Critical Design Review

The Mann 2 - Smart Vent Team

Project and Team

- Smart Vent Team

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Project

- Purpose of the Project
  - Reduce carbon emissions from the current HAVC of residential and commercial buildings.
  - Develop a standardized inline fan/damper system:
    I. Accurately regulate temperature in each room;
    II. Move air between rooms.

Customer's Requirements

Fans	Standardize the internal mounting backets
	Standardize the external duct support
	Maximize airflow through the duct when existing HVAC is in use
Dampers	Maximize air flow when open
	Standardize the internal mounting backets
Communication System	Compatible with the Manhattan 2's BuildingBus system
	No exposed wires in the duct
Installation and Maintenance	Compatible with current HVAC systems
	Easy access to location through vent opening
	Long life cycle
	Low vibration

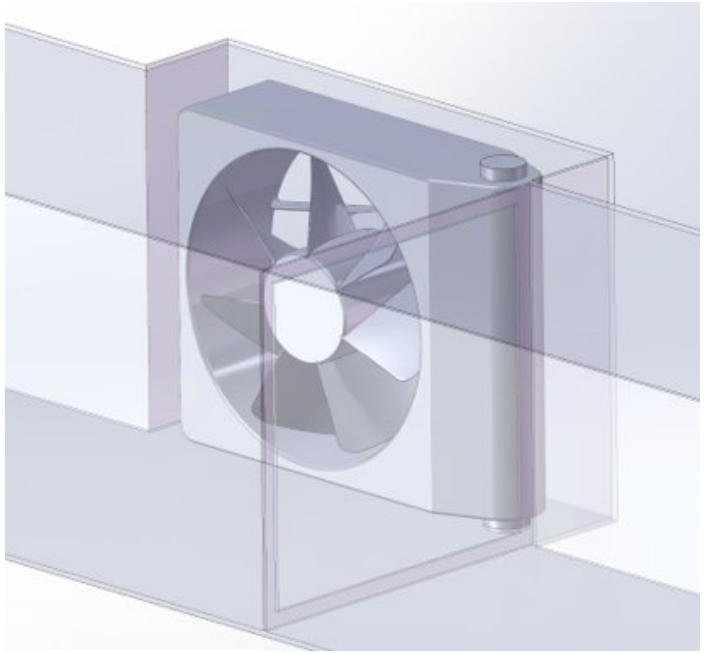
Engineering Specifications

	Target	Threshold
Air flow reduction through the fan system	2 %	10 %
Noise of the fan	25 dB	40 dB
The complete damper system shall not obstruct the air flow when fully open	10 %	20 %

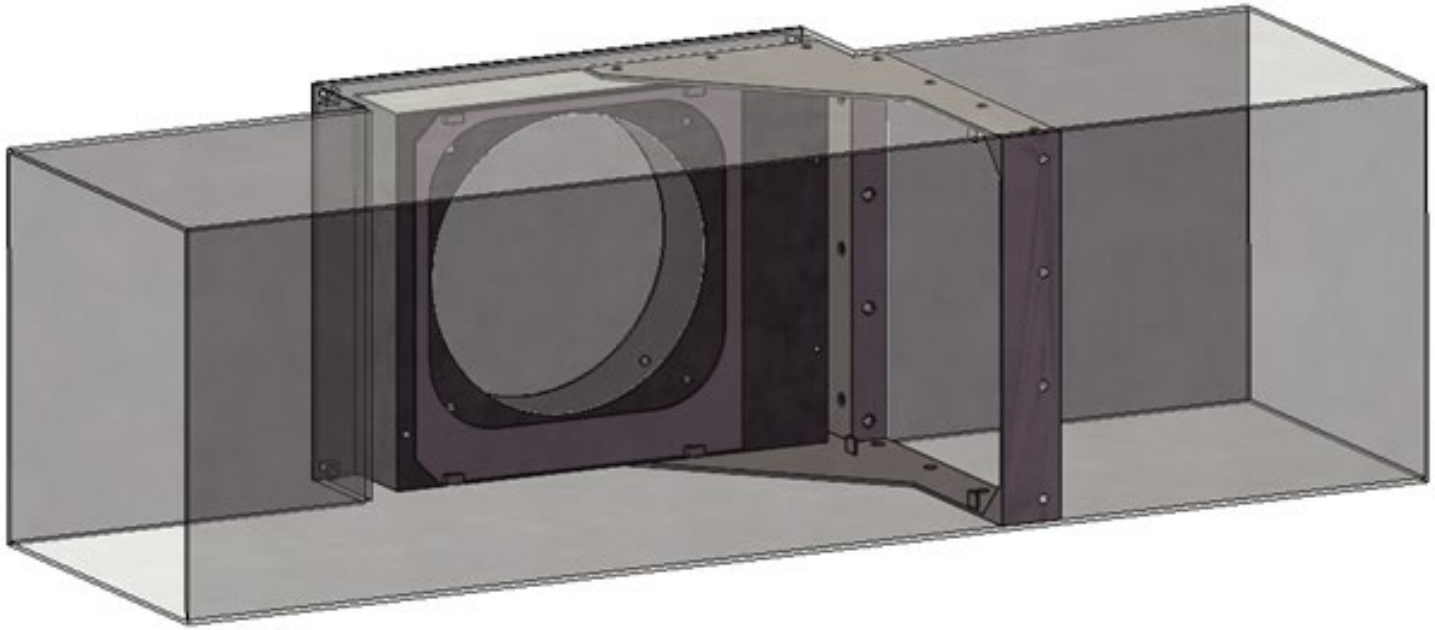
Engineering Specifications

	Target	Threshold
System load requirements	15 lbs	20 lbs
The percent reduction of air flow through system shall be low.	5 %	20 %

Pivoting Fan

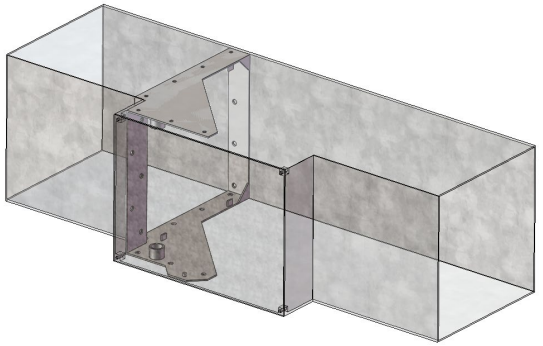


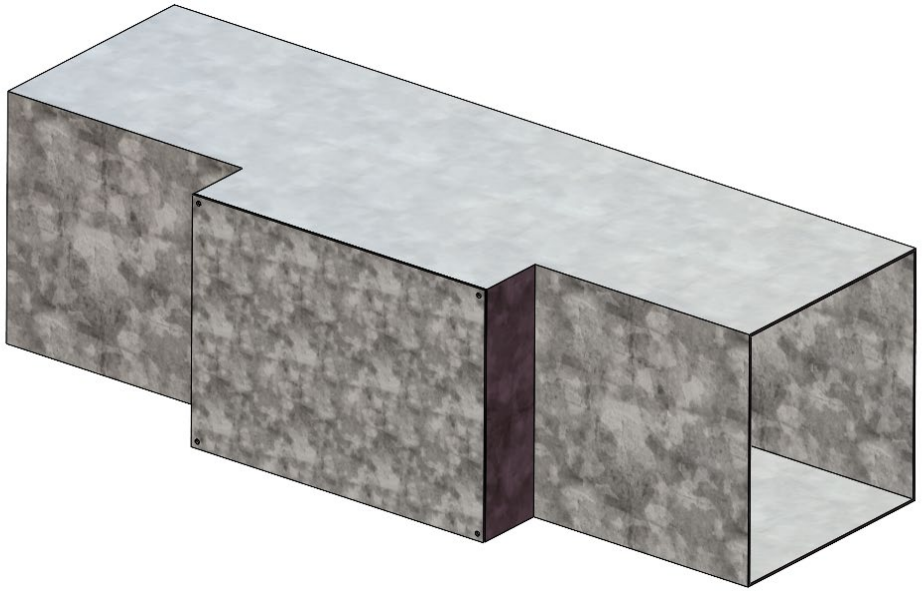
Pivoting fan progress at PDR



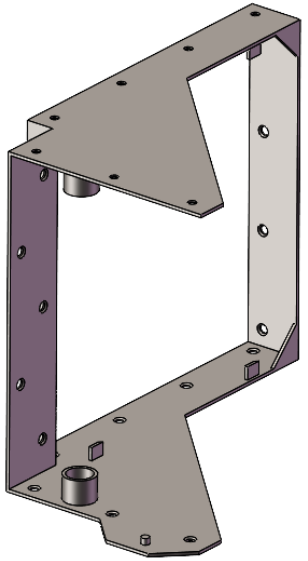
Current pivoting fan progress

Duct and Bracket



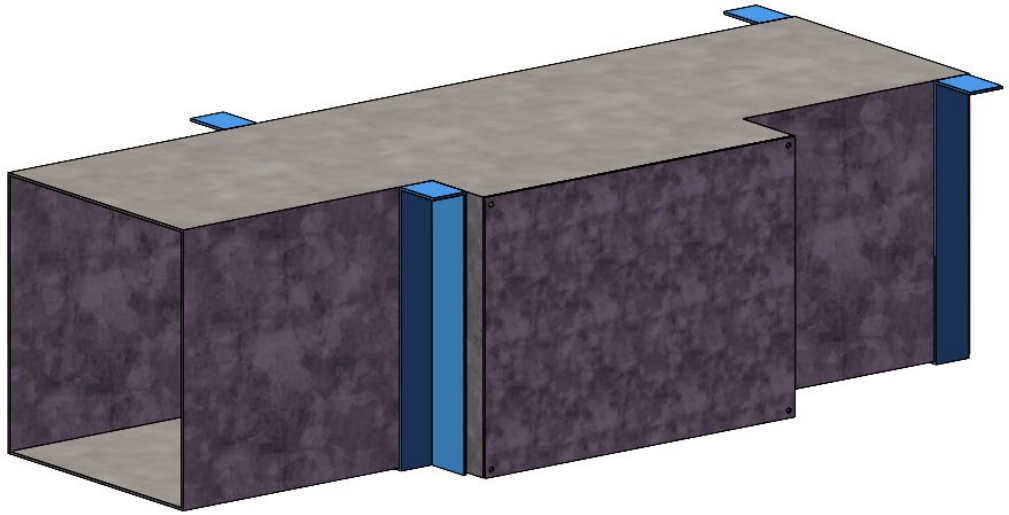


Custom Duct with Bump Out

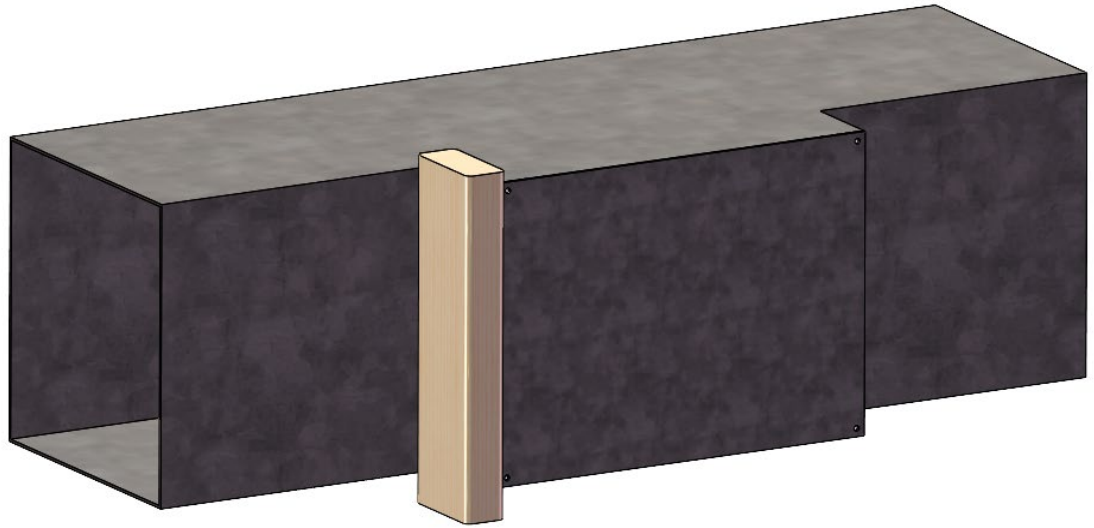


Mounting Bracket

Mounting Options

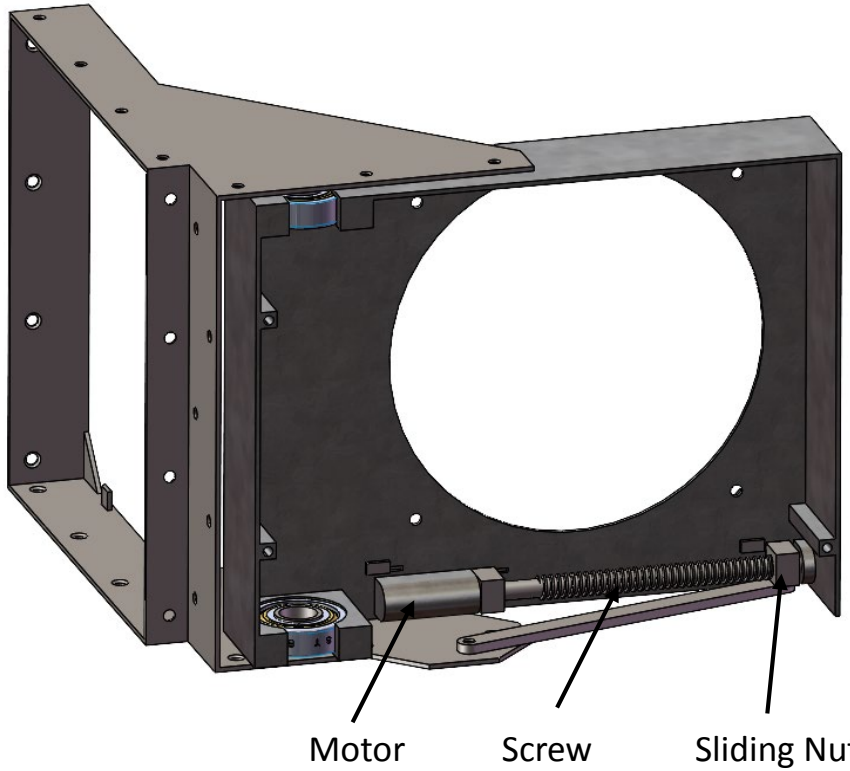


Metal bracket (highlighted in blue)

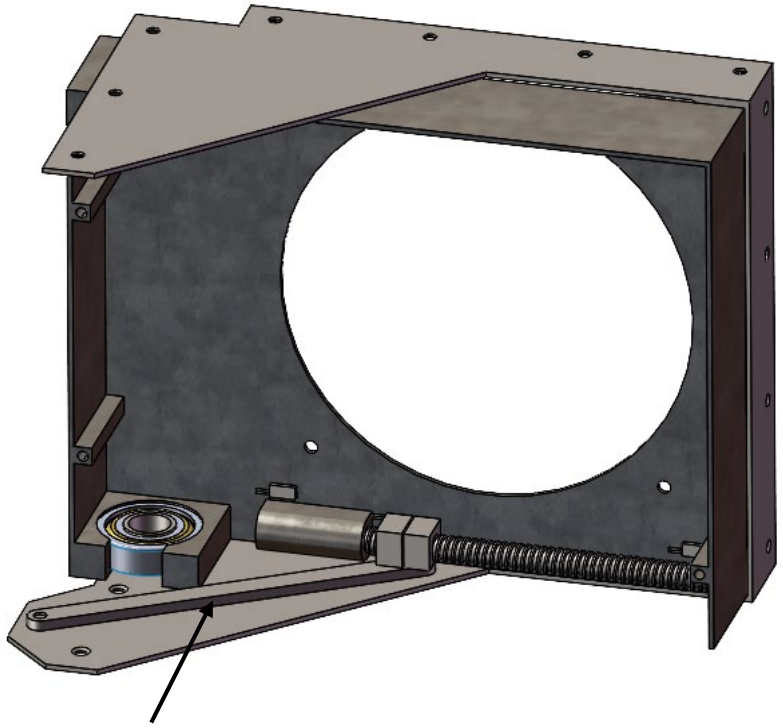


2 x 4 bracing

Pivoting Mechanism



Closed position



Open position

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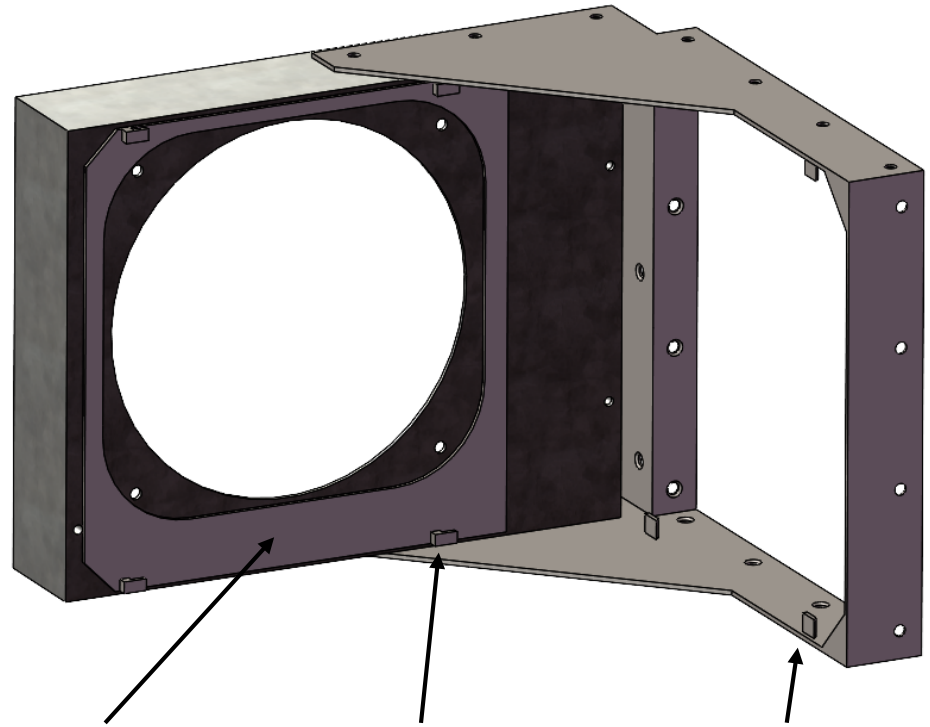
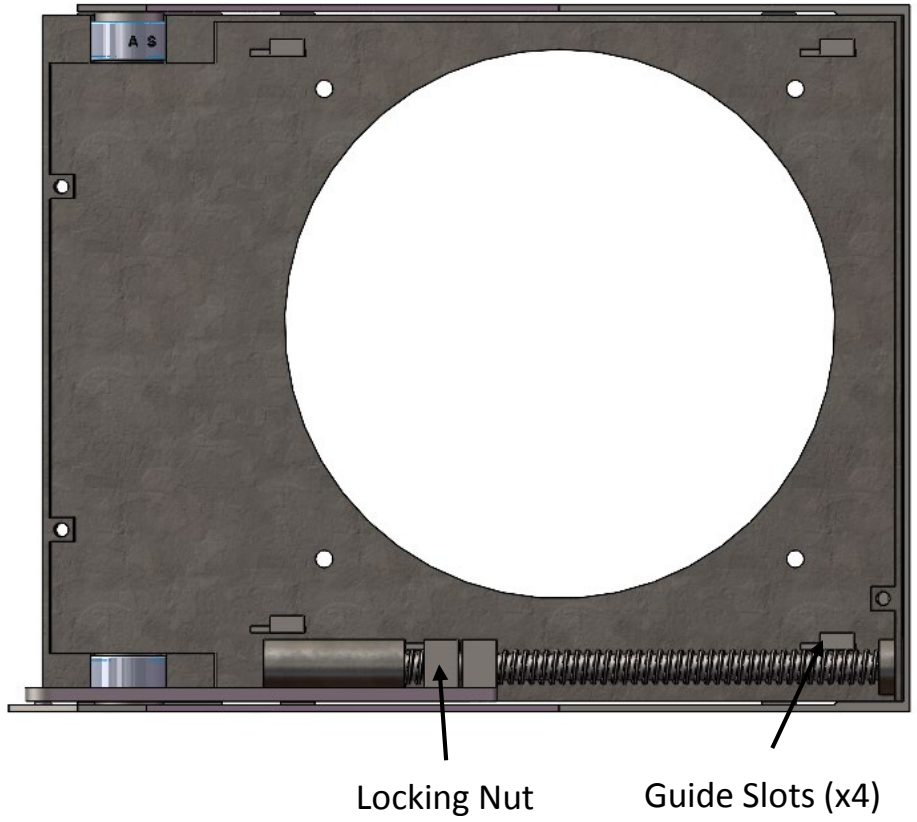
Locking Mechanism





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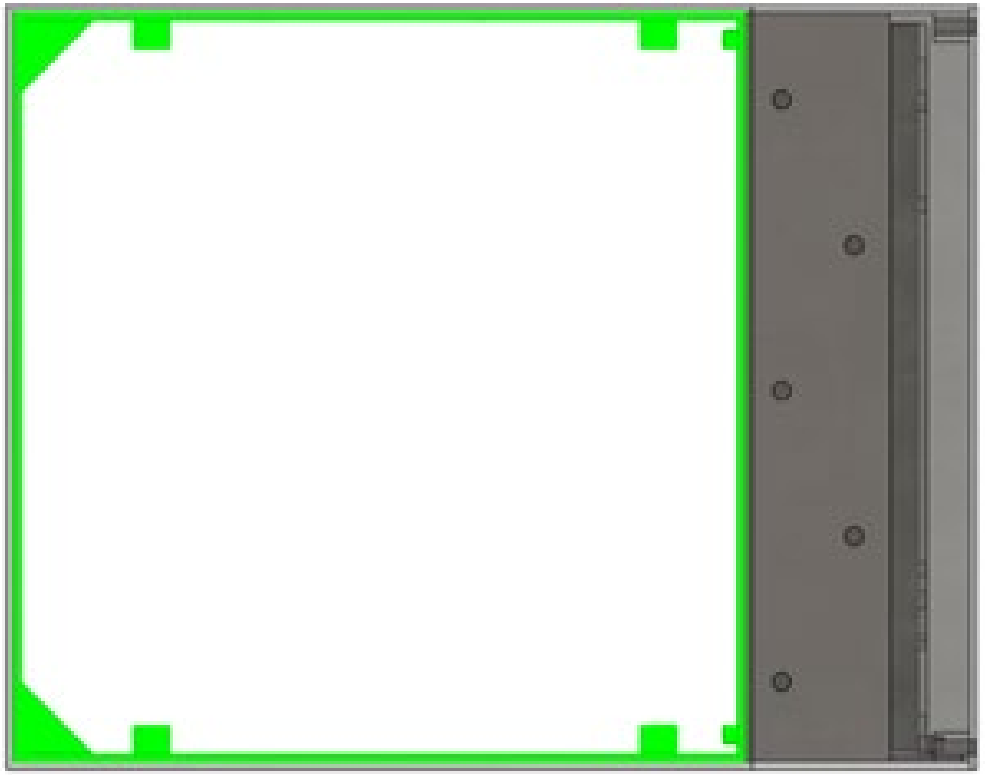
Airflow through the Bump Out duct

Maximize the amount of airflow through the duct when fan is open

Target Value: 2% Reduction
Threshold: 10% Reduction

Area of the Duct: 104.03 in^2
Area of the Fan: 6.01 in^2

Percent Reduction: 5.77%



Noise of the Fan

The location of the fan is determined from the ease of assembly and noise

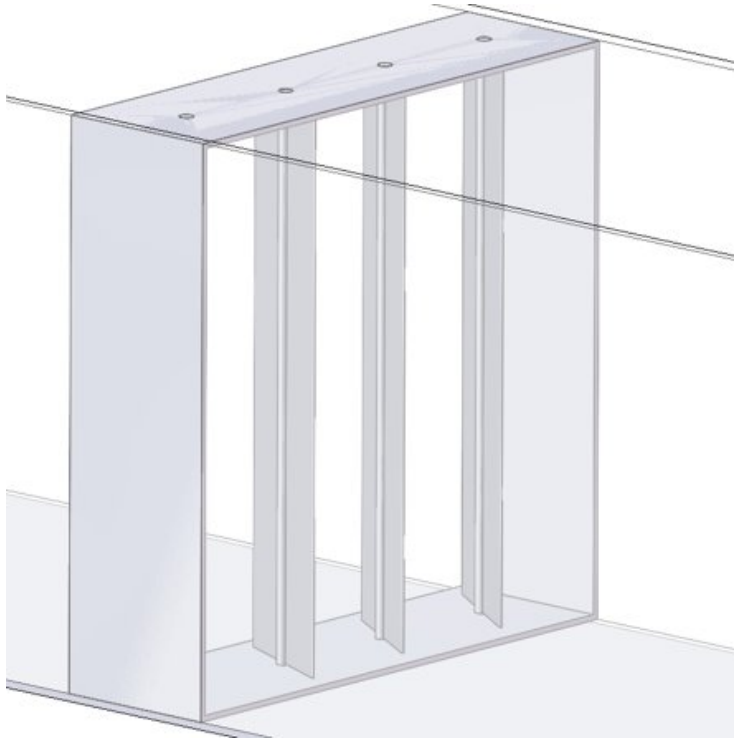
Target Value: 25 dB
Threshold: 40 dB

Current in-line fans operate between 33 dB and 40 dB

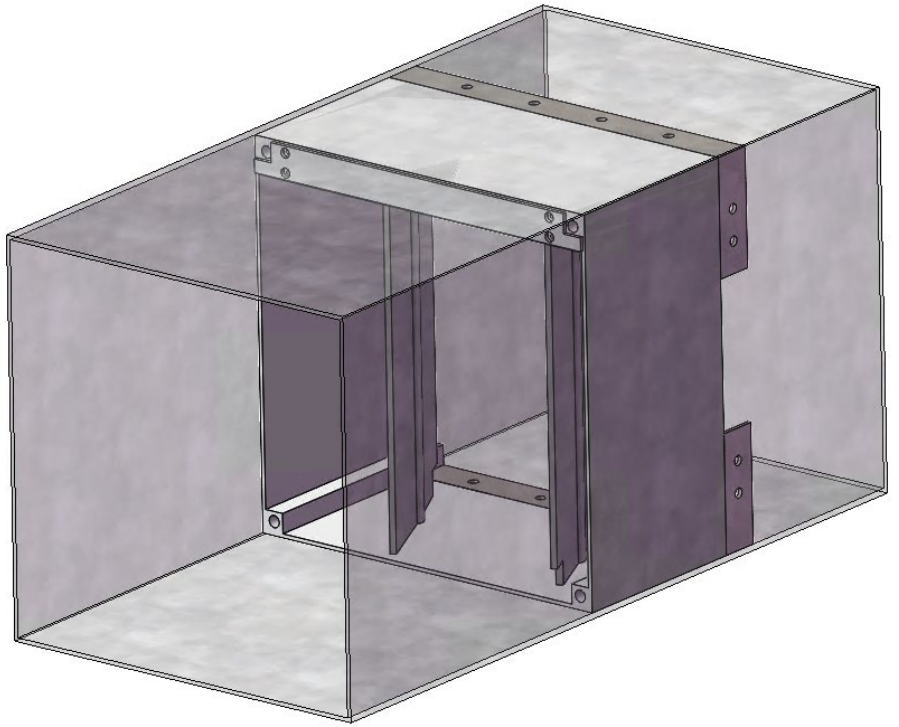
Noise should not be a significant factor in determine the location of the fan

Sound intensity level B = (dB)	Intensity I = (W/m2)	Example/effect
0	10^{-12}	Threshold of hearing at 1000 Hz
10	10^{-11}	Rustle of leaves
20	$10-^{10}$	Whisper at 1-m distance
30	10^{-9}	Quiet home
40	10^{-8}	Average home
50	10^{-7}	Average office, soft music
60	10^{-6}	Normal conversation
70	10^{-5}	Noisy office, busy traffic
80	10^{-4}	Loud radio, classroom lecture
90	10^{-3}	Inside a heavy truck; damage from prolonged exposure
100	10^{-2}	Noisy factory, siren at 30 m; damage from 8 h per day exposure

Self-Enclosed Damper Changes

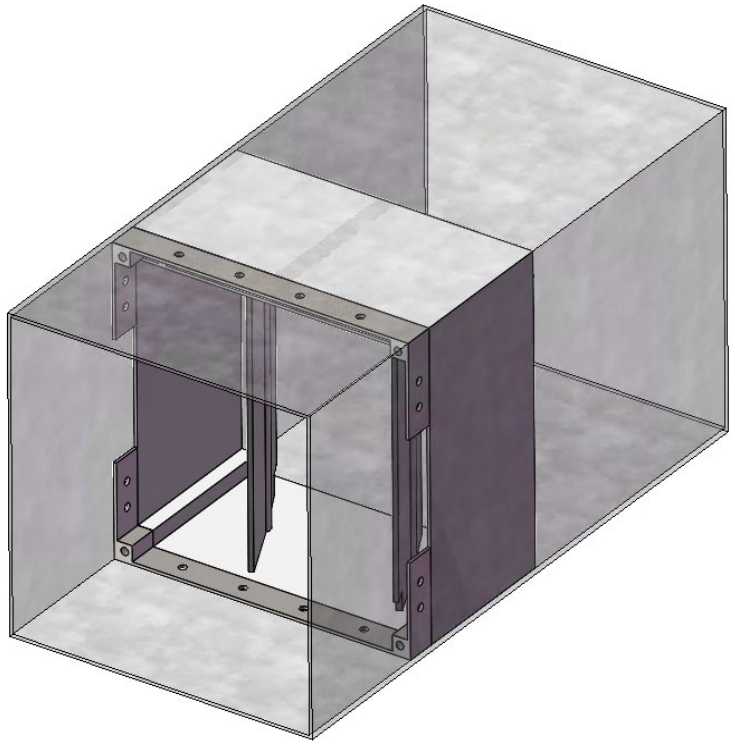


Damper progress at PDR

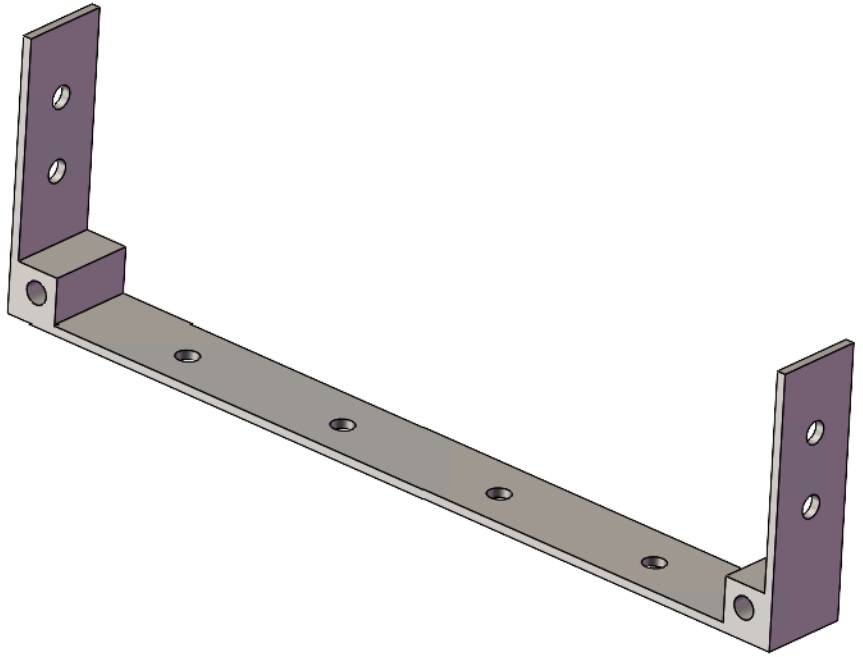


Current Damper Progress

Self-Enclosed Damper Mounting Bracket

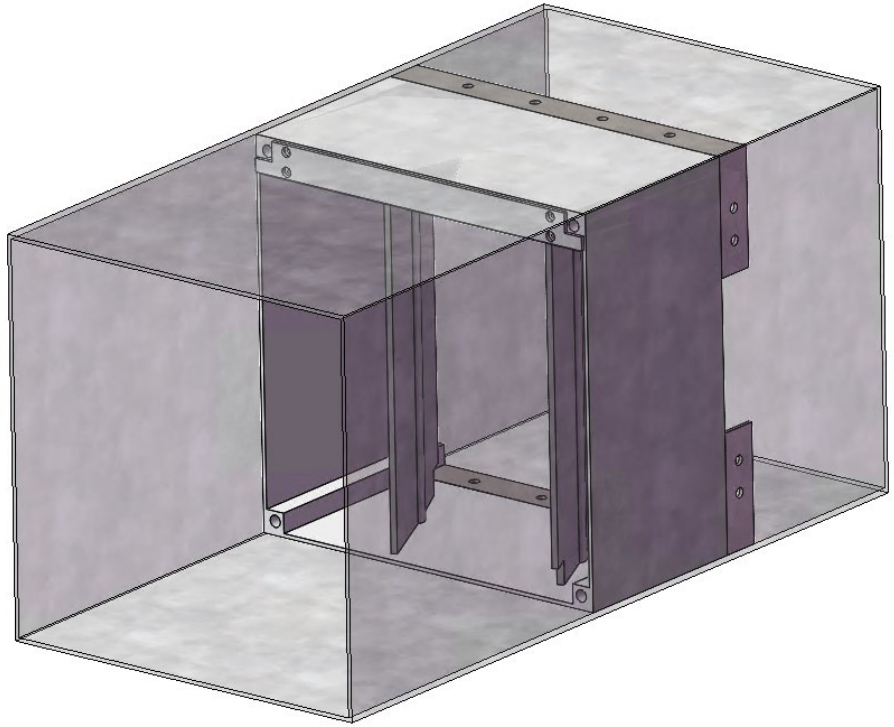


Back view of damper system

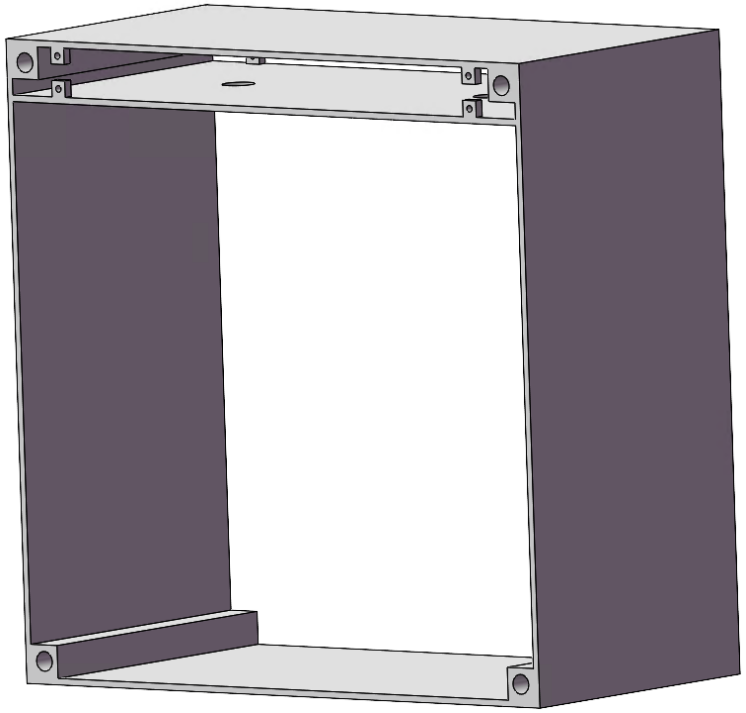


Mounting Bracket

Self-Enclosed Damper Frame



Front view of damper system



Damper Frame

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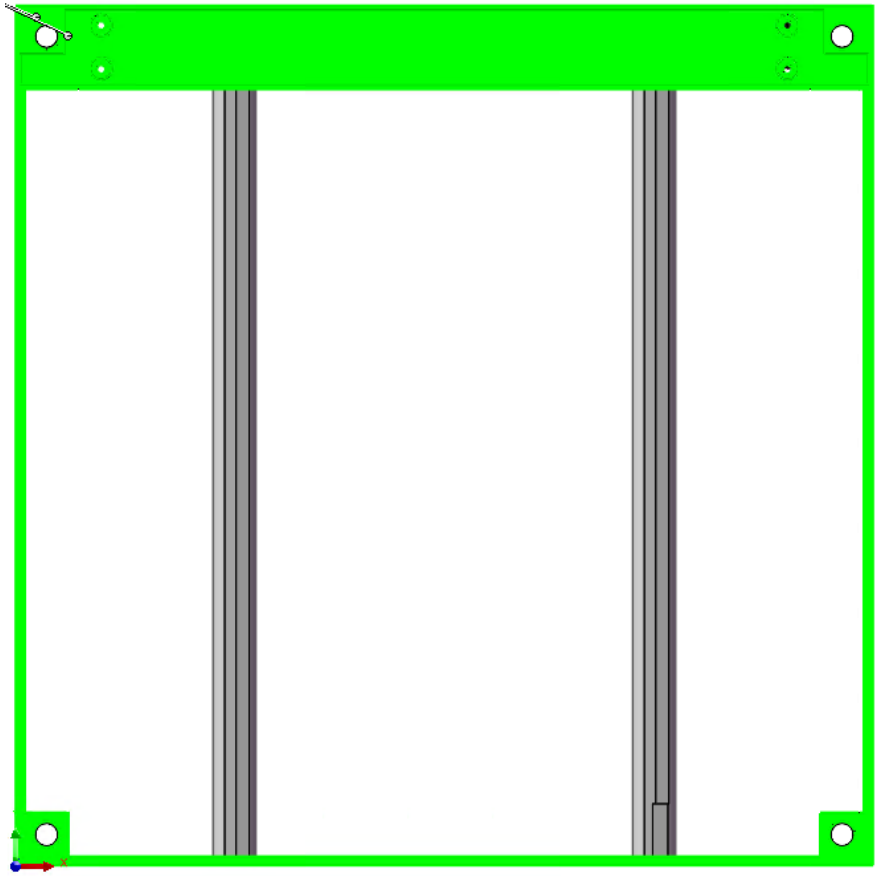
Airflow Through The Damper

Maximize amount of airflow through the duct when damper is open

Target Value: 10% Reduction
Threshold: 20% Reduction

Area of the Duct: 96.04 in^2
Area of the Damper: 13.23 in^2

Percent Reduction: 13.78%



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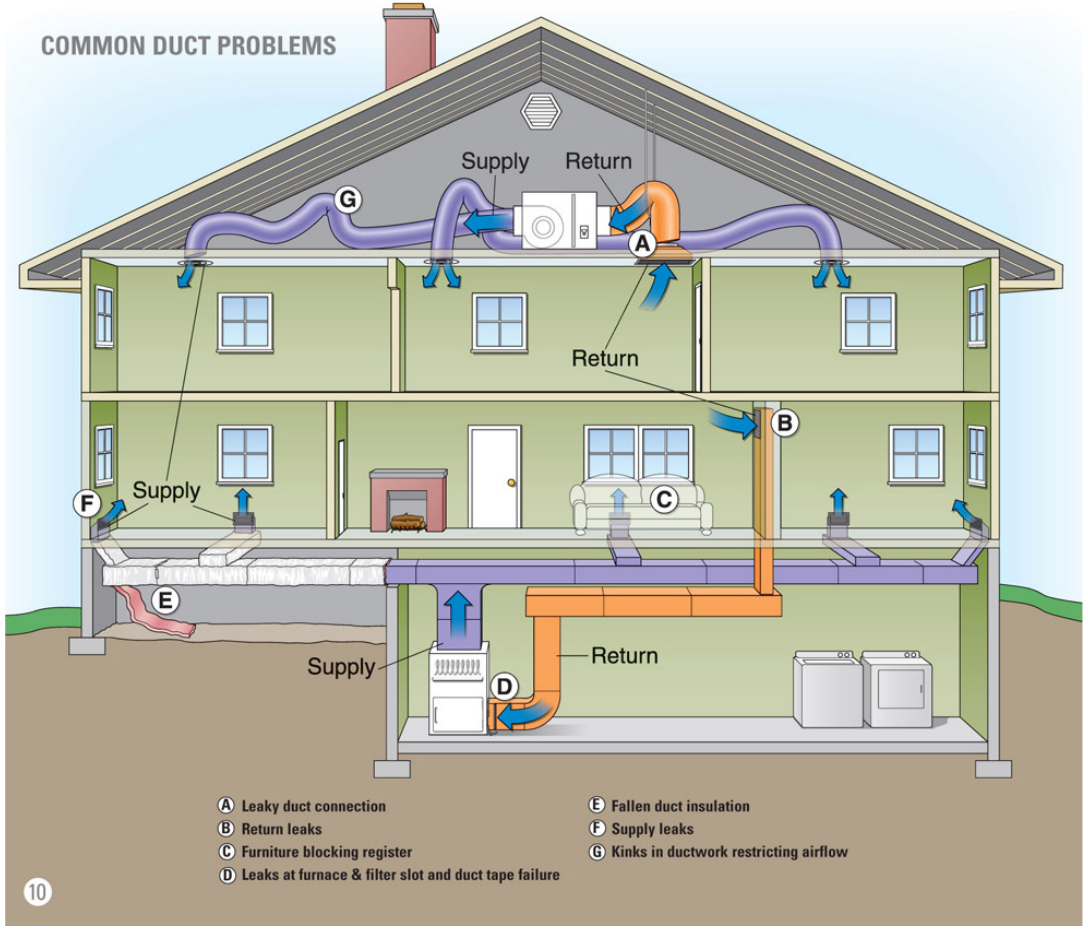
Design Overview of the System



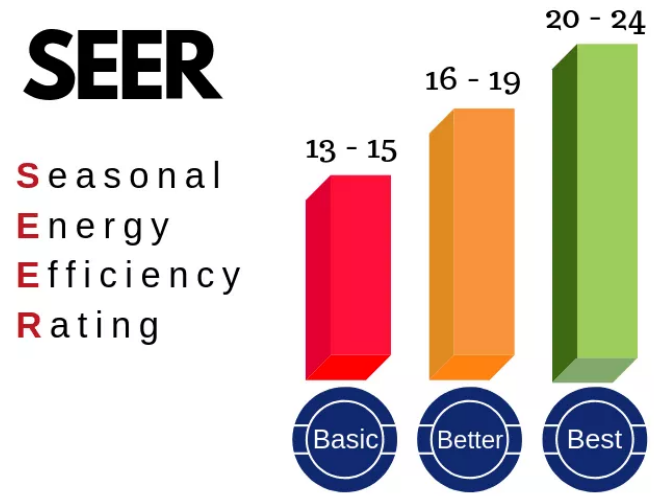
System Air flow Requirements

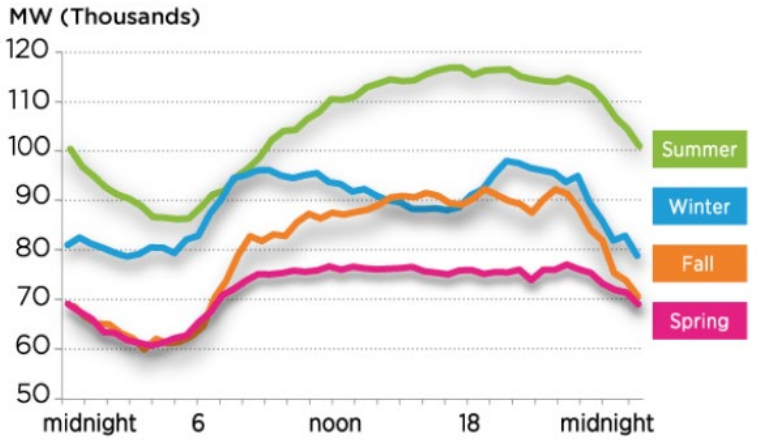
Most common Residential/Commercial buildings have a SEER rating between 14-20.

Newer System can have a rating from 20-24

$$\text{SEER} = \frac{\text{Cooling Output During Summer}}{\text{Energy Used During Summer}}$$

Target: 16
Threshold: 14
Actual: 15.4





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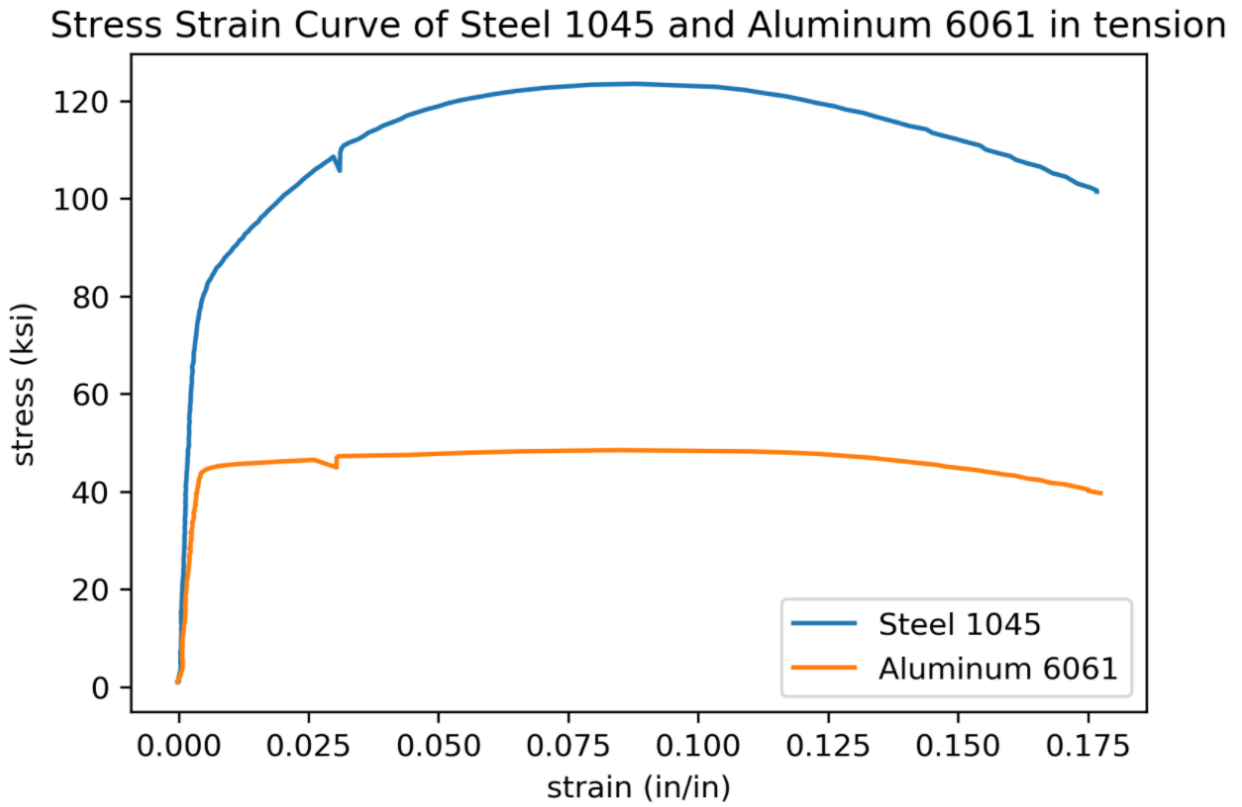
System Load Requirements

Height (In)	Width (In)	Moment of Area (in^4)	Expected Load (lbs.)	Centroid (in)	Stress (psi)
6	4	0.44	15	3	616.78
8	4	0.56	15	4	645.97
10	4	0.68	15	5	664.84
6	6	1.08	15	3	250.94
8	6	1.35	30	4	535.20
10	6	1.61	30	5	557.41
10	8	3.03	30	5	296.84
10	10	4.99	30	5	180.41



Target: 15 lbs.
Threshold : 30 lbs.

Damper Assembly: 14.4 lbs.
Fan Assembly: 14.91 lbs.

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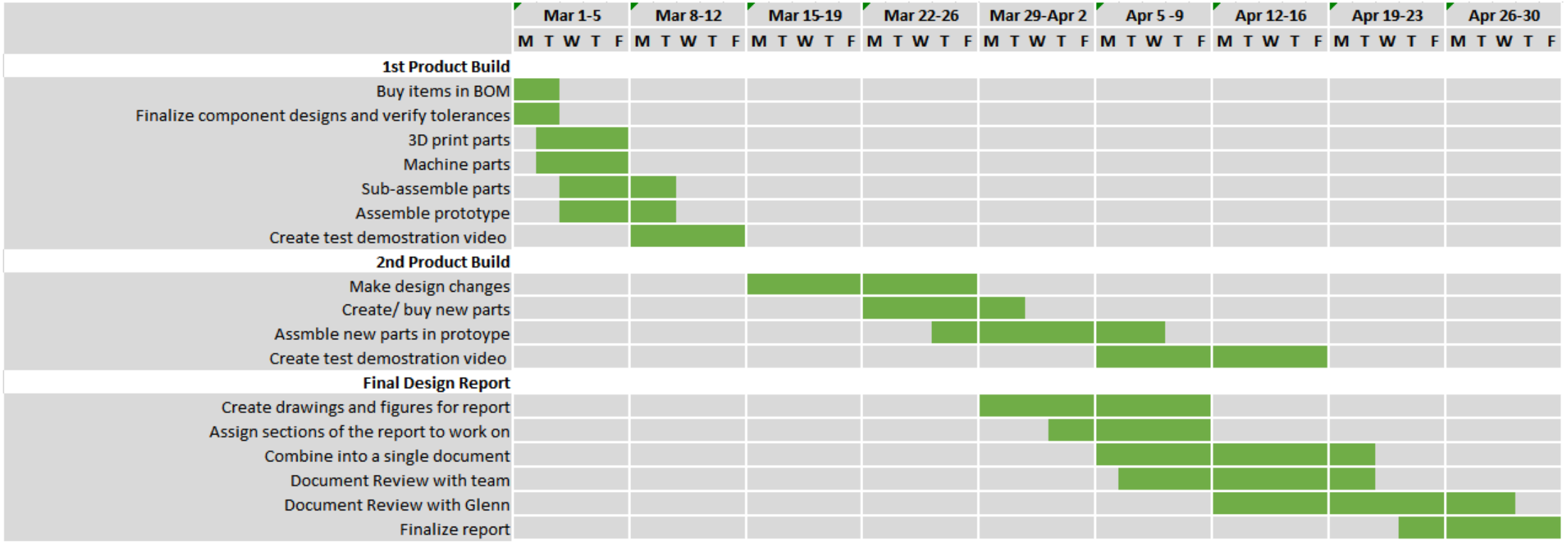
Budget

Item No.	Part Name	Cost	Quantity	Total
1	Bearings	$13.92	2	$27.84
2	12 in. x 8 in. x 4 ft. Half Section Rectangular Duct	$17.33	2	$37.66
3	12 in. x 8 in. Ceiling/Sidewall Vent Register Cover	$20.85	1	$20.85
4	PLA	$20.59	1	$20.59
5	Misc Hardware(Screws, sheet metal, duct tape, etc.)	$40	N/A	$40
			Total	**$141.94**

Schedule


Mar 1-5
Mar 8-12
Mar 15-19
Mar 22-26
Mar 29-Apr 2
Apr 5 -9
Apr 12-16
Apr 19-23
Apr 26-30
M T W T F
1st Product Build
Buy items in BOM
Finalize component designs and verify tolerances
3D print parts
Machine parts
Sub-assemble parts
Assemble prototype
Create test demostration video
2nd Product Build
Make design changes
Create/ buy new parts
Assmble new parts in protoype
Create test demostration video
Final Design Report
Create drawings and figures for report
Assign sections of the report to work on
Combine into a single document
Document Review with team
Document Review with Glenn
Finalize report

Questions