

# Team 515 Music Machine

15-Nov-2018

Jasmine Gay

Anjani Good

Isaac Guettler

Christian Morales

Taylor Shelby



# Team Introductions



**Jasmine Gay**  
Mechanical Systems  
Engineer



**Anjani Good**  
Electrical Systems  
Engineer



**Christian Morales**  
Power Systems  
Engineer



**Isaac Guettler**  
Systems Engineer



**Taylor Shelby**  
Audio Engineer

Isaac Guettler



# Sponsors



**Dean Murray Gibson**



**Mrs. Faye Gibson**

Isaac Guettler





# Project Overview



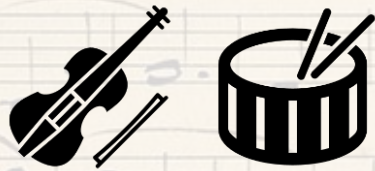
# Objective

The objective of this project is to create a portable device which utilizes musical and visual elements to engage an audience for the purpose of representing the FAMU-FSU College of Engineering to the public.

Isaac Guettler



# Key Goals



Plays a recognizable tune



Intrigues an audience



Portable



Serves as a public relations tool



Aesthetically pleasing



Durable

Isaac Guettler



# Completed Tasks



- Project Overview
  - Objective
  - Customer Needs



- Project Scope
  - Key Goals
  - Primary & Secondary Markets
  - Assumptions
  - Stakeholders



- Functional Decomposition

Isaac Guettler



# Targets

Category	Need	Target	Number
Audio	Move physical components to produce audio	Audible volume	40-110 dB (Virosteak, n.d.)
		Audible range	5 m <sup>2</sup> (Stierwalt, 2017)
	Recognizable song	Number of songs	1 song
Power source	Supply power	Corded/battery	12 V
Portability	Size	Volume	2.5 m <sup>3</sup>
		Weight	22 kg
		Max length/width	1.98m X 0.61m
	Ease to move	Force required to start motion	220 N (Canadian Centre for Occupational Health and Safety, n.d.)

Isaac Guettler



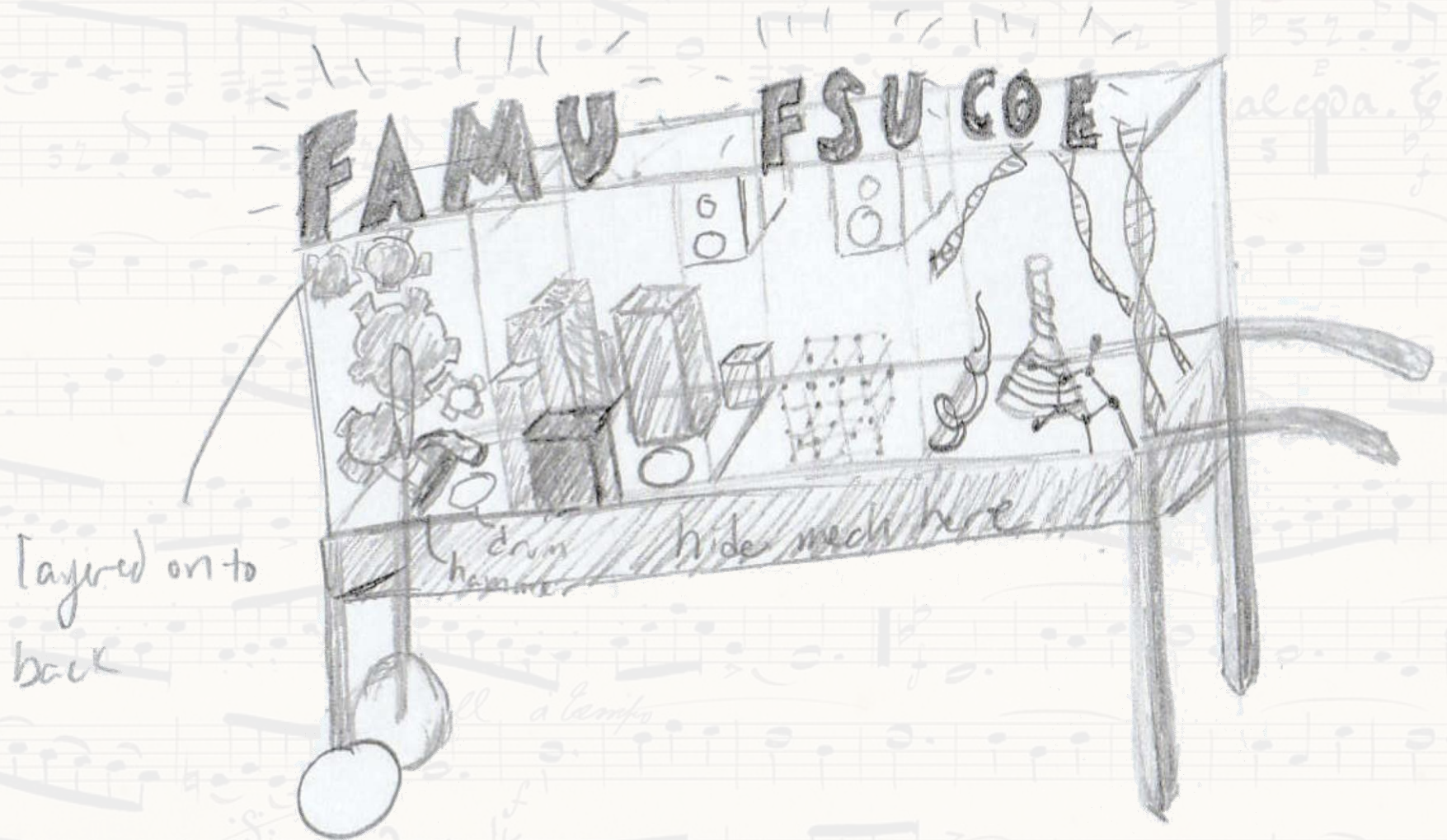




# Concept Generation



# Concept 1



Layered on to  
back

drum  
hammer

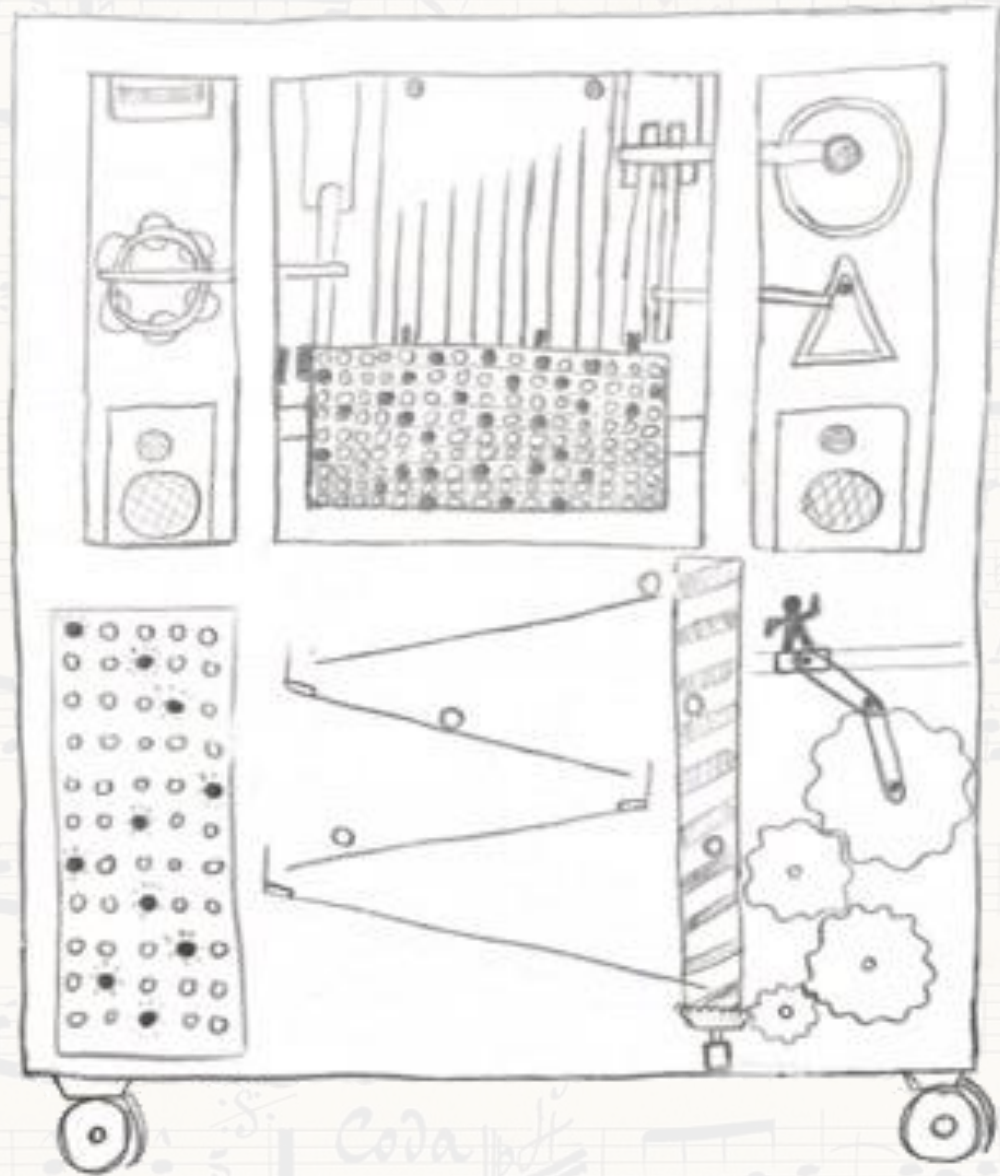
hide mech here

all a tempo

Coda

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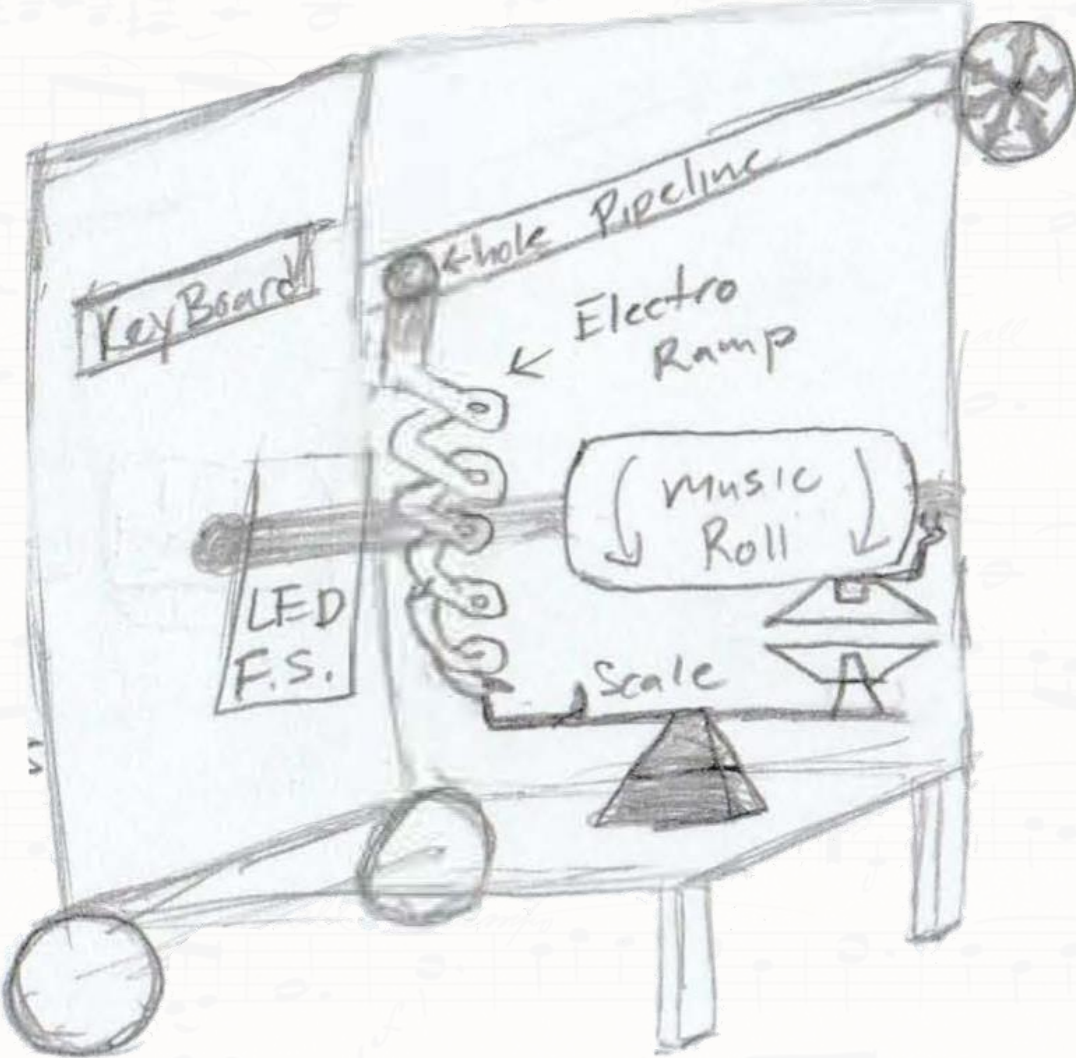
# Concept 2



Isaac Guettler



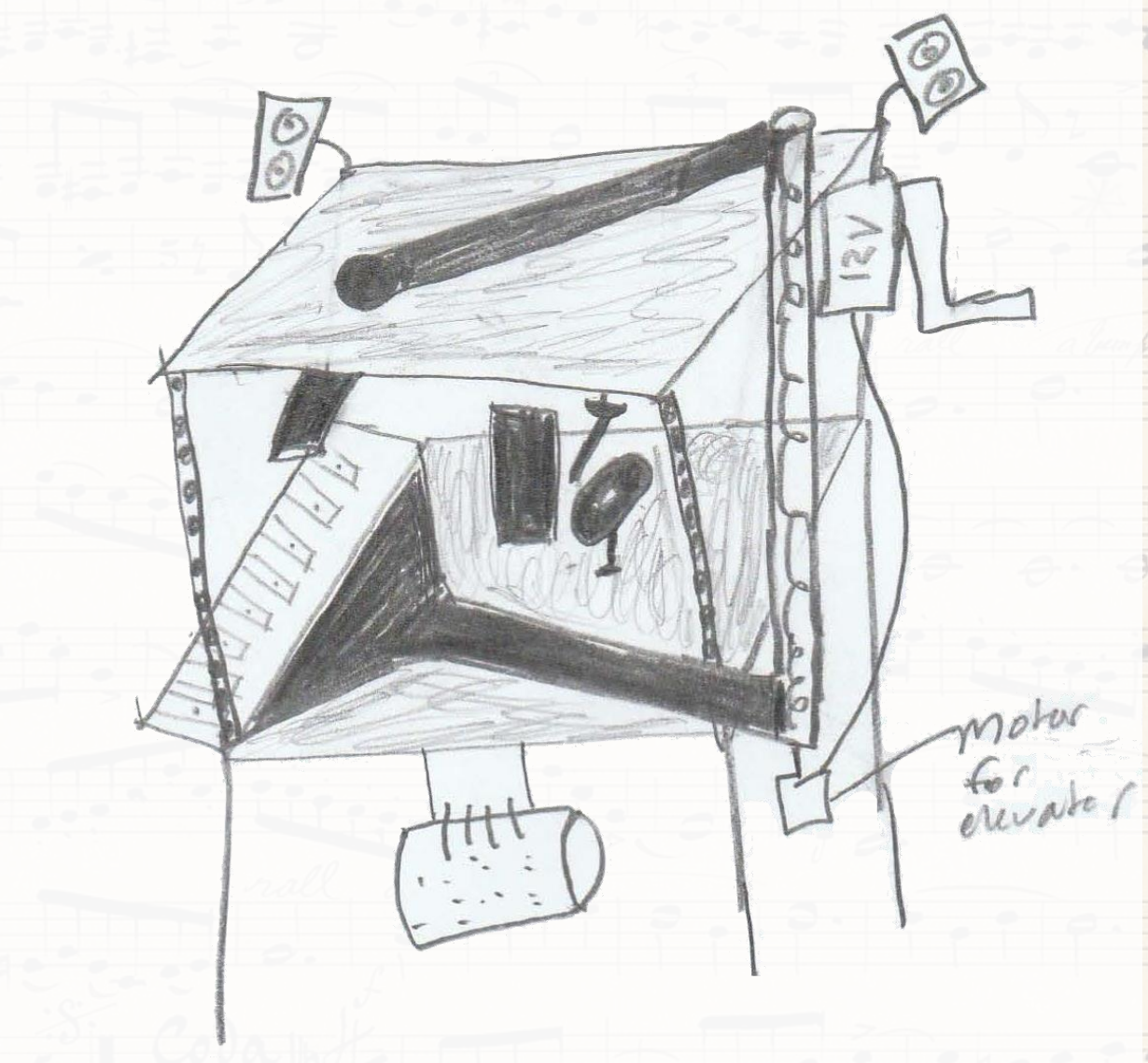
# Concept 3



Christian Morales



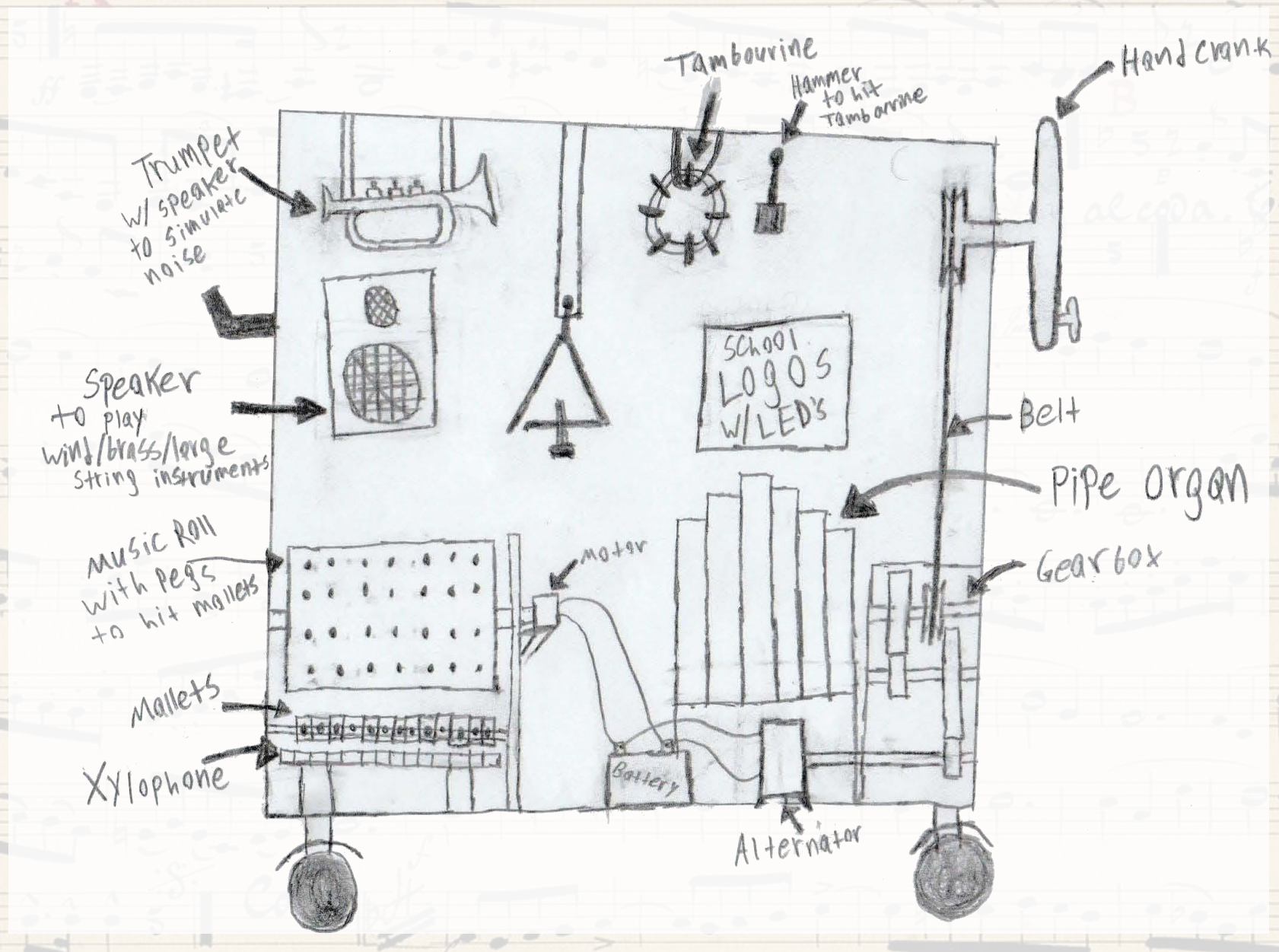
# Concept 4



Christian Morales



# Concept 5



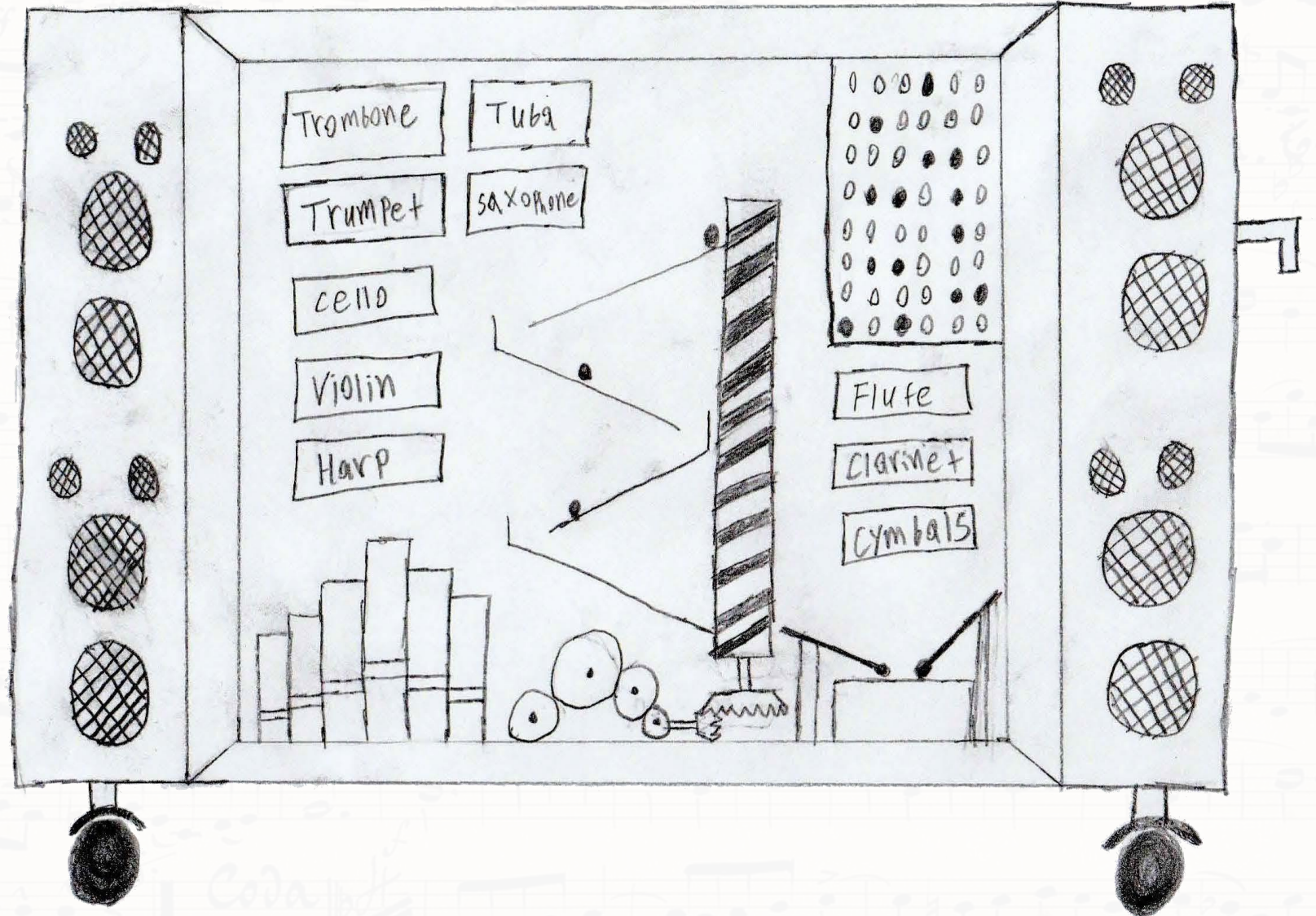
Christian Morales



# Concept 6



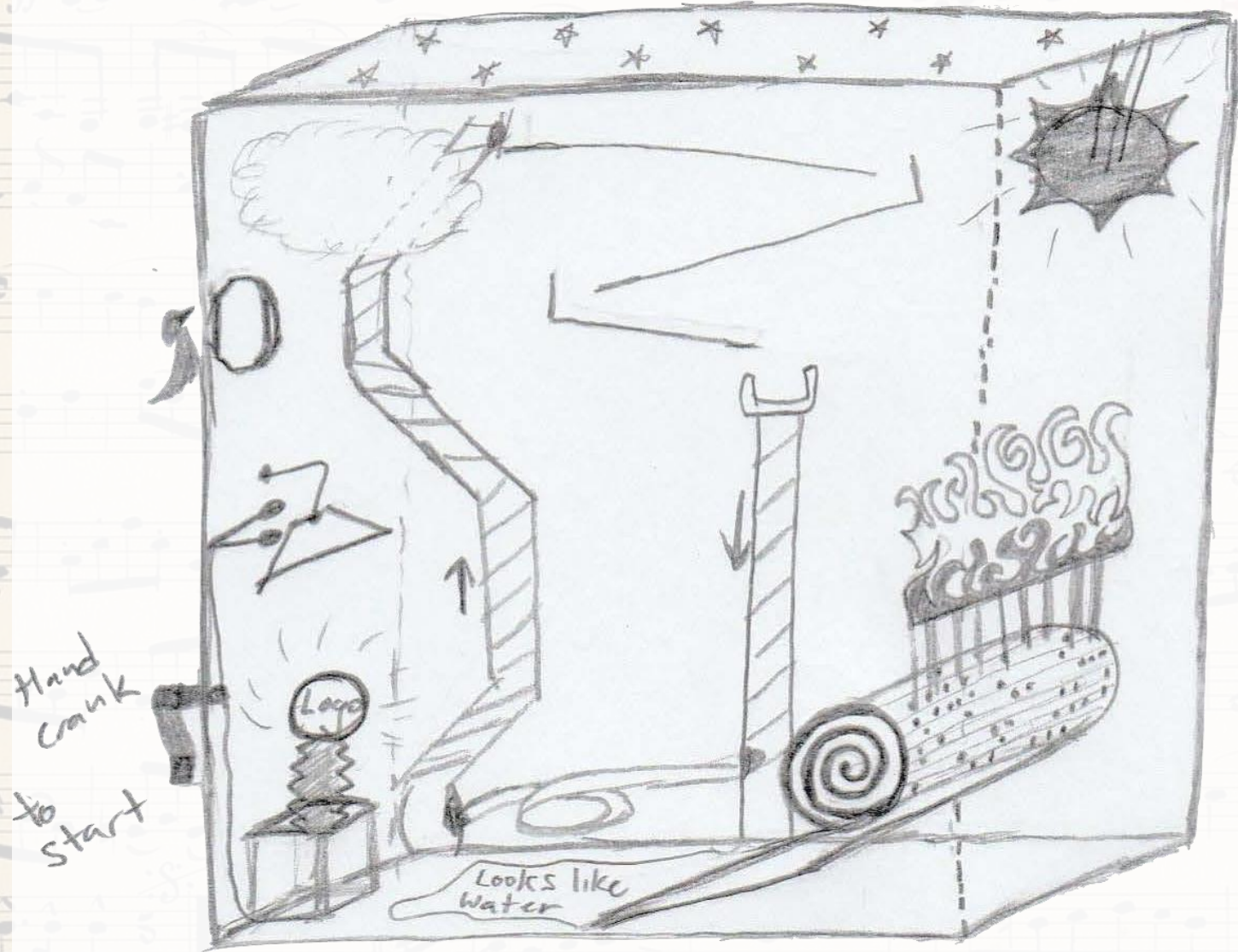
3rd after Pugh and AHP



Christian Morales



# Concept 7



Christian Morales

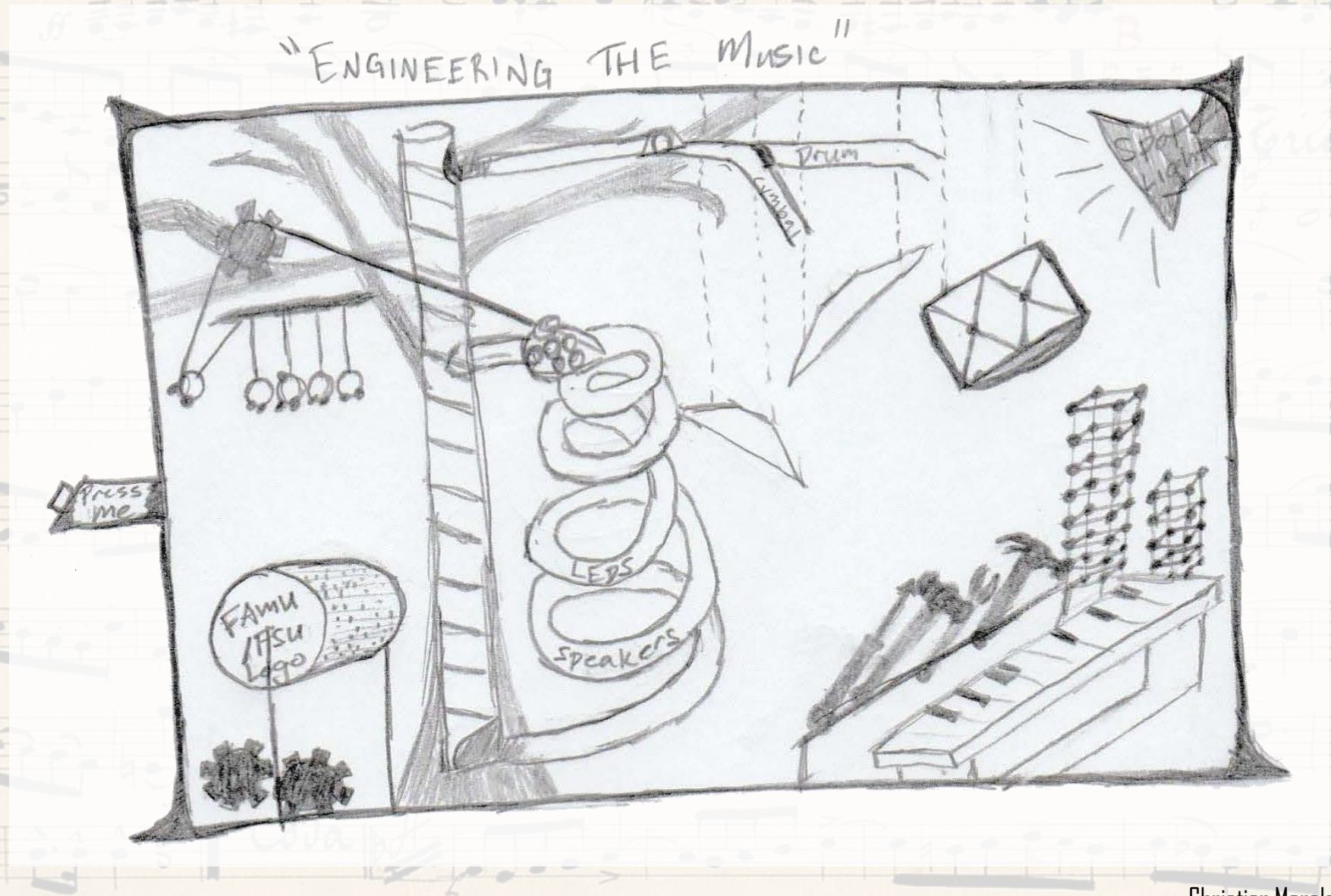




# Concept 8



Winner after Pugh  
and AHP



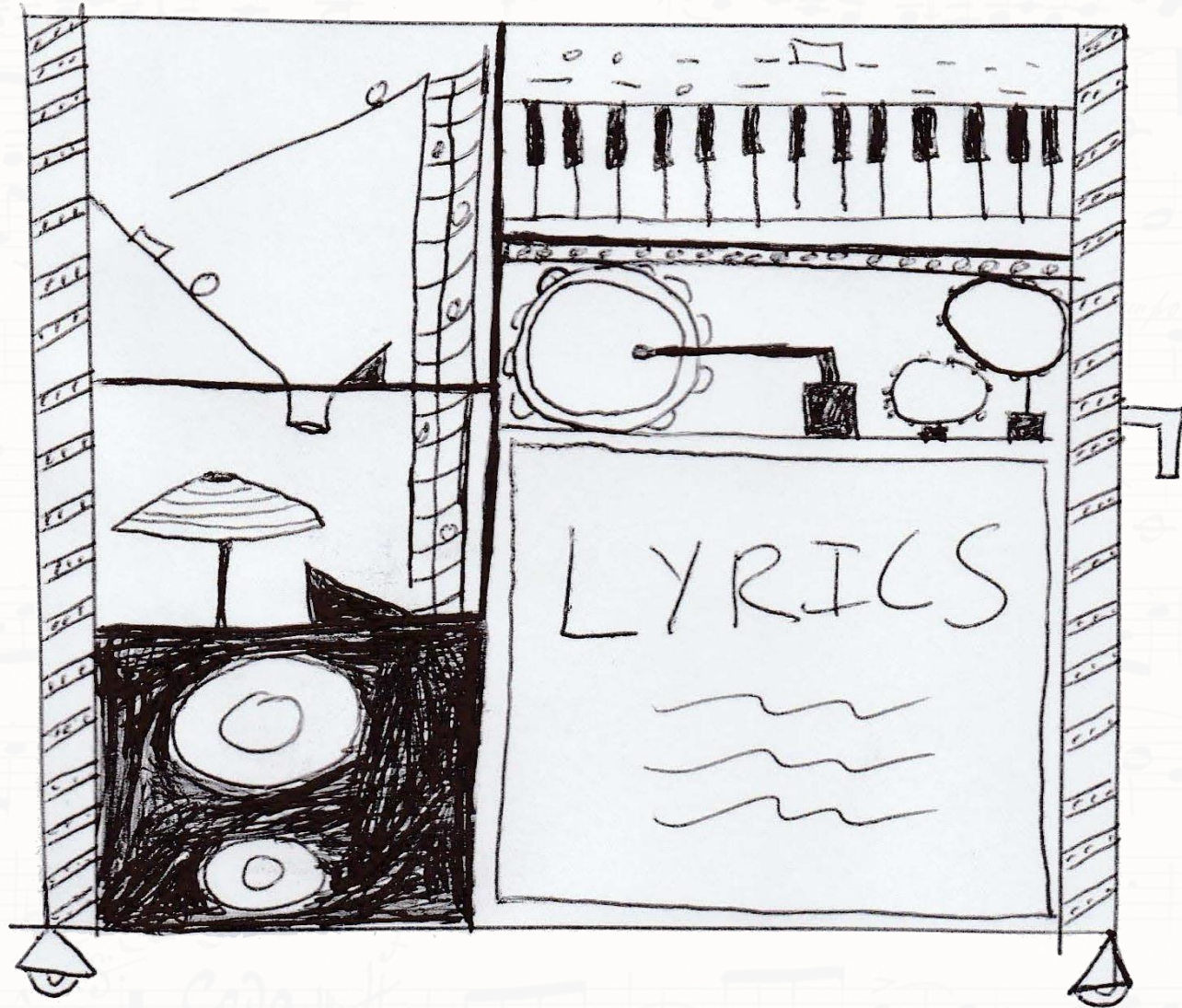
Christian Morales



# Concept 9



2nd after Pugh and  
AHP



Christian Morales





# Concept Selection



# House of Quality

		Column #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
		Direction of Improvement:			▲	▲		▼	x	▼				▲	x					▼	x	▼	▼	▼				
Relative Weight	Weight / Importance	Demanded Quality	Audible volume (dB)	Audible range (m <sup>2</sup> )	Number of songs	Attenuation percentage (Unwanted Sounds)	Sense sound (For attenuation)	Max power (Voltage from wall)	Corded/battery (Max Voltage)	Minimum Voltage	Mass of objects of Visual Interest	Size of objects of Visual Interest	Number of lights	Customizability of lights	Power required for lights	Number of moving elements	Number of electrical systems	Number of electronic instruments	Volume (m <sup>3</sup> )	Weight	Max length/width	Force required to start motion of device	Force required to maintain motion of device	Power through components (Watts)	Number of motion sensors (Max. min)	Number of audio sensors (max. min)	Cost	
3%	2	Keep cost low	▲	▲	○				○	▲	○	○	○	○		○	○	○	▲	▲					▲	▲	○	
16.7%	11	Play a song	○	○	○			▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	○	○	▲	▲	▲	▲	▲	▲	○	○	
6.1%	4	Attention grabbing	○	○	○	▲	▲	▲	▲	▲	▲	○	○	▲		○	○	▲	▲								○	
1.5%	1	Interesting audio	▲	▲	○	▲	▲									▲	▲	○						▲	▲		○	
12.1%	8	Mechanical components	▲	▲	○	▲		○	○	○	○	○				○			○	○	○	○	○				○	
10.6%	7	Electrical Components	○	○		○	○	○	○	○	▲	▲	○				○	○		▲	▲	▲	▲		○	○	○	
6.1%	4	Portable									○								○	○	○	○	○				○	
4.5%	3	Durable									▲	▲				○	○	○				▲	▲				○	
3%	2	Portable Power						○	○	○					○		○	○						○	▲	▲	○	
9.1%	6	Easy to Use			▲						▲	▲				▲						○	○				○	
13.6%	9	Presentable	○	○	○							▲															○	
13.6%	9	Professional	○	○	○							▲															○	
		Difficulty																										
		Max Relationship Value in Column	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
		Weight / Importance	334.8	334.8	436.4	115.2	103	254.5	263.6	166.7	219.7	204.5	157.6	50	43.9	168.2	209.1	215.2	322.7	193.9	190.9	277.3	277.3	45.5	119.7	151.5	900	
		Relative Weight	5.8%	5.8%	7.6%	2%	1.8%	4.4%	4.6%	2.9%	3.8%	3.6%	2.7%	0.9%	0.8%	2.9%	3.6%	3.7%	5.6%	3.4%	3.3%	4.8%	4.8%	0.8%	2.1%	2.6%	15.6%	

Christian Morales



# House of Quality

HOQ Ranking	Selection Criteria		Condensed Criteria
1	Cost		Cost
2	Number of songs		Number of songs
3	Audible volume (dB)	Tie	Audible volume (dB)
4	Audible range (m <sup>2</sup> )		
5	Volume (m <sup>3</sup> )		Volume (m <sup>3</sup> )
6	Force required to start motion of device	Tie	Weight
7	Force required to maintain motion of device		
8	Corded/battery (Max Voltage)		
9	Max power (Voltage from wall)		Max Power
10	Mass of objects of Visual Interest		Number of Moving Elements
11	Number of electronic instruments		Number of electronic instruments
12	Number of electrical systems		Customizability of lights

Christian Morales



# Pugh Chart

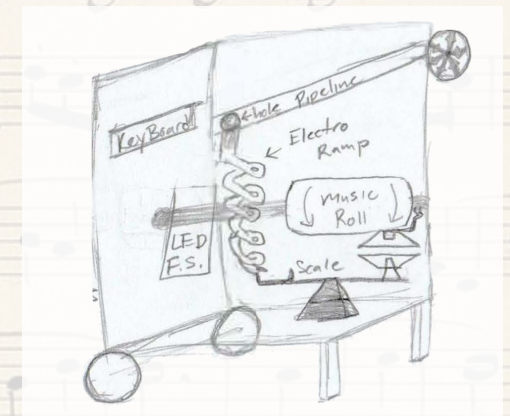
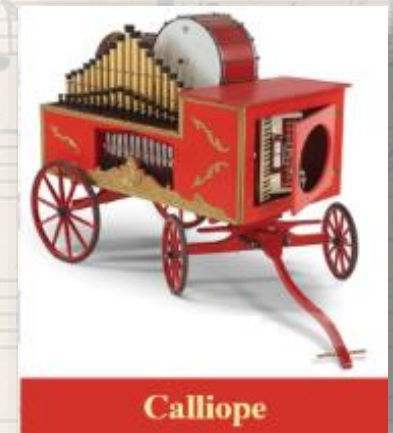
		Concepts								
Selection Criteria	Calliope	1	2	3	4	5	6	7	8	9
Number of songs	Datum	S	S	S	S	S	+	S	S	S
Audible Volume		-	-	-	+	-	-	-	+	+
Volume		+	+	+	+	+	+	+	+	+
Max Power		+	+	+	+	+	+	+	+	+
Number of Electronic Instruments		+	+	+	+	+	+	+	+	+
Weight		+	+	+	-	+	+	+	+	+
Number of Moving Elements		+	+	-	+	-	+	+	-	+
Customizability of Lights		+	+	+	+	-	-	-	+	+
Cost		+	+	+	+	+	+	+	+	-
# of Plus			7	7	6	7	5	7	6	7
# of Minus		1	1	1	1	3	2	2	1	1

Jasmine Gay



# Pugh Chart

Selection Criteria	Calliope	Concepts								
		1	2	3	4	5	6	7	8	9
Number of songs	Datum	S	S	S	S	S	+	S	S	S
Audible Volume		-	-	+	+	-	-	-	+	+
Volume		+	+	+	+	+	+	+	+	+
Max Power		+	+	+	+	+	+	+	+	+
Number of Electronic Instruments		+	+	+	+	+	+	+	+	+
Weight		+	+	+	-	+	+	+	+	+
Number of Moving Elements		+	+	-	+	-	+	+	-	+
Customizability of Lights		+	+	+	+	-	-	-	+	+
Cost		+	+	+	+	+	+	+	+	-
# of Plus			7	7	6	7	5	7	6	7
# of Minus		1	1	1	1	3	2	2	1	1



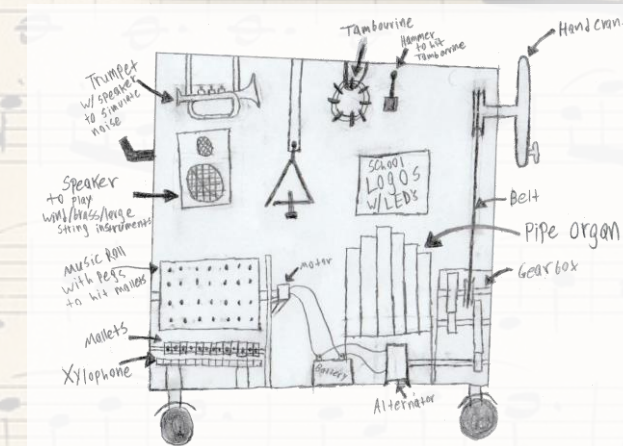
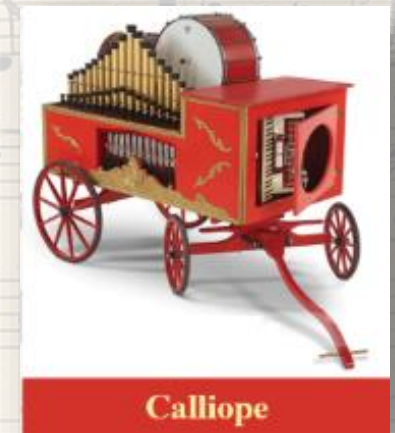
Concept 3

Jasmine Gay



# Pugh Chart

Selection Criteria	Calliope	Concepts								
		1	2	3	4	5	6	7	8	9
Number of songs	Datum	S	S	S	S	S	+	S	S	S
Audible Volume		-	-	+	+	-	-	-	+	+
Volume		+	+	+	+	+	+	+	+	+
Max Power		+	+	+	+	+	+	+	+	+
Number of Electronic Instruments		+	+	+	+	+	+	+	+	+
Weight		+	+	+	-	+	+	+	+	+
Number of Moving Elements		+	+	-	+	-	+	+	-	+
Customizability of Lights		+	+	+	+	-	-	-	+	+
Cost		+	+	+	+	+	+	+	+	-
# of Plus			7	7	6	7	5	7	6	7
# of Minus		1	1	1	1	3	2	2	1	1



Concept 5

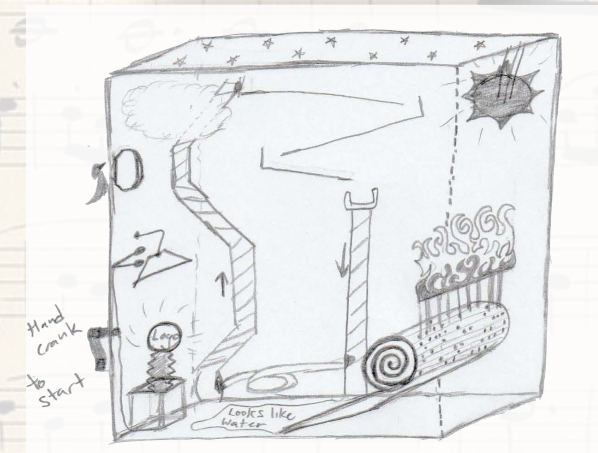
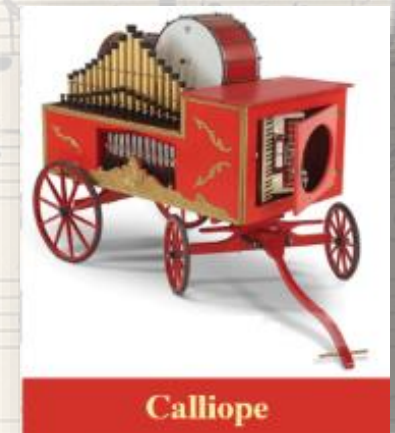
Jasmine Gay





# Pugh Chart

Selection Criteria	Calliope	Concepts								
		1	2	3	4	5	6	7	8	9
Number of songs	Datum	S	S	S	S	S	+	S	S	S
Audible Volume		-	-	+	+	-	-	-	+	+
Volume		+	+	+	+	+	+	+	+	+
Max Power		+	+	+	+	+	+	+	+	+
Number of Electronic Instruments		+	+	+	+	+	+	+	+	+
Weight		+	+	+	-	+	+	+	+	+
Number of Moving Elements		+	+	-	+	-	+	+	-	+
Customizability of Lights		+	+	+	+	-	-	-	+	+
Cost		+	+	+	+	+	+	+	+	-
# of Plus			7	7	6	7	5	7	6	7
# of Minus		1	1	1	1	3	2	2	1	1



Concept 7

Jasmine Gay



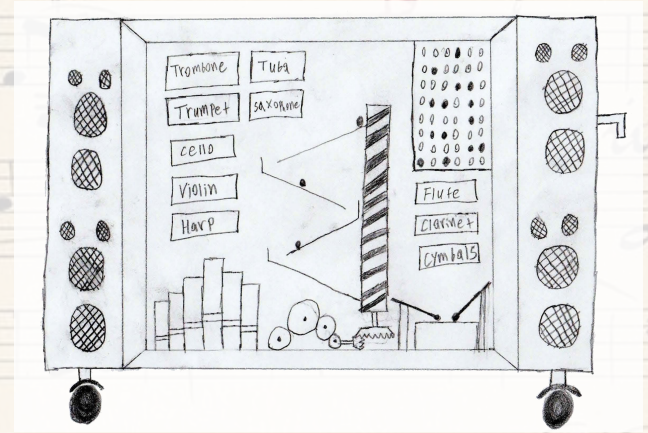
# Pugh Chart

		Concepts				
Selection Criteria	6	1	2	4	8	9
Number of songs	Datum	-	-	-	-	S
Audible Volume		-	-	-	-	-
Volume		+	S	+	+	+
Max Power		+	+	+	+	S
Number of Electronic Instruments		+	S	-	+	+
Weight		+	+	+	+	+
Number of Moving Elements		+	+	S	+	-
Customizability of Lights		S	S	-	+	+
# of Plus			5	3	3	6
# of Minus		2	2	4	2	2

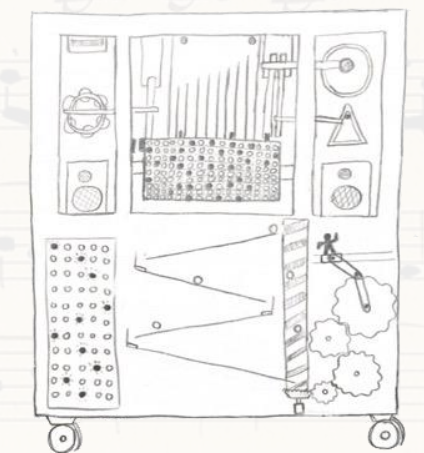


# Pugh Chart

Selection Criteria	6	Concepts				
		1	2	4	8	9
Number of songs	Datum	-	-	-	-	S
Audible Volume		-	-	-	-	-
Volume		+	S	+	+	+
Max Power		+	+	+	+	S
Number of Electronic Instruments		+	S	-	+	+
Weight		+	+	+	+	+
Number of Moving Elements		+	+	S	+	-
Customizability of Lights		S	S	-	+	+
# of Plus			5	3	3	6
# of Minus		2	2	4	2	2

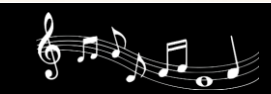


**Concept 6**



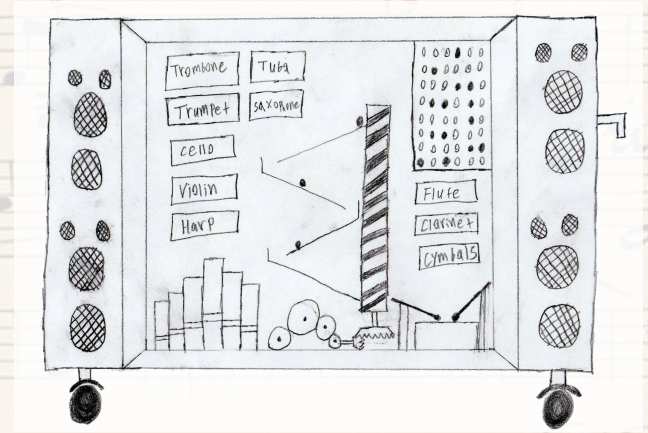
**Concept 2**

Jasmine Gay

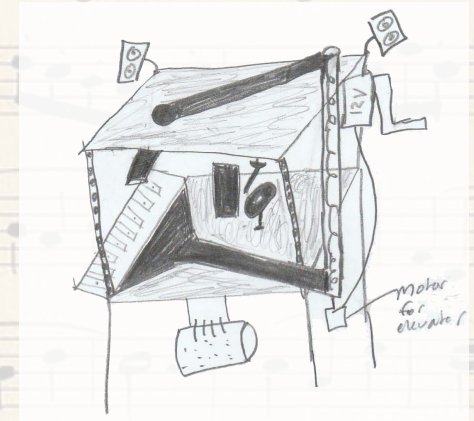


# Pugh Chart

Selection Criteria	6	Concepts				
		1	2	4	8	9
Number of songs	Datum	-	-	-	-	S
Audible Volume		-	-	-	-	-
Volume		+	S	+	+	+
Max Power		+	+	+	+	S
Number of Electronic Instruments		+	S	-	+	+
Weight		+	+	+	+	+
Number of Moving Elements		+	+	S	+	-
Customizability of Lights		S	S	-	+	+
# of Plus		5	3	3	6	4
# of Minus		2	2	4	2	2



**Concept 6**



**Concept 4**

Jasmine Gay



# Pugh Chart

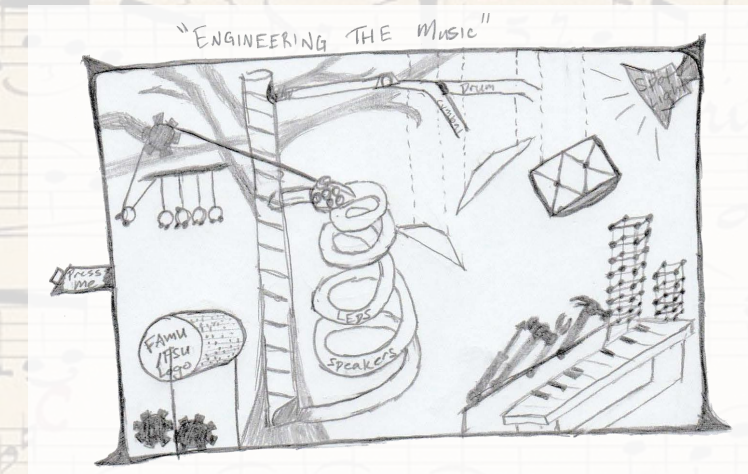
		Concepts		
Selection Criteria	8	1	6	9
Number of songs	Datum	-	+	+
Audible Volume		S	+	+
Volume		-	-	+
Max Power		-	-	-
Number of Electronic Instruments		+	-	+
Weight		-	-	-
Number of Moving Elements		S	-	-
Customizability of Lights		S	S	-
# of Plus		1	2	4
# of Minus		4	5	4

Jasmine Gay

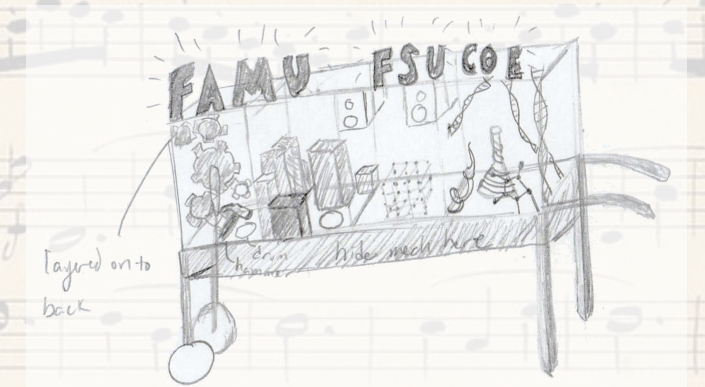


# Pugh Chart

		Concepts		
Selection Criteria	8	1	6	9
Number of songs	Datum	-	+	+
Audible Volume		S	+	+
Volume		-	-	+
Max Power		-	-	-
Number of Electronic Instruments		+	-	+
Weight		-	-	-
Number of Moving Elements		S	-	-
Customizability of Lights		S	S	-
# of Plus		1	2	4
# of Minus		4	5	4



Concept 8

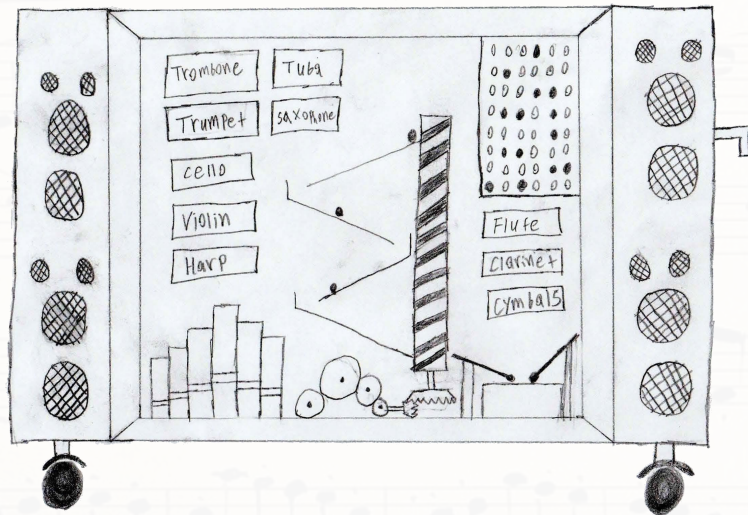


Concept 1

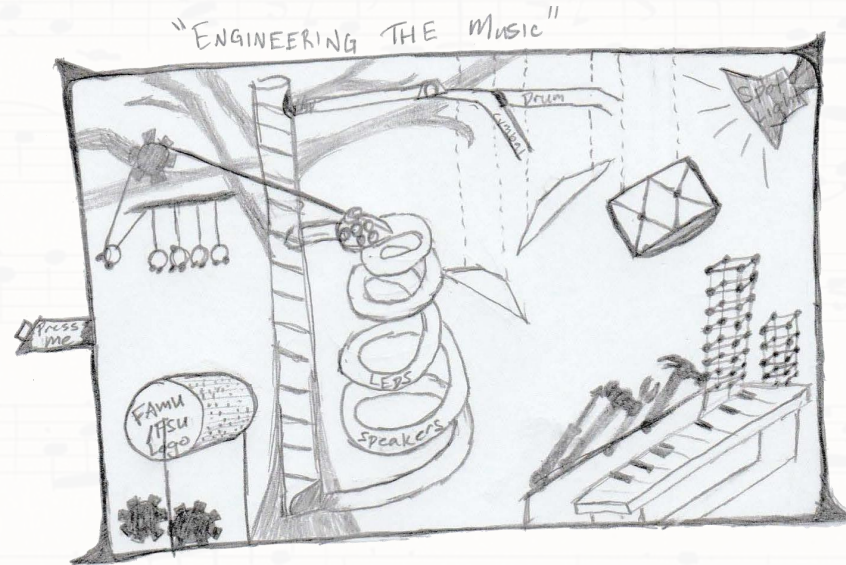
Jasmine Gay



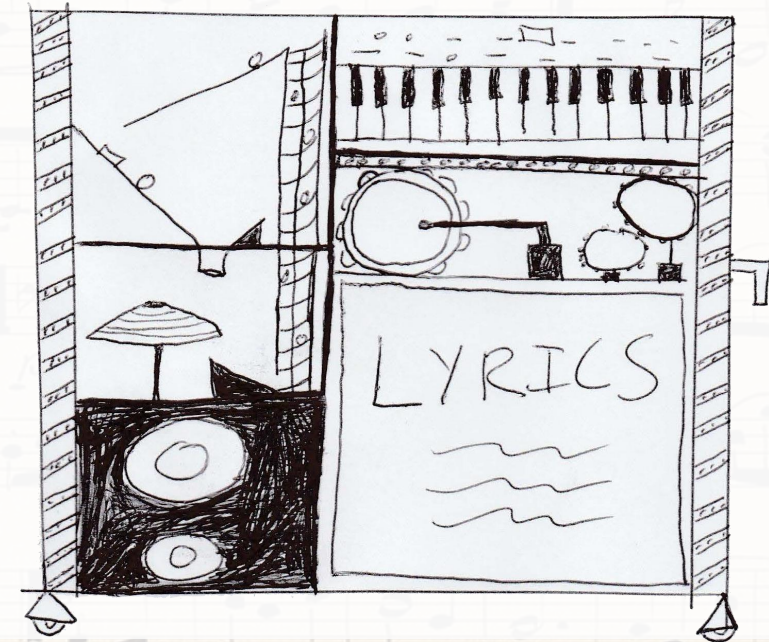
# Pugh Chart



Concept 6



Concept 8



Concept 9

# Analytical Hierarchy Process

Normalized Criteria Comparison Matrix [NormC]						
	Cost	Number of songs	Number of Electronic Instruments	Weight	Number of Moving Elements	Criteria Weights {W}
Cost	0.349	0.484	0.288	0.176	0.474	0.354
Number of songs	0.070	0.097	0.096	0.176	0.158	0.119
Number of Electronic Instruments	0.349	0.290	0.288	0.412	0.158	0.299
Weight	0.116	0.032	0.041	0.059	0.053	0.060
Number of Moving Elements	0.116	0.097	0.288	0.176	0.158	0.167
Sum	1.000	1.000	1.000	1.000	1.000	1.000





# Analytical Hierarchy Process

Normalized Criteria Comparison Matrix [NormC]

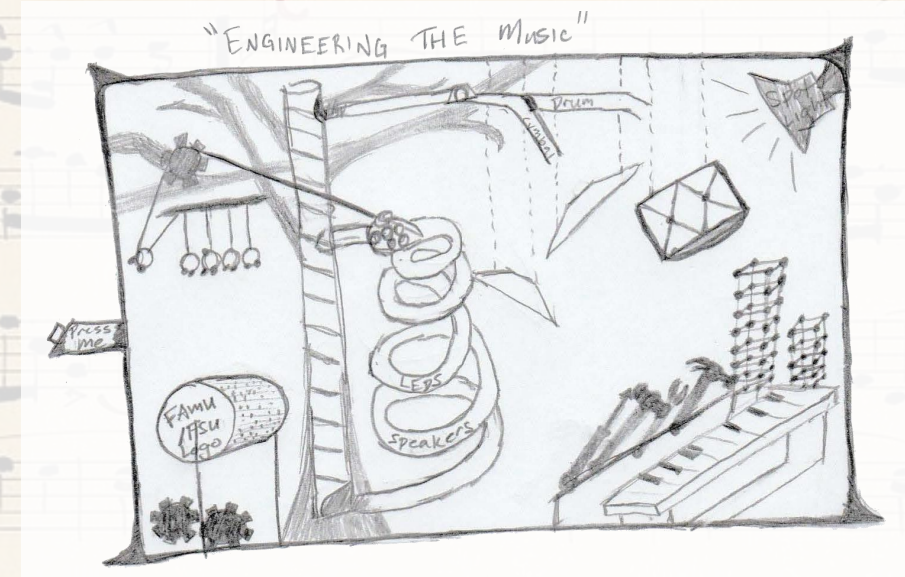
	Concept 6	Concept 8	Concept 9	Concept Weights {W}
Concept 6	0.158	0.143	0.333	0.211
Concept 8	0.789	0.714	0.556	0.686
Concept 9	0.053	0.143	0.111	0.102
Sum	1.000	1.000	1.000	1.000



# Analytical Hierarchy Process

Final Rating Matrix			
	Concept 6	Concept 8	Concept 9
Cost	0.106	0.633	0.260
Number of songs	0.467	0.067	0.467
Number of Electronic Instruments	0.140	0.286	0.574
Weight	0.143	0.714	0.143
Number of Moving Elements	0.211	0.686	0.102

Concept 6	0.179
Concept 8	0.476
Concept 9	0.345



**Concept 8**

Jasmine Gay

# Bill of Materials

Maturity Total	Overall Sum	Remaining Budget
15.00%	\$ 1,282.56	\$ 417.44

Category	Sub-category	Item	Purpose	Quantity	Units	Quantity Received	Cost per Unit	Total Cost	Vendor	Vendor Contact/Website	Purchased	Arrived	Installed	Manufacturer Part Number	Weight	Lead Time
Electrical																
	Lights															
		LED (Strips)	Along tree trunk/ Marble slide	30	FT	0	\$ 2.00	\$ 60.00	Amazon	<a href="https://www.amazon.com/dp/B077PN5CXY/ref=twister_B07H97FCJW?th=1">https://www.amazon.com/dp/B077PN5CXY/ref=twister_B07H97FCJW?th=1</a>	No	No	No	B077PN5CXY	4.58 lbs	2 days
		LED (Individual)	LED cube	100	EA	0	\$ 0.29	\$ 29.00	Jameco	<a href="https://www.jameco.com/z/RGB-LED-CC-5-WC-4-Pin-5mm-Water-Clear-RGB-LED-Common-Cathode_2228957.html?CID=GOOG">https://www.jameco.com/z/RGB-LED-CC-5-WC-4-Pin-5mm-Water-Clear-RGB-LED-Common-Cathode_2228957.html?CID=GOOG</a>	No	No	No	2228957	N/A	3 days

Jasmine Gay

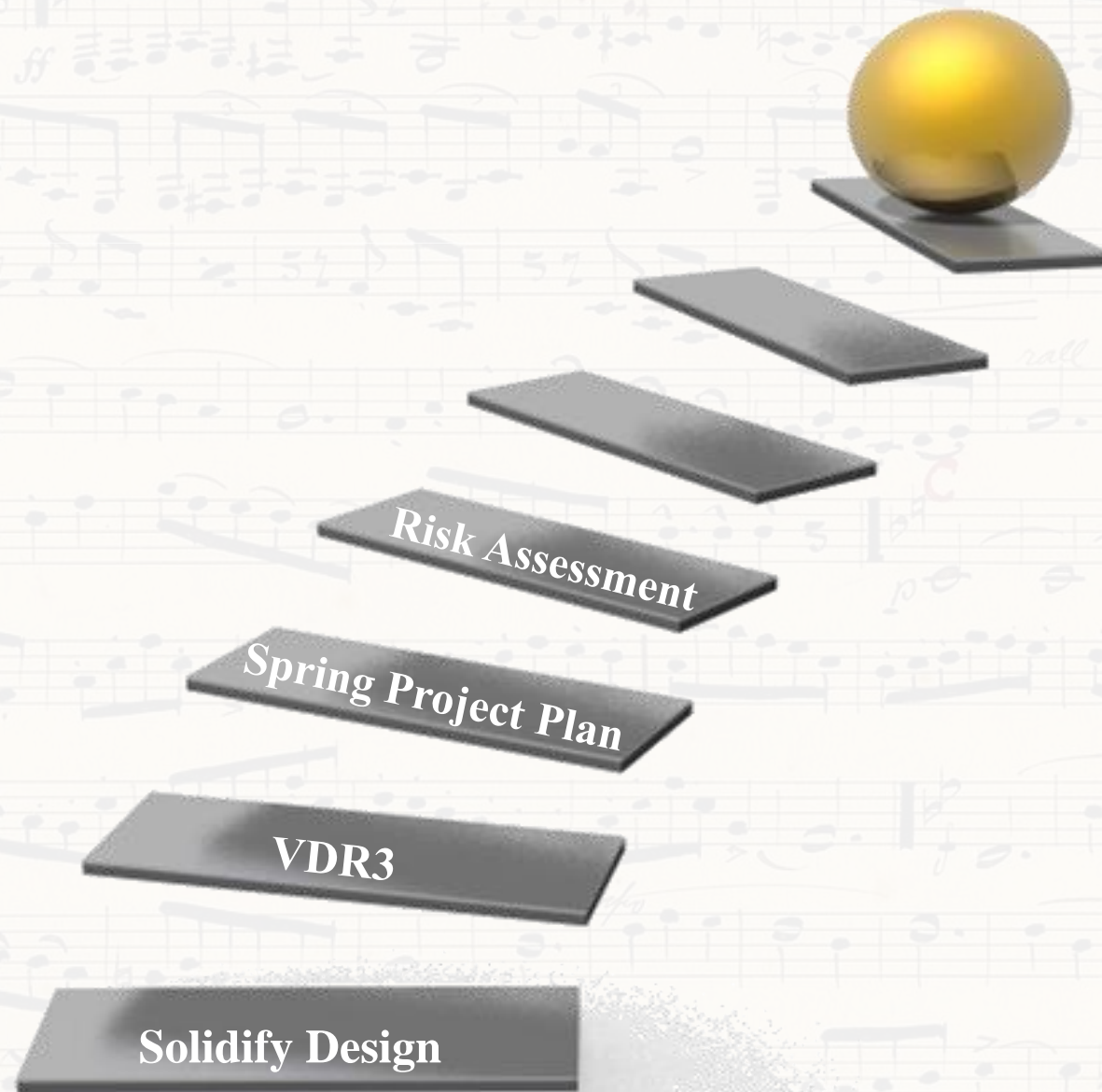


# Key Points

1. Create a portable music playing device that grabs the attention of an audience through the use of audio and visual elements
2. Through the HOQ, the most important criteria were determined. These were then used in Pugh charts to narrow the available options, which were then examined using the AHP.
3. Concept 8 won due to its combination of excellence across these fundamental metrics.
4. According to our initial BOM, we are on track for our budget.
5. Based on the current BOM, the project maturity is at 15%.



# Next Steps



Jasmine Gay



# References

<https://www.ccohs.ca/oshanswers/ergonomics/push2.htm>

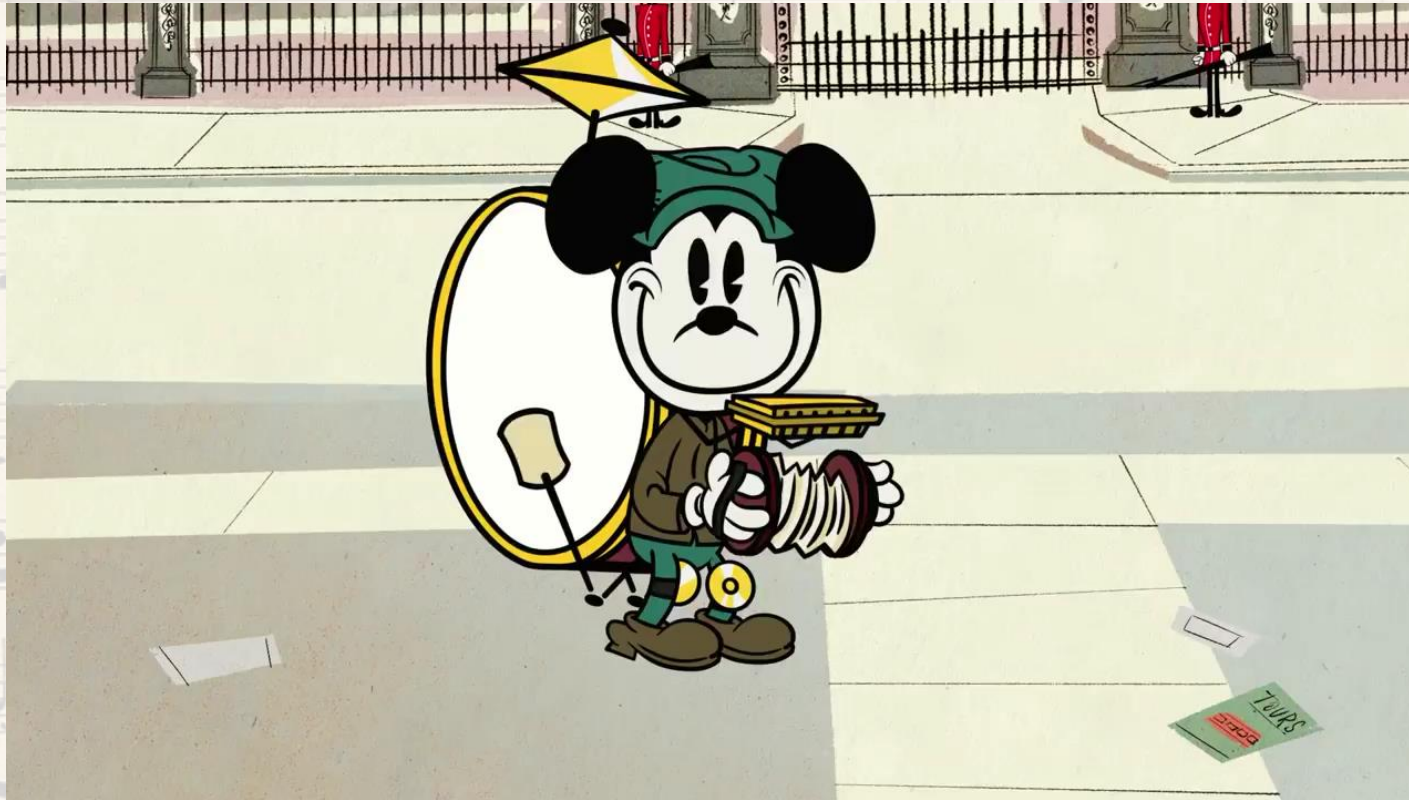
<https://www.creativefieldrecording.com/2017/11/01/sound-effects-decibel-level-chart/>

<https://www.creativefieldrecording.com/2017/11/01/sound-effects-decibel-level-chart/>

[https://www.hammacher.com/product/big-top-calliope?tid=youtube&utm\\_source=youtube&utm\\_medium=Social&utm\\_campaign=12658](https://www.hammacher.com/product/big-top-calliope?tid=youtube&utm_source=youtube&utm_medium=Social&utm_campaign=12658)



# Thank You



# Thank You



**Jasmine Gay**  
Mechanical Systems  
Engineer



**Anjani Good**  
Electrical Systems  
Engineer



**Christian Morales**  
Power Systems  
Engineer



**Isaac Guettler**  
Systems Engineer



**Taylor Shelby**  
Audio Engineer





# Backup/Previous Slides

Supporting Slides to the content above.





# Project Overview

**Anjani Good**

# Objective

The objective of this project is to create a portable device which utilizes musical and visual elements to engage an audience for the purpose of representing the FAMU-FSU College of Engineering to the public.

Anjani Good



# Customer Needs

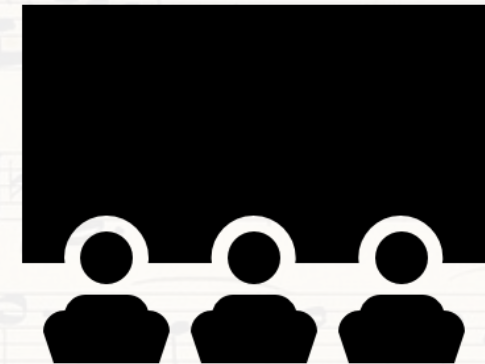
The  
Customer  
*is*  
Always  
Right



- Attention grabbing
- Serves as a public relations tool



- Play a recognizable song
- Incorporate mechanical and electrical components



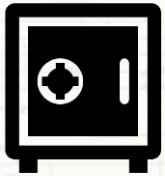
Anjani Good



# Customer Needs

The  
Customer  
*is*  
Always  
Right

- Portable



- Durable



- Self-explanatory to users with no music experience



- Device quality must meet university standards

Anjani Good



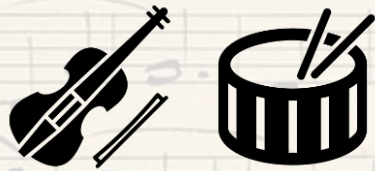


# Project Scope

## Taylor Shelby



# Key Goals



Plays a recognizable tune



Intrigues an audience



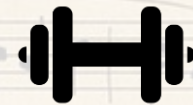
Portable



Serves as a public relations tool



Aesthetically pleasing



Durable

Taylor Shelby



# Primary Market

- Dr. Murray & Faye Gibson
- Students at the FAMU-FSU College of Engineering
- Alumnae/Alumni



Taylor Shelby





# Secondary Market

- Legislative officials
- K-12 Students
- Smithsonian Museum (ACCelerate)



Taylor Shelby



# Assumptions



The rights to the target song are attainable



Not required to play more than one song



The size is no larger than an interior door

Taylor Shelby



# Stakeholders

- Dean Murray Gibson and Faye Gibson
- Shayne McConomy
- Patrick Hollis
- Tisha Crews Keller
- FAMU President Larry Robinson
- FSU President John Thrasher



Taylor Shelby

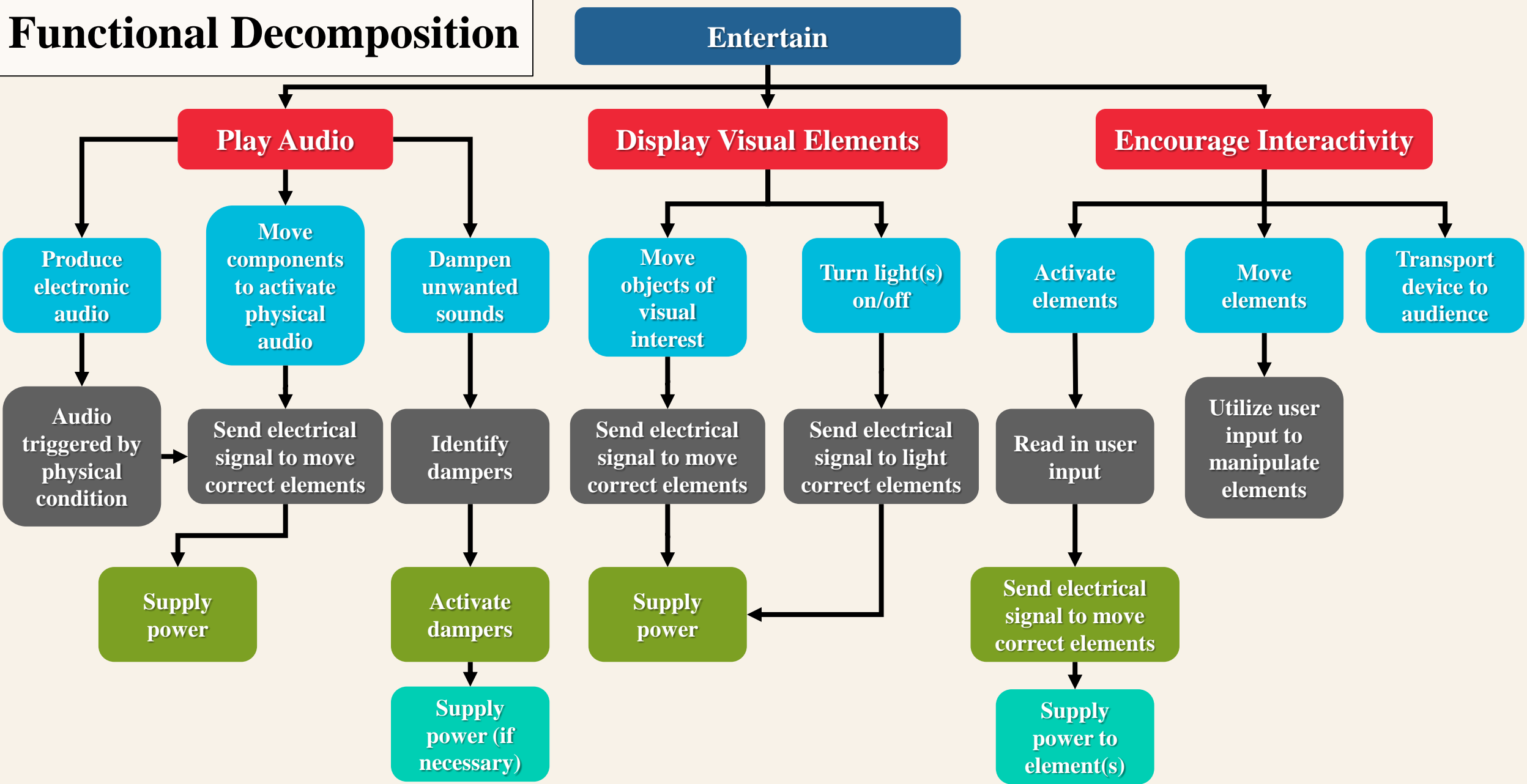




# **Functional Decomposition**

## **Taylor Shelby**

# Functional Decomposition



Taylor Shelby



# Functional Decomposition

Entertain

Play Audio

Display Visual Elements

Encourage Interactivity

Produce electronic audio

Move components to activate physical audio

Dampen unwanted sounds

Move objects of visual interest

Turn light(s) on/off

Activate elements

Move elements

Transport device to audience

Audio triggered by physical condition

Send electrical signal to move correct elements

Identify dampers

Send electrical signal to move correct elements

Send electrical signal to light correct elements

Read in user input

Utilize user input to manipulate elements

Supply power

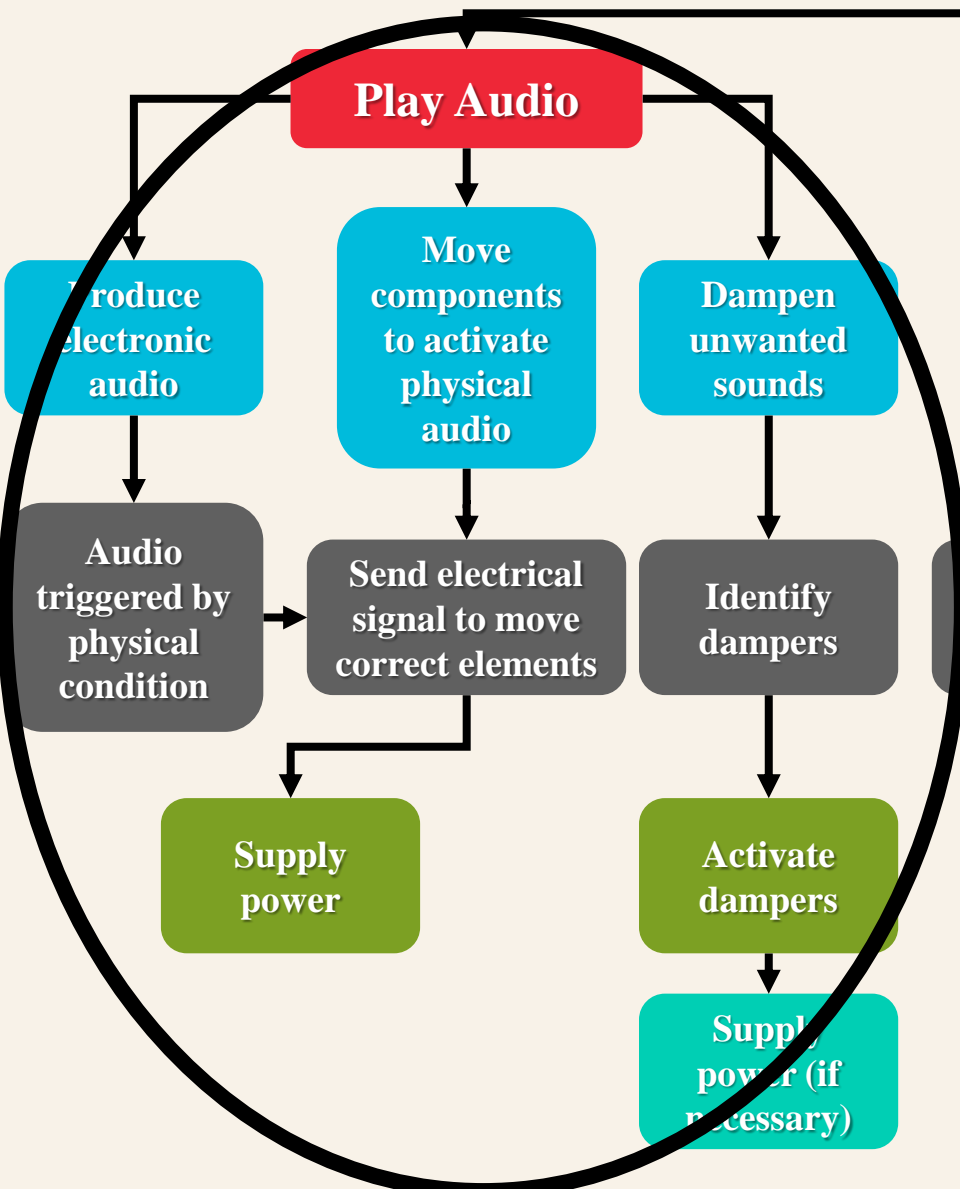
Activate dampers

Supply power

Send electrical signal to move correct elements

Supply power (if necessary)

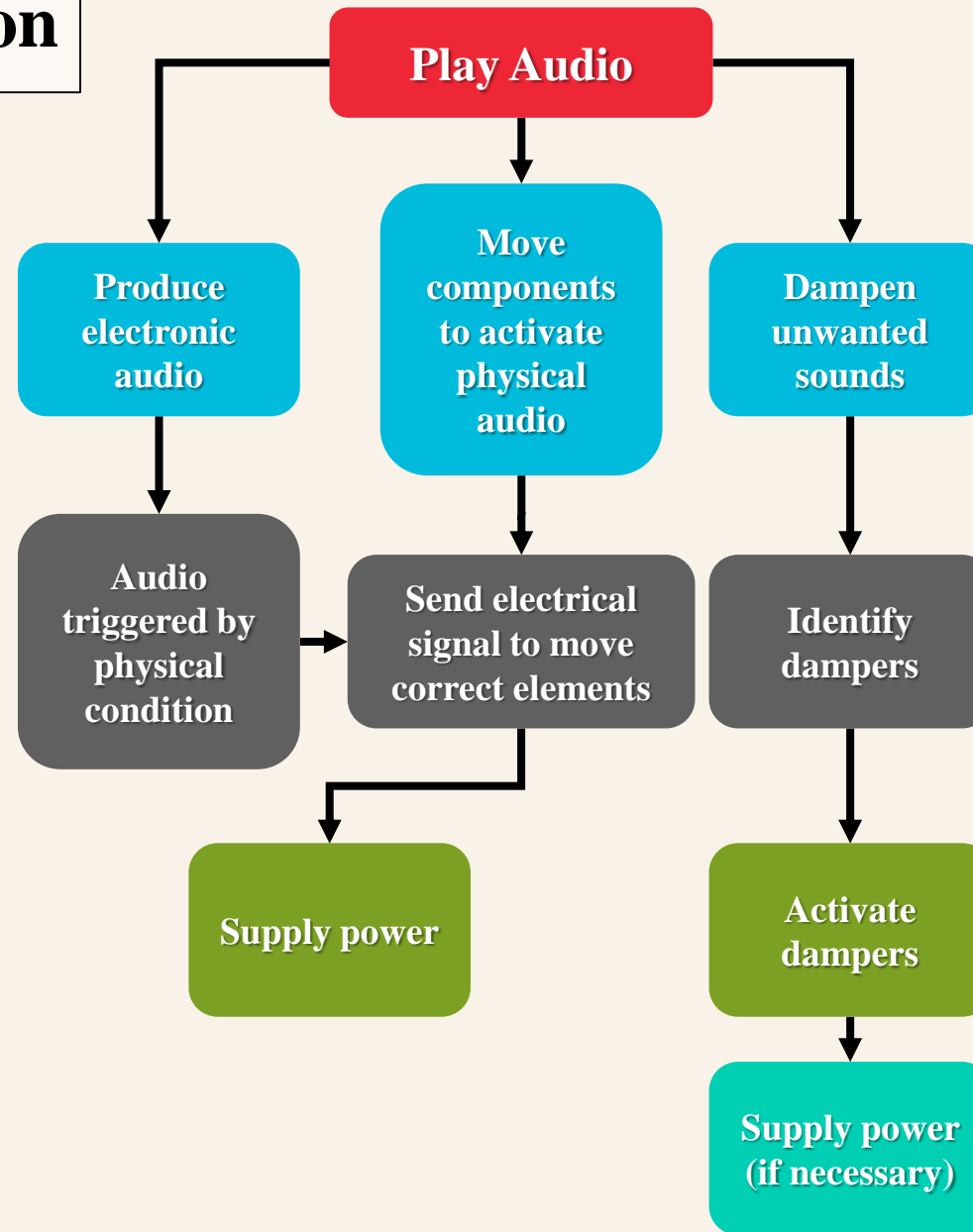
Supply power to element(s)



Taylor Shelby



# Functional Decomposition



Taylor Shelby



# Customer Needs

- Attention grabbing
- Incorporate mechanical components
- Incorporate electrical components
- Portable
- Maneuverable by just one person
- Must fit through interior doors
- Durable
- Indoor use
- Power through battery or cord
- Self-explanatory to users with no music experience
- Device quality must meet university standards





# Customer Needs

<u>Question</u>	<u>Customer Answer</u>	<u>Interpreted Need</u>
What is our budget for this project?	About \$1700	Keep the cost of the build as low as possible
Would you like the music to be a specific song, a variety of songs, a combinable variety of songs (loops, etc.), or notes that can be played by the user?	Notes that can be played by the user: good for interactivity Specific song: recognition factor (Alma mater, theme and variation) Changeable (stretch goal)	Should play both alma maters (FAMU and FSU)
Would you like the music box to be interactive? To what degree?	Ideally some human involvement, degree can vary	Must be attention grabbing
Would you like the audio to come from traditional instruments, electronic sounds, non-traditional instruments (such as found object percussion), or some combination thereof?	Combination, physical component triggers electronic phrase, such as demonstrated by the modulin. Whimsy and fun	The audio may come from any source which generates user interest Must involve both mechanical and electrical components



# Customer Needs

<u>Question</u>	<u>Customer Answer</u>	<u>Interpreted Need</u>
What is the maximum and minimum size that you would like this device to be?	Fit through interior door (~30in)	Needs to be portable (30inx80in)
Are there any weight restrictions for this project?	Carry for demonstration	Must be maneuverable by one person
Is the device intended to be used long term (>1 year)	Yes	The device needs to be durable
Where will the device be used (indoor, outdoor, on concrete, etc.)?	Primarily indoors, so carpet, tile, or wood.	Does not need to be weatherproof



# Customer Needs

<u>Question</u>	<u>Customer Answer</u>	<u>Interpreted Need</u>
What is the intended source of power for this device?	Ideally cordless, back-up with corded power	Can be powered either through battery or corded
Particularly if interactivity is an intended component, who is the target audience?	Usable by non-experts	Should be self-explanatory to those with no music experience
What would you like to get out of this at the end of this project?	PR suitable, a usable entertaining device	Device must be of a quality the FAMU-FSU College of Engineering would be proud to display
Do you want the device designed to be portable or stationary?	Portable (not necessarily backpack size, but transportable)	Mobile and portable, easy to display/set-up

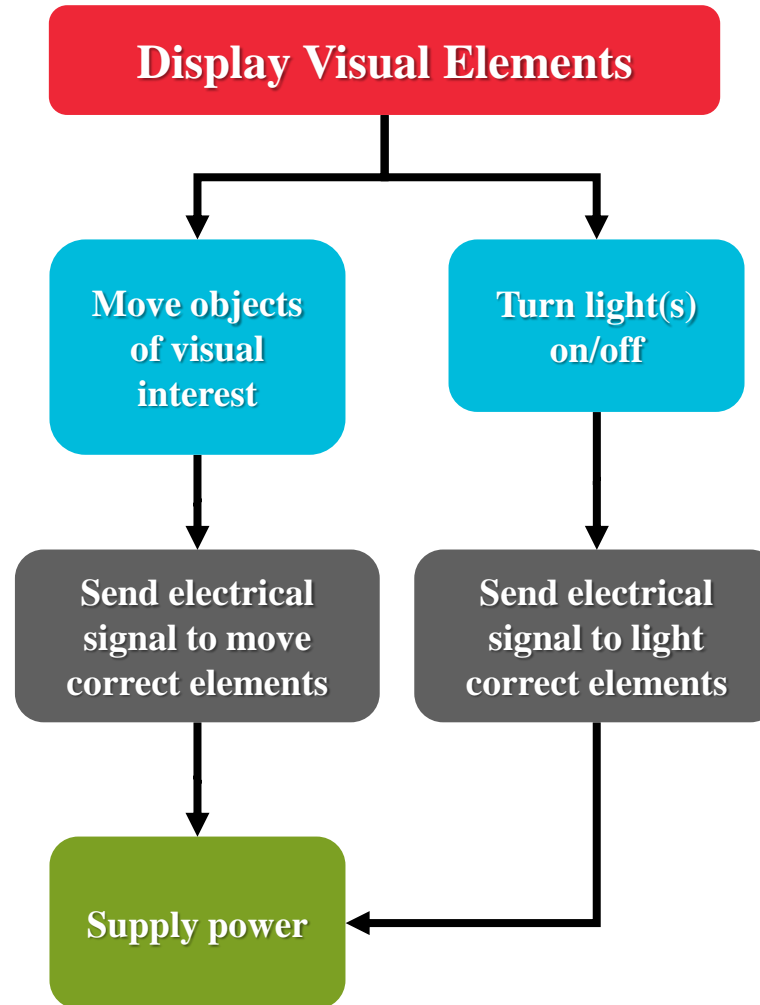


# Customer Needs

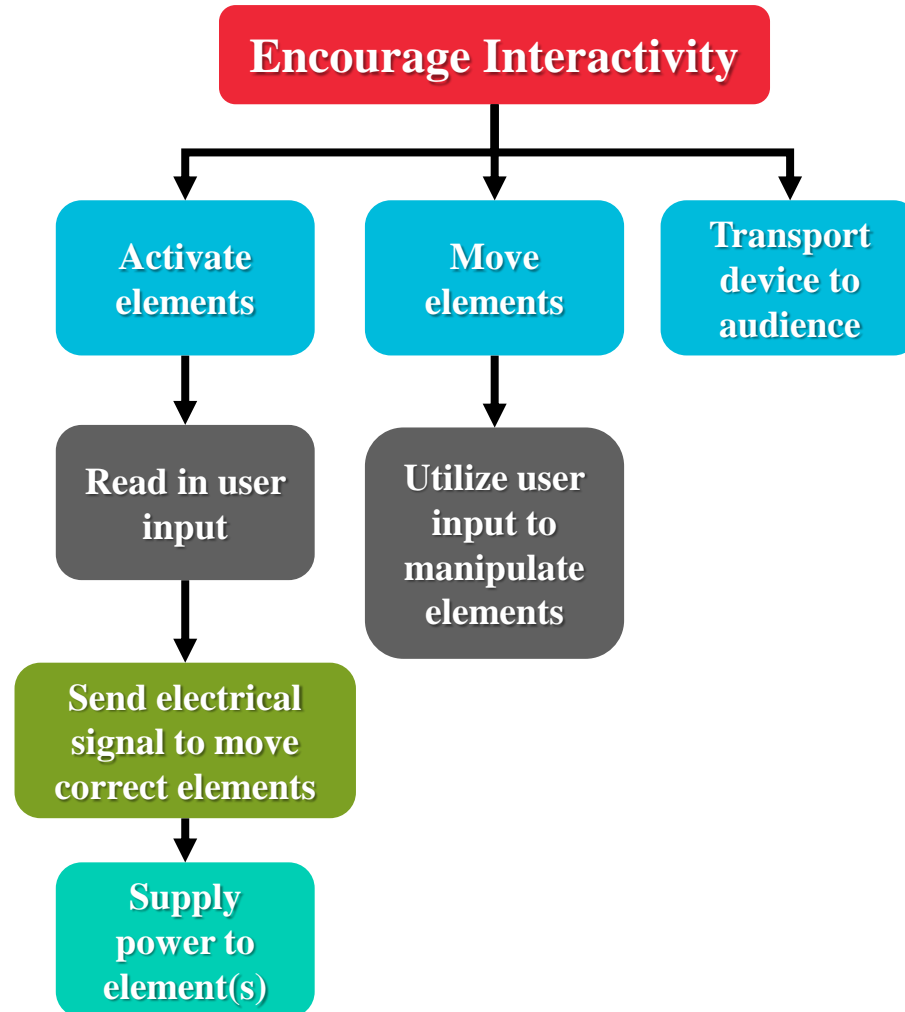
<u>Question</u>	<u>Customer Answer</u>	<u>Interpreted Need</u>
<b>How would you like this device to be displayed? (Free standing, mounted, on ground, on table, etc.)</b>	As long as the display is portable, display can be done in any way	The device should be simple enough that one person can set it up.
<b>Should the appearance be stylized in a particular fashion?</b>	Attractive and appealing to various audiences	Should be professional since it represents the universities, but no specific style required



# Functional Decomposition



# Functional Decomposition



# Analytical Hierarchy Process

Normalized Criteria Comparison Matrix [NormC]				
	Concept 6	Concept 8	Concept 9	Concept Weights {W}
Concept 6	0.467	0.467	0.467	0.467
Concept 8	0.067	0.067	0.067	0.067
Concept 9	0.467	0.467	0.467	0.467
Sum	1.000	1.000	1.000	1.000

**Number of songs**

# Analytical Hierarchy Process

Normalized Criteria Comparison Matrix [NormC]				
	Concept 6	Concept 8	Concept 9	Concept Weights {W}
Concept 6	0.143	0.077	0.200	0.140
Concept 8	0.429	0.231	0.200	0.286
Concept 9	0.429	0.692	0.600	0.574
Sum	1.000	1.000	1.000	1.000

Number of electronic elements



# Analytical Hierarchy Process

Normalized Criteria Comparison Matrix [NormC]				
	Concept 6	Concept 8	Concept 9	Concept Weights {W}
Concept 6	0.143	0.143	0.143	0.143
Concept 8	0.714	0.714	0.714	0.714
Concept 9	0.143	0.143	0.143	0.143
Sum	1.000	1.000	1.000	1.000

**Weight**

# Analytical Hierarchy Process

Normalized Criteria Comparison Matrix [NormC]				
	Concept 6	Concept 8	Concept 9	Concept Weights {W}
Concept 6	0.158	0.143	0.333	0.211
Concept 8	0.789	0.714	0.556	0.686
Concept 9	0.053	0.143	0.111	0.102
Sum	1.000	1.000	1.000	1.000

Number of moving elements