Deployable Trainer Structure
Team 515: VDR #2

Jarrod Darrow
Ryan Irwin
Kemuel Nelson
Christian Gonzalez

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Team Introductions

Jarrod Darrow

- Quality & Test Engineer

Ryan Irwin

- Control Systems Engineer

Kemuel Nelson

- Design & Test Engineer

Christian Gonzalez

- Project Manager & Research Engineer

Sponsor and Advisor

Sponsor

Jeffrey Payne, PE
Staff Mechanical Engineer
Mission Systems & Training

Engineering Advisor

Patrick Hollis, PhD
Mechanical Engineering Professor

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1. Meet the required weight specification
2. Require two people or less to carry
3. Assemble/Disassemble in a timely manner
4. Require a maximum of three cases for storage
5. Adjustable dimensions between seat and mounted simulator
6. Eliminate the need to source a chair/table

Objective

The objective of this project is to create a mechanism that supports an adjustable weaponized ground vehicle training simulator that will be set up by two individuals.

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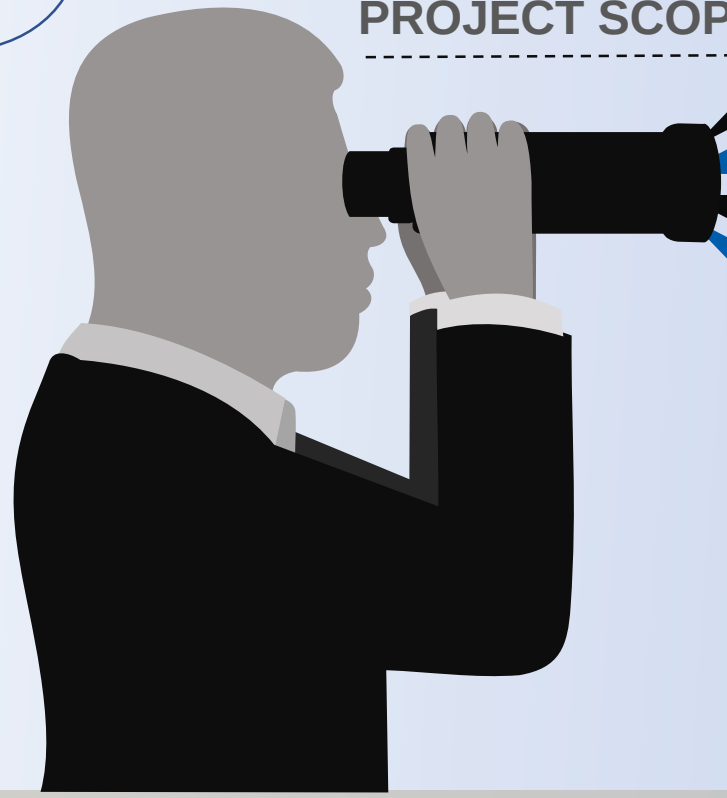
OUT OF SCOPE

ELECTRONICS

INCLINATION

PROJECT SCOPE



01 **Deflection**

Minimize deflection caused by the input force of the user operating the controls..

02 **Configuration**

Configure dimensions to accommodate individuals of various lengths and sizes.

03 **Portability**

Convenience of relocation and deployment.

04 **Maintain Fidelity**

Parallel operation with other AGTS modules in terms of functionality

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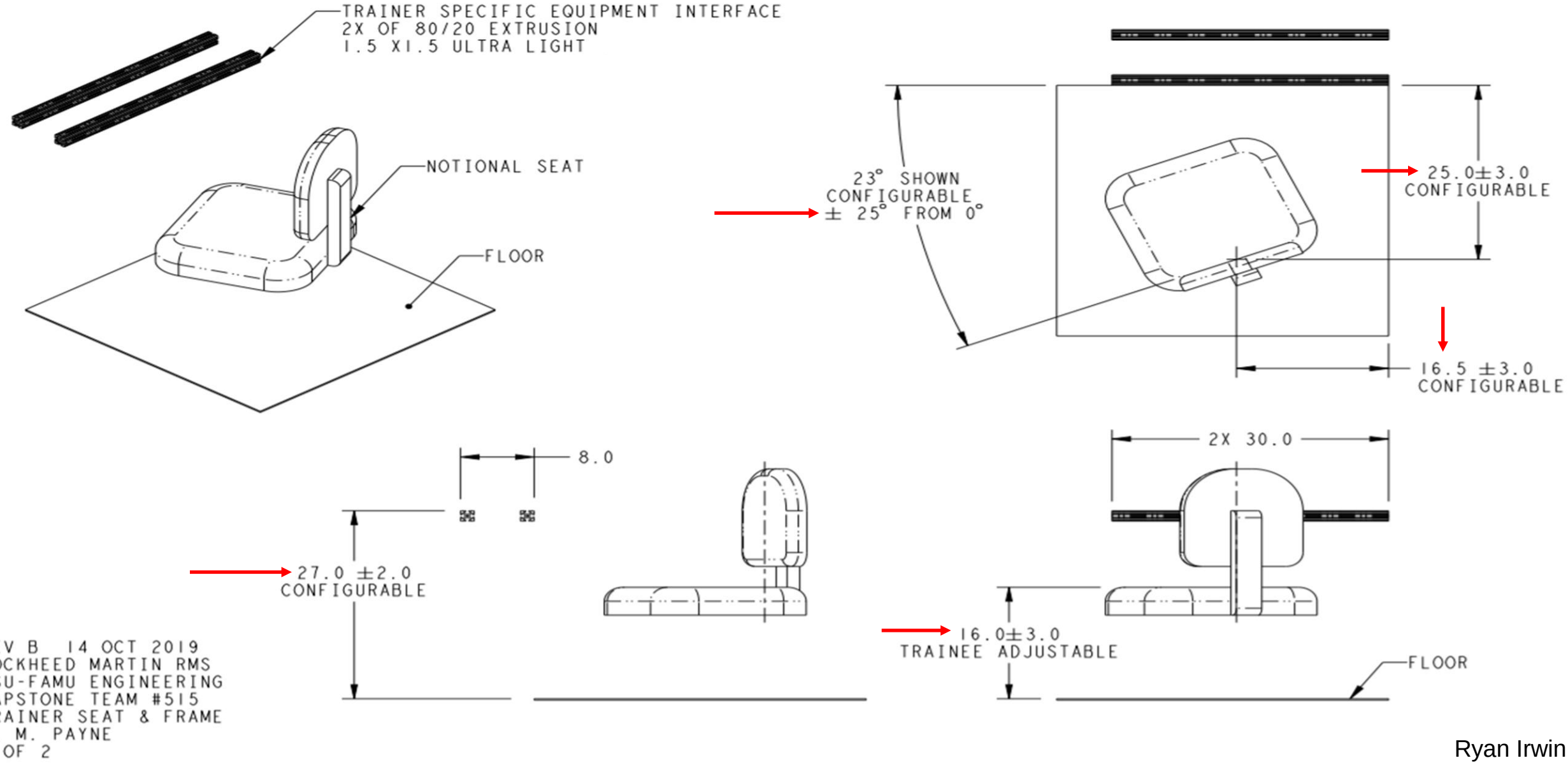
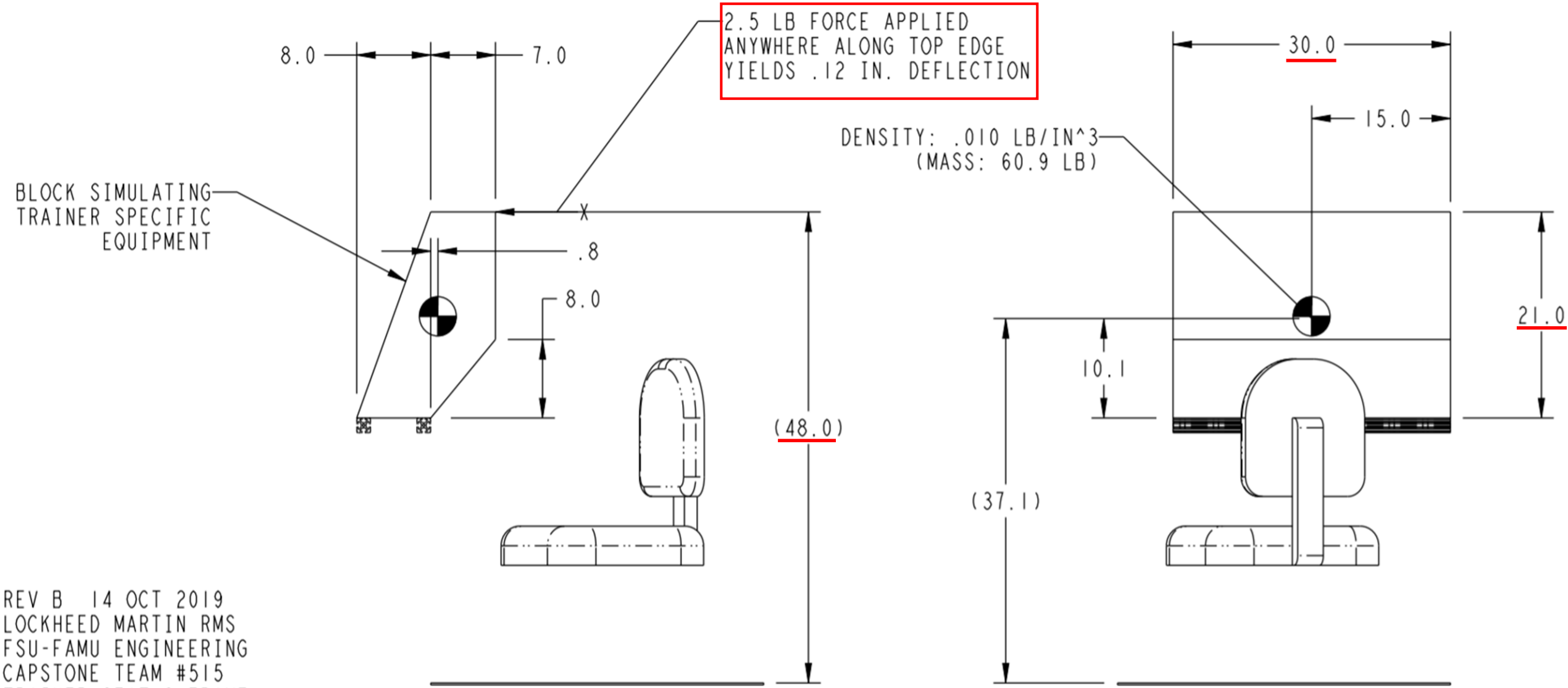
Targets and Metrics



REV B 14 OCT 2019
LOCKHEED MARTIN RMS
FSU-FAMU ENGINEERING
CAPSTONE TEAM #515
TRAINER SEAT & FRAME
J. M. PAYNE
1 OF 2

Ryan Irwin


8.0
7.0
2.5 LB FORCE APPLIED
ANYWHERE ALONG TOP EDGE
YIELDS .12 IN. DEFLECTION
BLOCK SIMULATING
TRAINER SPECIFIC
EQUIPMENT
.8
8.0
(48.0)
30.0
15.0
DENSITY: .010 LB/IN^3
(MASS: 60.9 LB)
21.0
10.1
(37.1)
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LOCKHEED MARTIN RMS
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CAPSTONE TEAM #515
TRAINER SEAT & FRAME
J. M. PAYNE
2 OF 2

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Targets and Metrics

Metric:	Measure:	Target:
Distance from Seat to Simulator	Length	25.0 ± 3.0"
Height of Seat relative to Ground	Length	17.0 ± 3.0"
Simulator Frame Height Relative to Ground	Length	27.0 ± 2.0"
Seat Width	Length	17.0 ± 3.0"
Simulator Width	Length	30"
Interior Case Length	Length	40.0 ± 10.0"
Interior Case Width	Length	18.0 ± 10.0"
Interior Case Height	Length	15.0 ± 5.0"
Maximum Frame Deflection from Joystick	Length	0.12"

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Targets and Metrics

Metric:	Measure:	Target:
Case and Mechanism	Weight	≤ 88 lbs.
Mounted Simulator	Weight	60 lbs.
Support User	Weight	214 lbs.
Product Life Cycle	Time	5 yr.
Assembly/Disassembly	Time	≤ 10 mins.
Storage Temperature	Temperature	-20°F - 150°F
Seat Angle Relative to Simulator	Degree	0 ± 25°

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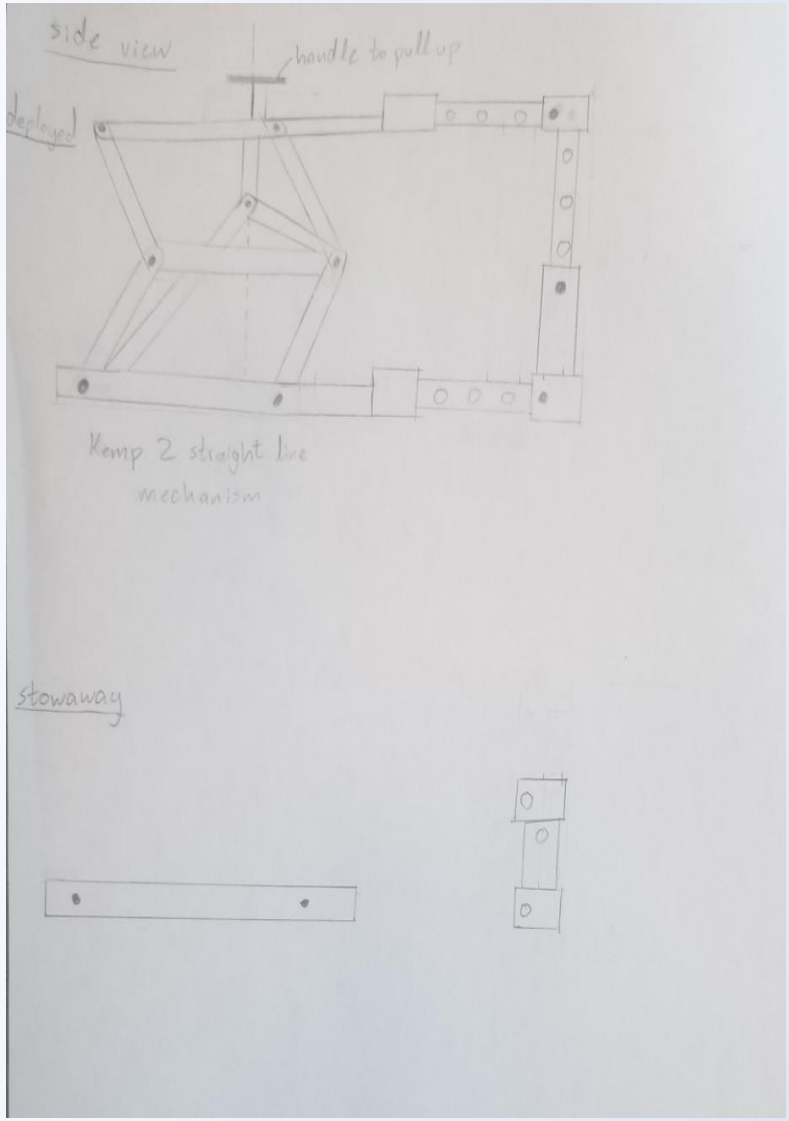
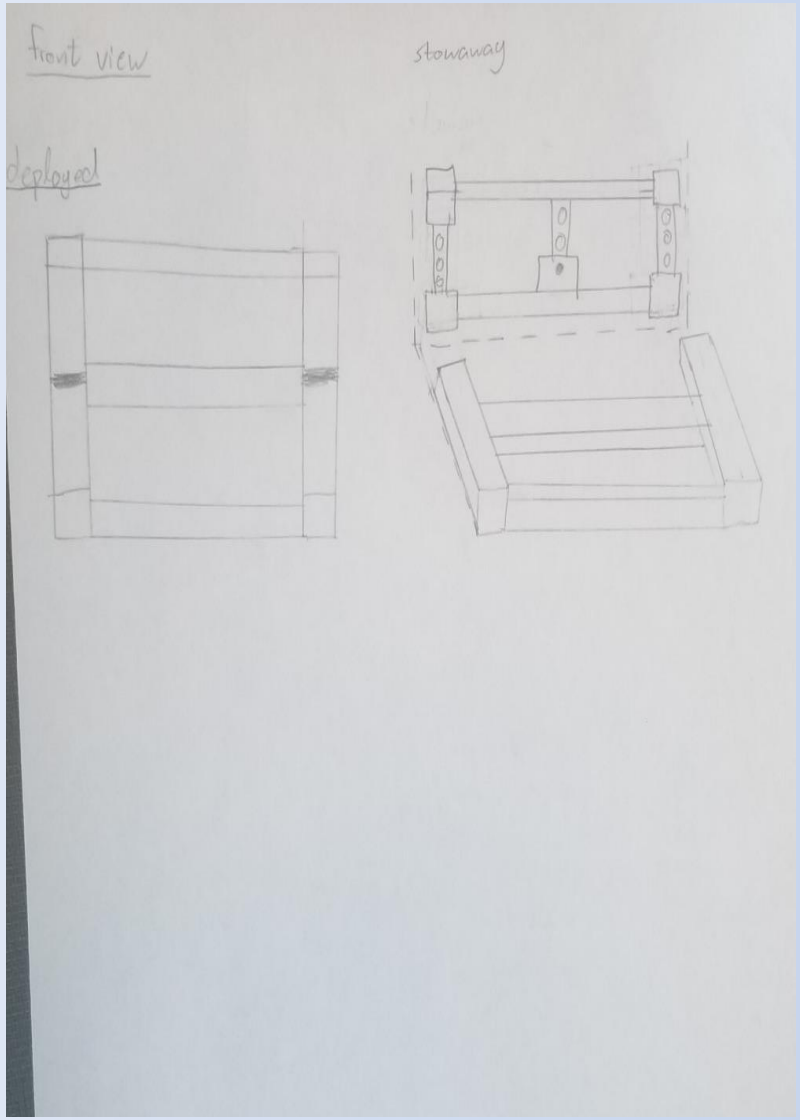
Concept Generation





Key Points

- Kemp mechanism reinforced by pin-adjustable linkage
- Fully collapsible for storage

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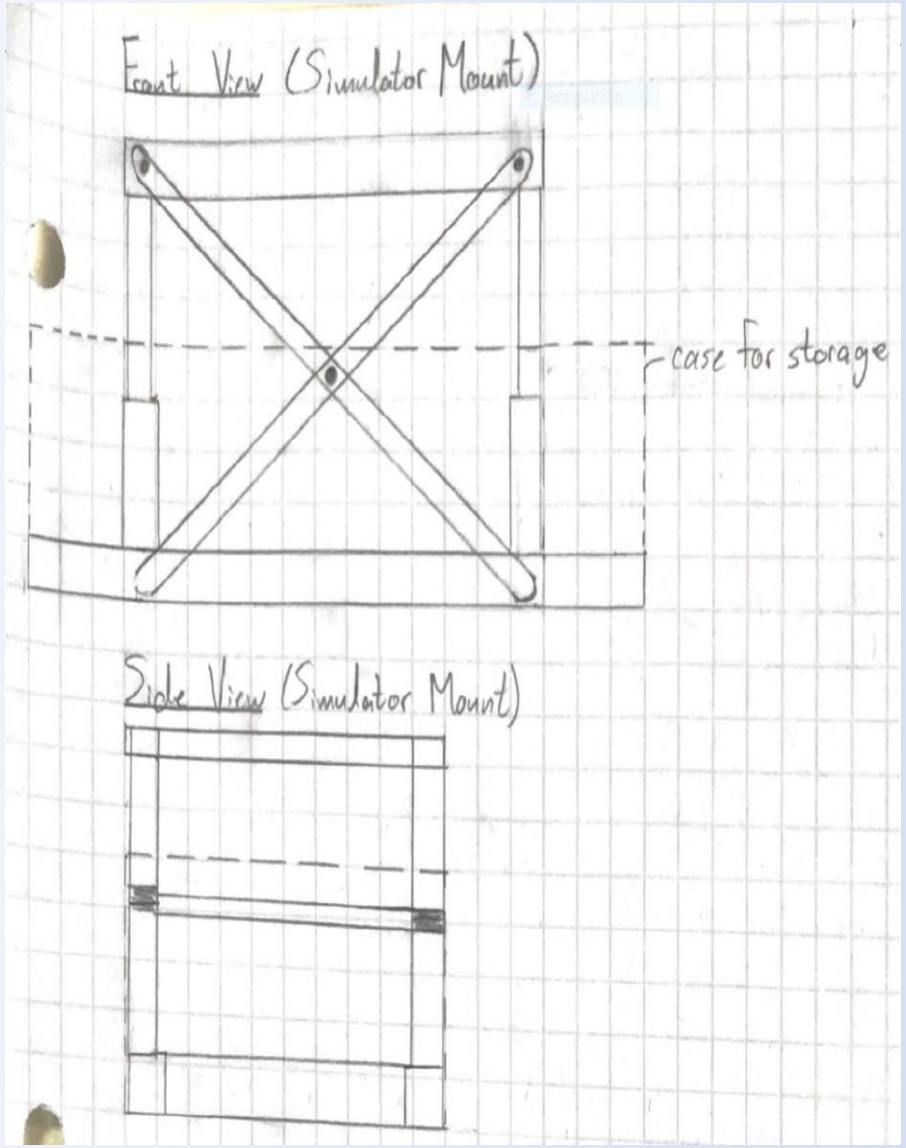

Key Points

- Simulator mount not fixed to storage case
- Eight links per side
- Vertical supports are telescopic and the base is wider than the top

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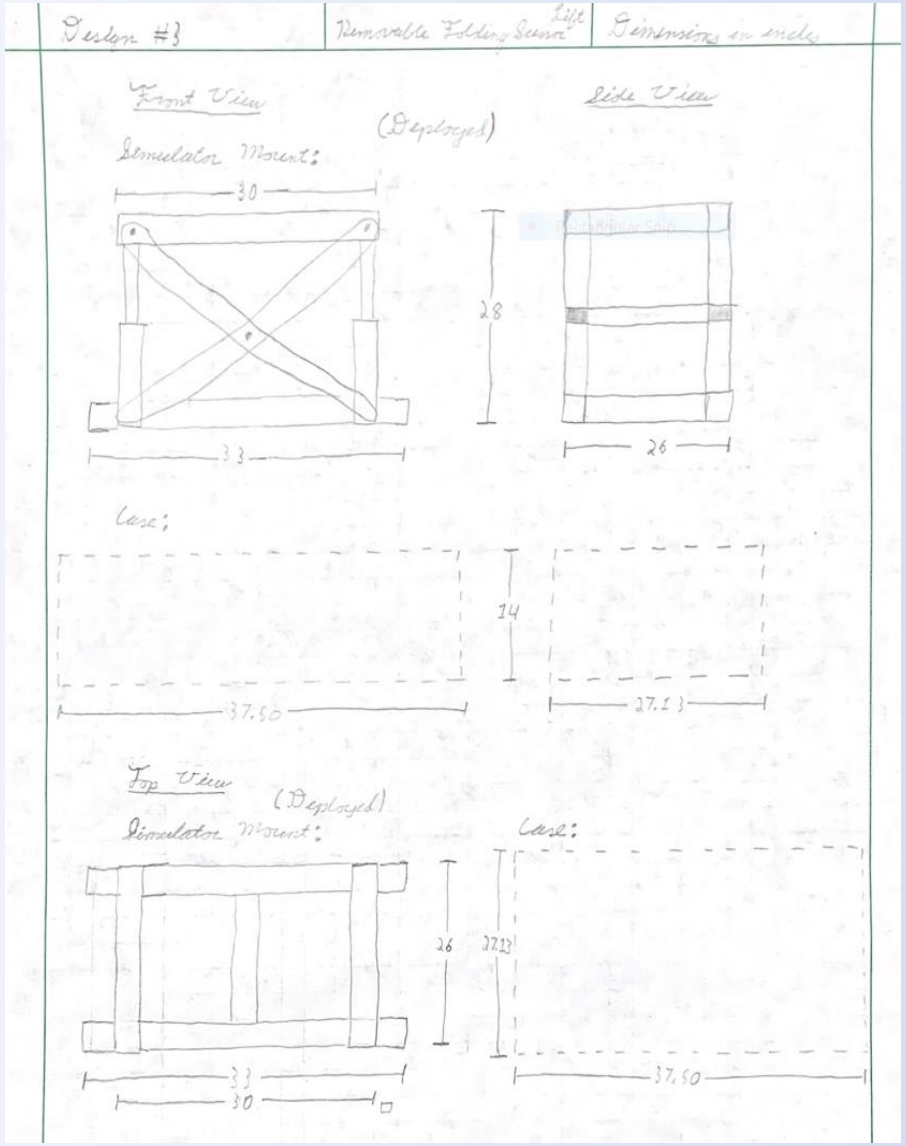

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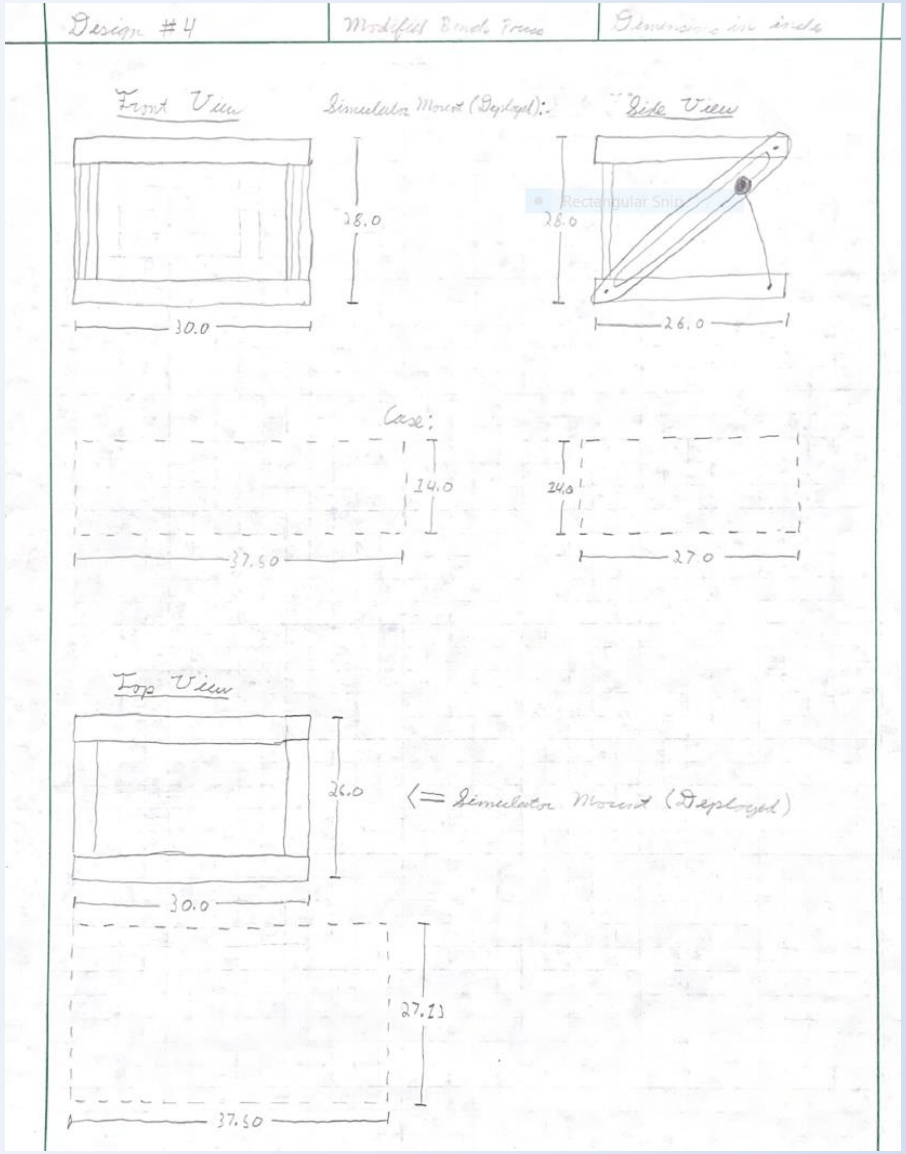

Key Points

- Inspired by adjustable bench press
- Link with slot in it goes in toggle to achieve desired height
- Most compact of the five concepts being compared

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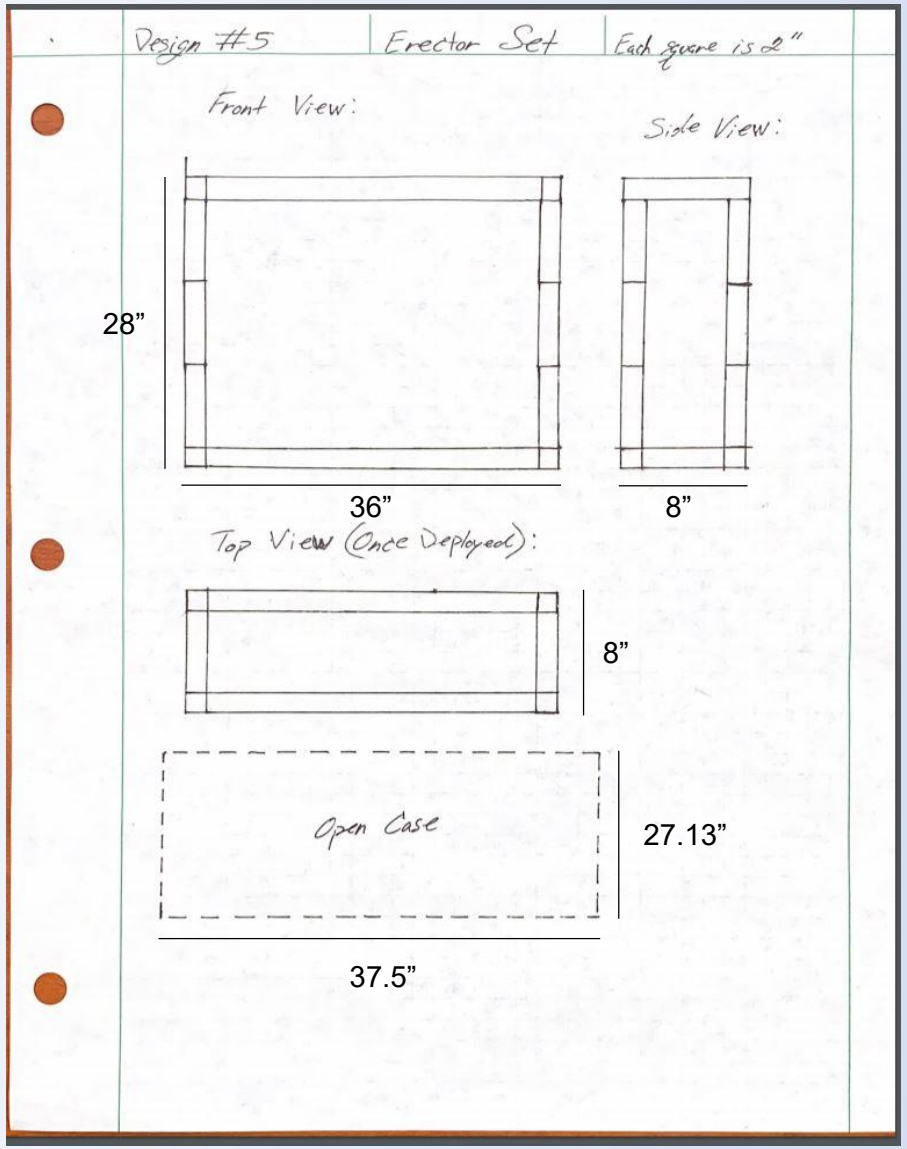

Key Points

- Modular design which allows for simple adjustment to product dimensions.
- Robust design since the components experience mostly static loads.
- Simple serviceability if a component becomes worn.

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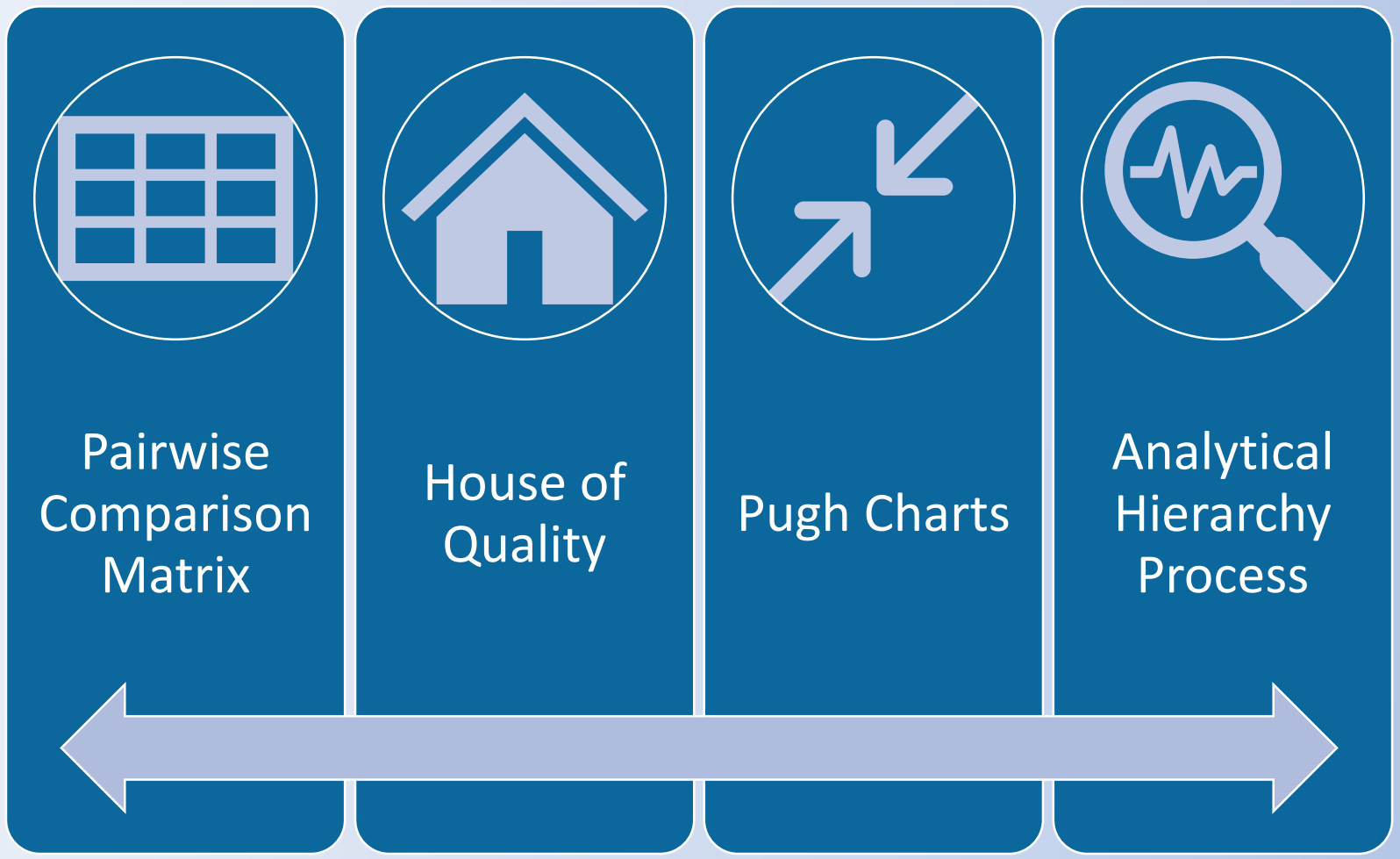
Concept Selection



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Pairwise Matrix

Importance Weight Factor	1	2	3	4	5	6	7	8	Total:
1. Meets Weight Requirements	-	1	1	1	1	1	1	1	7
2. Sturdy	0	-	1	1	0	0	0	1	3
3. Long Lasting	0	0	-	1	0	0	0	0	1
4. Minimizing Loose Parts	0	0	0	-	0	0	1	0	1
5. Supports Simulator	0	1	1	1	-	1	1	1	6
6. Support Person	0	1	1	1	0	-	1	1	5
7. Adjust Dimensions	0	1	1	0	0	0	-	1	3
8. Assemble/Disassemble Quickly	0	0	1	1	0	0	0	-	2
Total:	0	4	6	6	1	2	4	5	n-1=7

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House of Quality

Improvement Direction			⇩	⇩	⇧	⇧	⇧	⇩	⇧	⇧	⇩	⇩	⇧
Units			lbf	lbf	inches	inches	inches	inches	seconds	years	minutes	inches	%
Engineering Characteristics		Importance Weight Factor	Case and Mechanism weight	User Weight	Allowable Distance between Seat and Simulator	Max Height of Seat	Max Simulator Frame Height	Case Dimensions	Temperature Range	Product Life	Assemble/Disassemble Time	Maximum Frame Deflection	Reliability
Customer Requirements	Meets Weight Requirements	7	9	1	0	0	0	3	0	0	1	3	0
	Sturdy	3	3	9	0	9	9	0	1	1	0	9	9
	Long Lasting	1	0	9	0	1	1	0	3	9	1	9	9
	Minimizing Loose Parts	1	0	0	1	1	1	0	0	9	0	0	1
	Supports Simulator	6	1	0	0	0	3	1	0	3	0	9	9
	Support Person	5	0	9	3	3	1	0	0	3	0	1	9
	Adjust Dimensions	3	0	1	9	9	9	1	0	0	3	1	3
	Assemble/Disassemble Quickly	2	3	0	1	1	1	0	0	0	9	0	3
	Raw Score	769	84	91	45	73	81	30	6	54	35	119	151
	Relative Weight	-	10.92	11.83	5.85	9.49	10.53	3.90	0.78	7.02	4.55	15.47	19.64
	Rank Oder	-	4	3	8	6	5	10	11	7	9	2	1

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Pugh Charts

Engineering Characteristics	Datum (TAGTS)	1	2	3	4	5
1. Case & Mechanism Weight		-	-	-	-	-
2. User Weight		S	S	S	S	S
3. Allowable Distance between Seat and Simulator		+	S	S	+	+
4. Max Height of Seat		S	S	S	S	S
5. Max Simulator Frame Height		+	+	+	+	+
6. Case Dimensions		+	+	+	+	+
7. Temperature Range		+	+	+	+	+
8. Product Life		-	+	+	+	+
9. Assemble/Dissasemble Time		+	+	+	+	-
10. Maximum Frame Deflection		+	+	+	+	S
11. Reliability		-	+	S	+	+
# of pluses		6	7	6	8	6
# of minuses		3	1	1	1	2

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Engineering Characteristics	Datum (Concept #5)	2	3	4
1. Case & Mechanism Weight		+	+	-
2. User Weight		S	S	S
3. Allowable Distance between Seat and Simulator		-	-	S
4. Max Height of Seat		S	S	S
5. Max Simulator Frame Height		-	S	-
6. Case Dimensions		-	-	-
7. Temperature Range		S	S	S
8. Product Life		+	+	+
9. Assemble/Disassemble Time		+	+	+
10. Maximum Frame Deflection		+	+	+
11. Reliability		+	S	+
# of pluses		5	4	4
# of minuses		3	2	3

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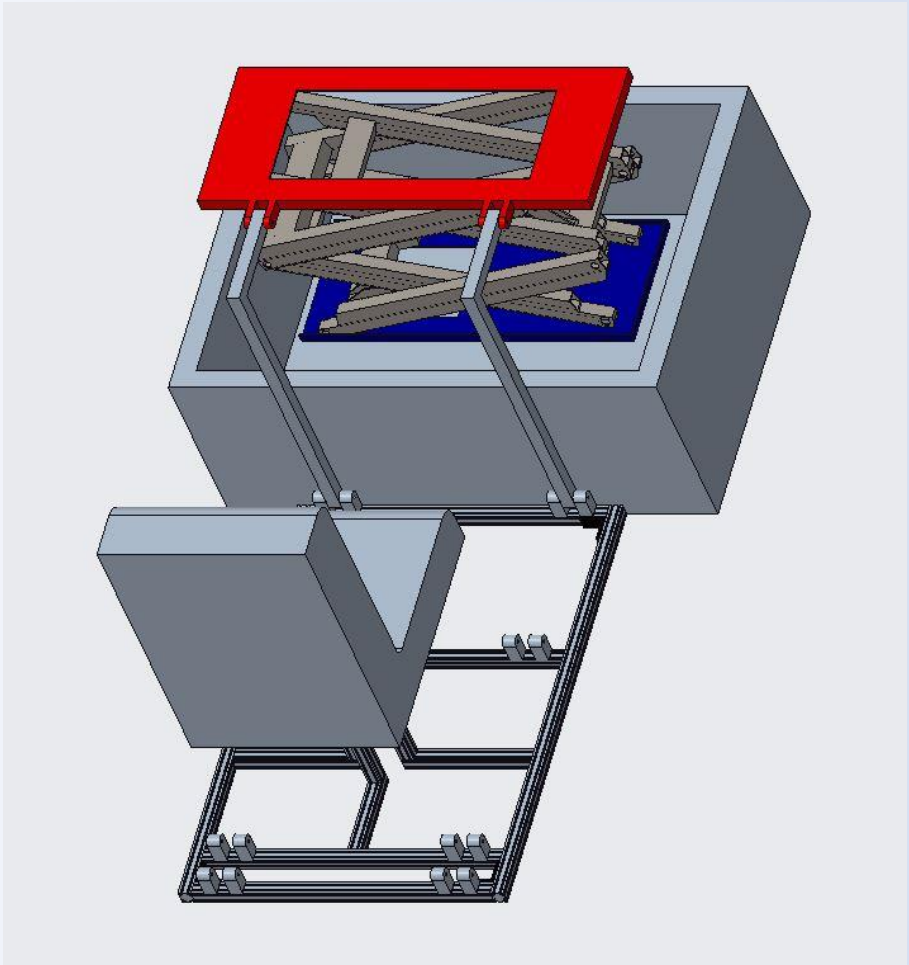
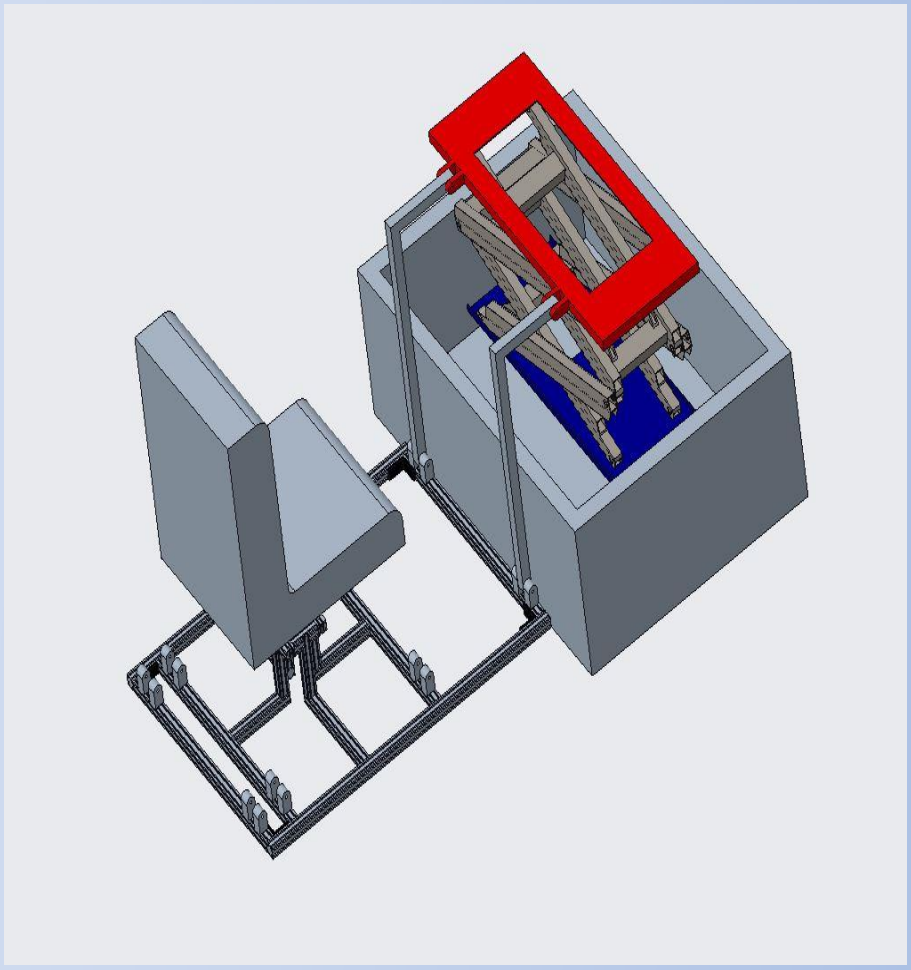
Final Design





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Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process

	Reliability	Sturdiness	Case and Mechanism Weight	Long Lasting	Ease of Assembly	Criteria Weights {W}
1. Reliability	0.098	0.333	0.161	0.034	0.059	0.137
2. Sturdiness	0.020	0.067	0.097	0.034	0.176	0.079
3. Case + Mechanism Weight	0.294	0.333	0.484	0.517	0.529	0.432
4. Long Lasting	0.294	0.200	0.097	0.103	0.059	0.151
5. Ease of Assembly	0.294	0.067	0.161	0.310	0.176	0.202
	1.000	1.000	1.000	1.000	1.000	1.000

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Analytical Hierarchy Process

Weighted Sum Vector {W_s}	Criteria Weights {W}	Consistency Vector [C]
0.212	0.212	1.055
0.412	0.412	1.056
0.056	0.056	1.057
0.173	0.173	1.055
0.203	0.203	1.057

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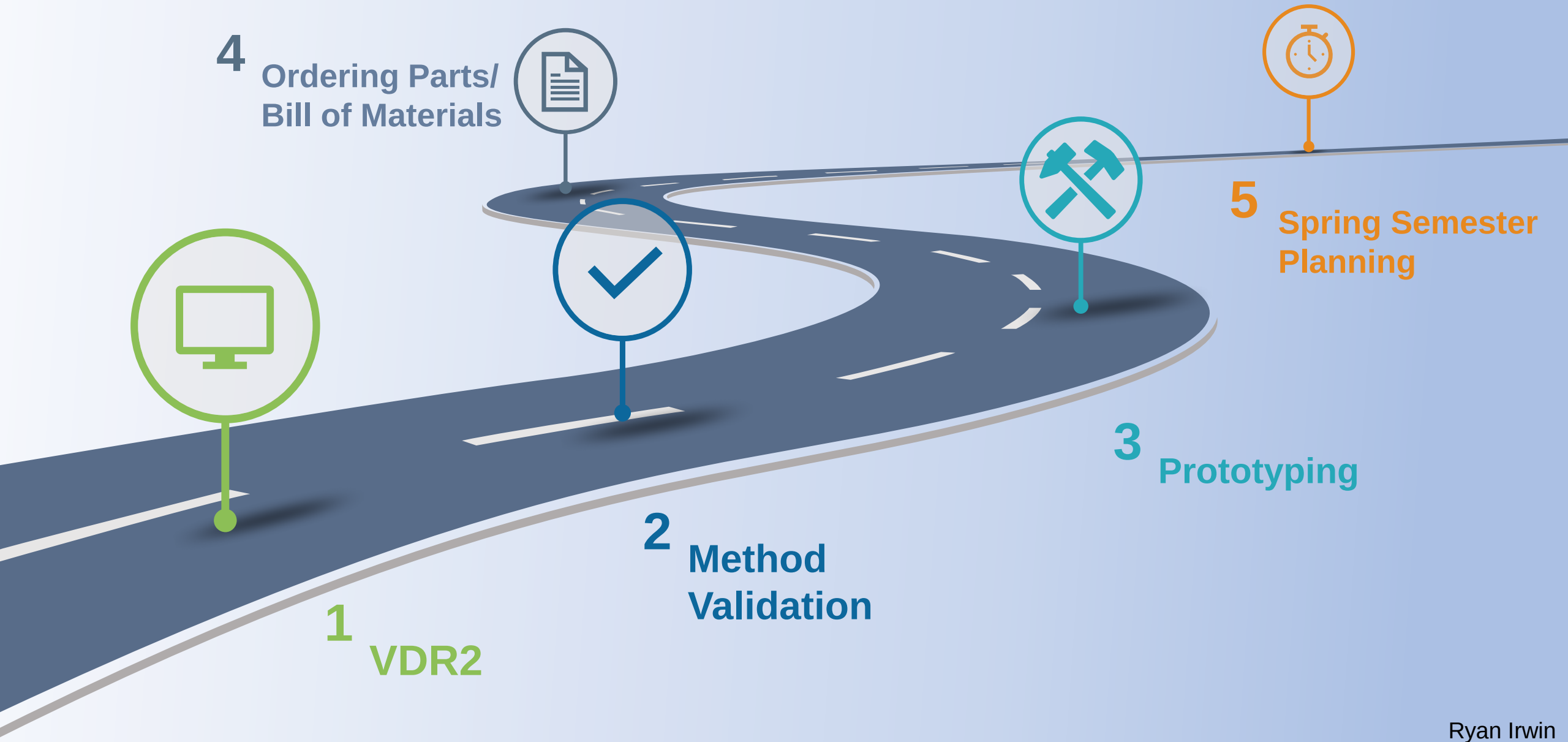
4
Ordering Parts/
Bill of Materials
5
Spring Semester
Planning
3
Prototyping
2
Method
Validation
1
VDR2

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Contact Information

- **Ryan Irwin**
- rwi15@my.fsu.edu
- **Kemuel Nelson**
- kjn16@my.fsu.edu
- **Jarrod Darrow**
- jld15b@my.fsu.edu
- **Christian Gonzalez**
- cgg15b@my.fsu.edu

“The Pessimist Sees Difficulty In Every Opportunity. The Optimist Sees Opportunity In Every Difficulty.” – Winston Churchill