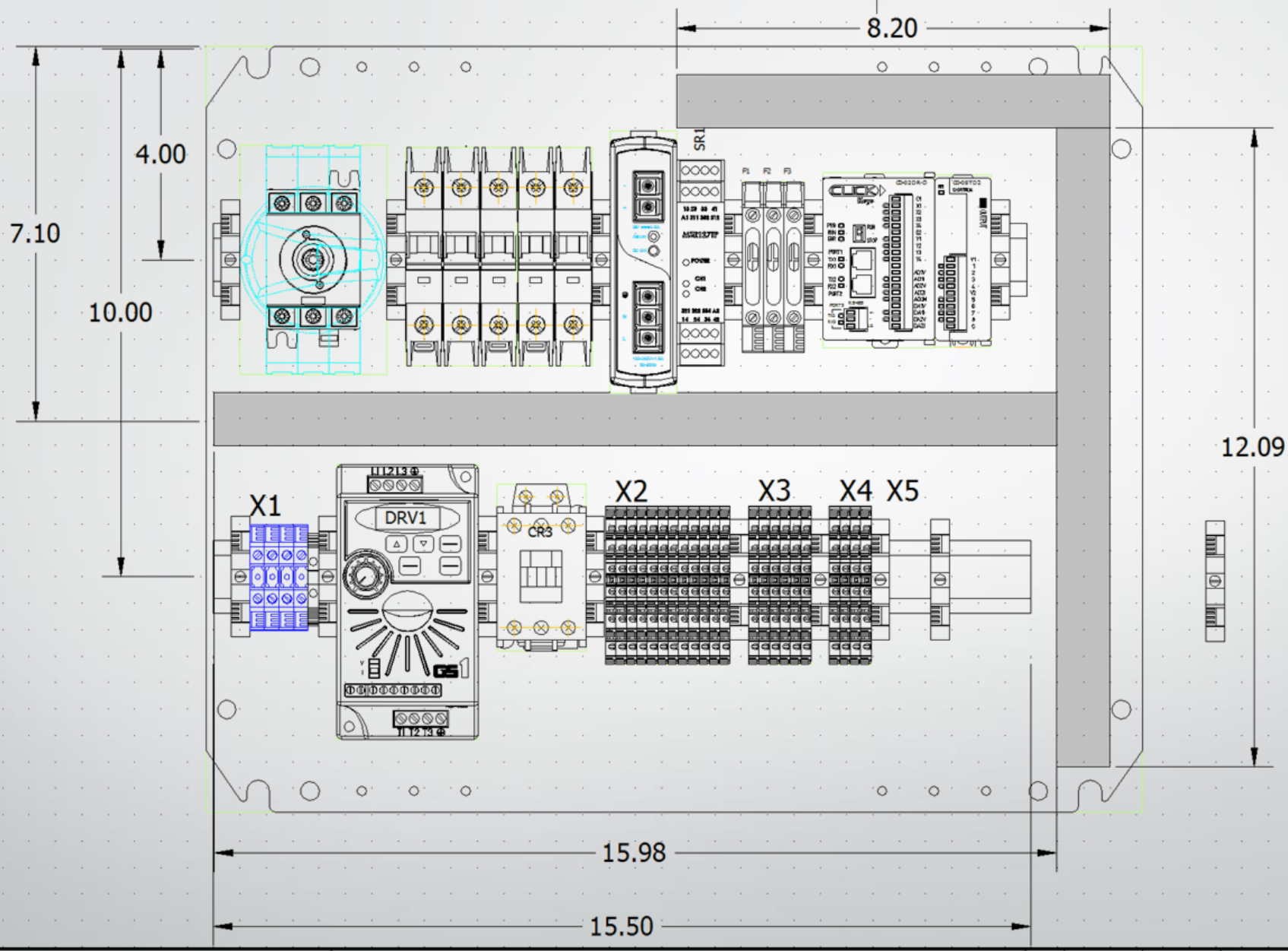
what does it cost?

PLC systems

- Less than $1000 is achievable
- The more you spend, the more you get (to a point)
- PLC systems are modular, so adding features increments price slowly

make your life easier

- Have a plan!
- Document your plan!
- Seriously, document your plan!
- Follow your plan!
- Learn how to troubleshoot correctly!



Frontier Fermentation
701 Frontier Ct
Fort Collins, CO 80526
www.frontierfermentation.com

Power/Control Cabinet Layout

REV.	DATE	NAME	CHANGES
0	9/13/2016	Frontier	

SCALE 1/2
REVISION 0
PAGE 07

PROJECT:
LOCATION: K00089-01
Power/Control Cabinet
User data 1
User data 2

automation in brewing

it's like having a friend helping you brew every day

(a good friend)

(who knows what they're doing)