FAMU-FSU College of Engineering
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Team 315
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Concept Selection

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<u>Trade-off matrix</u>

	Polarity	Cost	Dimension	Memory Size	Processing Power	Weight
		-	-	-	+	-
Simulation performance	+	↑↑	0	↑↑	↑↑	0
FPV	+	↑	↑	0	0	↑
Portable	+	0	↓	0	0	↓
AI Functionality	+	↑	0	↑↑	↑↑	0
Controller Functionality	+	↑	↑	0	0	↑
Low Cost	+	↓↓	0	↓	↓	0

		Cost	Dimension	Memory Size	Processing Power	Weight
		-	-	-	+	-
Cost	-		↓↓	↓↓	↓	↓↓
Dimension	-			↓↓	↓	↓↓
Memory size	-				↓↓	↓
Processing Power	+					↓
Weight	-					

House of Quality

Polarity		Cost	Dimension	Memory Size	Processing Power	Weight
		-	-	-	+	-
Simulation performance	+	↓↓	0	↓↓	↑↑	0
FPV	+	↓	0	↓	↑	0
Portable	+	0	↓	0	0	↓
AI Functionality	+	↑	0	↑↑	↑↑	0
Controller Functionally	+	↑↑	↑	0	0	↓↓
Low Cost	+	↓↓	↑	↑	↑	0
Target for Requirements		<$500	<15 feet cube	<50 GB	<3 GHz	<20 pounds

<u>Roof of the house</u>

Requirement	Cost	Dimension	Memory Size	Processing Power	Weight
Cost	↓	↓	↑	↓	↑
Dimension		↓		↑	
Memory Size	↑		↓	↑	
Processing Power	↓	↑	↑	↓	

Weight	↑				↓

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.

<u>Pugh Chart Options</u>
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

<u>Pugh chart</u>

		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. Simulate Performance	1.000	5.000	3.000	1.000	1.000	3.000
2. FPV	0.200	1.000	3.000	0.333	0.200	0.333
3. Portable	0.333	0.333	1.000	0.333	0.200	0.333
4. AI Functionality	1.000	3.000	3.000	1.000	1.000	1.000
5. Controller Functionality	1.000	5.000	5.000	1.000	1.000	3.000
6. Low Cost	0.333	3.000	3.000	1.000	0.333	1.000
Sum	3.867	17.333	18.000	4.667	3.733	8.667

Criteria Weights Comparison matrix

	1	2	3	4	5	6	Criteria Weights
1. Simulate Performance	0.259	0.288	0.167	0.214	0.268	0.346	0.257
2. FPV	0.052	0.058	0.167	0.071	0.054	0.038	0.073
3. Portable	0.086	0.019	0.056	0.071	0.054	0.038	0.054
4. AI Functionality	0.259	0.173	0.167	0.214	0.268	0.115	0.199
5. Controller Functionality	0.259	0.288	0.278	0.214	0.268	0.346	0.276
6. Low Cost	0.086	0.173	0.167	0.214	0.089	0.115	0.141
Sum	1	1	1	1	1	1	1.000

Consistency Check

	{Ws}=[C]{W}	Criteria Weights	Cons={Ws}./{W}
1. Simulate Performance	1.683	0.257	6.548
2. FPV	0.455	0.073	6.216
3. Portable	0.333	0.054	6.151
4. AI Functionality	1.255	0.199	6.295
5. Controller Functionality	1.791	0.276	6.500
6. Low Cost	0.900	0.141	6.389

Simulation performance

	Concept 1	Concept 2	Concept 3
Concept 1	1.000	1.000	1.000
Concept 2	1.000	1.000	1.000
Concept 3	1.000	1.000	1.000
Sum	3.000	3.000	3.000

Normalized Comparison [NormC]

	Concept 1	Concept 2	Concept 3	Design Alternative Priorities {Pi}
Concept 1	0.333	0.333	0.333	0.333
Concept 2	0.333	0.333	0.333	0.333
Concept 3	0.333	0.333	0.333	0.333
Sum	1	1	1	1

Consistency Check

CR should be < 0.10

Weight Sum Factor {Ws}	Design Alternative Priorities {Pi}	Consistency Vector {Cons}
{Ws} = [C]{Pi}		{Cons} = {Ws}./{Pi}
1.000	0.333	3.000
1.000	0.333	3.000
1.000	0.333	3.000

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

FPV

	Concept 1	Concept 2	Concept 3
Concept 1	1.000	1.000	1.000
Concept 2	1.000	1.000	1.000
Concept 3	1.000	1.000	1.000
Sum	3.000	3.000	3.000

Normalized Comparison [NormC]

	Concept 1	Concept 2	Concept 3	Design Alternative Priorities {Pi}
Concept 1	0.333	0.333	0.333	0.333
Concept 2	0.333	0.333	0.333	0.333
Concept 3	0.333	0.333	0.333	0.333
Sum	1	1	1	1

Consistency Check

CR should be < 0.10

Weight Sum Factor {Ws}	Design Alternative Priorities {Pi}	Consistency Vector {Cons}
{Ws} = [C]{Pi}		{Cons} = {Ws}./{Pi}
1.000	0.333	3.000
1.000	0.333	3.000
1.000	0.333	3.000

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

Portable

	Concept 1	Concept 2	Concept 3
Concept 1	1.000	1.000	1.000
Concept 2	1.000	1.000	1.000
Concept 3	1.000	1.000	1.000
Sum	3.000	3.000	3.000

Normalized Comparison [NormC]

	Concept 1	Concept 2	Concept 3	Design Alternative Priorities {Pi}
Concept 1	0.333	0.333	0.333	0.333
Concept 2	0.333	0.333	0.333	0.333
Concept 3	0.333	0.333	0.333	0.333
Sum	1	1	1	1

Consistency Check

CR should be < 0.10

Weight Sum Factor {Ws}	Design Alternative Priorities {Pi}	Consistency Vector {Cons}
{Ws} = [C]{Pi}		{Cons} = {Ws}./{Pi}
1.000	0.333	3.000
1.000	0.333	3.000
1.000	0.333	3.000

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

AI Comparison [C]			
	Concept 1	Concept 2	Concept 3
Concept 1	1.000	1.000	1.000
Concept 2	1.000	1.000	1.000
Concept 3	1.000	1.000	1.000
Sum	3.000	3.000	3.000

Normalized Comparison [NormC]				
	Concept 1	Concept 2	Concept 3	Design Alternative Priorities {Pi}
Concept 1	0.333	0.333	0.333	0.333
Concept 2	0.333	0.333	0.333	0.333
Concept 3	0.333	0.333	0.333	0.333
Sum	1	1	1	1

Consistency Check

CR should be < 0.10

Weight Sum Factor {Ws}	Design Alternative Priorities {Pi}	Consistency Vector {Cons}
{Ws} = [C]{Pi}		{Cons} = {Ws}./{Pi}
1.000	0.333	3.000
1.000	0.333	3.000
1.000	0.333	3.000

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

Controller Functionality			
	Concept 1	Concept 2	Concept 3
Concept 1	1.000	3.000	1.000
Concept 2	0.333	1.000	0.333
Concept 3	1.000	3.000	1.000
Sum	2.333	7.000	2.333

Normalized Comparison [NormC]				
	Concept 1	Concept 2	Concept 3	Design Alternative Priorities {Pi}
Concept 1	0.333	1.000	0.333	0.556
Concept 2	0.111	0.333	0.111	0.185
Concept 3	0.333	1.000	0.333	0.556
Sum	0.777777778	2.333333333	0.77777778	1.296296296

Consistency Check

CR should be < 0.10

Weight Sum Factor {Ws}	Design Alternative Priorities {Pi}	Consistency Vector {Cons}
{Ws} = [C]{Pi}		{Cons} = {Ws}./{Pi}
1.667	0.556	3.000
0.556	0.185	3.000
1.667	0.556	3.000

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

Low Cost			
	Concept 1	Concept 2	Concept 3
Concept 1	1.000	3.000	1.000
Concept 2	0.333	1.000	0.333
Concept 3	1.000	3.000	1.000
Sum	2.333	7.000	2.333

Normalized Comparison [NormC]				
	Concept 1	Concept 2	Concept 3	Design Alternative Priorities {Pi}
Concept 1	0.429	0.429	0.429	0.429
Concept 2	0.143	0.143	0.143	0.143
Concept 3	0.429	0.429	0.429	0.429
Sum	1	1	1	1

Consistency Check

CR should be < 0.10

Weight Sum Factor {Ws}	Design Alternative Priorities {Pi}	Consistency Vector {Cons}
{Ws} = [C]{Pi}		{Cons} = {Ws}./{Pi}
1.286	0.429	3.000
0.429	0.143	3.000
1.286	0.429	3.000

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

Final Rating Matrix

Values transferred from AHP design alternatives pairwise comparisons

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. AI 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

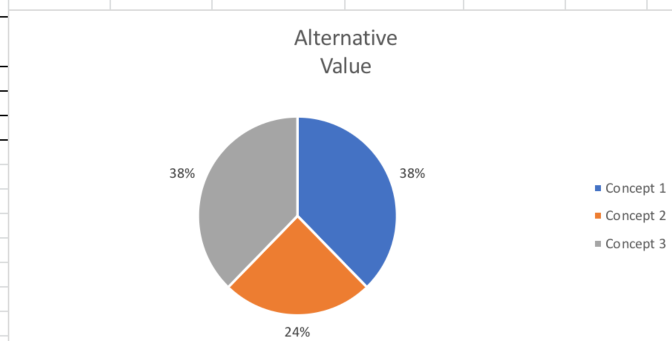
Values from Final Rating Matrix transposed

Final Concepts	1. Simulate Performance	2. FPV	3. Portable	4. AI 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 criteria weights

Final Concepts	Alternative Value
Concept 1	0.408
Concept 2	0.266
Concept 3	0.408



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

Final Concepts	Alternative Value
Concept 1	0.408
Concept 2	0.266
Concept 3	0.408