Multidisciplinary Capstone Design:

VIA Dynamic Load Simulation On A Journal Bearing Test Rig

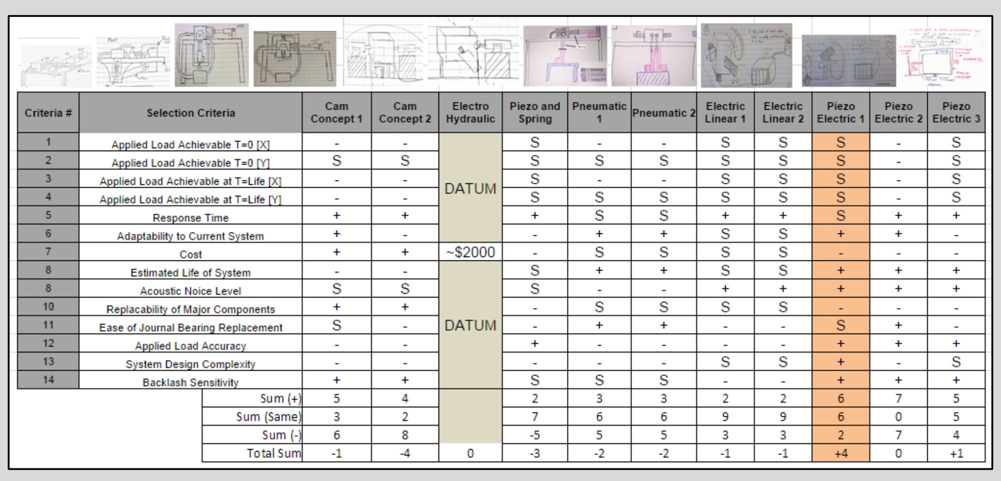
In 2010, Dresser-Rand, a global supplier of rotating equipment, donated ESH-1 reciprocating compressor to the Rochester Institute of Technology and has continually sponsored multidisciplinary senior design (MSD) projects. Dr. Jason Kolodziej, Assistant Professor of Mechanical Engineering at Rochester Institute of Technology, commissioned the construction of a dynamic journal bearing similarity test rig. The objective of this rig is to reduce the time required to perform seed of fault research of journal bearings. The project was split into a two phase build utilizing two consecutive multidisciplinary senior design teams. While the similarity test rig will assist Dr. Kolodziej and future graduate students with research at RIT, it also served as a "real world" design and development project for 10 soon-to-be engineers.

Course Structure:

- Required for all engineering seniors
- Team-Based, Capstone Design Experience
- Two Semester Breakdown – 30 Weeks
- MSD I focus – Design phase
- MSD II – Implementation, build & Test

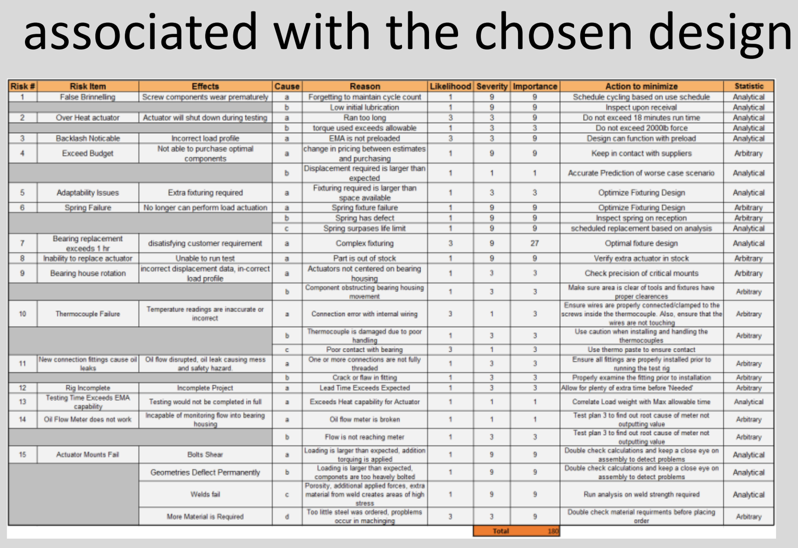
Concept Selection (5)

Pugh charts assist in team based concept selection, by measuring how well each option meets requirements



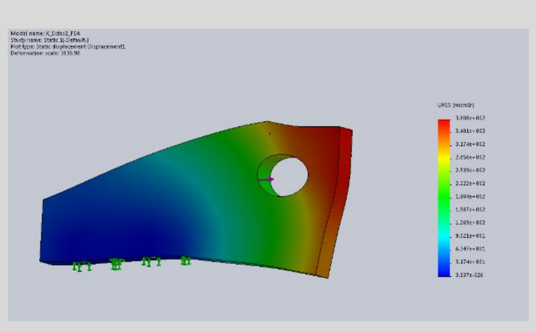
Risk Assessment (6)

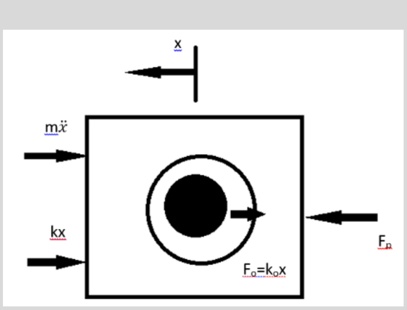
Measure the likelihood and severity of the risks associated with the chosen design

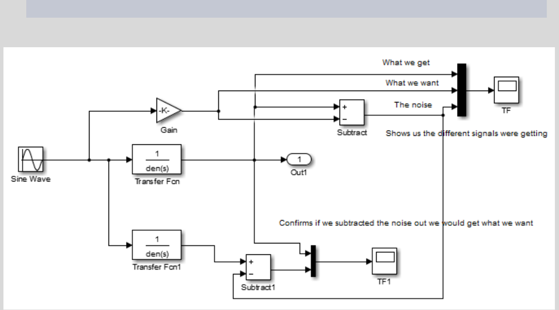


Theoretical Analysis (7)

Can the concept be proved? Theoretically? By software?

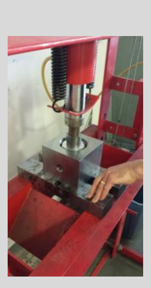


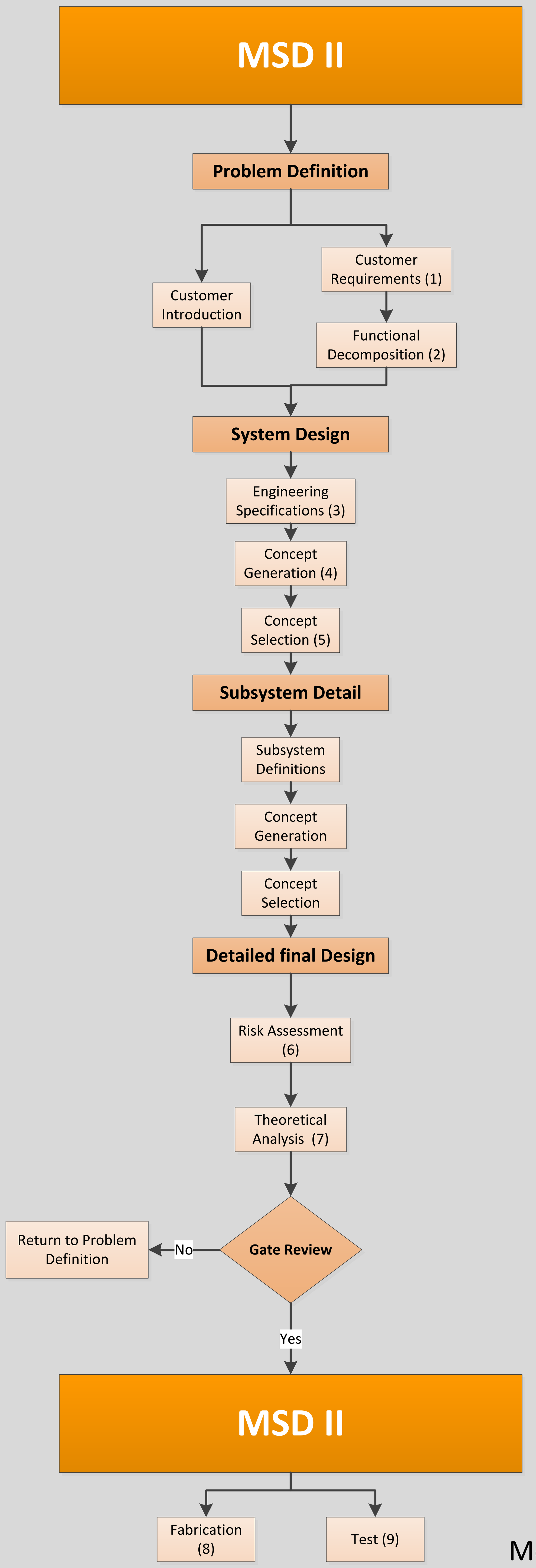




Fabrication (8)

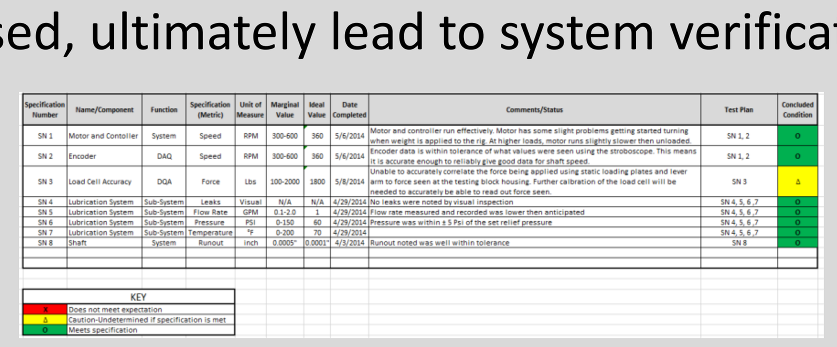
Students working hand and hand with RIT machine shop faculty to build design to specifications





Test (9)

Test plans consisting of detailed steps which will, if passed, ultimately lead to system verification.



Customer Needs (1)

The key requirements the customer expects from the finished product

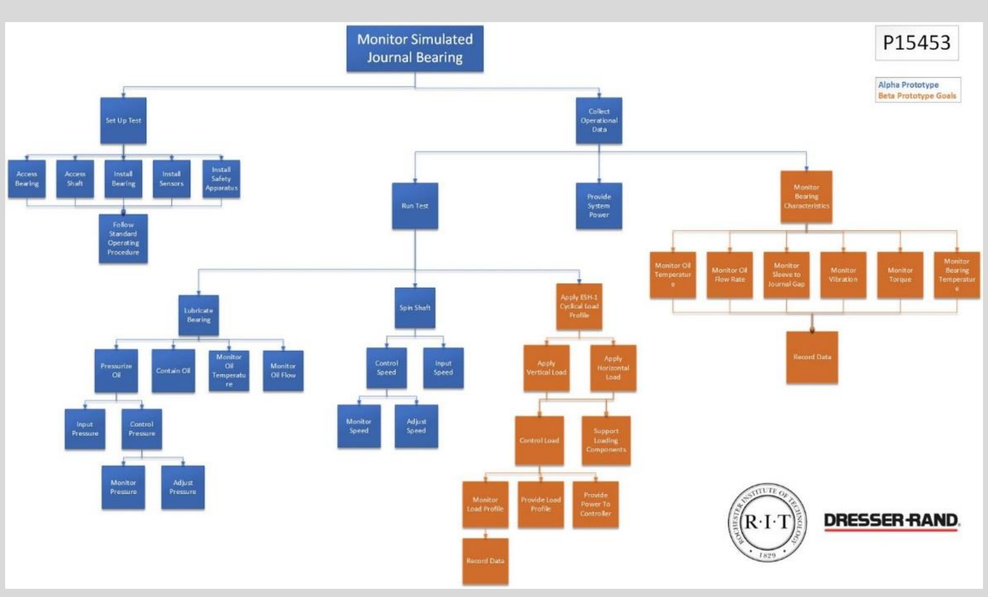
P15453 Customer Requirements

Revision Letter: -

Type	Cust. Rqmt. #	Importance	Description
Cost	CR 1.1	9	Fits within budget
Functionality Properties	CR 2.1	9	Replicates load profile of ESH-1 Compressor
	CR 2.2	9	Rapid Bearing replacment
	CR 2.3	9	Measures Load
	CR 2.4	9	Measures Oil Return Temperature
	CR 2.5	9	Measures Bearing Temperature
	CR 2.6	9	Measures Oil Pan Temperature
	CR 2.7	9	Measures Vibration
	CR 2.8	3	Measure Gap Between Journal & Sleeve
	CR 2.9	3	Modify Oil Flow Rate In/Out Measurment
	CR 2.10	3	Able to isolate bearing vibration from oil system vibration
	CR 2.11	1	Measures Bearing Wear
Safety	CR 3.1	9	Guarded Rotating Assembly
	CR 3.2	9	Add E-Stop
	CR 3.3	3	Low noise
Usability	CR 4.1	9	Records test data
	CR 4.2	9	Compatible with existing DAQ equipment

Functional Decomposition (2)

Small ,easily definable steps, taken to achieve customer requirements



Engineering Requirements (3)

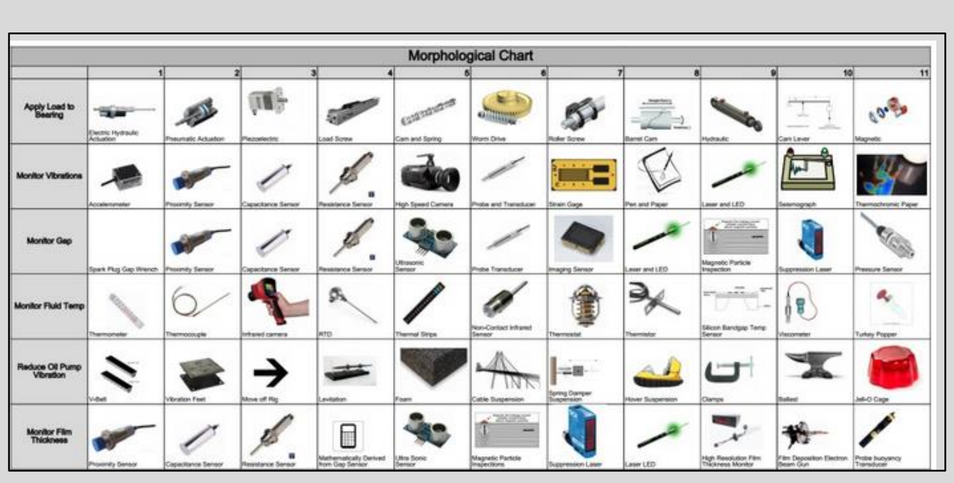
A set of requirements that coincide with customer requirements but have technical values of measure.

P15453 Engineering Requirements

Rqmt. #	Importance	Source Cust. Rqmt #	Function	Engr. Requirement (metric)	Unit of Measure	Ideal Value (range)	Accuracy
ER 1	9	CR 1.1	Meet Financial Constraints	Yes/No	$	$5,000.00	
ER 2	9	CR 2.1	Dynamic Load Actuating	Apply cyclical load profile	Lbf / Hz	1900 / 6	
ER 3	9	CR 2.2	Rapid Bearing replacment	Does not exceed an hour	Min	45 min	
ER 4	9	CR 2.3	Measure Load	Measure load at a bit rate of 10 hz	Lbf	0 - 2000	10%
ER 5	9	CR 2.4	Measure Oil Return Temperature	Measures Oil Return temperature at a bit rate of 10 hz	°F	0 - 150	10%
ER 6	9	CR 2.5	Measure Bearing Temperature	Measures Bearing temperature at a bit rate of 10 hz	°F	0 - 150	10%
ER 7	9	CR 2.6	Measure Oil Pan Temperature	Measures Oil pan temperature at a bit rate of 10 hz	°F	0 - 150	10%
ER 8	9	CR 2.7	Measure Bearing Vibration	Accelerometer measures vibration	kHz	0-10	10%
ER 9	3	CR 2.8	Measure Journal-Sleeve Clearance	Measures gap distance at a bit rate of 10 khz	µin	0 - 1970	10%
ER 10	3	CR 2.9	Modify Oil Flow Rate In/Out Measurment	Measures Oil Flow Rate for entire range of bearing load cycle at a bit rate of 10 hz	in3/s	0 - 5	10%
ER 11	3	CR 2.10	Isolate Oil Pump Vibration	80% less vibration than current system produces without isolation	Hz	0	10%
ER 12	1	CR 2.11	Measure Bearing Wear	Measures bearing wear at a bit rate of 10 hz	µin	0 - 1970	10%
ER 13	9	CR 3.1	Guarded Rotating Assembly	Rotated assembly is to safety specifications	Binary	yes	
ER 14	9	CR 3.2	Add E-Stop	E-stop is present and functioning	Binary	yes	
ER 15	3	CR 3.3	Low noise	Meets manufacturing decible requirements or lower than current state	Decible	90	10%
ER 16	9	CR 4.1	Records test data	Follows instrumentation properly & records data within current system	bit / s	12	10%
ER 17	9	CR 4.2	Compatible with existing DAQ equipment	No extra programs are required to monitor data	Binary	Yes	

Concept Generation (4)

Morphological charts provide a platform to brainstorm concept ideas based on system or function.



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DRESSER-RAND R·I·T MOOG