

Evan Haupert (ASM), Tyler Peas (ASM), Devin Vincent (ASM)

Objective:

To design and create a prototype that can be installed quickly and easily by two employees and will reduce fan noise levels to 80 decibels, without reducing fan airflow by more than 10%. This will allow employees to work around fans without hearing protection.

Background:

ADM uses these fans on site to keep grain in condition, these fans produce sounds in excess of 115 decibels. This puts ADM in a bind, they need these fans to keep grain from spoiling, but the noise they produce requires employees to wear hearing protection. The noise also puts strain on relations with the community surrounding the elevator.



Figure 2: AutoCAD drawing implementing baffles

Sponsor: Tim Schaal- Archer Daniels Midland Technical Advisor: Dr. Patrick Murphy

CAPSTONE EXPERIENCE 2011 Grain Bin Aeration Fan Silencer

Economics

Sound Abatement MaterialMetalSilencer ShellBafflesTrack	\$577.92 \$105.42 \$43.20	\$3,000.00 \$3,500.00
Silencer Shell Baffles	· · · · · · · · · · · · · · · · · · ·	\$3,500.00
Baffles	· · · · · · · · · · · · · · · · · · ·	
	\$43.20	
Track		
	\$52.74	
Miscellaneous	\$27.60	\$1,000.00
Testing Equipment		\$500.00
Decibel Reader	\$198.17	
Velocity Meter	\$106.76	
Total	\$1,111.81	\$8,000.00





Recommendations:

We ran multiple test setups with varying success. Our test results indicated the biggest noise reduction when the silencer had baffles installed, and the opened end was pointed into the air.

We recommend squaring off and extending the shell an additional 12-18"

We also recommend using a different type of sound abatement material. Our results indicated an average of 0.85 decibel loss with AcustiBlok installation.

Installation of handles would greatly improve handling of prototype.

est Point		ecibles			W/O SILENCER Speed (mph)					
1	Test 1	Test 2	Test 3	Average	Test Point	_	Test 2	Test 3	Average	
	119.5	119.9	119.6	119.7	1	39.5	34.4	31.9	35.3	
2	103.2	103.2	102.4	102.9	2	36.4	35.3	34.6	35.4	
3	99.8	99.8	97.6	99.1	3	33.5	34.2	36.6	34.8	
4	99.3	99.3	99.1	99.2	4	1.1	1.5	2	1.5	
5	93.6	99.6	91.9	95.0	5	39.5	38.4	38.4	38.8	
			Average	103.2				Average	29.2	
	De	ecibles		Average	LES & ACU	Sp	eed (m	ph)		
Fest Point		Test 2	Test 3	Average	Tost Point	_	· · · · · · · · · · · · · · · · · · ·	/		
			10010	/ WCluge		TESUT	Test 2	Test 3	Average	
1	94.9	95.4	94.6	95.0	1	4.4	7.1	2.6	Average 4.7	
1 2	94.9 89.3	95.4 90.1	94.6 88.1	95.0 89.2	1 2	4.4 23.9	7.1 17.8	2.6 20.1	4.7 20.6	
1 2 3	94.9 89.3 95.1	95.4 90.1 96.2	94.6 88.1 95.6	95.0 89.2 95.6	1 2 3	4.4 23.9 22.5	7.1 17.8 19.6	2.6 20.1 21.4	4.7 20.6 21.2	
1 2 3 4	94.9 89.3 95.1 90.3	95.4 90.1 96.2 90.7	94.6 88.1 95.6 90.7	95.0 89.2 95.6 90.6	1 2 3 4	4.4 23.9 22.5 24.8	7.1 17.8 19.6 23	2.6 20.1 21.4 24.1	4.7 20.6 21.2 24.0	
1 2 3	94.9 89.3 95.1	95.4 90.1 96.2 90.7 82.9	94.6 88.1 95.6 90.7 92.9	95.0 89.2 95.6 90.6 86.2	1 2 3 4 5	4.4 23.9 22.5 24.8 4.2	7.1 17.8 19.6 23 3.3	2.6 20.1 21.4 24.1 3.3	4.7 20.6 21.2 24.0 3.6	
1 2 3 4	94.9 89.3 95.1 90.3	95.4 90.1 96.2 90.7 82.9	94.6 88.1 95.6 90.7	95.0 89.2 95.6 90.6	1 2 3 4 5 6	4.4 23.9 22.5 24.8 4.2 16.3	7.1 17.8 19.6 23 3.3 14	2.6 20.1 21.4 24.1 3.3 15.8	4.7 20.6 21.2 24.0 3.6 15.4	
1 2 3 4	94.9 89.3 95.1 90.3	95.4 90.1 96.2 90.7 82.9	94.6 88.1 95.6 90.7 92.9	95.0 89.2 95.6 90.6 86.2	1 2 3 4 5 6 7	4.4 23.9 22.5 24.8 4.2 16.3 16.1	7.1 17.8 19.6 23 3.3 14 14.3	2.6 20.1 21.4 24.1 3.3 15.8 14.9	4.7 20.6 21.2 24.0 3.6 15.4 15.1	
1 2 3 4	94.9 89.3 95.1 90.3	95.4 90.1 96.2 90.7 82.9	94.6 88.1 95.6 90.7 92.9	95.0 89.2 95.6 90.6 86.2	1 2 3 4 5 6 7 8	4.4 23.9 22.5 24.8 4.2 16.3 16.1 16.5	7.1 17.8 19.6 23 3.3 14 14.3 18.3	2.6 20.1 21.4 24.1 3.3 15.8 14.9 15.2	4.7 20.6 21.2 24.0 3.6 15.4 15.1 16.7	
1 2 3 4	94.9 89.3 95.1 90.3	95.4 90.1 96.2 90.7 82.9	94.6 88.1 95.6 90.7 92.9	95.0 89.2 95.6 90.6 86.2	1 2 3 4 5 6 7 8 9	4.4 23.9 22.5 24.8 4.2 16.3 16.1 16.5 27.2	7.1 17.8 19.6 23 3.3 14 14.3 18.3 27.9	2.6 20.1 21.4 24.1 3.3 15.8 14.9 15.2 26.1	4.7 20.6 21.2 24.0 3.6 15.4 15.1 16.7 27.1	
1 2 3 4	94.9 89.3 95.1 90.3	95.4 90.1 96.2 90.7 82.9	94.6 88.1 95.6 90.7 92.9	95.0 89.2 95.6 90.6 86.2	1 2 3 4 5 6 7 8	4.4 23.9 22.5 24.8 4.2 16.3 16.1 16.5	7.1 17.8 19.6 23 3.3 14 14.3 18.3	2.6 20.1 21.4 24.1 3.3 15.8 14.9 15.2	4.7 20.6 21.2 24.0 3.6 15.4 15.1 16.7	
1 2 3 4	94.9 89.3 95.1 90.3	95.4 90.1 96.2 90.7 82.9	94.6 88.1 95.6 90.7 92.9	95.0 89.2 95.6 90.6 86.2	1 2 3 4 5 6 7 8 9 10	 4.4 23.9 22.5 24.8 4.2 16.3 16.1 16.5 27.2 20.8 	7.1 17.8 19.6 23 3.3 14 14.3 18.3 27.9 17.8	2.6 20.1 21.4 24.1 3.3 15.8 14.9 15.2 26.1 17.6	4.7 20.6 21.2 24.0 3.6 15.4 15.1 16.7 27.1 18.7	

	De	23 ecibles	SU V FAN	W SHOP	N/O SILENO		eed (m	oh)	
Fest Point	Test 1	Test 2	Test 3	Average	Test Point	· · · · · ·	Test 2	Test 3	Average
1	119.5	119.9	119.6	119.7	1	39.5	34.4	31.9	35.3
2	103.2	103.2	102.4	102.9	2	36.4	35.3	34.6	35.4
3	99.8	99.8	97.6	99.1	3	33.5	34.2	36.6	34.8
4	99.3	99.3	99.1	99.2	4	1.1	1.5	2	1.5
5	93.6	99.6	91.9	95.0	5	39.5	38.4	38.4	38.8
			Average	103.2				Average	29.2
	De	cibles			LES & ACUSTIBLOK POINTED UP Speed (mph)				
Fest Point	Test 1	Test 2	Test 3	Average	Test Point		Test 2		Average
1	94.9	95.4	94.6	95.0	1	4.4	7.1	2.6	4.7
		90.1							
2	89.3		88.1	89.2	2	23.9	17.8	20.1	20.6
3	95.1	96.2	95.6	95.6	3	22.5	19.6	21.4	21.2
3 4	95.1 90.3	96.2 90.7	95.6 90.7	95.6 90.6	3 4	22.5 24.8	19.6 23	21.4 24.1	21.2 24.0
3	95.1	96.2	95.6 90.7 92.9	95.6 90.6 86.2	3 4 5	22.5 24.8 4.2	19.6 23 3.3	21.4 24.1 3.3	21.2 24.0 3.6
3 4	95.1 90.3	96.2 90.7	95.6 90.7	95.6 90.6	3 4	22.5 24.8	19.6 23	21.4 24.1	21.2 24.0 3.6 15.4
3 4	95.1 90.3	96.2 90.7	95.6 90.7 92.9	95.6 90.6 86.2	3 4 5 6	22.5 24.8 4.2 16.3	19.6 23 3.3 14	21.4 24.1 3.3 15.8	21.2 24.0 3.6
3 4	95.1 90.3	96.2 90.7	95.6 90.7 92.9	95.6 90.6 86.2	3 4 5 6 7	22.5 24.8 4.2 16.3 16.1	19.6 23 3.3 14 14.3	21.4 24.1 3.3 15.8 14.9	21.2 24.0 3.6 15.4 15.1
3 4	95.1 90.3	96.2 90.7	95.6 90.7 92.9	95.6 90.6 86.2	3 4 5 6 7 8	22.5 24.8 4.2 16.3 16.1 16.5	19.6 23 3.3 14 14.3 18.3	21.4 24.1 3.3 15.8 14.9 15.2	21.2 24.0 3.6 15.4 15.1 16.7
3 4	95.1 90.3	96.2 90.7	95.6 90.7 92.9	95.6 90.6 86.2	3 4 5 6 7 8 9	22.5 24.8 4.2 16.3 16.1 16.5 27.2	19.6 23 3.3 14 14.3 18.3 27.9	21.4 24.1 3.3 15.8 14.9 15.2 26.1	21.2 24.0 3.6 15.4 15.1 16.7 27.1
3 4	95.1 90.3	96.2 90.7	95.6 90.7 92.9	95.6 90.6 86.2	3 4 5 6 7 8 9 10	22.5 24.8 4.2 16.3 16.1 16.5 27.2 20.8	19.6 23 3.3 14 14.3 18.3 27.9 17.8	21.4 24.1 3.3 15.8 14.9 15.2 26.1 17.6	21.2 24.0 3.6 15.4 15.1 16.7 27.1 18.7 12.4 6.4
3 4	95.1 90.3	96.2 90.7	95.6 90.7 92.9	95.6 90.6 86.2	3 4 5 6 7 8 9 10 11	22.5 24.8 4.2 16.3 16.1 16.5 27.2 20.8 13.1	19.6 23 3.3 14 14.3 18.3 27.9 17.8 11.1	21.4 24.1 3.3 15.8 14.9 15.2 26.1 17.6 13.1	21.2 24.0 3.6 15.4 15.1 16.7 27.1 18.7 12.4 6.4
3 4 5	95.1 90.3	96.2 90.7 82.9	95.6 90.7 92.9 Average	95.6 90.6 86.2 91.3	3 4 5 6 7 8 9 10 11 12	22.5 24.8 4.2 16.3 16.1 16.5 27.2 20.8 13.1 5.8	19.6 23 3.3 14 14.3 18.3 27.9 17.8 11.1 6.4	21.4 24.1 3.3 15.8 14.9 15.2 26.1 17.6 13.1 7.1 Average	$\begin{array}{c} 21.2 \\ 24.0 \\ 3.6 \\ 15.4 \\ 15.1 \\ 16.7 \\ 27.1 \\ 18.7 \\ 12.4 \\ 6.4 \\ 15.5 \end{array}$

After three design changes and testing after each change we have found that we were able to reduce decibels to 95 at the fan while only losing 1.52% airflow. Upon further analysis of the fan and silencer we have found that we can be within 18-20 feet of the fan and be under 85 dBs, whereas without the silencer it was 55 feet.

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