Hi-Tech Chimes for Low and High Winds

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Here is an outstanding example about how to design a chime set that will withstand high winds often found seaside and at high altitudes, not to mention St. Charles, IL.

Lyndon wanted a chime set to be loud and work well with high winds. His engineering background made good use of the Fletcher-Munson equal loudness curves so he selected the D Major Pentatonic scale as shown below. This section of the Fletcher-Munson curve remains relatively equal in loudness over the note range from D4 to D5. Middle C (C4) has an orange line under the key.

D Major Pentatonic Scale

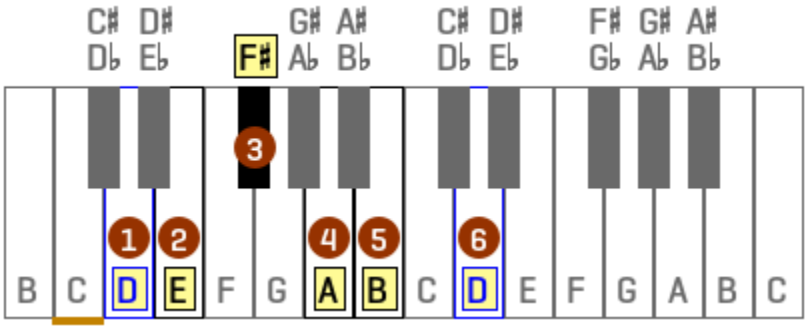


Photo courtesy Basic Music Theory

The chimes are made from 1” trade size EMT tube, (a nominal 1.049” inside and 1.163” outside diameter) galvanized steel tubing and tuned for notes of the D Major Pentatonic scale as shown above. These notes consume most of a 10 ft length of available tubing.

At first, he was experiencing an unpleasant clang sound from the longest tube. He assumed it was from the overtones produced for that note in combination with all the metal involved in the design. He decided to cut the top and bottom off to create the same note one octave higher and it solved that problem.

Being a certified Solid Works CAD designer, Lyndon made good use of those skills. The top design is configured to position the bells to hang even at the bottom so he could strike at the end of the tubes. In addition, this approach used the same length chain for each bell so they would all wiggle equally.

The five support levels are the same shape and maintain an even balance among the chimes. The concept of a solid chain suspended construction among the tubes and top add a resonance that creates a unique sustain time to the vibration. He can tap the top with a hard object and hear a distinct resonant ring.

The top support was laser cut from ¼ inch aluminum sheet. Spacers were designed to spread the tube lengths properly in height to acquire the lengths he needed to keep the bottoms of the tubes level. The assembly uses carriage bolts, washers, and cap nuts to provide a finished appearance. Even though it was a mechanical design, it turned out to simulate an Oriental look.

The keeper and striker are 3D printed from plastic that provide a balance between metal and hard rubber. It is sharp, but not excessively sharp. Painting may reduce the 3D printed appearance.

Lyndon created the center mount as a threaded rod to hold the striker and keeper horizontal while providing adjustability. The weight balance between the striker and sail was a challenge. At first, he used chain to support the sail with a fishing spinner but later discovered nylon string provided more movement.
He also discovered, while adjusting the support string length, the striker and sail should weigh almost the same but the sail should be a bit lighter.

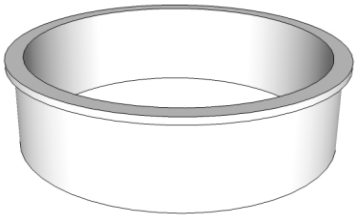
Prior to painting with silver grill paint, the parts were sand blasted. Grill paint was chosen for the expected durability and because it has a metallic finish that makes the chimes practically glow in the dark, as shown to the right. Plus, it has an epoxy finish that did not require priming. Since the paint would not achieve its rated temperature of 1200 °F, he assumed it would provide durability.

However, not the case. The chimes scarred badly even though the parts were plastic, as shown right. Perhaps the paint should be super-heated to cure. After all, it is grill paint. Eventually the parts may be powder coated for better durability as originally planned.

Because the tuning used musical notes with their fundamental frequency in the audible range, Lyndon successfully used a chromatic tuner for frequency adjustment.

He reports these chimes are loud, but pleasant and not disturbing. Neighbors and family have, so far, done nothing less than raved about them. They are obviously hearing them. Inside his home he can hear them singing and he can hear them from a neighbor's home across the street.

In the video the winds were exceeding 60 mph. You can hear the chains hitting the bells. Lyndon corrected that issue by adding inserts at the top of the tubes to reduce that scraping noise, as shown right. They were also 3D printed and look like the picture below.



Instead of inserts you can slip clear plastic tubing over the chain. If you want color in the design, use colored plastic tubing.

As you can see in the video, the striker is scarring the finish at the bottom of the tube. He may also consider a press fit piece on the outer bottom, but it will probably deaden the sound. Instead, maybe rounding the point on the striker will lessen the damage.

On the next page is a spreadsheet that he created which may be of use to others. It illustrates the audible range of frequencies and overtones.

He came to realize the perception of loudness varies with frequency as illustrated in the Fletcher-Munson curves.

Moving forward he will be using this spreadsheet to find proper note sequences for notes loudest to the human ear. In the spreadsheet, the darker blues represent the louder sound.

LLH November 2022
Chime length information derived from
Say It with Chimes – An Engineering Approach to Wind Chime

OFFSET	NOTE	OCTAVE	FUNDAMENTAL 1ST HARMONIC	2ND HARMONIC 1ST OVERTONE	3RD HARMONIC 2ND OVERTONE	4TH HARMONIC 3RD OVERTONE	5TH HARMONIC 4TH OVERTONE	6TH HARMONIC 5TH OVERTONE
-57	C	0	16.3516	45.1304	88.2986	146.0198	218.1303	304.7938
-56	C#	0	17.3239	47.8140	93.5491	154.7026	231.1010	322.9178
-55	D	0	18.3540	50.6572	99.1119	163.9016	244.8430	342.1195
-54	D#	0	19.4454	53.6694	105.0054	173.6477	259.4021	362.4629
-53	E	0	20.6017	56.8608	111.2493	183.9734	274.8270	384.0161
-52	F	0	21.8268	60.2419	117.8645	194.9130	291.1690	406.8509
-51	F#	0	23.1247	63.8240	124.8731	206.5031	308.4828	431.0435
-50	G	0	24.4997	67.6192	132.2985	218.7825	326.8262	456.6747
-49	G#	0	25.9565	71.6401	140.1653	231.7919	346.2603	483.8300
-48	A	0	27.5000	75.9000	148.5000	245.5750	366.8500	512.6000
-47	A#	0	29.1352	80.4132	157.3303	260.1776	388.6640	543.0808
-46	B	0	30.8677	85.1949	166.6856	275.6486	411.7752	575.3740
-45	C	1	32.7032	90.2608	176.5973	292.0395	436.2606	609.5876
-44	C#	1	34.6478	95.6280	187.0983	309.4051	462.2020	645.8355
-43	D	1	36.7081	101.3143	198.2237	327.8033	489.6860	684.2389
-42	D#	1	38.8909	107.3388	210.0107	347.2955	518.8042	724.9259
-41	E	1	41.2034	113.7215	222.4986	367.9468	549.6540	768.0322
-40	F	1	43.6535	120.4837	235.7291	389.8260	582.3381	813.7018
-39	F#	1	46.2493	127.6481	249.7462	413.0063	616.9657	862.0870
-38	G	1	48.9994	135.2384	264.5969	437.5649	653.6524	913.3494
-37	G#	1	51.9131	143.2801	280.3307	463.5839	692.5206	967.6599
-36	A	1	55.0000	151.8000	297.0000	491.1500	733.7000	1025.2000
-35	A#	1	58.2705	160.8265	314.6605	520.3553	777.3281	1086.1616
-34	B	1	61.7354	170.3897	333.3712	551.2972	823.5504	1150.7481
-33	C	2	65.4064	180.5216	353.1945	584.0791	872.5213	1219.1751
-32	C#	2	69.2957	191.2560	374.1966	618.8102	924.4041	1291.6711
-31	D	2	73.4162	202.6287	396.4474	655.6066	979.3720	1368.4778
-30	D#	2	77.7817	214.6776	420.0214	694.5910	1037.6085	1449.8517
-29	E	2	82.4069	227.4430	444.9972	735.8935	1099.3079	1536.0644
-28	F	2	87.3071	240.9675	471.4581	779.6520	1164.6762	1627.4036
-27	F#	2	92.4986	255.2962	499.4925	826.0125	1233.9314	1724.1740
-26	G	2	97.9989	270.4769	529.1938	875.1298	1307.3048	1826.6987
-25	G#	2	103.8262	286.5602	560.6613	927.1677	1385.0412	1935.3199
-24	A	2	110.0000	303.6000	594.0000	982.3000	1467.4000	2050.4000
-23	A#	2	116.5409	321.6530	629.3211	1040.7106	1554.6561	2172.3231
-22	B	2	123.4708	340.7795	666.7425	1102.5945	1647.1008	2301.4962
-21	C	3	130.8128	361.0433	706.3890	1168.1581	1745.0425	2438.3503
-20	C#	3	138.5913	382.5120	748.3931	1237.6204	1848.8081	2583.3421
-19	D	3	146.8324	405.2574	792.8949	1311.2132	1958.7440	2736.9556
-18	D#	3	155.5635	429.3552	840.0429	1389.1820	2075.2170	2899.7035
-17	E	3	164.8138	454.8860	889.9944	1471.7870	2198.6158	3072.1288
-16	F	3	174.6141	481.9350	942.9162	1559.3041	2329.3523	3254.8071
-15	F#	3	184.9972	510.5923	998.9849	1652.0251	2467.8628	3448.3480
-14	G	3	195.9977	540.9537	1058.3877	1750.2596	2614.6096	3653.3975
-13	G#	3	207.6523	573.1205	1121.3227	1854.3355	2770.0823	3870.6398
-12	A	3	220.0000	607.2000	1188.0000	1964.6000	2934.8000	4100.8000
-11	A#	3	233.0819	643.3060	1258.6422	2081.4212	3109.3123	4344.6463
-10	B	3	246.9417	681.5590	1333.4849	2205.1889	3294.2016	4602.9924
-9	C	4	261.6256	722.0866	1412.7781	2336.3163	3490.0850	4876.7005
-8	C#	4	277.1826	765.0241	1496.7862	2475.2409	3697.6163	5166.6842
-7	D	4	293.6648	810.5148	1585.7897	2622.4264	3917.4880	5473.9113
-6	D#	4	311.1270	858.7105	1680.0857	2778.3640	4150.4340	5799.4070
-5	E	4	329.6276	909.7721	1779.9888	2943.5741	4397.2316	6144.2577
-4	F	4	349.2282	963.8699	1885.8324	3118.6081	4658.7046	6509.6142
-3	F#	4	369.9944	1021.1846	1997.9699	3304.0502	4935.7256	6896.6960
-2	G	4	391.9954	1081.9074	2116.7754	3500.5192	5229.2191	7306.7949
-1	G#	4	415.3047	1146.2410	2242.6454	3708.6709	5540.1647	7741.2796
0	A	4	440.0000	1214.4000	2376.0000	3929.2000	5869.6000	8201.6000
1	A#	4	466.1638	1286.6120	2517.2843	4162.8424	6218.6246	8689.2925
2	B	4	493.8833	1363.1179	2666.9698	4410.3779	6588.4032	9205.9847
3	C	5	523.2511	1444.1731	2825.5561	4672.6326	6980.1701	9753.4011
4	C#	5	554.3653	1530.0481	2993.5724	4950.4818	7395.2326	10333.3685
5	D	5	587.3295	1621.0295	3171.5795	5244.8528	7834.9760	10947.8225
6	D#	5	622.2540	1717.4210	3360.1714	5556.7279	8300.8679	11598.8140
7	E	5	659.2551	1819.5441	3559.9776	5887.1482	8794.4632	12288.5153
8	F	5	698.4565	1927.7398	3771.6649	6237.2162	9317.4092	13019.2285
9	F#	5	739.9888	2042.3692	3995.9398	6608.1004	9871.4512	13793.3921
10	G	5	783.9909	2163.8148	4233.5507	7001.0385	10458.4382	14613.5899
11	G#	5	830.6094	2292.4819	4485.2907	7417.3419	11080.3293	15482.5591
12	A	5	880.0000	2428.8000	4752.0000	7858.4000	11739.2000	16403.2000