Concept Selection

After enough design concepts were generated for an alignment fixture the team focused on eliminating concepts. Concept selection tools were used to help with selecting the most promising concept. It was important that the design selected best fulfilled the customer needs. To input the customer needs for the project to the selection of our design a house of quality was used.

House of Quality

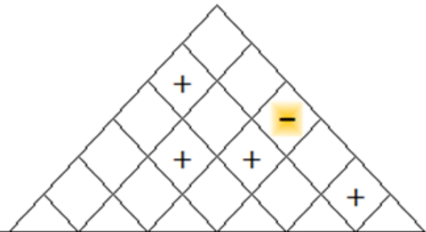
To rank the significance of each customer need a pairwise comparison chart was used. This chart can be seen in table 1.

Table 1: Pairwise Comparison Chart of Customer Needs.

Pairwise Comparison Chart						
	1	**2**	**3**	**4**	**Total**	**Importance Weight**
1. Work Station Space	-	0	0	0	0	1
2. Appropriate Press Selected	1	-	0	1	2	3
3. Alignment Tolerance Met	1	1	-	1	3	4
4. Critical Temperature	1	0	0	-	1	2

Using a house of quality tool the customer needs were interpreted into quantifiable engineering characteristics that can be used to compare the design concepts. The house of quality chart can be seen in table 2.

Table 2: House of Quality



Row #	Weight Chart	Relative Weight	Customer Importance	Customer Requirements / Engineering Characteristics	1	2	3	4	5	6
				Column #	1	2	3	4	5	6
				units	m^2	C	m	C/s	$	Yrs
				Direction of Improvement	◇	▼	◇	▼	▼	▲
					3m x 3m Work Space	325C Critical Temperature	.001mm Axial Alignment Tolerance	Determine Cooling Rates	Cost	Service Life
1		22%	4	Work station Space	9	1		1	1	
2		28%	5	Appropriately Selected Press	3	3	3	3	9	9
3		28%	5	Alignment Tolerance Met		3	9	3	9	3
4		22%	4	Critical Temperature Determined	1	9	3	9		
				Raw Score	55	27	63	63	55	108
				Relative Weight	26.4%	13.0%	30.3%	30.3%	26.4%	51.9%
				Rank Order	3	4	2	2	3	1

The weights of customer needs determined from the pairwise chart were used to determine the rank of the engineering characteristics. These quantifiable engineering characteristics are used to compare the quality of the design concepts.

Pugh Matrix

To help with selecting the most promising design concept a Pugh matrix was used. The selection criteria used for the Pugh matrix was interpreted from the engineering characteristics from the house of quality. A reference concept chosen to use as the datum is compared to the other concepts. The datum chosen was as the semi-cylindrical shells. The Pugh matrix can be seen below in table 3.

Table 3: Pugh matrix with cylindrical shells as the reference concept

Pugh Matrix - *A Decision Matrix*					
Problem/Situation:			Alignment Fixture for Press		
			1	2	3
			Alternatives		
Selection Criteria	**Shells**		Automated Arms	Guiding Rods	Gates
Alignment Tolerance	Datum		–	–	–
Size			–	0	+
Cost			–	–	+
Saftey			–	0	0
Efficiency			+	+	0
Service Life			0	–	–
	Totals		-3	-2	0
	Rank		3	2	1

From the rank of the Pugh matrix the open/closing gates seems to be a promising design. To determine if the gates is the best design concept another Pugh matrix was made with the guiding Rods as the reference.

Table 4: Pugh matrix with the guiding rods as the reference concept

Pugh Matrix - *A Decision Matrix*					
Problem/Situation:			Alignment Fixture for Press		
			1	2	3
			Alternatives		
Selection Criteria	**Guiding Rods**		Automated Arms	Shells	Gates
Alignment Tolerance	Datum		−	+	+
Size			+	0	+
Cost			−	+	+
Saftey			0	0	0
Efficiency			+	−	−
Service Life			−	+	−
	Totals		-1	2	1
	Rank		3	1	2

After analyzing another Pugh matrix it was determined that the overall most promising design concept was the semi-cylindrical shells. This design concepts had the best service life and most precise alignment tolerance which were the highest ranked engineering characteristics from the house of quality. To confirm that the concept selection was not determined from personal biases another way of ranking the customer needs was used called the Analytical Hierarchy Process.

Analytical Hierarchy Process

The analytical hierarchy process (AHP) was used on the engineering criteria to determine what to prioritize during concept selection. The results are shown below in tables 5, 6, 7, and 8.

Table 5: Pairwise Comparisons						
Item Description	Alignment Tolerance	Size	Cost	Safety	Efficiency	Service Life
Alignment Tolerance	1	7	3	1/5	3	5
Size	1/7	1	1/5	1/5	1/3	1/3
Cost	1/3	5	1	1/3	3	1
Safety	5	5	3	1	7	7
Efficiency	1/3	3	1/3	1/7	1	1
Service Life	1/5	3	1	1/7	1	1
Sum	7.010	24.000	8.533	2.019	15.333	15.333

Table 6: Normalized Matrix							
	Alignment Tolerance	Size	Cost	Safety	Efficiency	Service Life	Criteria Weight
Alignment Tolerance	0.143	0.292	0.352	0.099	0.196	0.326	0.234
Size	0.020	0.042	0.023	0.099	0.022	0.022	0.038
Cost	0.048	0.208	0.117	0.165	0.196	0.065	0.133
Safety	0.713	0.208	0.352	0.495	0.457	0.457	0.447
Efficiency	0.048	0.125	0.039	0.071	0.065	0.065	0.069
Service Life	0.029	0.125	0.117	0.071	0.065	0.065	0.079
Sum	1	1	1	1	1	1	1

Table 7: Consistency Index and Consistency Rating								
	Alignment Tolerance	Size	Cost	Safety	Efficiency	Service Life	Weighted Sum	Consistency Vector
Alignment Tolerance	0.234	0.266	0.400	0.089	0.206	0.393	1.589	6.778
Size	0.033	0.038	0.027	0.089	0.023	0.026	0.237	6.228
Cost	0.078	0.190	0.133	0.149	0.206	0.079	0.835	6.273
Safety	1.172	0.190	0.400	0.447	0.482	0.551	3.241	7.252
Efficiency	0.078	0.114	0.044	0.064	0.069	0.079	0.448	6.509
Service Life	0.047	0.114	0.133	0.064	0.069	0.079	0.505	6.425

Table 8: CI/CR Summary	
Size	6
lambda	6.577
Consistency Index	0.115
Consistency Ratio	0.093
RI Constant	1.24

The takeaway from the analysis above is that the engineering criteria should be ranked as follows: Safety, Alignment Tolerance, Cost, Service Life, Efficiency, and size. The consistency ratio is less than 0.1, so the results should be trustworthy.