FAMU/FSU College of Engineering

Department of Electrical and Computer Engineering

Concept Selection

Team 303 Software Defined Radio

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House of Quality

Table 1 House of Quality

		Engineering Characteristics							
		Lost Cost	Power Supply	Durable	Weight	Device Size	Easy to Use	Complex Modulation	
Customer Requirements	Programmable	(-)	(-)				(++)	(+)	
	Affordable	(++)	(-)	(+)	(+)	(+)			Relationship
	Power Supply	(+)	(++)		(++)	(+)			High (++)
	Portable		(-)	(-)	(++)	(++)			Medium (+)
	Durable	(+)		(++)	(+)	(+)			Weak (-)
	Complex Modulation						(-)	(++)	
	High Instantaneous Bandwidth						(+)	(++)	
	Memory	(-)				(-)	(+)	(+)	
	Target for Requirements	< $3000	12V	Yes	8.8 oz	7.5 x 4.3 x 1.2 in.	Reprogrammable	100MHz	

A house of quality chart was used to determine how the customers requirements relate directly to the ways and methods companies can use to achieve those requirements. Based on this comparison chart, we were able to determine which requirements and characteristics were most important to our project and list the target requirements in the last row.

Pugh Chart

Table 2 Pugh Chart

	Weight	Design 1	Design 2	Design 3	Design 4	Design 5	Design 6
Engineering Concept (Design Criteria)		FPGA	Digitial to Analog Converter	Frequency Modulator	Oscillator	Operational Amplifier Level-Shift	USB Connection
Programmability	3	+	0	0	0	0	+
Affordability	2	+	0	+	0	0	0
Power Supply	1	0	0	0	0	0	0
Memory	2	+	N/A	N/A	N/A	N/A	+
Durability	2	0	0	0	0	0	0
Weight	1	0	0	0	0	0	0
Complex Modulation	3	0	0	++	N/A	N/A	N/A
High Fidelity	3	++	0	++	0	0	0
Score	x	10	0	14	0	0	5

The Pugh chart is a tool used for evaluating multiple options against each other. Rather than basic consideration of the pros and cons of each funding option, the Pugh chart gives a holistic overview of the needs, goals and other important criteria for the team versus the available alternatives. All aspects of the design are needed, but we found the FPGA and frequency modulator to be most important.

Analytical Hierarchy Process:

Table 3 Analytical Hierarchy Process Comparison Chart

	Programmable	Affordable	Power Supply	Portable	Durable	Complex Modulation	High Instantaneous Bandwidth	Memory	Geom. Mean	
Programmable	1	3	5	3	1	1	1	5	1.968	Legend
Affordable	1/3	1	1/5	1	1/7	1/7	1/7	1/3	0.2988	1 = Equally important
Power Supply	1/5	5	1	1/5	1/5	1/5	1/5	1/5	0.3657	3 = moderate
Portable	1/3	1	5	1	1/3	1/7	1/7	1/5	1.3027	5 = strong
Durable	1	7	5	3	1	1/3	1/3	1	1.4417	7 = very strong
Complex Modulation	1	5	5	7	3	1	1	3	1.5027	9 = extreme
High Instantaneous Bandwidth	1	7	5	7	3	1	1	3	1.5167	
Memory	1/5	3	5	5	1	1/3	1/3	1	1.4127	
Sum	5.0667	32	31.2	27.2	9.6762	4.1524	4.1524	13.7333	9.809	

Table 4 AHP Normalized Comparison Chart

	Programmable	Affordable	Power Supply	Portable	Durable	Complex Modulation	High Instantaneous Bandwidth	Memory	Normal Weight
Programmable	0.1974	0.0938	0.1603	0.1103	0.1033	0.2408	0.2408	0.3641	0.1889
Affordable	0.0658	0.0313	0.0064	0.0368	0.0053	0.0344	0.0344	0.0243	0.0298
Power Supply	0.0395	0.1563	0.0321	0.0123	0.0207	0.0482	0.0482	0.0146	0.0465
Portable	0.0658	0.0313	0.1603	0.1724	0.0344	0.0344	0.0344	0.0146	0.0685
Durable	0.1974	0.2188	0.1603	0.1103	0.1033	0.0803	0.0803	0.0728	0.1279
Complex Modulation	0.1974	0.1563	0.1603	0.2574	0.31	0.2408	0.2408	0.2184	0.2227
High Instantaneous Bandwidth	0.1974	0.2188	0.1603	0.2574	0.31	0.2408	0.2408	0.2184	0.2305
Memory	0.0395	0.0938	0.1603	0.1838	0.1033	0.0803	0.0803	0.0728	0.1018

1.8064	x	5.2966	=	8.6627
0.2875	x	33.557	=	9.6478
0.3836	x	21.5054	=	8.2494
0.5215	x	14.5985	=	7.6131
1.2163	x	7.8186	=	8.5100
2.1922	x	4.4903	=	9.8436
2.2518	x	4.3384	=	9.1692
0.9899	x	9.8232	=	9.0924

Principal Eigen Value, λ_i = 8.1292

Random Consistency Index (RI)

Matrix Size	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
RI	**0**	**0**	**0.58**	**0.9**	**1.12**	**1.24**	**1.32**	**1.41**

Random Consistency Index = RI
Consistency Index = CI
Consistency Ratio = CR
CI = λ_i - n/(n-1) , n=8
CI =0.1292
RI = 1.41
CR = CI/RI =0.0916312057< 10%(Eq. 2)

The Analytical Hierarchy Process (AHP) is used to calculate our trade study. We use the House of Quality and the Pugh Chart, to create a Pair Wise Chart that represents our AHP. The AHP concluded that complex modulation and high instantaneous bandwidth are the most important functional characteristics to prioritize with our trade study. The data from the AHP was able to calculate the ratio of the consistency index (CI). The result of the Random

Consistency Index (RI) was gathered through an online resource. The calculation of consistency ratio (CR) was under 10 % thus by the Saaty method, consistent with no bias.

Final Selection:

For the final design implementation, we will be using these components for each design:

Design Component	Selection Made (Product Number)
FPGA	XC6SLX9-2TQG144C
Voltage Regulators (Linear/Switching)	TPS561201DDCR
Buffer	SI5330F-B00214-GMR
DAC	MAX5852ETL+T
Oscillator	SIT8103AI-23-33E-100.00000X

The components above were determined by our sponsor Pete Stenger from Northrop Grumman for a variety of reasons. After taking a look at each parts' specifications, it is evident that the choices of components were made because of the desired input and output of each module. For example, the output of the oscillator is a 100 MHz signal, which is the required input of the FPGA for the clock. These parts - beyond fitting the requirements of the circuit - also had elements of familiarity, simplicity, and reliability; in much the same way that the chosen selection of simulation and testing software offers.