FAMU-FSU College of Engineering Department of Mechanical, Electrical, and Computer Engineering

Team 315

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Concept Selection

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Trade-off matrix

Pola	rity	Cost	Dimension	Memory Size	Processing Power	Weight
		-	-	-	+	-
Simulation performance	+	↑ ↑	0	↑ ↑	↑ ↑	0
FPV	+	ſ	1	0	0	↑
Portable	+	0	\downarrow	0	0	Ļ
AI Functionality	+	ſ	0	↑ ↑	↑↑	0
Controller Functionality	+	ſ	Î	0	0	ſ
Low Cost	+	$\downarrow\downarrow$	0	Ļ	Ļ	0

		Cost	Dimension	Memory Size	Processing Power	Weight
		-	-	-	+	-
Cost	-		$\downarrow\downarrow$	$\downarrow\downarrow$	Ļ	$\downarrow\downarrow$
Dimension	-			t t	Ļ	$\downarrow\downarrow$
Memory size	-				† †	Ļ
Processing Power	+					ţ
Weight	-					

Po	larity	Cost	Dimension	Memory Size	Processing Power	Weight
		-	-	-	+	-
Simulation performance	+	↓↓	0	$\downarrow\downarrow$	↑ ↑	0
FPV	+	Ļ	0	Ļ	1	0
Portable	+	0	Ļ	0	0	Ļ
AI Functionality	+	ſ	0	↑ ↑	<u>↑</u> ↑	0
Controller Functionally	+	↑↑	1	0	0	↓↓
Low Cost	+	$\downarrow\downarrow$	1	1	Ţ	0
Target for Requirements		<\$500	<15 feet cube	<50 GB	<3 GHz	<20 pounds

House of Quality

Roof of the house

Requirement	Cost	Dimension	Memory Size	Processing Power	Weight
Cost	↓	↓	1	↓	Ť
Dimension		\downarrow		1	
Memory Size	Î		Ļ	Î	
Processing Power	Ļ	Î	Î	Ļ	

For our house of quality chart, we started off by creating a trade off matrix with the requirements we thought were necessary for our project. We labeled the desirable traits with '+' marks and the negative ones with '-' marks. By comparing each row with each column, we decided whether certain impacts had a positive or negative correlation, or no impact at all. Then we put our requirements on a mirrored chart to compare their correlation as well. Lastly, we put it all together and created our house of quality based on our correlations, requirements, and specific targets.

Pugh Chart Options

- 1. Gaming controller with a VR display with an obstacle course created in Unity.
- 2. Motion controller with VR display with obstacle course created in Unity
- 3. Gaming controller with VR display with urban setting created in Unity
- 4. Plane yoke with VR display with obstacle course created in Unreal Engine
- 5. Motion controller with VR display with urban setting created in Unreal Engine

Pugh chart

		Option 1	Option 2	Option 3	Option 4	Option 5
Simulate a drone	5	-	0	0	0	0
FPV	2	-	0	0	0	0
Portable	3	-	0	0	0	0
AI	3	-	0	0	0	0
Controller	4	-	-1	0	-1	-1
Low Cost	4	-	-1	0	-1	-1
Score		-	-8	0	-8	-8
continue?		-	No	No	No	No

In our Pugh analysis, we evaluated our top 5 design options for a VR-based gaming controller setup, each with different configurations. Our options included various controller types, VR settings, and development platforms, such as Unity and Unreal Engine. We established criteria based on the needs of our sponsor, including the ability to simulate a drone, provide a first-person view (FPV), ensure portability, incorporate AI functionality, offer an custom controller, and maintain low cost. Option 1: "a gaming controller with a VR display and an obstacle course

created in Unity", was set as the baseline. Each alternative was scored against Option 1 for each criterion, with scores of +1, 0, or -1 indicating whether an option was better, equal, or worse, respectively. Based on our Pugh Chart, we concluded that the best game engine to use is Unity. The best controller to use is a gaming controller, and the best environment to build is an obstacle course. All of the other options scored lower than option 1, indicating that the other design options are less desirable. With these conclusions, we decided option 1 met the needs most efficiently by balancing cost, functionality, and met requirements. Ultimately, no further Pugh charts were necessary.

Analytical Hierarchy Process (AHP)

Pairwise

							1	2		3		4		5	6		
			1. Simula	te Perform	ance	1.0	000	5.0	00	3.000		1.00	0	1.000	3.000		
				2. FPV		0.2	200	1.0	00	3.000		0.33	3	0.200	0.333		
			3.	Portable		0.3	333	0.3	33	1.000		0.33	3	0.200	0.333		
			4. Al I	Functionalit	ty	1.0	000	3.0	00	3.000		1.00	0	1.000	1.000		
			5. Control	ller Functio	nality	1.0	000	5.0	00	5.000		1.00	0	1.000	3.000		
			6.	Low Cost		0.3	333	3.0	00	3.000		1.00	0	0.333	1.000		
				Sum		3.	867	17.3	33	18.000)	4.66	57	3.733	8.667		
											-					-	
Criteria	a Weigh	ts					1	2		3		4		5	6	Criteria V	Veig
Compa	arison m	atrix	1. Simula	te Perform	ance		0.25	Ð	0.288		0.167	0.	214	0.268	0.346		0
				2. FPV			0.05	2	0.058		0.167	0.	071	0.054	0.038		0
			3.	Portable			0.08	- 5	0.019		0.056	0	071	0.054	0.038		
			4 41	Functionali	tv		0 259	9	0.173		0.167		214	0.268	0.115		
			5. Control	ller Functio	nality		0.25	3	0.288		0 278	0.	214	0.268	0 346		0
			6	Low Cost			0.080	5	0 173		0 167	0.	214	0.089	0.115	1	0
		-	0.	Cum		• ——	1	1	0.175	1	0.107	1	214	1	1	1.0	000
				Sulli			1	1		1		1		1		1.0	00
Canala	tomay Ch	a alí				(14/2)-[C	1(14/)	Critoria	Voiahta	Came=(14/a) //	14/1						
consis	tency cr	еск	1 Cincula	+- D		{vvs}=[C	1 (0)		veignts	Cons={ws}./{	VV }				├────	-	
			1. Simula	a rev	ance		1.68	-	0.257		6.548				├────		
				2. FPV			0.45	>	0.073		6.216				<u> </u>		
			3.	Portable			0.33	-	0.054		6.151					-	
			4. AI I	unctionalit	ty		1.25		0.199		6.295				┝────		
			5. Contro	ller Functio	nality		1.793		0.276		6.500				┝────		
			6.	Low Cost			0.900		0.141		6.389				┝────		
															L		
	Simulatio	n performance			-+		Comment 1	FPV	Concent					lestable		1	
Concent 1	Concept 1	Concept 2	Concept 3	0		Concept 1	1.000	1.000	Concept				Concept 1	Concept	2 Concept 3		
Concept 2	1.000	1	.000 1.00	0		Concept 2 Concept 3	1.000	1.000		1.000	Co	ncept 1 ncept 2	1.00	0 0	1.000 1.000 1.000 1.000	2	
.oncept 3 m	3.000	1. 3.	000 1.00	0		Sum	3.000	3.000	3	.000	Co	ncept 3	1.00 3.00	0 :	1.000 1.000 3.000 3.000	2	
							Norr	nalized Comparise	n [NormC]								
	Norma	lized Compariso	on [NormC]	Design			Concent	Concent 2	Conco-t	Design		1	Norm	alized Comparis	son [NormC]	Design	
	Concept 1	Concept 2	Concept 3	Alternative Priorities (Pi)	_		concept 1	concept 2	concept :	Priorities {Pi}			Concept 1	Concept	2 Concept 3	Alternative	
Concept 1	0.333	0	333 0.33	3 0.333		Concept 1 Concept 2	0.333	0.333		0.333 0.333 0.333 0.333	Co	ncept 1	0.33	3	0.333 0.333	0.333	
Concept 2	0.333	0	.333 0.33	3 0.333		Concept 3 Sum	0.333	0.333	(0.333 0.333	Co	ncept 2 ncept 3	0.33	3	0.333 0.333 0.333 0.333	0.333	
m	1		1	1 1							Sum			1	1 1	ι <u>1</u>	
					_	6	Charal										
onsistency	y Check					CONSISTENCY CR should be < 0.2	10				Con	sistency	Check				
anound be < 0					- r		Design				CR sh	ould be < 0.1	J		_		
/eight Sum	Design Alternative	Consistency	,			Weight Sum	Alternative	Consistency			Wei	ght Sum	Design	Consisten	cy		
actor {Ws}	Priorities {Pi}	Vector (Con	\$}			(Ma) - (c)(c)	{Pi}	(Canal - (1911) //21			Fac	tor {Ws}	riorities (Pi	} Vector {Co	ns}		
		{Cons} = {Ws}./	[Pi] .000			\vvs} = [C]{Pi} 1.000	0.333	(cons) = (Ws)./{Pi} 3.000			{Ws	} = [C]{Pi}	0.33	{Cons} = {Ws}	/{Pi}		
Ns} = [C]{Pi}	0.333					1.000	0.333	3.000				1.000	0.33	3	ana and a second		
Ns} = [C]{Pi} 1.000 1.000	0.333	3	.000			1.000	0.333	3.000				1.000	-		3.000		
Ws} = [C]{Pi} 1.000 1.000 1.000	0.333 0.333 0.333	3	000			1.000	0.333	3.000		Consistency		1.000	0.33	3	3.000		
Ws} = [C]{Pi} 1.000 1.000 1.000 Average	0.333 0.333 0.333 0.333	3 Consistency In	000 000 dex Random Index Value:	Consistency s Ratio	-1	1.000 1.000 Average Consistency	0.333 Number of Concepts	3.000 Consistency Index (CI)	Random Inc Values (Ri	ex Consistency Ratio	A	1.000 verage	0.33 Number of	3 Consistency I	3.000 3.000 ndex Random Index Values	Consistency Ratio	

						Controller	Functionality							1
	AI Co	mparison [C]		-		Concent 1	Concent 2	Concept 3			Convent 1	ow cost	Concent 2	
	Concept 1	Concept 2	Concept 3	-	Concent 1	1 000	2 000	1.000		Concept 1	1 000	2 000	1 000	
Concept 1	1.000	1.000	1.000	-	Concept 2	0.333	1,000	0.222		Concept 2	0 333	1,000	0.333	
Concept 2	1.000	1.000	1.000	-	Concept 2	1.000	2,000	1.000		Concept 3	1.000	3.000	1.000	
Concept 3	1.000	1.000	1.000		Sum	1.000	7.000	1.000		Sum	2.333	7.000	2.333	
Sum	3 000	3 000	3 000		Juli	2.555	7.000	2.333						
Juin	5.000	5.000	5.000			Nerme	lined Commenteen [8	la ren Cl						
						Norma	lized comparison [r	l	Desian					
			- [N C]			C	C	C	Design				fr	
	NOT	malized Compariso	n (Norme)			Concept 1	Concept 2	Concept 3	Alternative		Nor	malized Compariso	on [NormC]	
				Design					Priorities (PI)		Concont 1	Concent 2	Concent 2	Design
	Concept 1	Concept 2	Concept 3	Alternative	Concept 1	0.333	1.000	0.333	0.556		concept 1	concept 2	concept 5	Priorities (Pi)
				Priorities (Pi)						Concept 1	0.429	0.429	0.429	0.429
Concept 1	0.333	0.333	0.333	0.333	Concept 2					Concept 2	0.143	0.143	0.143	0.143
Concept 2	0.333	0.333	0.333	0.333		0.111	0.333	0.111	0.185	Concept 3	0.429	0.429	0.429	0.429
Concept 3	0.333	0.333	0.333	0.333	Concept 3	0.333	1.000	0.333	0.556	Sum	1	1	1	1
Sum	1	1	1	1	Sum	0.77777778	2.333333333	0.77777778	1.296296296		-	-		-
					Consistence CR should be <	y Check								
Consistency	/ Check									Consistency	Check			
CR should be < 0.	.10				Weight Sum	Design	Consistency			CR should be < 0.	10			
					Factor {Ws}	Alternative	Vector {Cons}							
Woight Sum	Design	Consistency			{Ws} = [C]{Pi}	Priorities (Pi)	{Cons} = {Ws}./{Pi}			Weight Sum	Design Alternative	Consistency		
Eactor /Wel	Priorities	Vector (Cons)			1.667	0.556	3.000			Factor {Ws}	Priorities	Vector (Cons)		
ractor (way	(pi)	vector (cons)			0.556	0.185	3,000				{Pi}			
(M/s) = [C](B)	1 Trij	(Conc) = (M(c) ((Di)			0.000	0.105	5,000			{Ws} = [C]{Pi}		{Cons} = {Ws}./{Pi}		
(vvs/=[C]{PI}		(cons) - (WS)./(PI)								1				
1.000	0.333	3.000								1 786	0.429	3 000		
1.000	0.333	3.000			1.667	0.556	3.000			0.429	0.143	3.000		
1.000	0.333	3.000			1.007	0.550	5.000			1.286	0.429	3.000		
						1		Random	Consistency					
Average Consistency	Number of Concepts (n)	Consistency Index (CI)	Random Index Values (RI)	Consistency Ratio CR = CI/RI	Average Consistency	Number of Concepts (n)	Consistency Index (CI)	Index Values (RI)	Ratio CR = CI/RI	Average Consistency	Number of Concepts (n)	Consistency Index (CI)	Random Index Values (RI)	Consistency Ratio CR = CI/RI
3.000	3	0.0000	0.52	0.0000	3.000	3	0.0000	0.52	0.0000	3.000	3	0.0000	0.52	0.0000
5.000		0.0500	2.52	0.0000										

Final Rating Matrix						
Values transferred from AHP design alternatives	pairwise comparisons	5				
Selection Criteria	Concept 1	Concept 2	Concept 3			
1. Simulate Performance	0.333	0.333	0.333			
2. FPV	0.333	0.333	0.333			
3. Portable	0.333	0.333	0.333			
4. Al Functionality	0.333	0.333	0.333			
5. Controller Functionality	0.556	0.185	0.556			
6. Low Cost	0.429	0.143	0.429			
Final Rating Matrix, Transposed						
Values from Final Rating Matrix transposed						
Final Concepts	1. Simulate Performance	2. FPV	3. Portable	4. Al Functionality	5. Controller Functionality	6. Low Cost
Concept 1	0.333	0.333	0.333	0.333	0.556	0.429
Concept 2	0.333	0.333	0.333	0.333	0.185	0.143
Concept 3	0.333	0.333	0.333	0.333	0.556	0.429
Alternative Value Matrix						
Transposed final rating matrix multiplied by crite	eria weights					



In our AHP process, we systematically evaluated three concepts against a set of six criteria: Simulate Performance, FPV, Portability, AI Functionality, Controller Functionality, and Low Cost. We started by creating a pairwise comparison matrix for the criteria, which allowed us to calculate their relative weights based on their importance to the project. Each criterion was rated in comparison to the others using the AHP scale, resulting in a normalized matrix where each criterion's weight was determined. We then evaluated each concept (Concept 1, Concept 2, and Concept 3) against each criterion using pairwise comparisons, generating priority values for each alternative. These values were compiled into a final rating matrix, which was then multiplied by the criteria weights to yield an overall score for each concept. The final scores revealed that Concepts 1 and 3 were the top choices. This systematic approach ensured a consistent and objective evaluation process, highlighting Concept 1 as the preferred choice due to its high alignment with the criteria.

Final Selection

Top 3 concepts

- 1. Gaming controller with a VR display with an obstacle course created in Unity.
- 2. Motion controller with VR display with obstacle course created in Unity
- 3. Gaming controller with VR display with urban setting created in Unity

Based on our previous concept selection techniques, all in all we decided to go with option #1: "Gaming controller with a VR display with an obstacle course created in Unity". We believe this concept fulfills the requirements of our project the most efficiently compared to the other options, while also taking into consideration the needs of our sponsor. We came to this conclusion initially by filling in the pugh chart, and seeing that every other option, while similar, had some negative parts attached to them compared to option 1. It should be noted that our top 3 options, concepts 1 and 3 are the most viable for meeting the requirements of our sponsor as seen in the scores of the AHP chart we created [figure 1]. As such, we ultimately decided to go with option 1 for now as it's easier to implant, and possibly building in the urban setting from option 3 in the future, should we have more time.



Figure 1