
# Virtual Design Review 2

## Flight Simulator Egress System

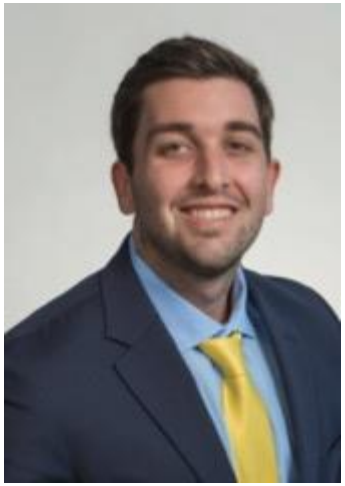
LOCKHEED MARTIN

# Introduction

**Team Leader**
Frank Cullen

**Design Engineer**
Andrew Filiault

**Research Engineer**
Andrew Porter



**Financial Advisor**
Daniel Swope

**Historian**
Marco Karay

# Project Background

- Sponsor: Lockheed Martin
- The purpose of this project is to support pilot training through the design of a system to improve the way pilots get in and out of F-16 cockpit simulators.


Figure 1: A Lockheed Martin F-16 in flight. (Lockheed Martin, n.d)

# Design Constraints

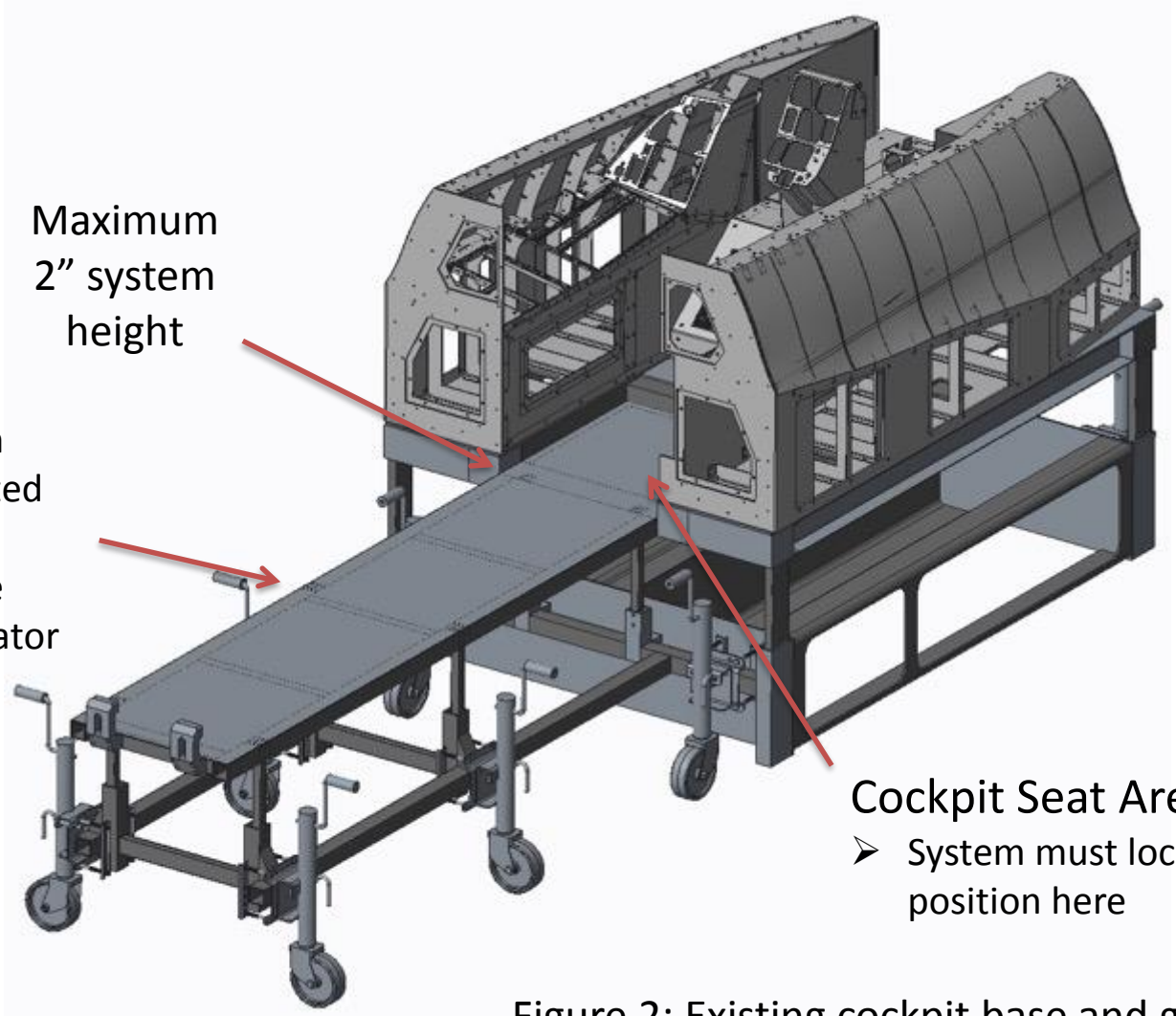



Figure 2: Existing cockpit base and gurney system.

# Project Summary

- System must move 5th and 95th percentile users in and out of cockpit dome
- Must position user in exact orientation of current fixed cockpit seat
- Allows user to egress in case of emergency
- Produce functional prototype in under $2000

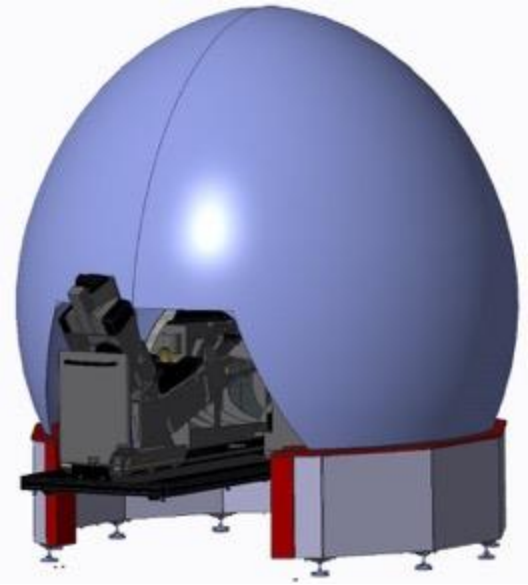


Figure 3: Existing cockpit dome design.

Frank Cullen

Functions, Metrics and Targets

# Targets

**Function**
Move seat far enough for 95th percentile male to exit

**Metric**
Distance from edge of simulator to front of seat

**Target**
28 inches[1]

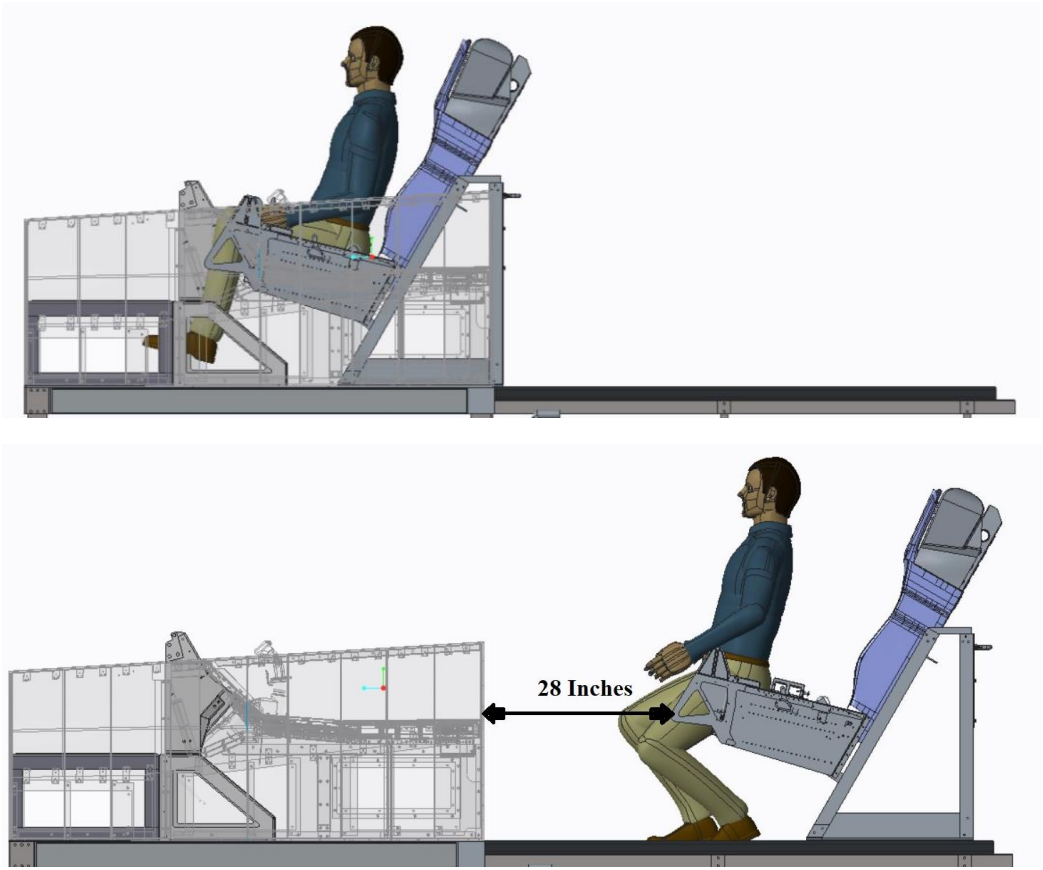



Figure 4: Seat in locked and extended position

1 - value derived from range of motion for 95th percentile male from MIL-STD-1472G

# Targets

**Function**
Allow user to control seat movement

**Metric**
Distance from user to seat control mechanism

**Target**
28.2 inches[2]

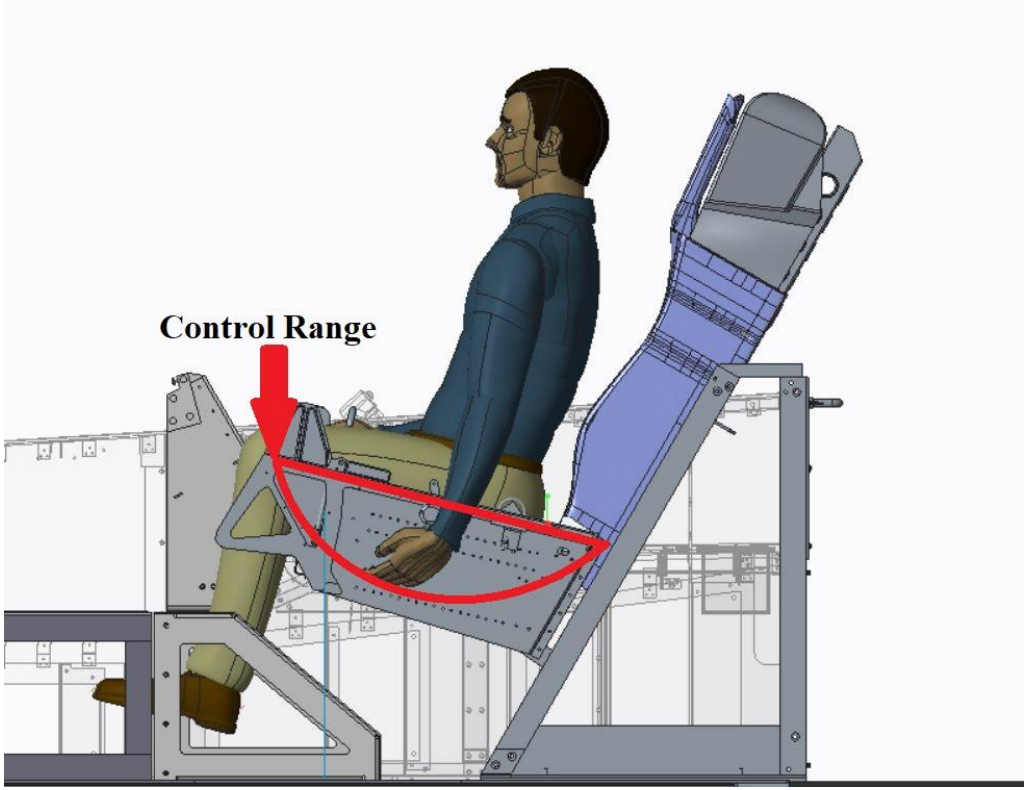



Figure 5: Control range of user while in seat

2 - value derived from length of arm of 5th percentile female from MIL-STD-1472G

# Targets

**Function**
Secure seat in cockpit

**Metric**
Force locking mechanism can withstand

**Target**
338 pound-force[3]

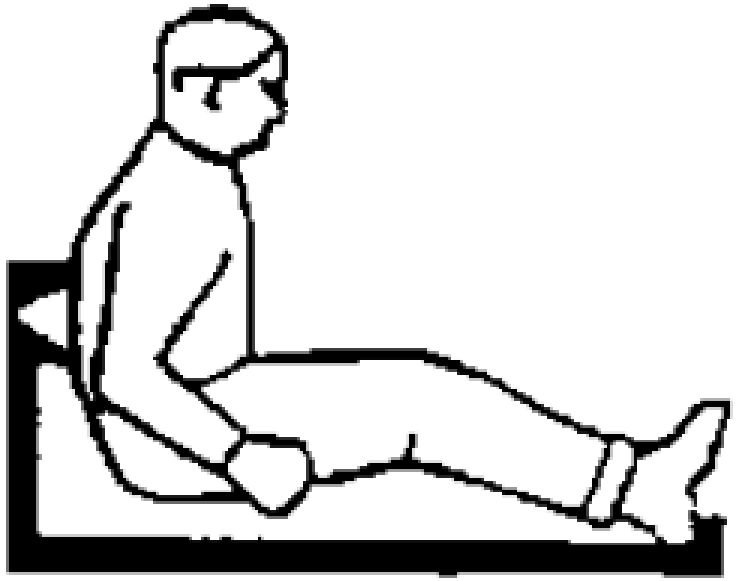


Figure 6: Position where user can apply maximum force (DoD, 2012)

3 - value derived maximum leg strength of 95th percentile male from MIL-STD-1472G

# Targets

| Function | Metric | Target |
| --- | --- | --- |
| Support weight of seat and user | Material deflection under passenger load | **To be determined** |

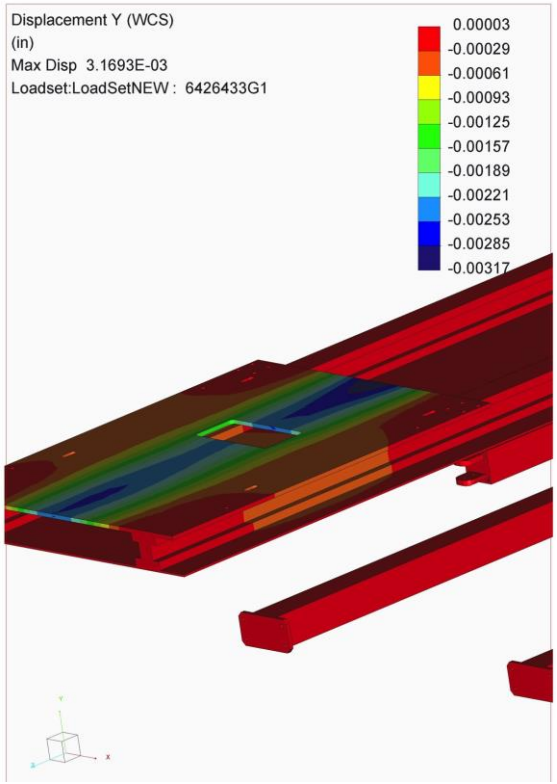



Figure 7: Material displacement in vertical direction

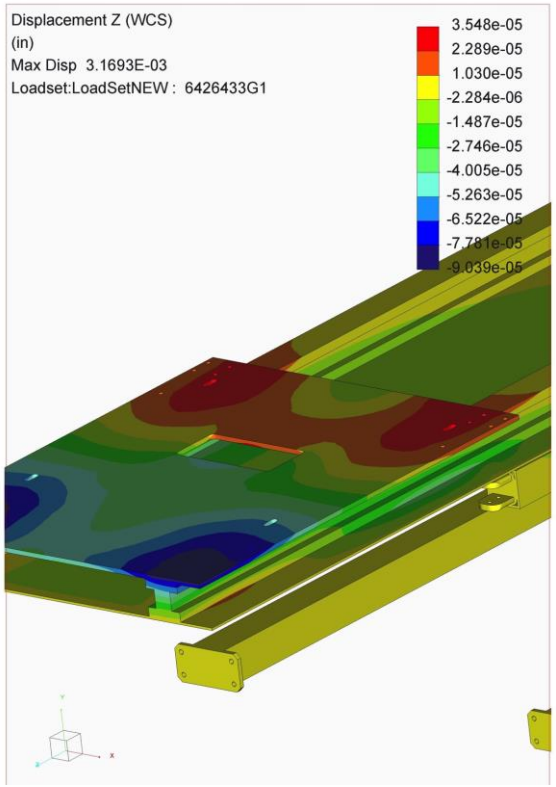



Figure 8: Material displacement in horizontal direction

# Andrew Filiault

## Concept Generation

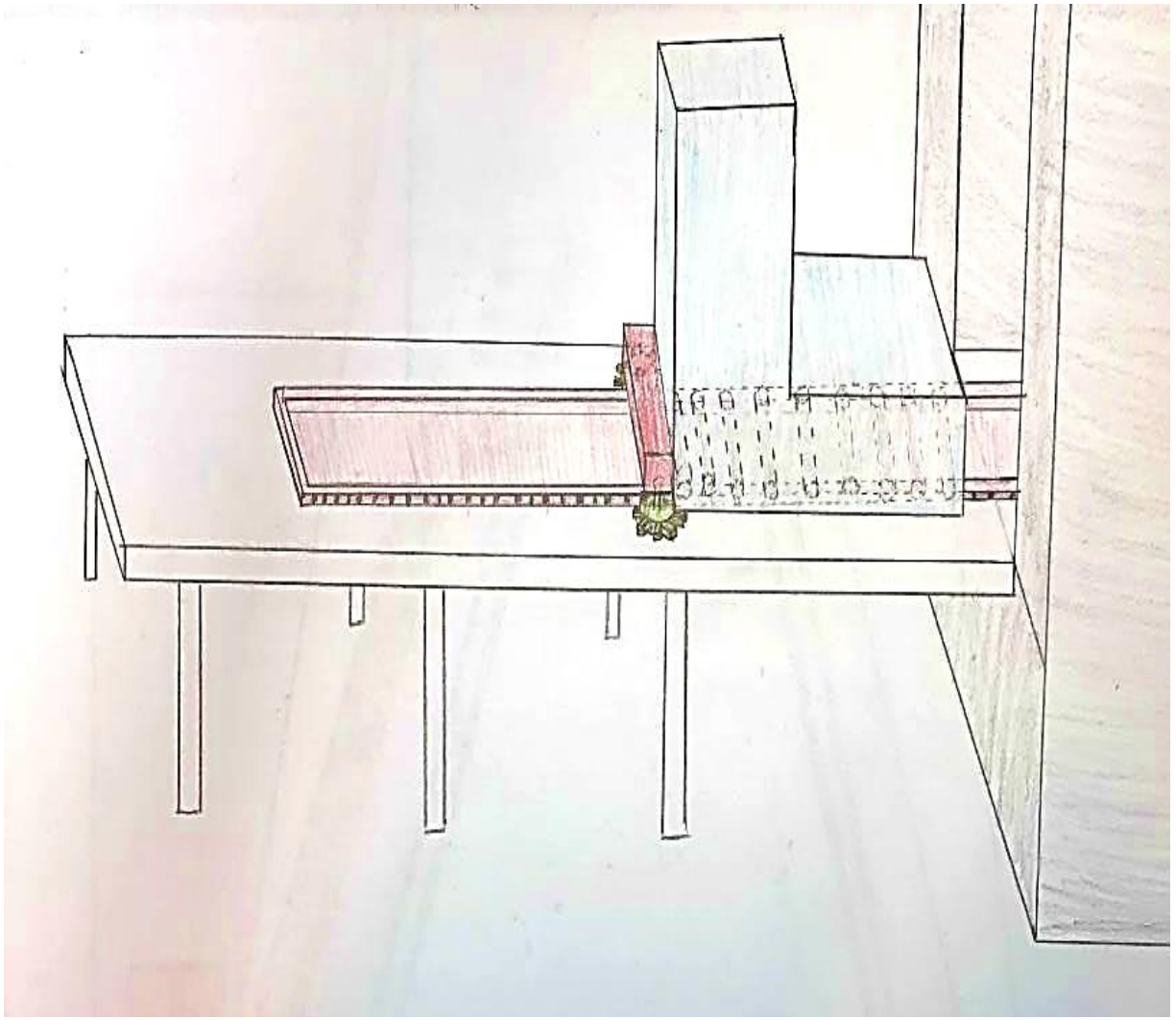
# Concept 1

**Drive System**
Rack and Pinion

- Two motors will each turn a gear that is in mesh with a rack

**Guide system**
Rollers in channel

- The seat is guided along the extruded slot



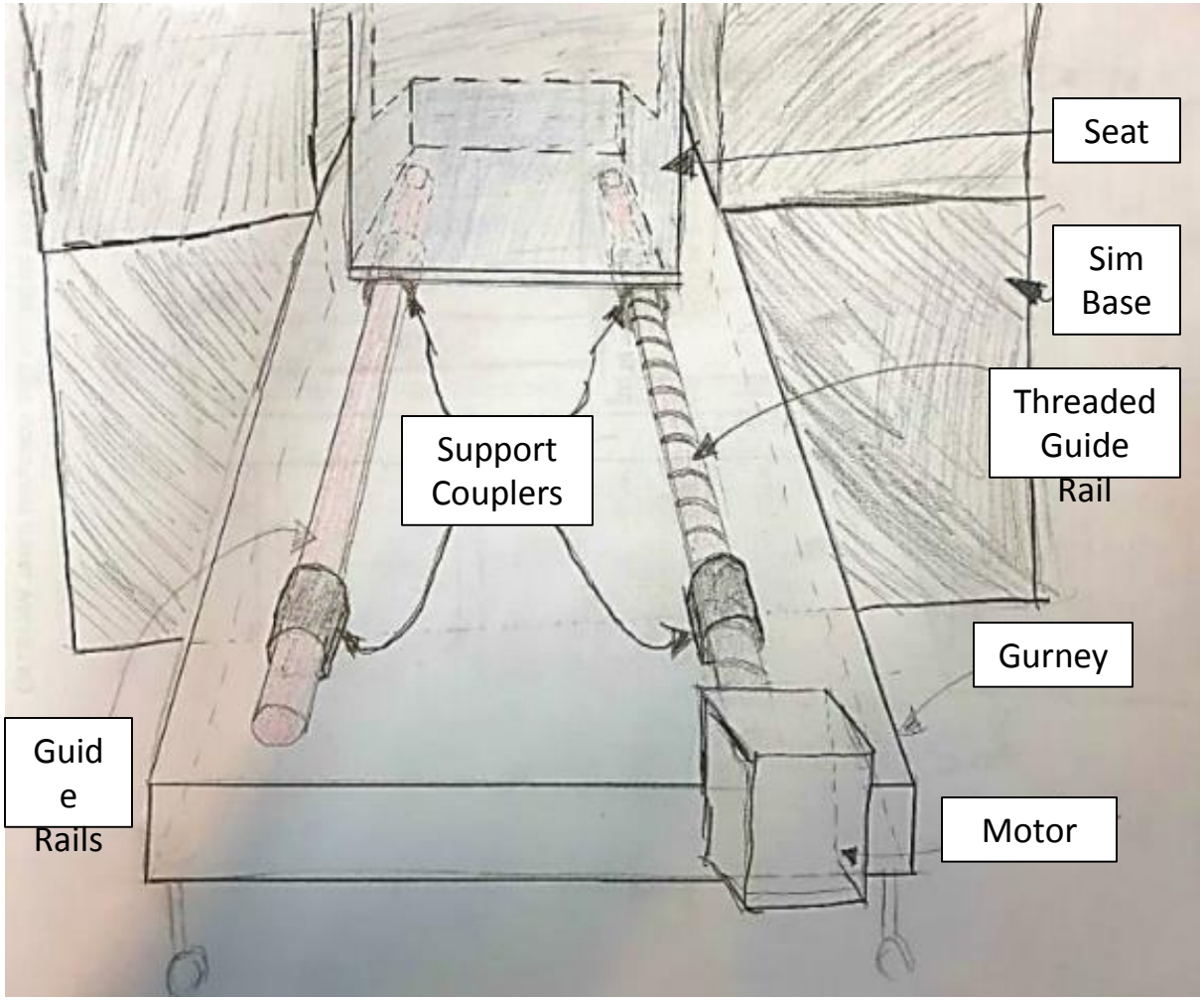
# Concept 2

**Drive System**
Worm Gear

- Motor turns worm gear that meshes with threaded coupler

**Guide system**
Cylindrical rails

- Non-threaded rail guides linear bearing
- Threaded rail drives coupler



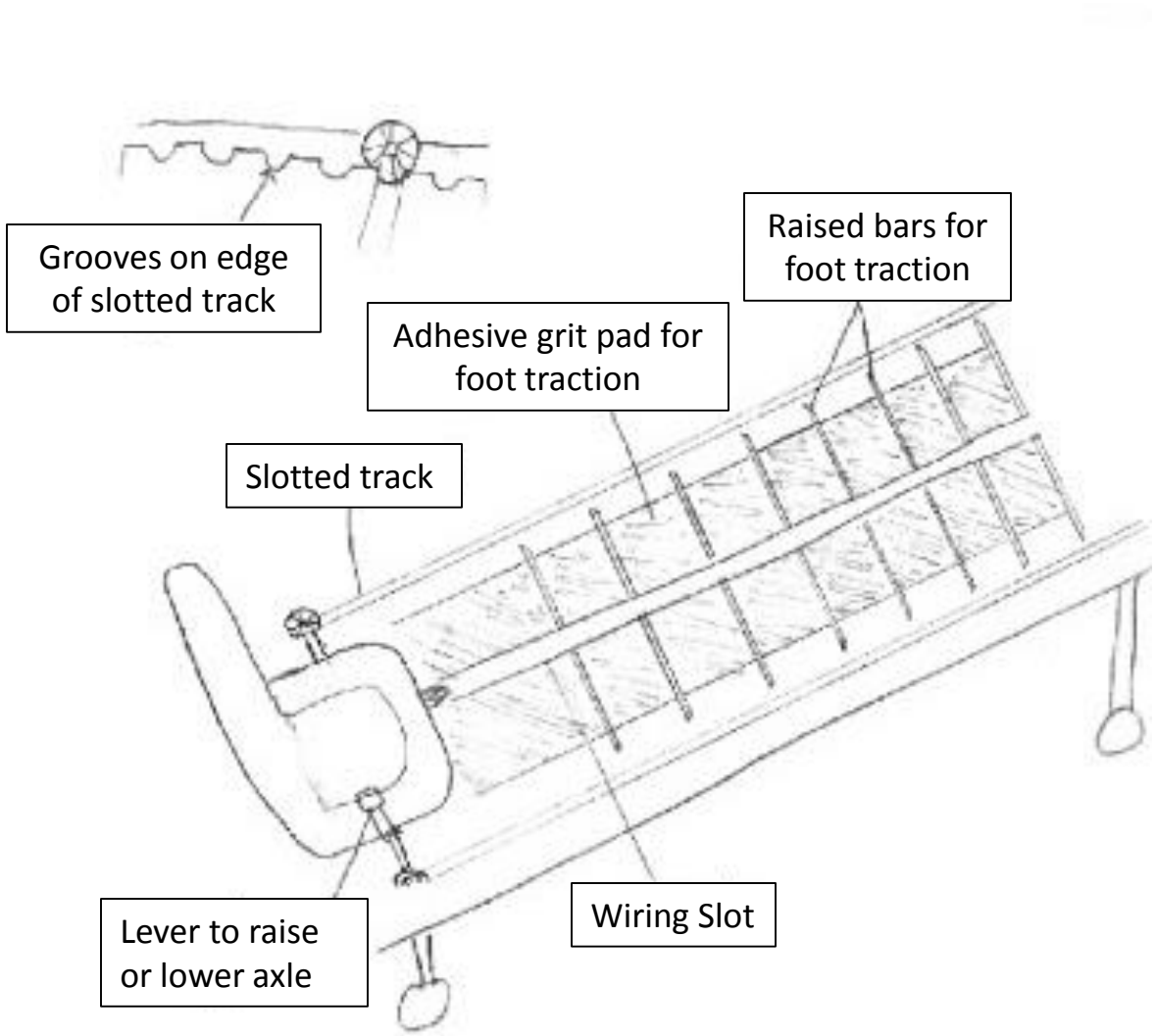
# Concept 3

**Drive System**
Manual foot power

- Pilot pushes and pulls seat using his feet
- Grip tape and raised bars to increase traction

**Guide system**
Slotted track

- Mounted wheels guided on slotted track



# Looking Forward

- Concept Selection
- Low-level prototyping for proof of concept
- Stress analysis
- Final concept generation

# Acknowledgments


- Thank you to Lockheed Martin for their sponsorship
- Thank you to Jeff Payne, Robert Kenney, and Ken Clonts of Lockheed Martin for their guidance and direction
- Thank you to Dr. Hollis for his expertise on our project


# References

Lockheed Martin. (n.d). *F-16 Block 70.* [Photograph] Retrieved from http://www.lockheedmartin.com/us/products/f16/F-16-Block-70.html

U.S. Department of Defense. (2012, January 11). *Design Criteria Standard: Human Engineering.* [Table] Retrieved from http://everyspec.com/MIL-STD/MIL-STD-1400-1499/MIL-STD-1472G_39997/

# Supplemental Slides

Additional Concepts

# Concept 4

Andy Design #1

**Description:**

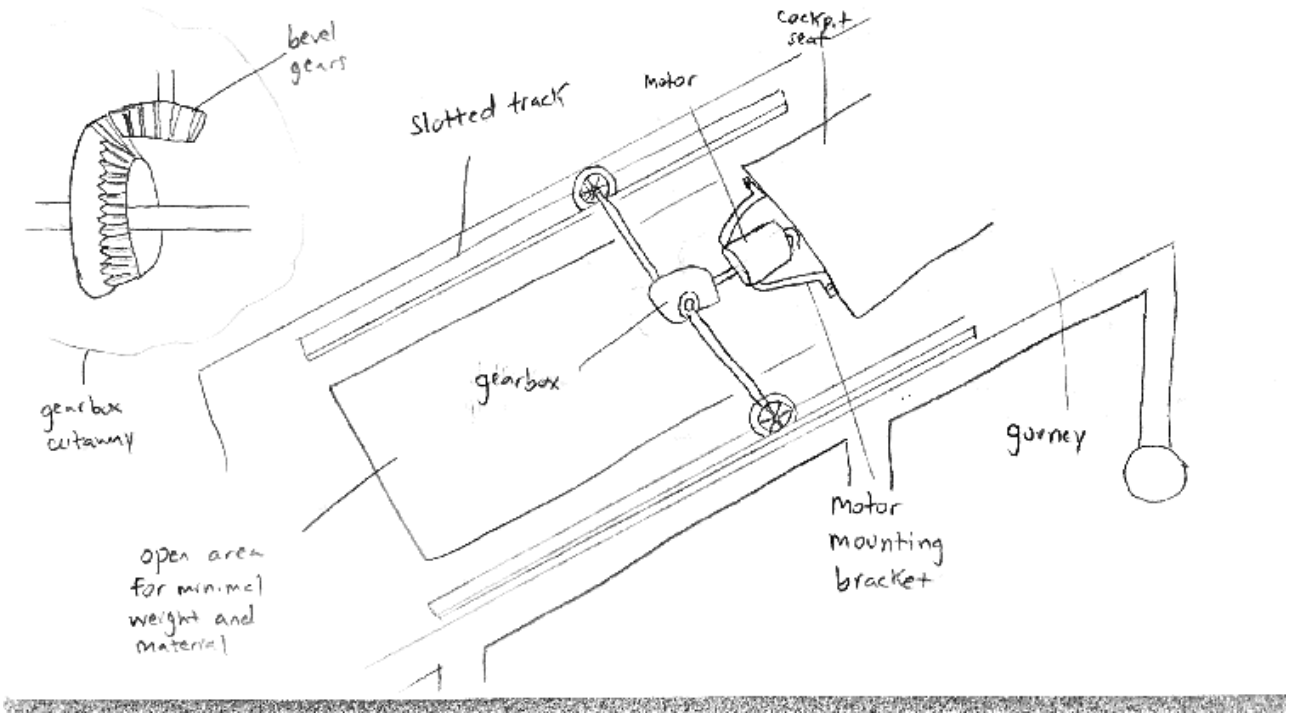
This design revolves around the use of a motor attached behind the cockpit set. Power is transmitted to wheels in a slotted track via bevel gears.

**Pros:**

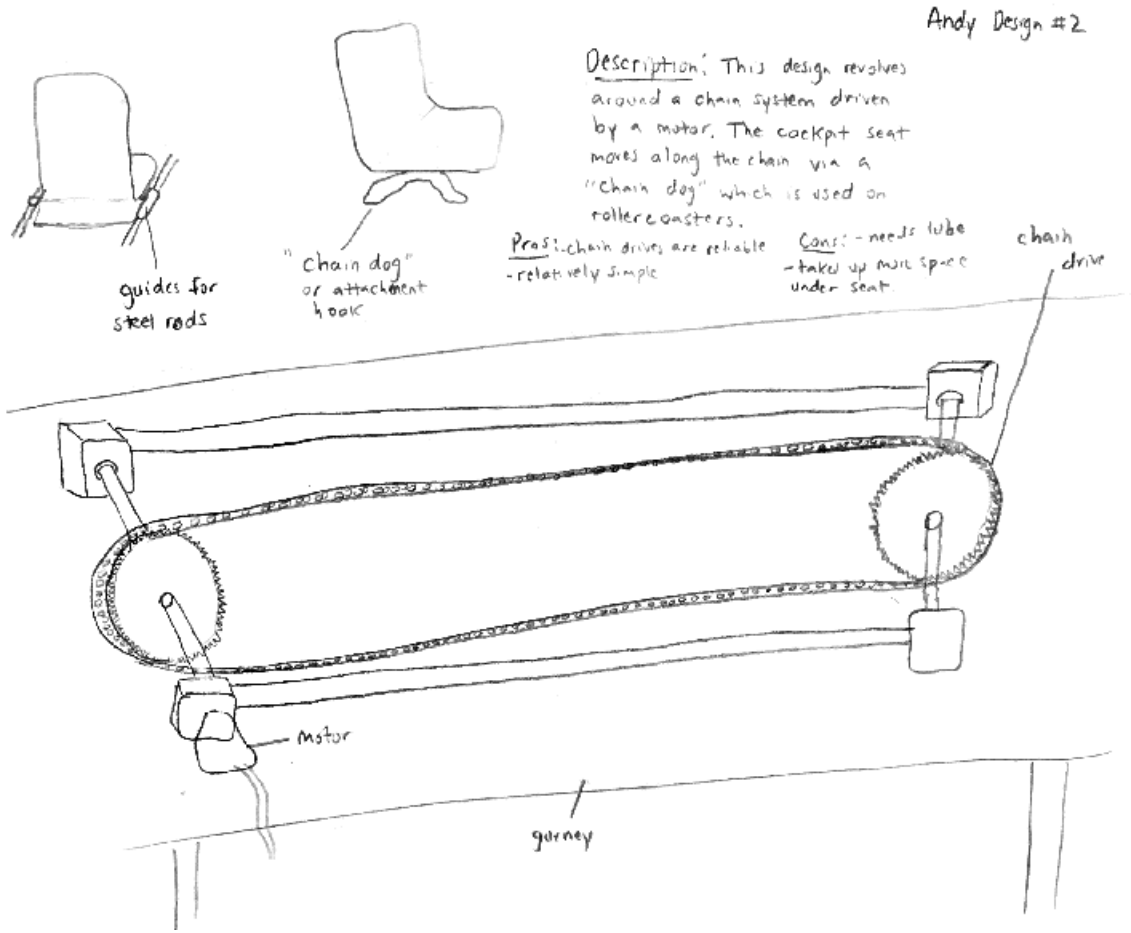
- Nearly direct power transfer from motor
- minimal moving parts
- motor in same horizontal plane as cockpit seat

**Cons:**

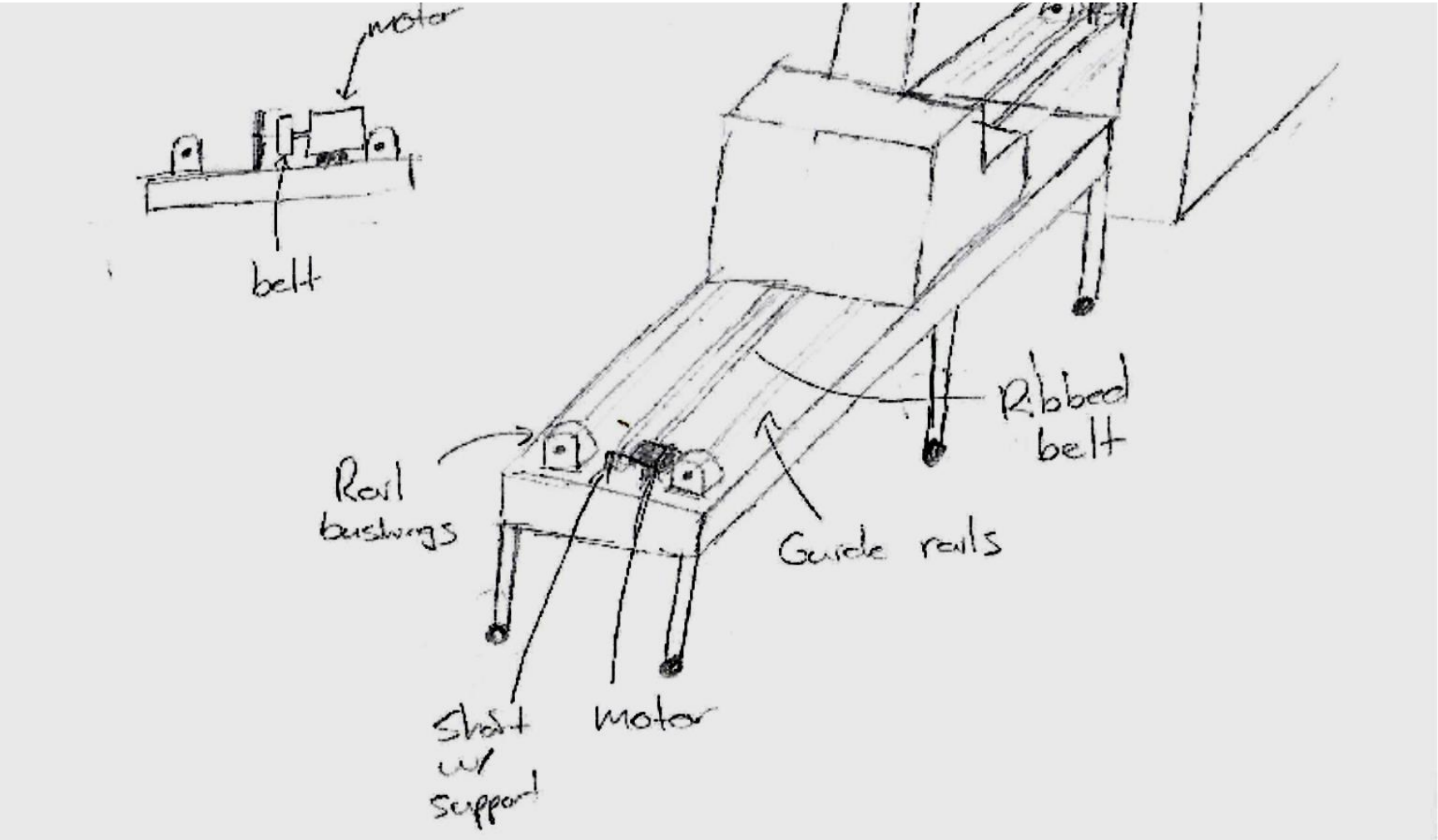
- mounting motor behind seat
- bevel gear design
- wheel axle farther away from center of mass.



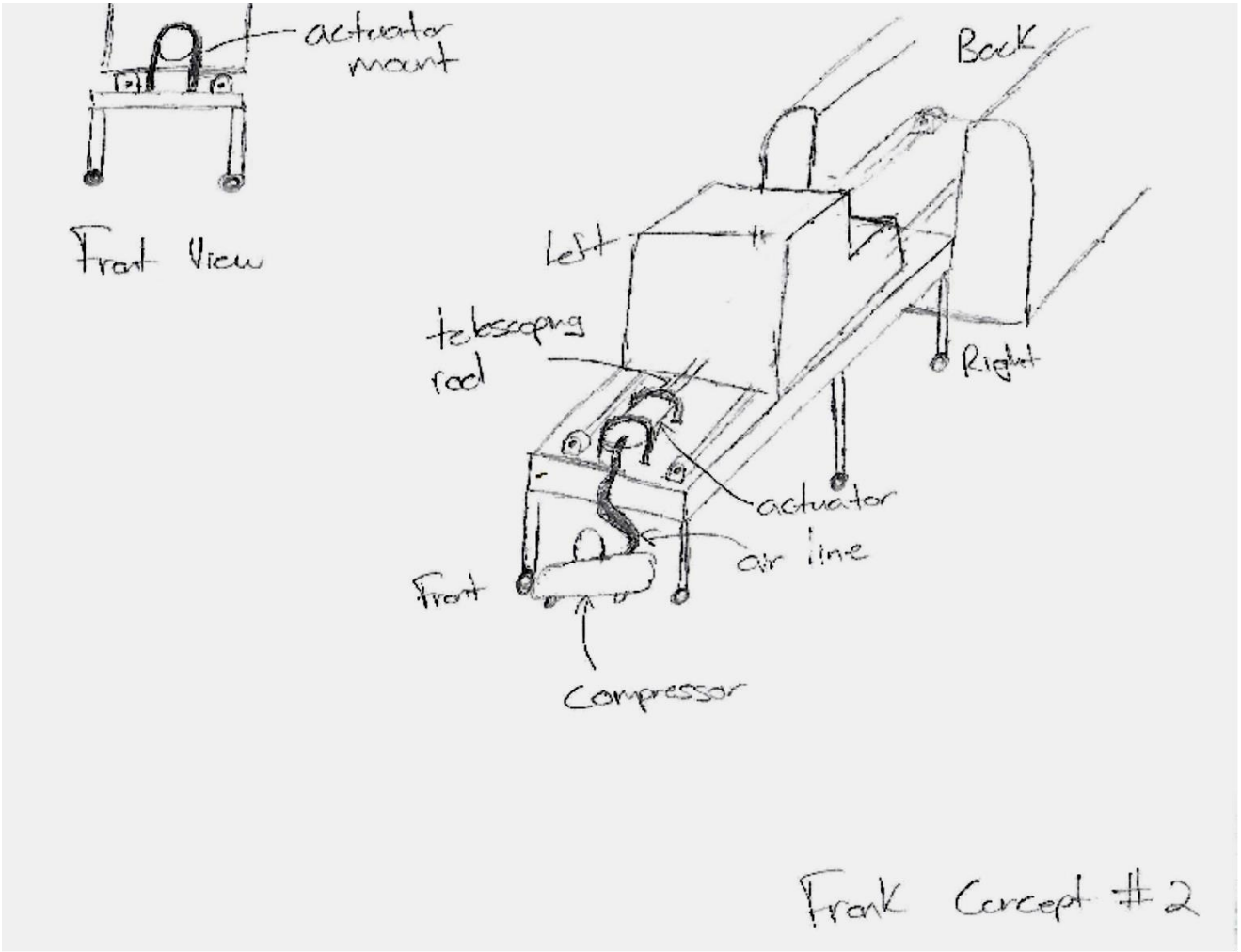
# Concept 5


Andy Design #2
Description: This design revolves around a chain system driven by a motor. The cockpit seat moves along the chain via a "chain dog" which is used on rollercoasters.
Pros: - chain drives are reliable
- relatively simple
Cons: - needs lube
- takes up more space under seat
guides for steel rods
"chain dog" or attachment hook
chain drive
motor
gurney

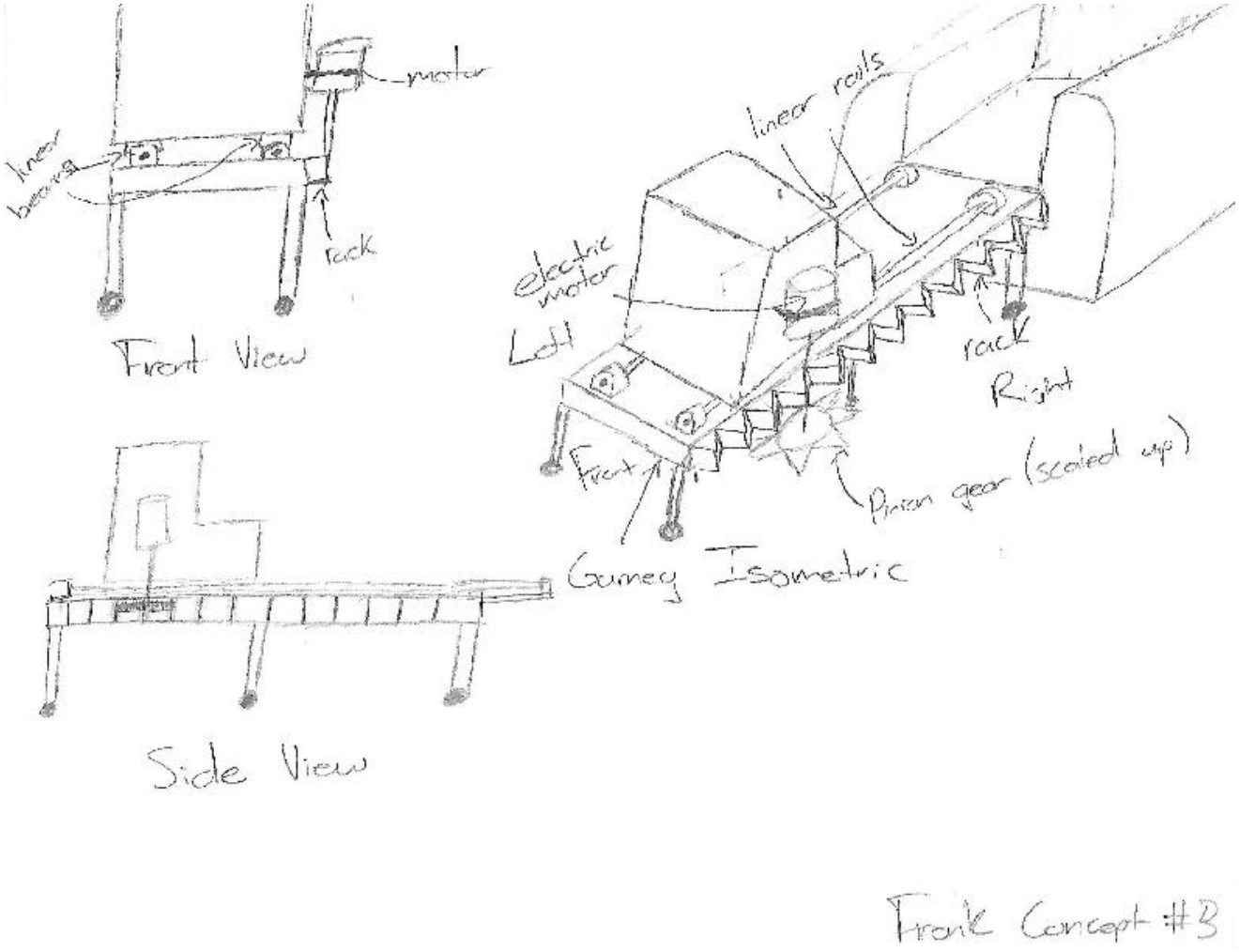
# Concept 6


motor
belt
Ribbed belt
Rail bushings
Guide rails
Shaft w/ support
motor

# Concept 7


actuator mount
Front View
Back
Left
telescoping rod
Right
actuator
air line
Front
Compressor
Frank Concept #2

# Concept 8



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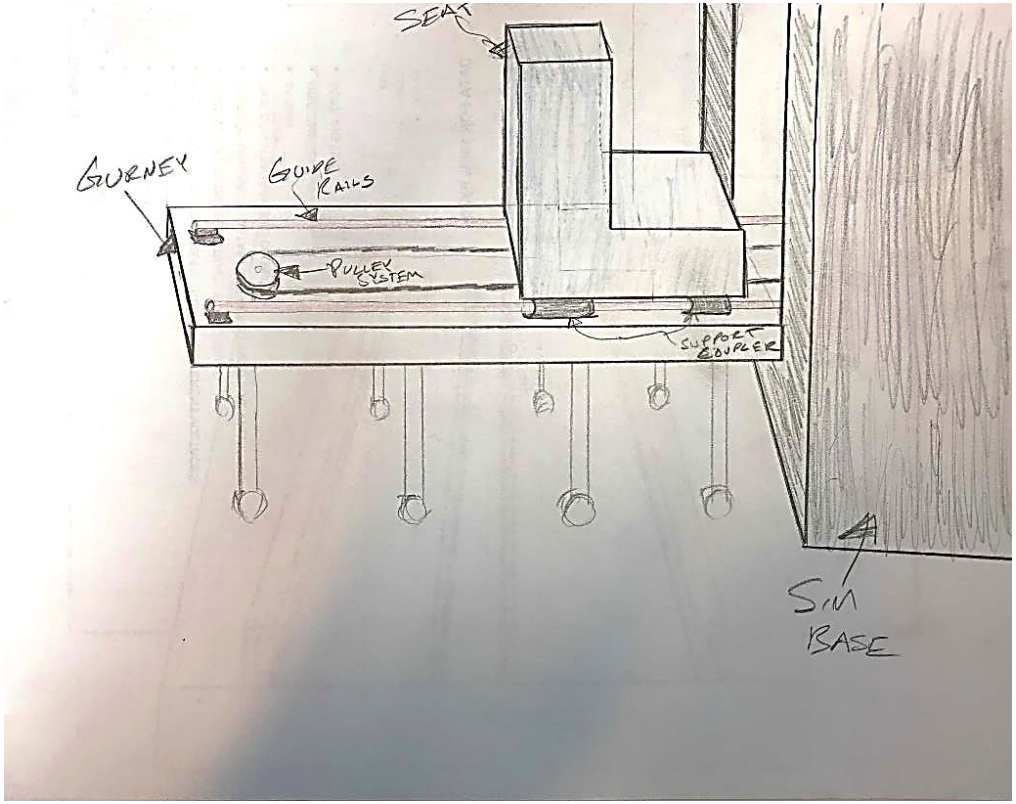
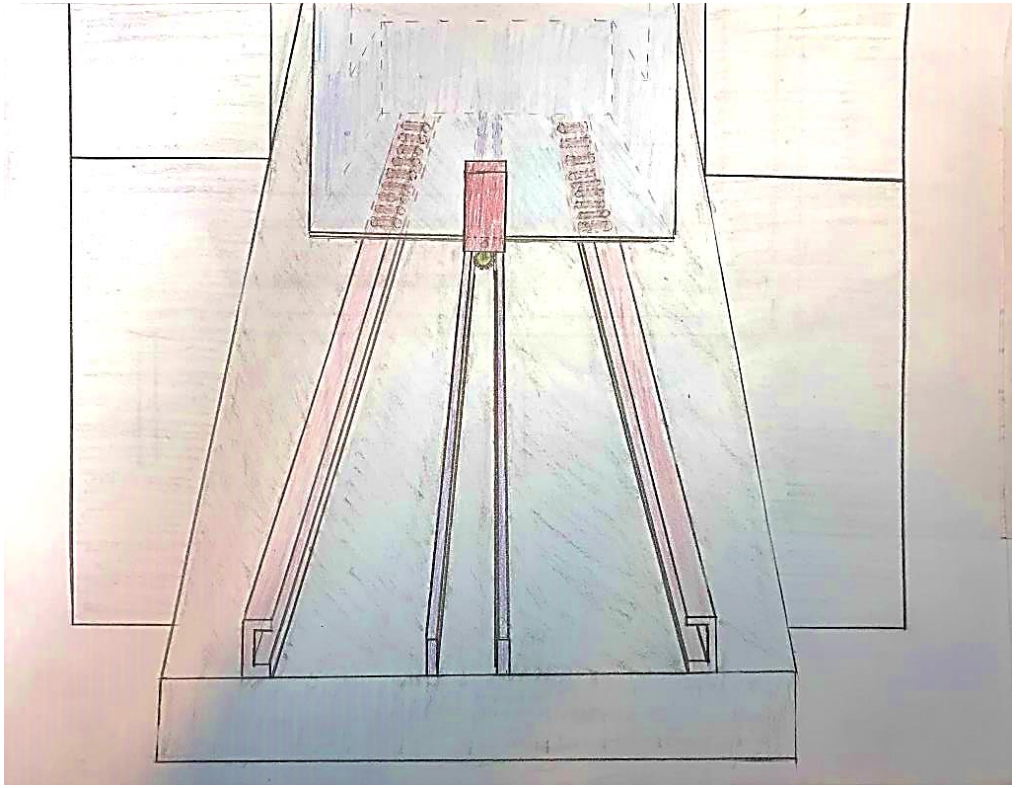
# Concept 9


SEAT
GURNEY
GUIDE RAILS
PULLEY SYSTEM
SUPPORT COVER
SIM BASE

# Concept 10



# Concept 11