

SRP EVAP

ME 476C Spring 2025

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CAD & Schematics

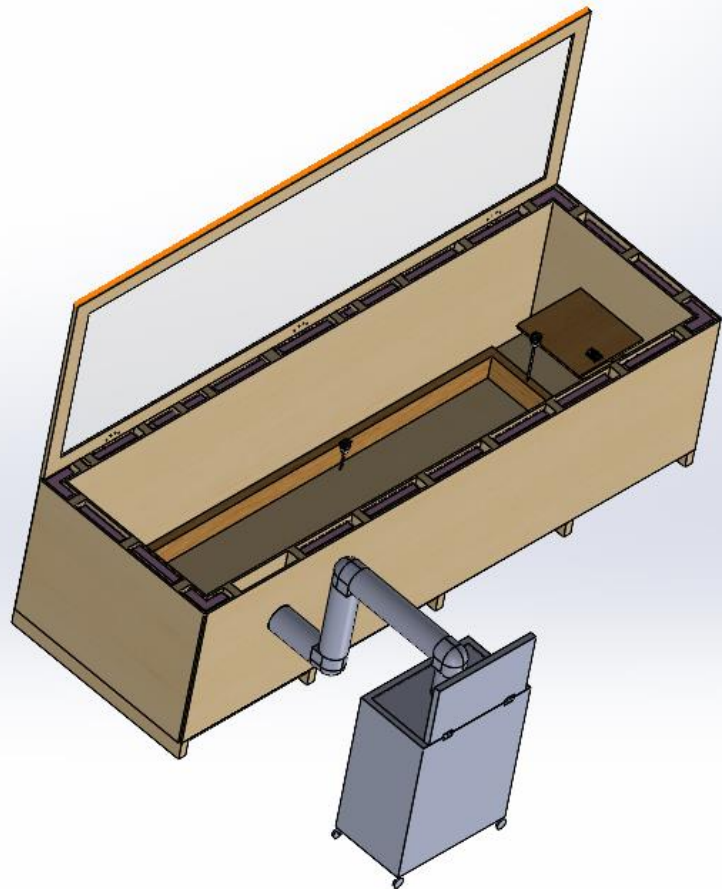


Figure 1: CAD View 1

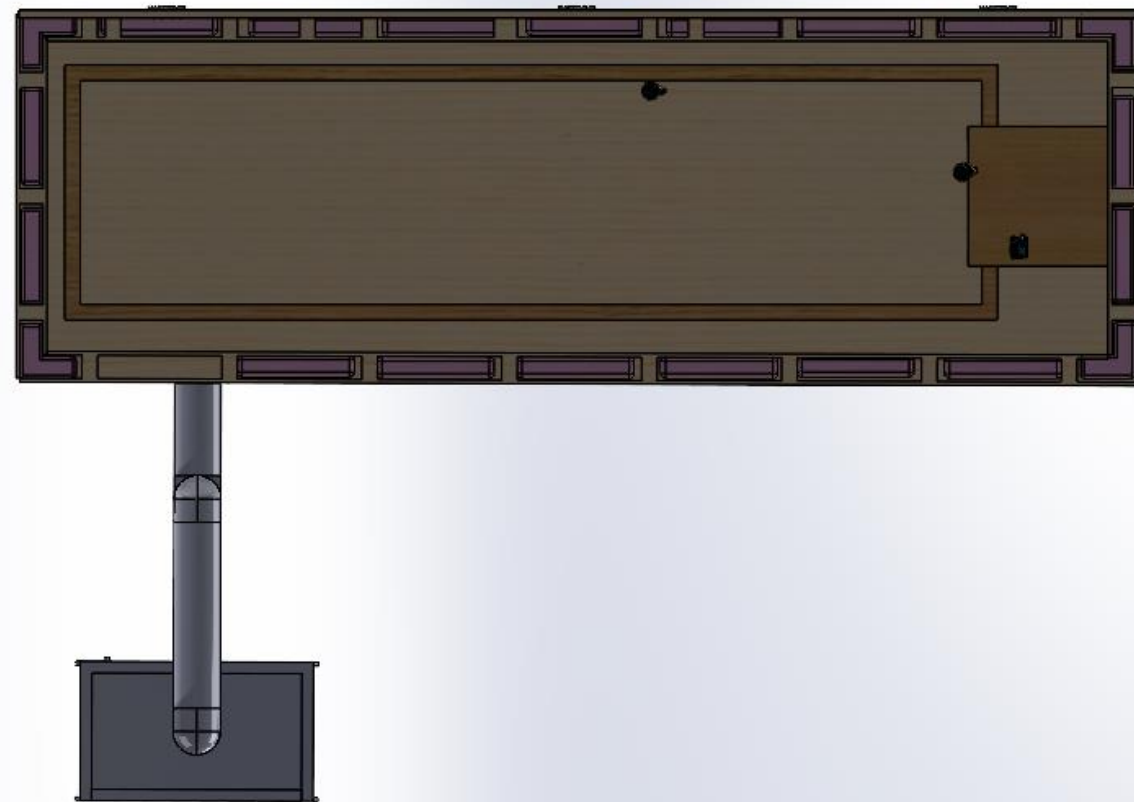
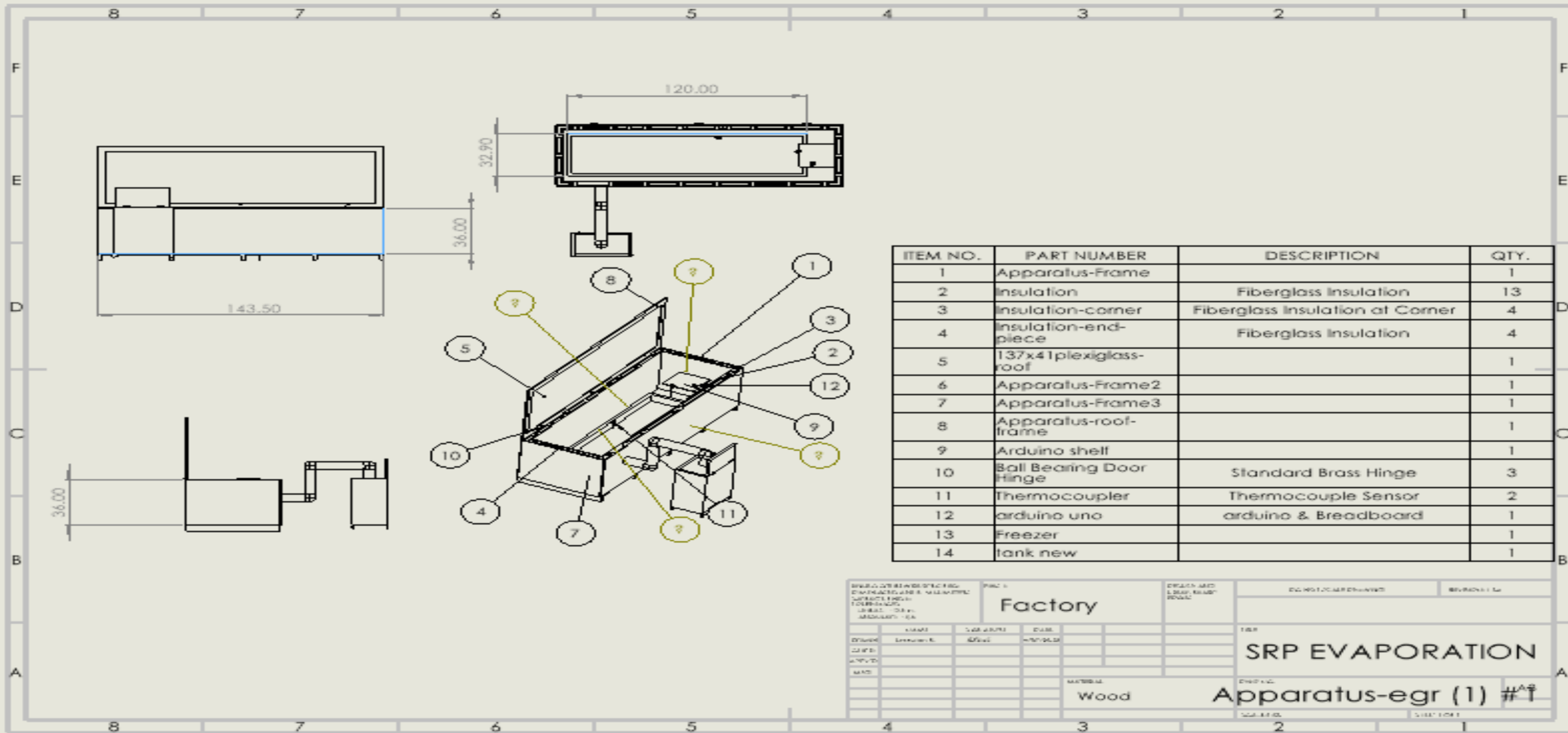


Figure 2: CAD View 2

CAD & Schematics



Updated Design Efforts & Engineering Calculations

We are creating conditions for turbulent free convection to mimic the average conditions at the Grand Canal in April 2025.

Weather data from SRP gave us the parameters needed to characterize the buoyant forces and viscous forces which drive evaporation under free convective conditions.

Final design parameters to achieve this Grashof number:

$$Gr_m = 7.179 \times 10^{11}$$

After dimensionless scaling, closest Grashof number we can reproduce in the apparatus:

$$Gr_m = 1.226 \times 10^{11}$$

Final design parameters to achieve this Grashof number:

$$T_\infty = 45^\circ\text{F}$$

$$T_s = 90^\circ\text{F}$$

$$\phi = 2\%$$

$$L_c = 10\text{ft}$$

MATLAB Code

```
%% ----- TARGET -----
Gr_target_canal = 7.751e11;      % Canal average @ 2 m above water (from SRP Grand Canal data)
band_pct        = 0.50;         % ±50% tolerance band for matches
require_same_stability = true;   % Requires the same Δrho_air sign as canal
stability_eps    = 1e-9;        % Anything with |Δrho_air| < eps is treated as "neutral"

% OPTIONAL: scale target by (L/L_ref)^3 to account for shorter apparatus
scale_target_by_L3 = true;      % <<< set true to preserve regime with short L
L_ref_canal_m      = 13.716;    % [m] canal characteristic length used in doc

%% ----- RANGES -----
% Length (feet → meters)
L_ft = 10;                     % Apparatus length in feet
L_m  = L_ft * 0.3048;          % Convert to meters

% Temperatures (°F → K)
Tinf_F = 45:1:90;              % Ambient air temperature (°F)
Ts_F   = 45:1:90;              % Water surface temperature (°F)
toK     = @(F) (F - 32) * 5/9 + 273.15;

% Relative humidity
RH_vec = (2:1:80)/100;         % 2-80% → 0.02-0.80
```

Figure 3: MATLAB Code Based on Calculated Grashof Number

Exact matches (top 15):

L(ft)	L(m)	T_inf(F)	T_s(F)	RH(%)	Gr (signed)	err %	Δrho_air	Stability
10.00	3.048	53.0	49.0	68.0	-8.507e+09	0.01	-8.112e-03	STABLE
10.00	3.048	89.0	82.0	58.0	-8.505e+09	0.01	-9.671e-03	STABLE
10.00	3.048	57.0	53.0	75.0	-8.507e+09	0.01	-8.284e-03	STABLE
10.00	3.048	78.0	72.0	58.0	-8.507e+09	0.02	-9.171e-03	STABLE
10.00	3.048	52.0	48.0	66.0	-8.508e+09	0.02	-8.071e-03	STABLE
10.00	3.048	72.0	67.0	69.0	-8.503e+09	0.03	-8.919e-03	STABLE
10.00	3.048	79.0	71.0	25.0	-8.508e+09	0.03	-9.151e-03	STABLE
10.00	3.048	66.0	59.0	8.0	-8.510e+09	0.05	-8.588e-03	STABLE
10.00	3.048	88.0	82.0	70.0	-8.502e+09	0.05	-9.654e-03	STABLE
10.00	3.048	59.0	54.0	45.0	-8.502e+09	0.05	-8.335e-03	STABLE
10.00	3.048	76.0	69.0	36.0	-8.510e+09	0.05	-9.046e-03	STABLE
10.00	3.048	62.0	57.0	52.0	-8.501e+09	0.06	-8.465e-03	STABLE
10.00	3.048	86.0	80.0	68.0	-8.501e+09	0.06	-9.552e-03	STABLE
10.00	3.048	85.0	79.0	67.0	-8.511e+09	0.06	-9.515e-03	STABLE
10.00	3.048	85.0	77.0	38.0	-8.500e+09	0.07	-9.430e-03	STABLE

Best achievable by length (max |Gr|; tie→closest % to target):

L(ft)	L(m)	T_inf(F)	T_s(F)	RH(%)	Gr	err %	Δrho_air	Stability
10.00	3.048	45.0	90.0	2.0	1.212e+11	1325.00	1.191e-01	UNSTABLE

Figure 4: Output of MATLAB Code

Bill of Materials

- Link to BOM

Fall BOM.xlsx

Purchasing Plan

Part	Quantity Needed	Purchase Quantity	Current Quantity	Unit Price(\$)	Total Price(\$)	Total Price Order Placed (Y/N)	Link	Notes
Plywood	15	5	10	14.98	224.7	Y	https://www.homedepot.com/p/QSB-7-16-Application-as-4ft-X-8-ft-Sheathing-Panel-386081/202106230	
Wood Beams	35	15	20	2.98	104.3	Y	https://www.homedepot.com/p/2-in-x-3-in-x-8-ft-2-Select-Grade-Dimensional-Lumber-845000/100038668?MERCH=REC--	
#8 2in Flat head Philips exterior screws(5lb pk of 6720	1	0	1	33.39	33.39	Y	https://www.homedepot.com/p/Grip-Rite-8-x-2-in-2-Phillips-Bugle-Head-Coarse-Thread-Coated-Exterior-Wood-Screws-5-lb-Box-PTN2SS/100136822	
2" Corner Brace Zinc 3X 20pk	3	0	3	14.97	44.91	Y	https://www.homedepot.com/p/Everbilt-2-in-Zinc-Plated-Corner-Brace-20-Pack-40915/326115906	
#6 3/4in Flat Head Philips metal to wood screws (50 pk)	4	0	4	5.98	23.92	Y	https://www.homedepot.com/p/DECKMATE-Marine-Grade-Stainless-Steel-6-X-3-4-in-Flat-Head-Phillips-Screw-50-Pieces-866900/319949363	
Waterproof floor putty	1	0	1	6.97	6.97	Y	https://www.homedepot.com/p/ROBERTS-Palette-Quick-Repair-Putty-3-oz-Tan-for-Wood-Laminate-and-Vinyl-Flooring-PC7730/204846143	Used to seal any mistakes
5" x 5" Zinc T-Plate	12	0	12	2.86	34.39	Y	https://www.homedepot.com/p/Everbilt-5-in-x-5-in-Zinc-Plated-T-Plate-6-Pack-12504/315016295	
Insulation	2	0	2	20.67	41.34	Y	https://www.homedepot.com/p/Grip-Rite-8-x-2-in-2-Phillips-Bugle-Head-Coarse-Thread-Coated-Exterior-Wood-Screws-5-lb-Box-PTN2SS/100136822	No longer being used but already purchased
Reptile Humidity & Thermometer	2	0	2	6.99	13.98	Y	https://www.petsmart.com/reptiles/environmental-control-and-lighting/humidity-and-temperature-control/zoo-med-creatures-dual-thermometer-and-humidity-gauge-49700.html?gclid=093bdda5d9a41bbfa	Used in last semesters prototype
Digital Water Thermometer	2	0	2	11.99	23.98	Y	https://www.petsmart.com/fish/heating-and-lighting/heating-and-lighting-accessories/top-fin-digital-aquarium-thermometer-16591.html	Used in last semesters prototype
Plastic Water Container	3	0	3	4	12	Y	https://www.target.com/p/12-34-x-6-34-x-4-34-all-purpose-storage-1-2-storage-bin-brightroom-8482/-/A-83279865#lnk=sametab	Used in last semesters prototype
Hot Glue Sticks	2	0	2	3	6	Y	https://www.michaels.com/product/4-full-size-dual-temperature-glue-sticks-by-ashland-10228078?michaelsStore=9608&inv=15	Used in last semesters prototype

Purchasing Plan

1500W Water Heater	1	1	0	104.5	104.5	Y	https://www.homedepot.com/p/brand-x-titanium-portable-hot-tub-heater-bridge-a-fully-immersion-water-heater-with-anti-	
LED Detachable Tripod Light	2	0	2	24.88	49.76	Y	https://www.homedepot.com/p/Husky-800-Lumen-LED-Rechargeable-Detachable-Tripod-Work-Light-K40526/331757756	
Wall & Cavity Foam	1	0	1	199.98	199.98	Y	https://www.homedepot.com/p/DAP-Touch-N-Foam-Wall-and-Cavity-Low-Gw/P-10-5-lb-Spray-Foam-Sealant-Kit-756500035/325778090	
Wide Spray Foam Sealant	4	0	4	39.98	159.92	Y	https://www.homedepot.com/p/GREAT-STUFF-Wide-Spray-18-oz-Spray-Foam-Sealant-12107825/334627354	
Arduino	1	0	1	0	0	Y	https://www.arduino.cc/	
Vinyl Pool liner	1	1	0	104.97	104.97	Y	Wave-48-in-x-54-in-D-Round-12-ft-Blue-Standard-Gauge-Overlap-Liner-ML321-20/320489524?MERCH=REC_-rv_cat_tr_-nta_-0_-nta_-nta_-nta_-nta_-nta_-nta	
Hinges	7	0	0	0		N		
Silicone Caulk	2	2	0	6.89	13.78	Y	https://www.homedepot.com/p/DAP-Alex-Plus-10-1-oz-White-Acrylic-Latex-Caulk-Plus-Silicone-18103/100097524	
Caulk Gun	1	1	0	11.98	11.98	N	https://www.homedepot.com/p/Husky-10-oz-Heavy-Duty-High-Leverage-Drip-Free-Caulk-Gun-19PT0902/314993814	
Construction Mask	6	6	0	2	12	Y	https://www.homedepot.com/p/3M-8511-N95-Sanding-and-Fiberglass-Disposable-Respirator-with-Cool-Flow-Valve-1-Pack-23309-L/Nitrile-Gloves/Unile-Black-Industrial-Nitrile-Gloves-Powder-Free-4-Mil-Large?pricodes=wB1029&gadtype=pla&ids	For Safety
4mm Rubber Gloves (200 count)	2	2	0	13	26	Y	https://www.homedepot.com/p/Commercial-Electric-1-Gang-Extra-Duty-Horizontal-Vertical-Non-Metallic-Weatherproof-In-Use-Cover-16-in-1-Configurations-Clear-W/Cw/IPC/300849073	For Safety
GFI Outlit box	3	3	0	10.48	31.44	Y	https://www.homedepot.com/pepi/Leviton-20-Amp-Self-Test-SmartlockPro-Slim-GFCI-Duplex-Outlet-White-3-Pack-GFNT2-3W-M22-GFNT2-03W/2059999893	
Desiccant	1	0	0	0		N		Undecided
Glass Siphon Receiving Dish	1	0	0	0		N		Undecided
Scientific Balance	1	0	0	0		N		Undecided
Rubber Siphon Tube	1	0	0	0		N		Undecided
GCFI Outlit	3	3	0	15.51	46.53	Y	https://www.homedepot.com/pepi/Leviton-20-Amp-Self-Test-SmartlockPro-Slim-GFCI-Duplex-Outlet-White-3-Pack-GFNT2-3W-M22-GFNT2-03W/2059999893	
Total Cost (\$):				1330.74				

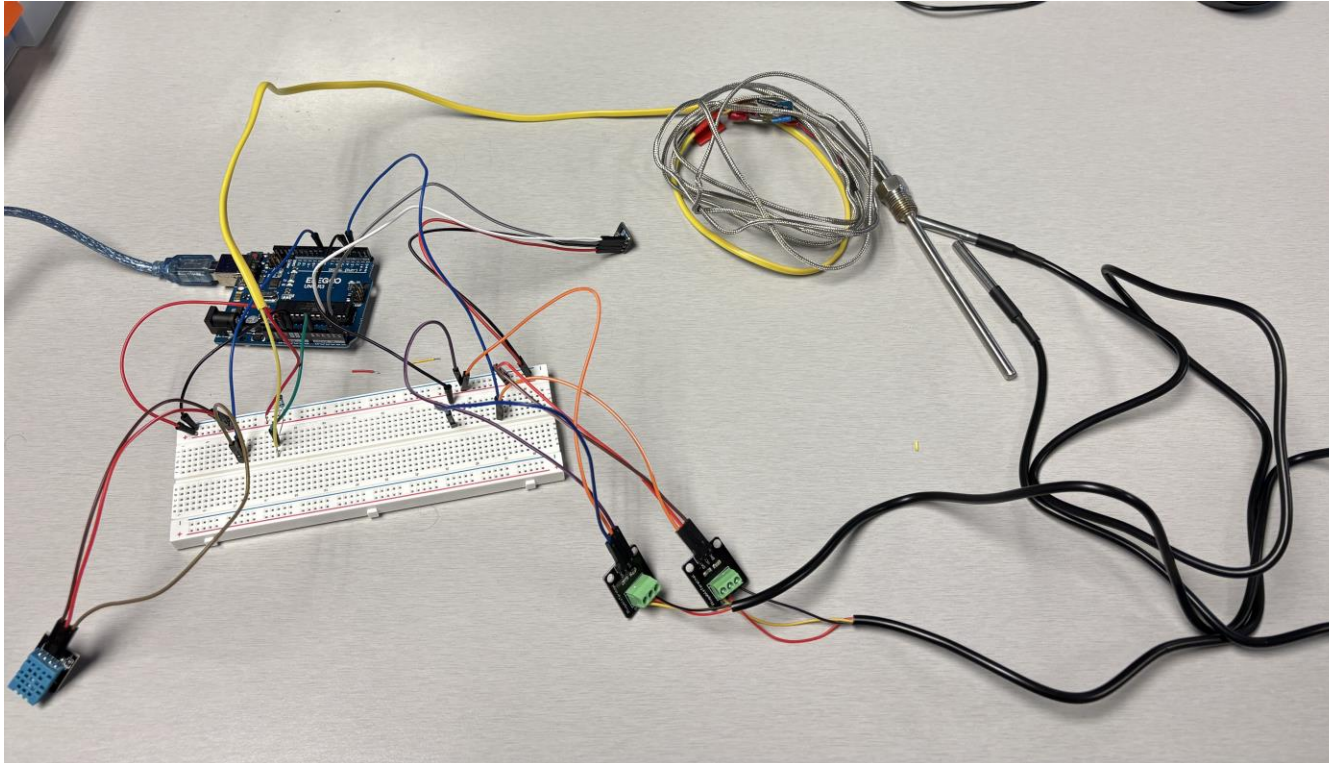
Manufacturing Plan

Part	Time [hours]	Manufacturing Method	Progress Percentage
Apparatus Base, Walls, & Roof	15.5	Woodworking/Assembly	85%
Data Collection Circuit	3	Electronics/Wiring	50%
Water Pool	2.5	Woodworking/Lining	20%
Air Cooling System	3	Installation/Mounting	20%
Sensor Mounting and Calibration	2	Calibration	35%
Siphon for Water Level & Balance Calibration	1.5	Tubing/Calibration	0%
Total	27.5		35.0%

Demonstration



Demonstration



SHT21

- $\pm 0.3 - 0.4$ °C
- $\pm 2 - 3$ RH
- Factory Calibrated

DS18B20 x 2

- ± 5 °C
- Factory Calibrated

DHT11

- ± 2 °C
- ± 5 RH
- Factory Calibrated

Thermistor

- $\pm 1 - 2$ °C
- Not Calibrated

Gantt Chart

- Link to Gantt Chart

[SRP EVAP Gantt Chart ME486C.xlsx](#)

Thank You!