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Angle Iron Profile Rotator

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Peddinghaus

ANGLE IRON ROTATOR

Ethan Hodel, Dan Lahners, and Gavin Muhlstadt

Mentor: Dr. Lew

ACKNOWLEDGMENTS

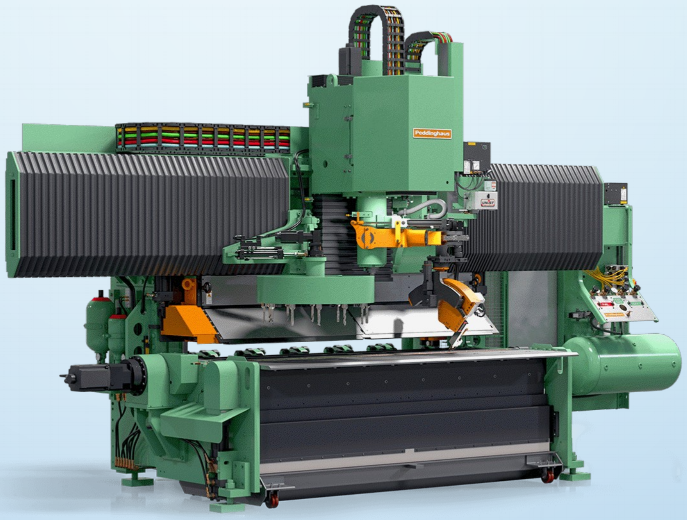
Over the past school year our senior design team has been devoted to working on the Peddinghaus Angle Iron Rotator project.

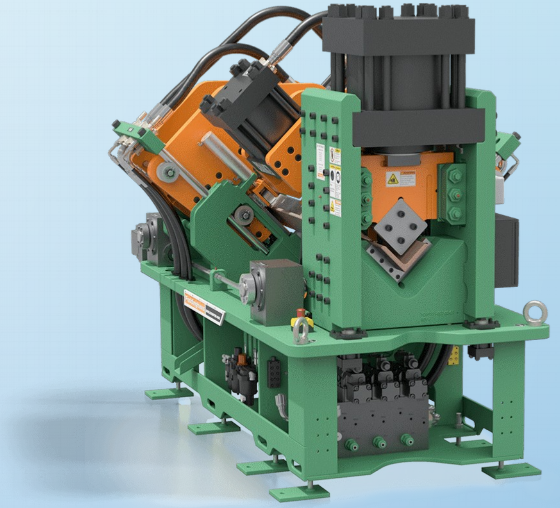
Extend our thanks to Peddinghaus Corporation for providing this opportunity. We also would like to thank our Senior Design mentor, Dr. Seok Lew, for providing guidance over the past two semesters. Finally, we extend thanks to Olivet's engineering faculty for providing a variety of different resources throughout the duration of the project.

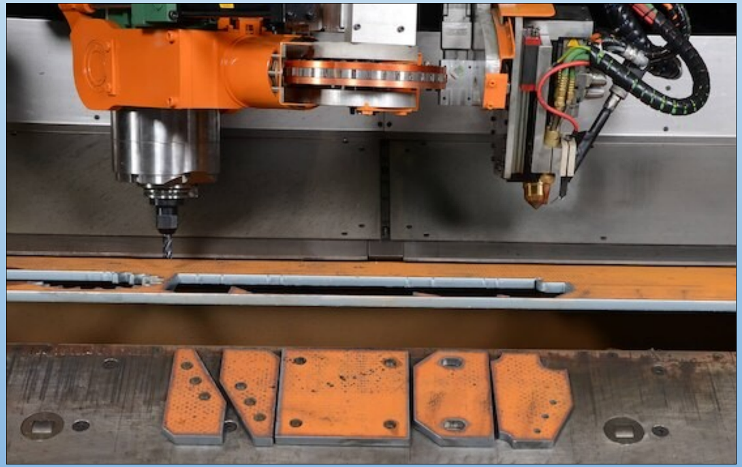
PEDDINGHAUS CORPORATION

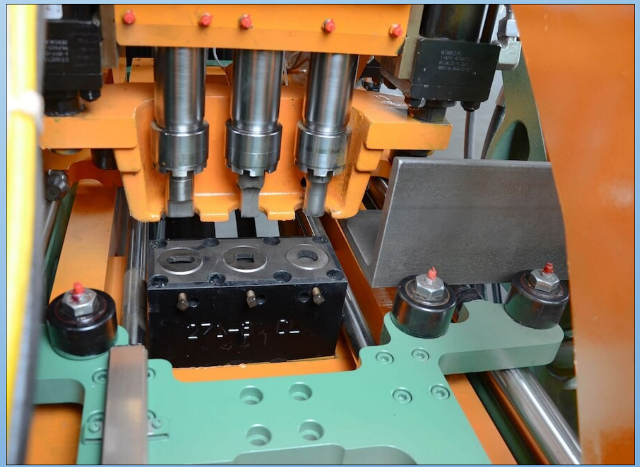
- Manufactures machines for processing structural steel
- 5th generation family-owned company
- Started in Germany in 1903
- Expanded to Bradley Illinois in 1977
- Machines are sold all over the world.

PEDDINGHAUS MACHINES

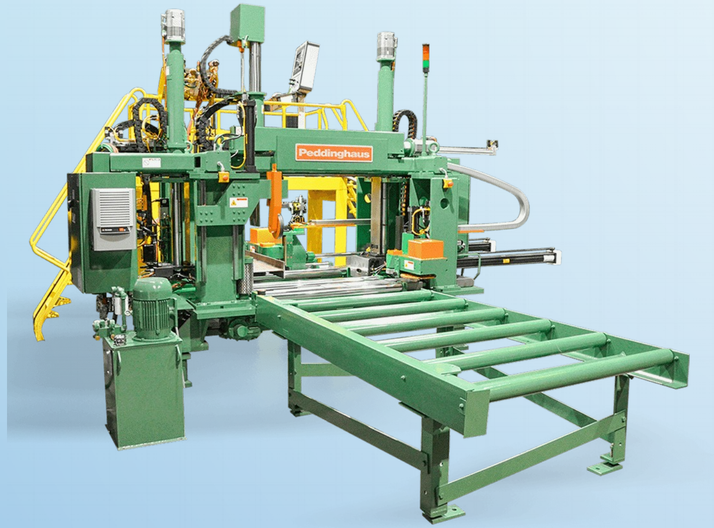




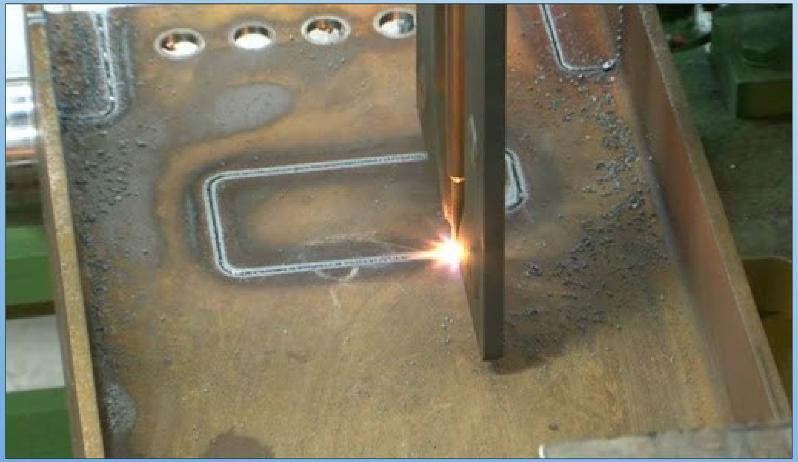




PEDDINGHAUS MACHINES



Coping machines



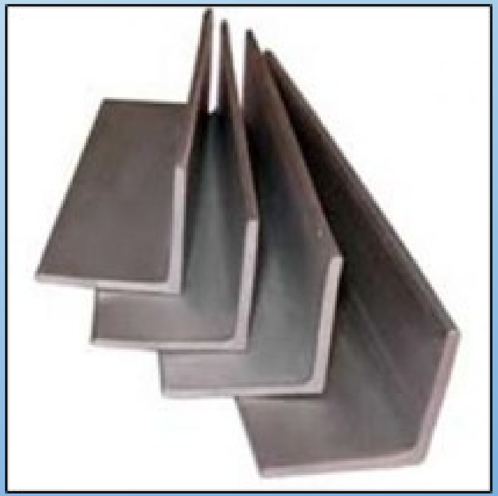
Plasma Burning machines

BACKGROUND

- In order for material to be processed, it must be positioned correctly
- Angle is processed differently in PeddiBot
- Angle is currently rotated manually

PROJECT DESCRIPTION

- The purpose of our project is to design a machine capable of rotating and positioning angle iron
- The angle iron must be rotated before and after processing and then moved against the conveyor datum
- This allows the PeddiBot to cut it efficiently

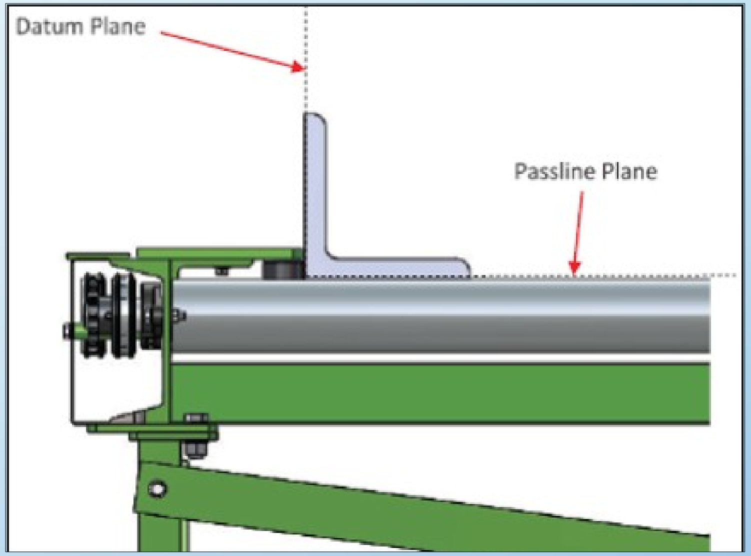


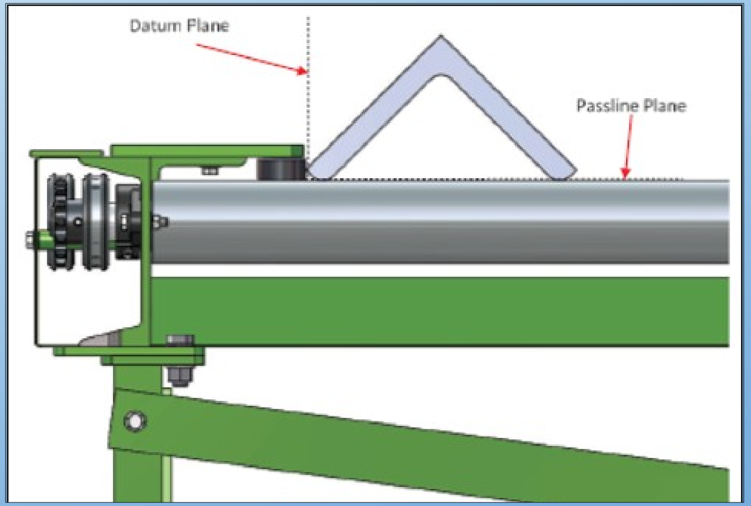
DESIGN OBJECTIVES

- Main objectives of the product is safety (3:1)
- The device must be compact and durable
- Must be user-friendly
- Design simplicity
- Cost effective for production, installation, and application
- Time effective design

FUNCTIONAL REQUIREMENTS

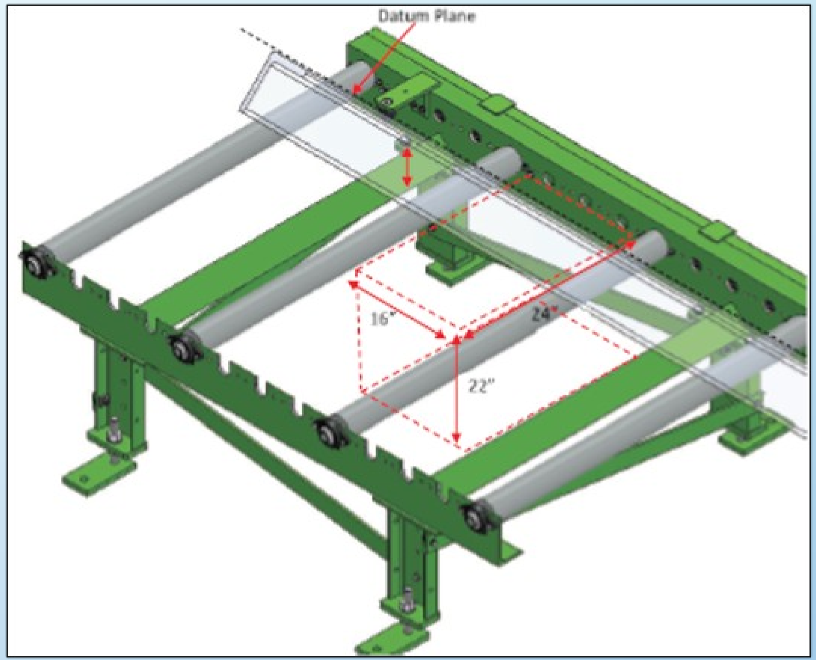
- Primary Function: Rotate angle iron from incoming position to position on its legs
- After rotation, angle must be pushed against datum
- Process must be completed in reverse
- All stands must be synchronous

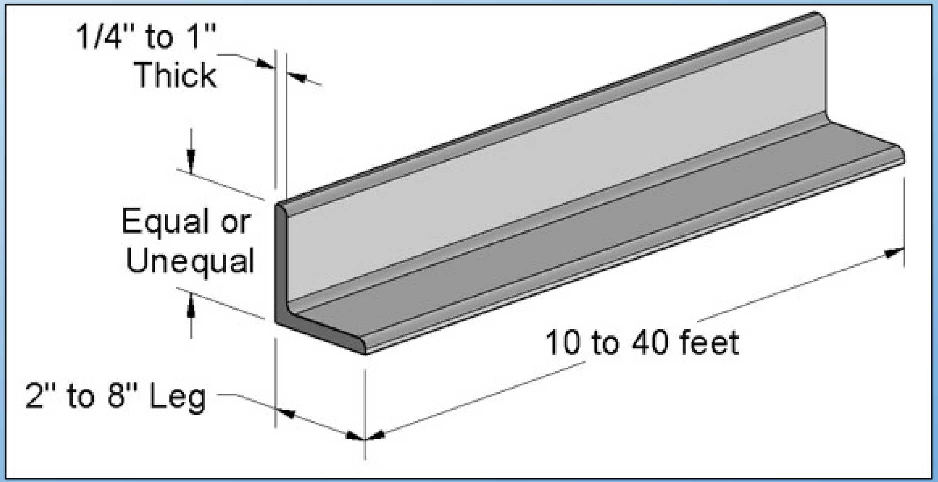




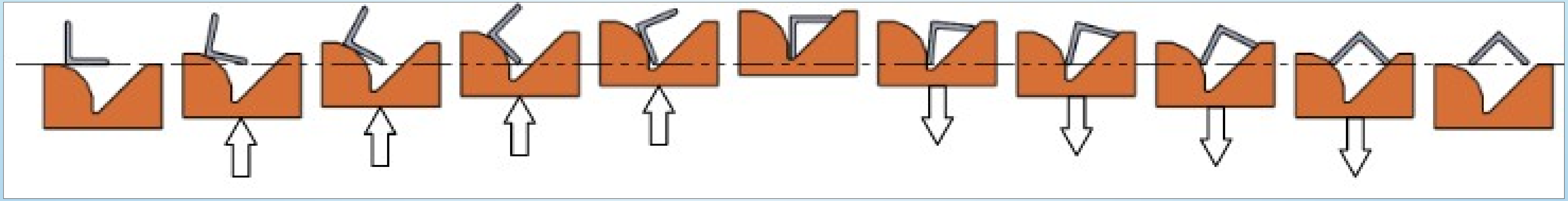
DESIGN CONSTRAINTS

- Fit within a 22”H x 16”W x 24”D volume
- Handle profiles with:
  - 2” – 8” leg lengths
  - 1/4” – 1” leg thickness
  - 10’ – 40’ overall lengths
  - Unequal leg lengths
- Accommodate uneven floor surfaces
- Withstand harsh working environments
- No pneumatic power





INITIAL DESIGN: NOTCHED PLATE



- Rising plate from below passline rollers
- Notched to manipulate the angle rotation
- Uses pusher to push against datum

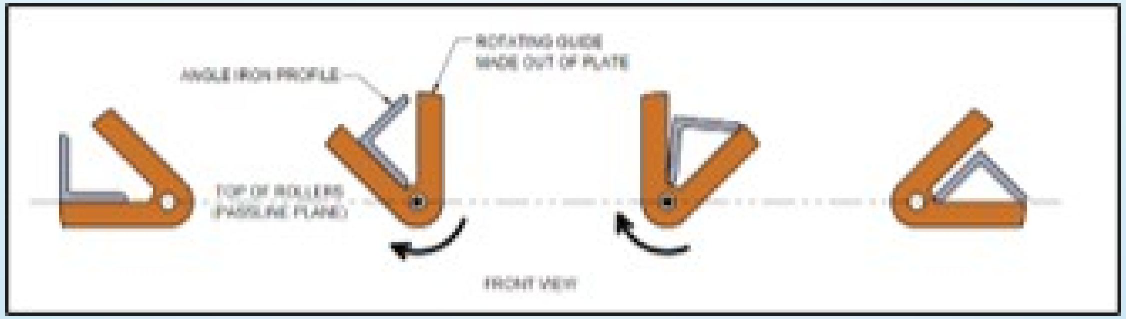
<u>Pros</u>

- Simple plate & pusher motion
- Innovative
- Low manufacturing complexity

<u>Cons</u>

- Unpredictable geometry
- Lots of R&D time
- Multiple plates for material sizes

INITIAL DESIGN: ROTATING GUIDE



- V-shaped plate
- Rotates 135°
- Moves under conveyor to lift angle iron back to datum

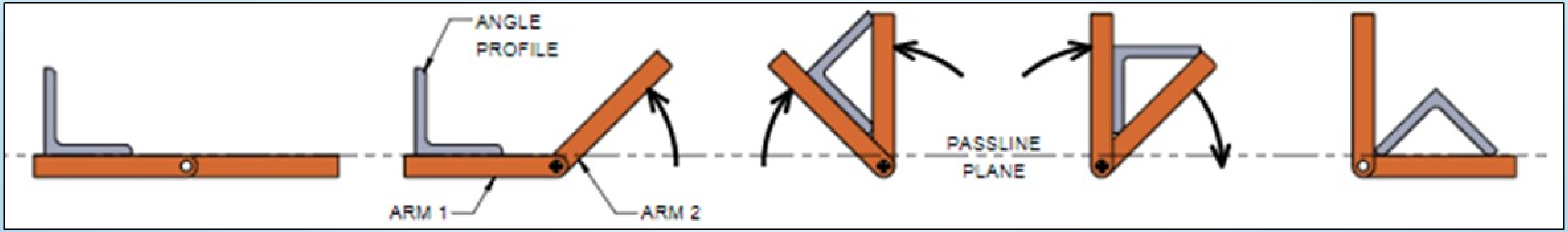
<u>Pros</u>

•Fully supports angle iron
•Main drive shaft able to synchronize with other stands
•The device is reversible
•Very time efficient and reliable
•Guide and linear motion would not be size dependent

<u>Cons</u>

•More complex mechanical motions
•The guide will move material farther away from the datum plane
•May exceed our soft limit parameter
•More mechanical parts & stress analysis required

INITIAL DESIGN: ROTATING ARMS



- Two independently controlled arms
- Concept used to rotate I-Beams

<u>PROS</u>

- Simple and stable
- Fits any size of angle iron
- Arms allow angle to be pushed against datum & reversible

<u>CONS</u>

- Rotating beyond 90° is difficult
- Multiple actuators required for each stand-complex motions
- Exceed size constraints

DESIGN MATRIX

Estimated Design Rankings

Required Functions	Notched Plate	Rotating Arms	Rotating Guide
Angle rotation before processing	5.3	5.3	8.7
Angle rotation after processing	4.3	5.3	8.7
Pushing angle to datum plane	6.3	6.3	8.3
Synchronous across multiple stands	6.0	5.7	8.3
Meets Spaces Constraints	9.0	5.0	6.7
Complexity (10 = least complex)	5.7	3.7	5.7
Stability during rotation	4.7	7.3	8.7
R&D Time (10 = least time)	2.3	5.7	7.3
Material Profile Size Adaptability	4.3	9.3	9.7
Device Percentage Score out of 100%	53% Notched Plate	60% Rotating Arms	80% Rotating Guide

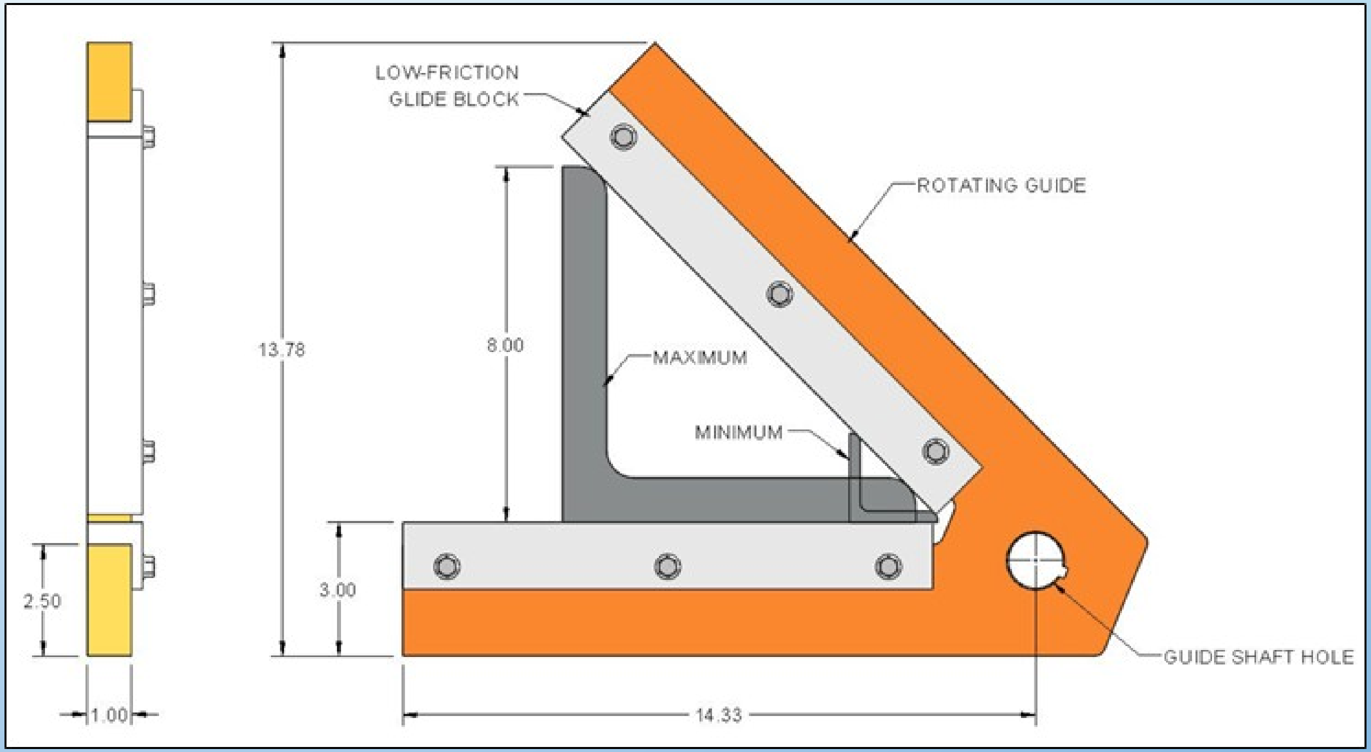
Rankings are from 1-10
Scores shown are the average
1 = least effective, 10 = most effective

DESIGN SELECTION

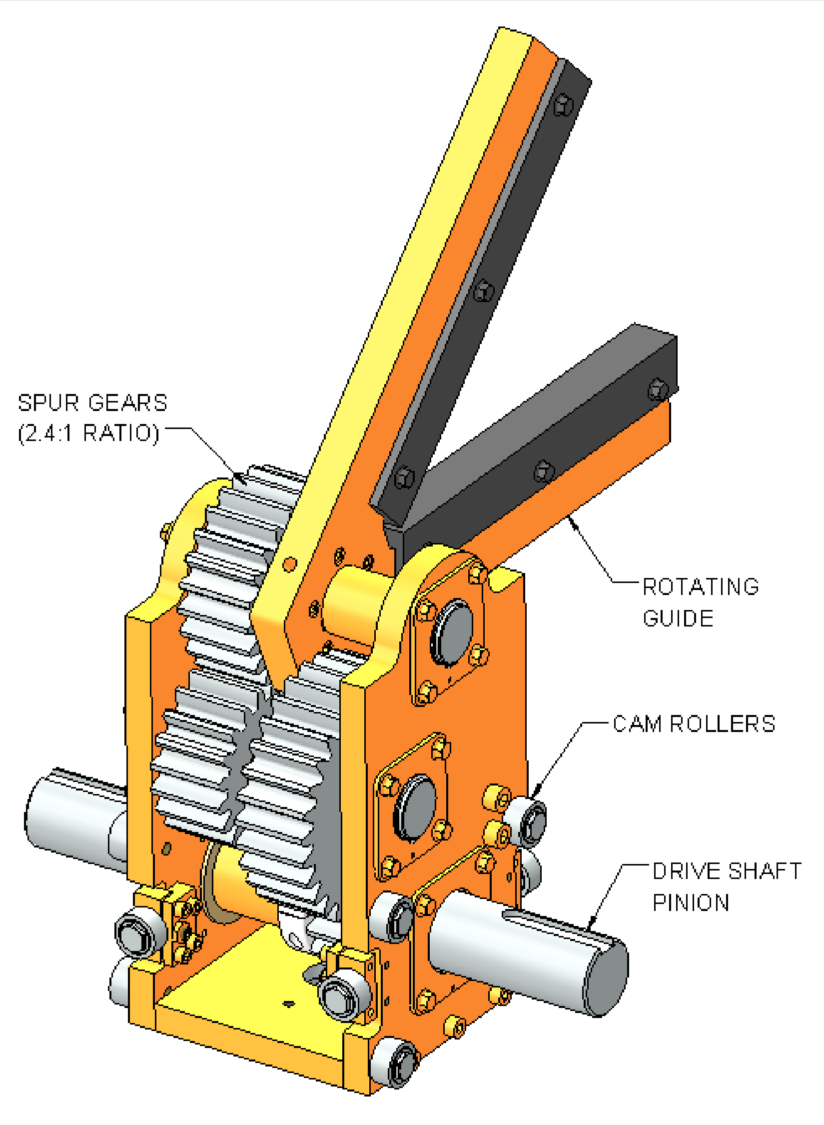
- Meets all functional requirements
- Did not exceed any constraints

For the client:

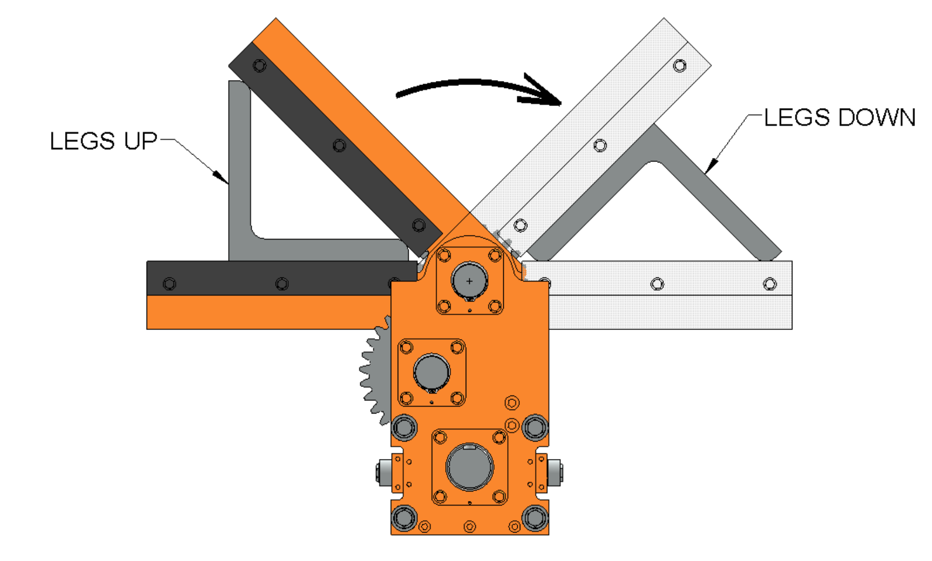
- Single movement procedure for all types of angle iron
- More complex mechanical system => easier use for the client
- Most reliable option for rotating the angle iron

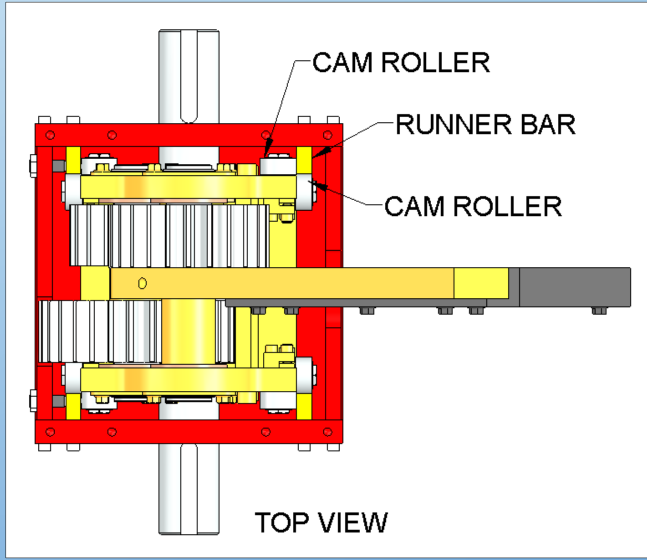


ROTATING GUIDE: UPPER ASSEMBLY

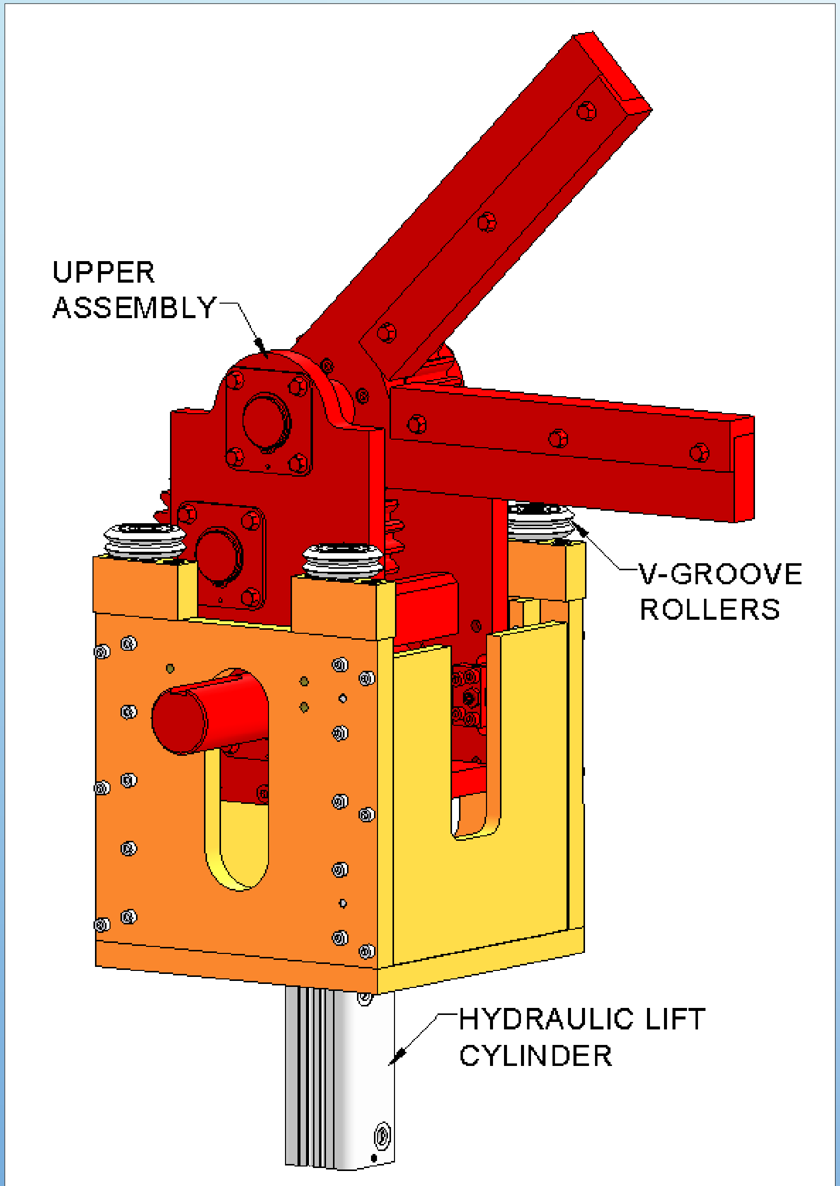


- Rotating Guide with Glide Blocks
- Spur Gear Train – 2.4:1 Torque Reduction
- Cam Rollers – Guides Vertical Travel

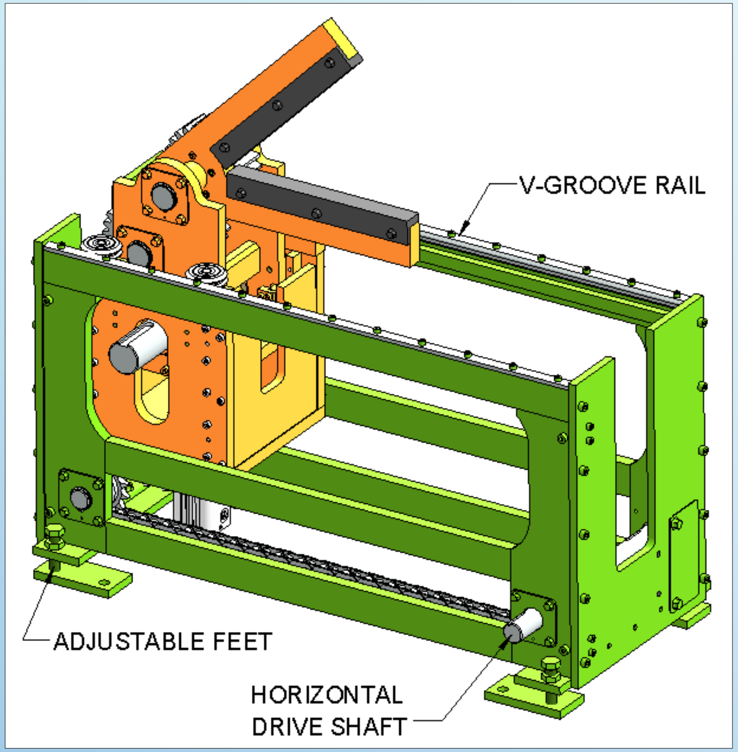


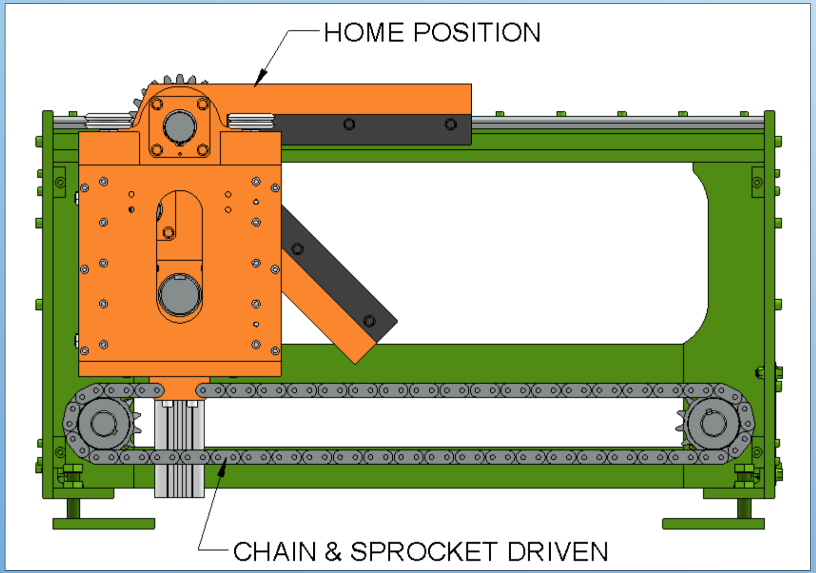


BOX ASSEMBLY



- Upper Assembly mounts inside
- Hydraulic cylinder mounts underneath
- V-groove rollers – horizontal travel
- Cam Roller Guide Bars



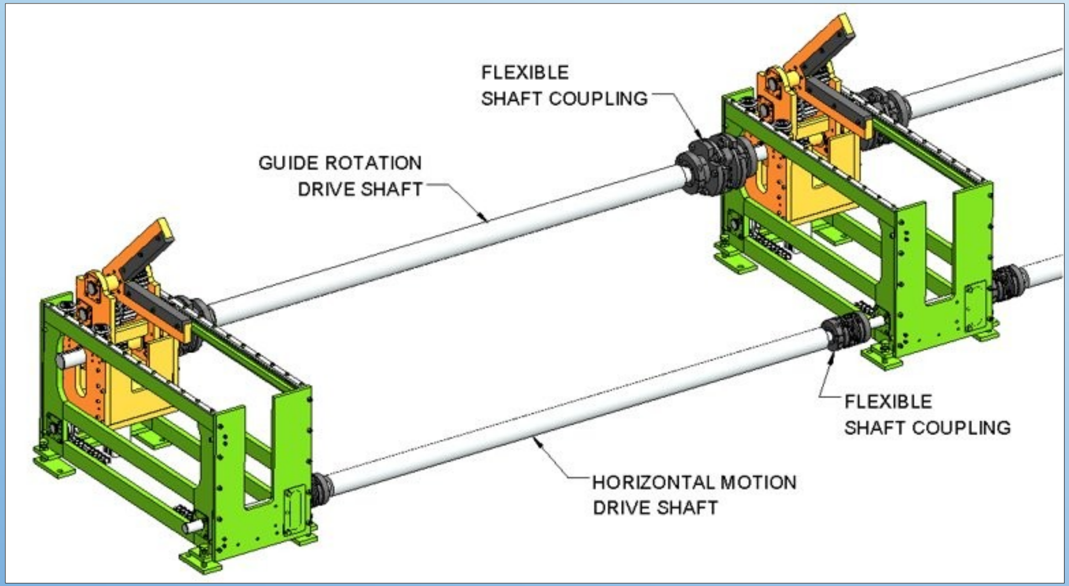


FRAME

- Box Assembly Rides the Rails
- Chain and Sprocket drive horizontal motion.
- Weldment side plates, Solid endplates
- Adjustable mounting feet

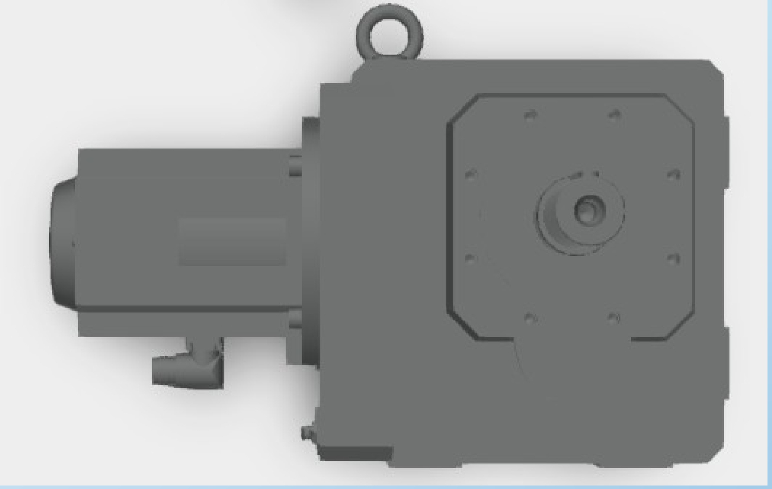
MULTI-STAND CONNECTION

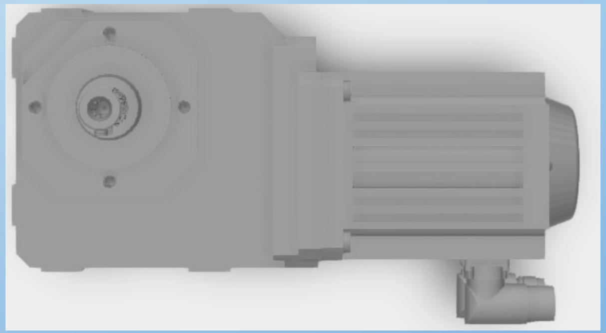
- Hollow low carbon steel shafts
- Zero-Max double clamp type steel hubs
  - Allows for misalignment



MOTORS AND GEARBOX

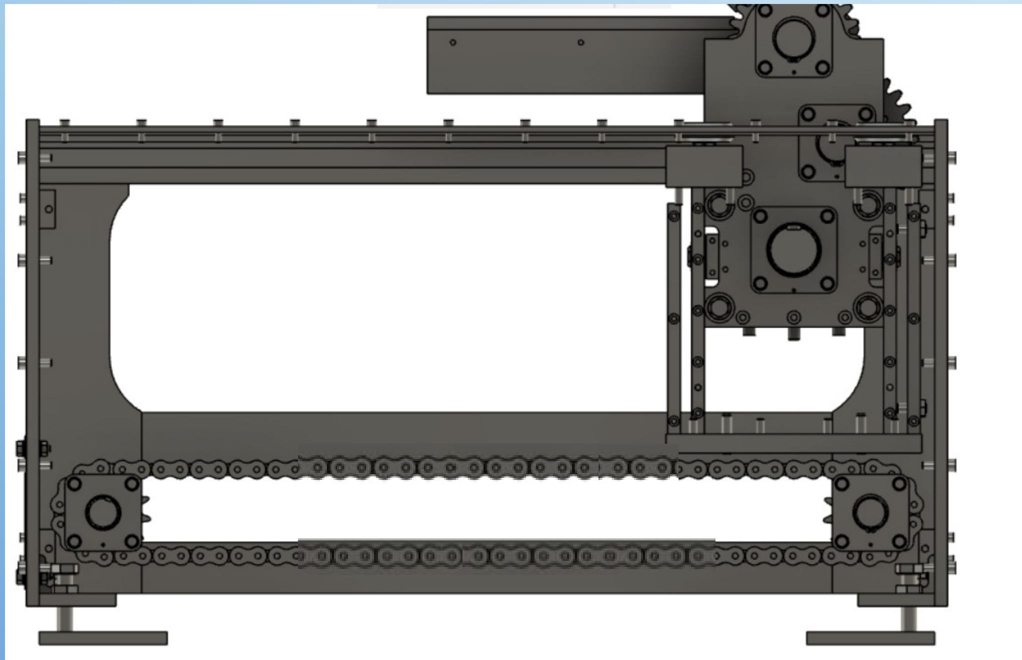
- Stober K-Series Gearboxes
  - Guide Rotation: K614VG1850EZ701U
    - Output Torque: 1,450 Nm or 1069 ft-lbs
  - Horizontal Motion: K102VG0250EZ502U
    - Output Torque: 96 Nm or 71 ft-lbs
- Stober EZ-Series Servo Motos
  - Includes encoder and break

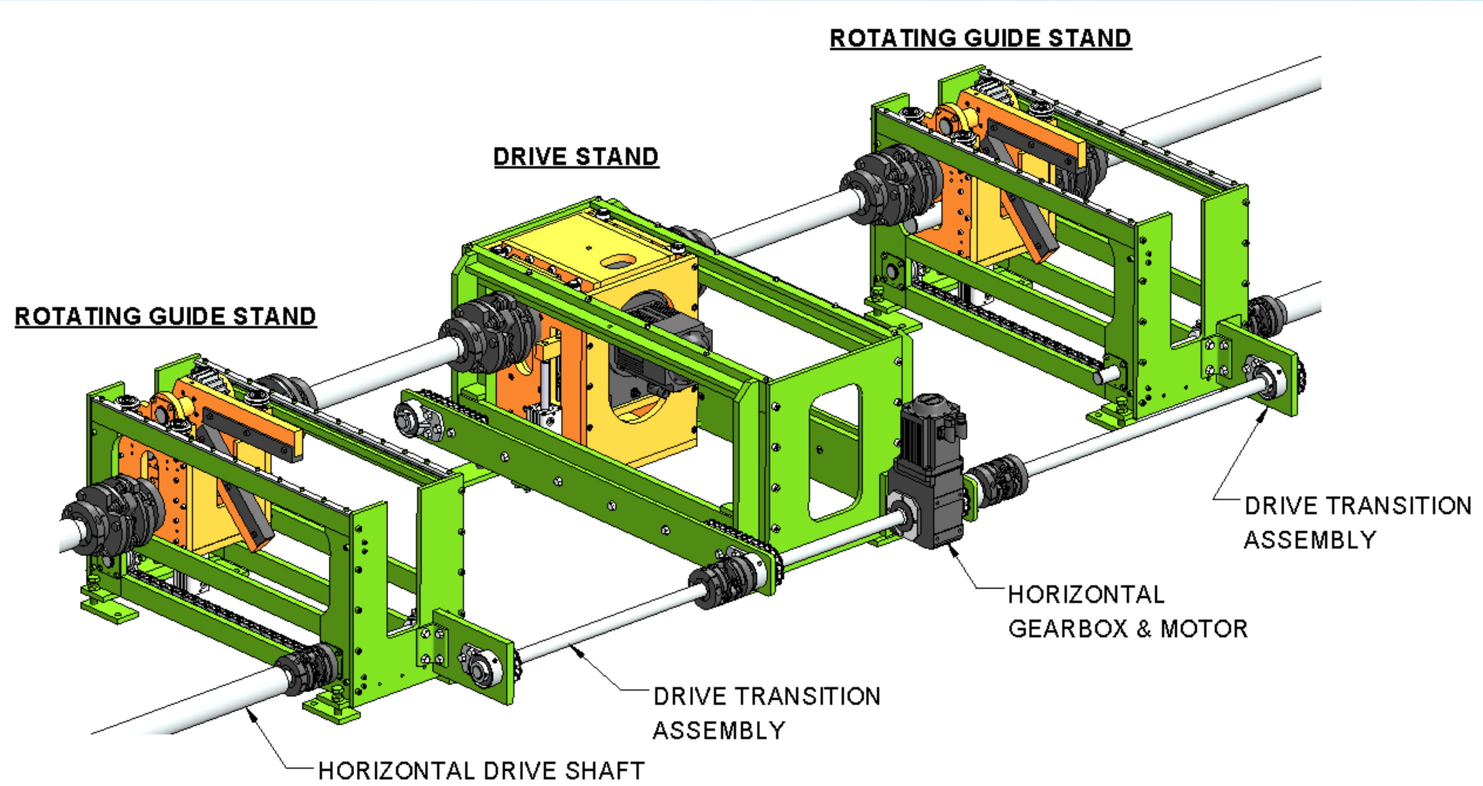




HORIZONTAL MOTION

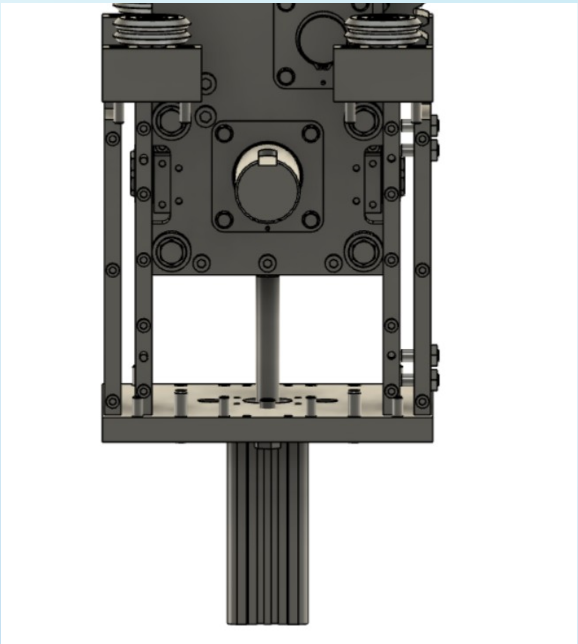
- Powered by horizontal gear box
- Driven by chain and sprocket
- Box assembly attached to chain within drive stand
- Cam rollers supporting drive stand

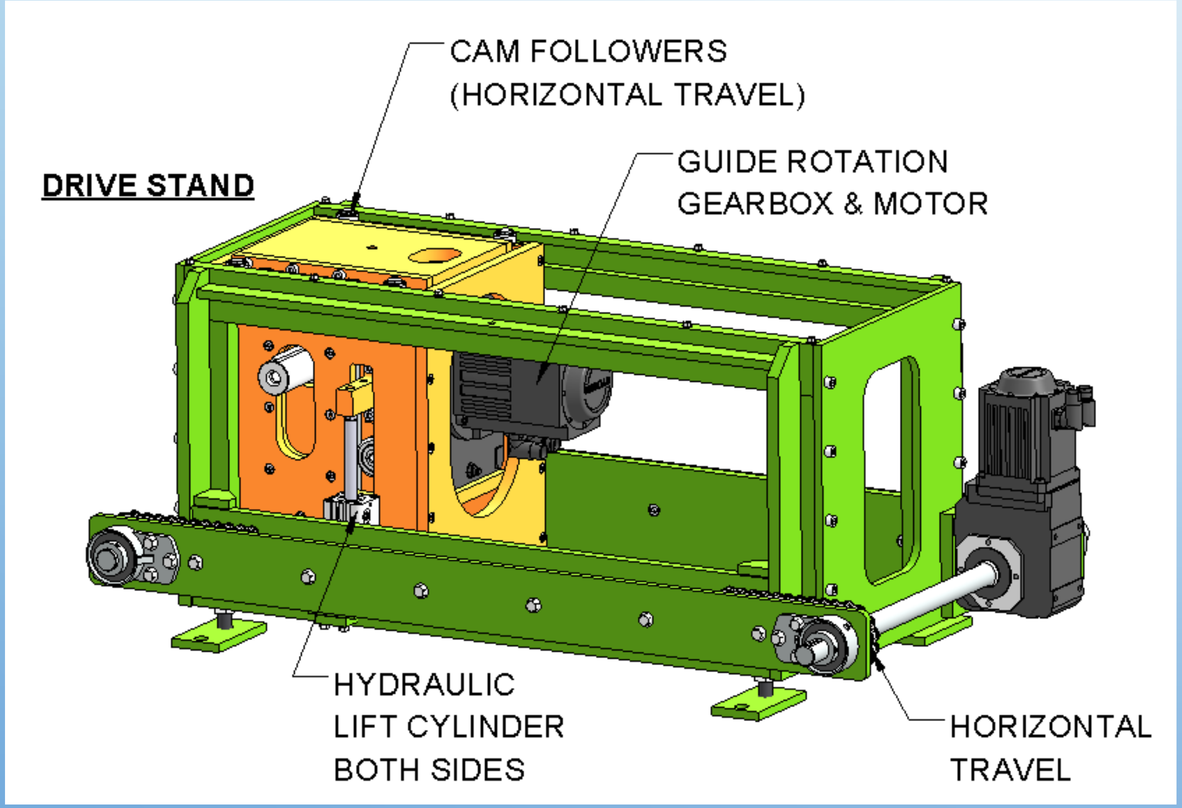


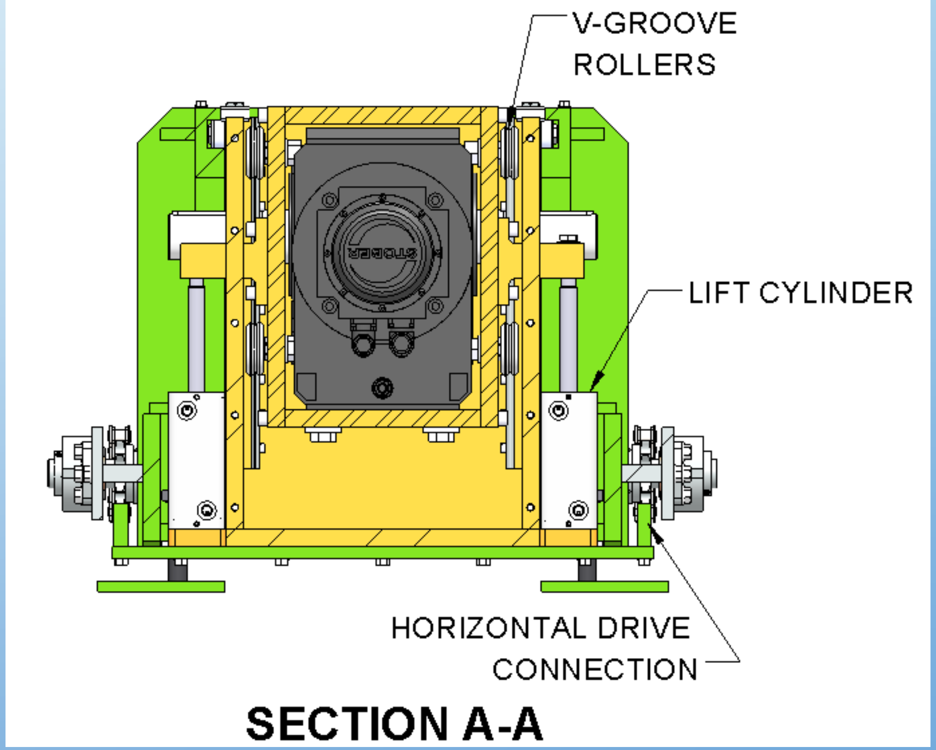


VERTICAL MOTION

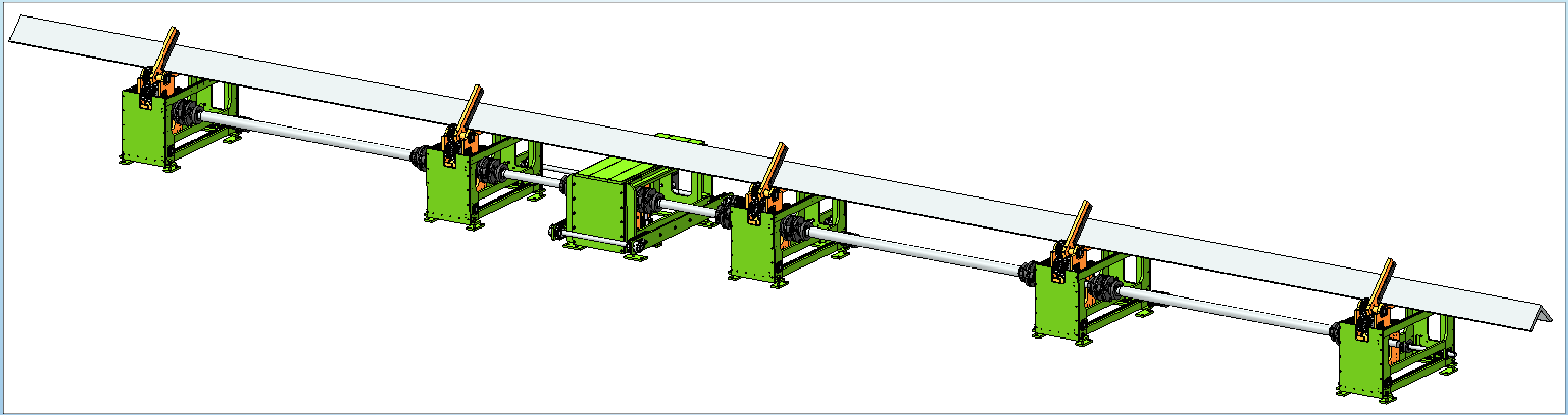
- Gear box and guide upper assembly driven by hydraulic cylinders
- V-groove bearing rollers supporting gearbox

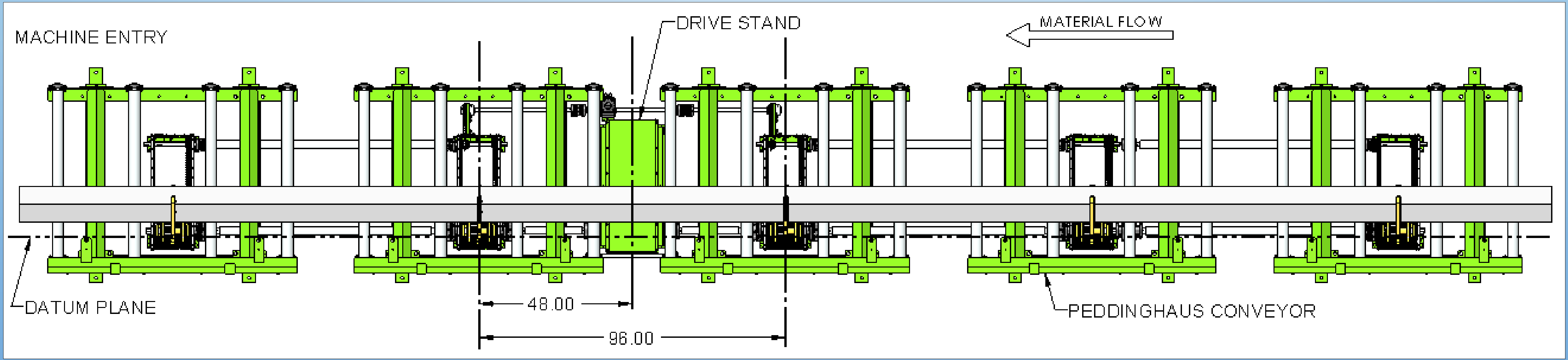






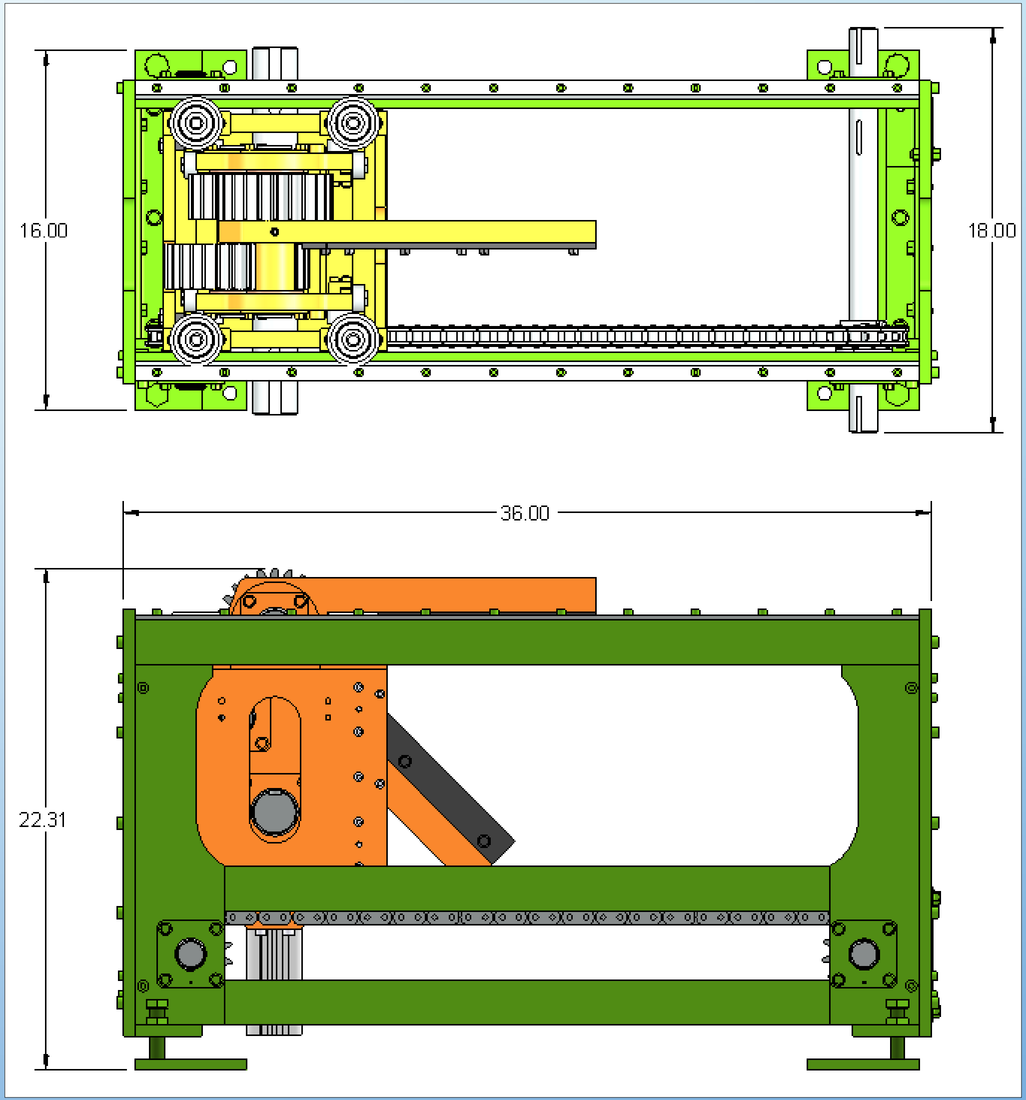
FULL ASSEMBLY PICTURE





PROBLEMS & CHALLENGES

- Fabrication of prototype
- FEA Analysis & Calculations
- Torque needs vs. equipment size
- Torque reduction
- Space constraints
- Mounting gearbox & motor



PROTOTYPE

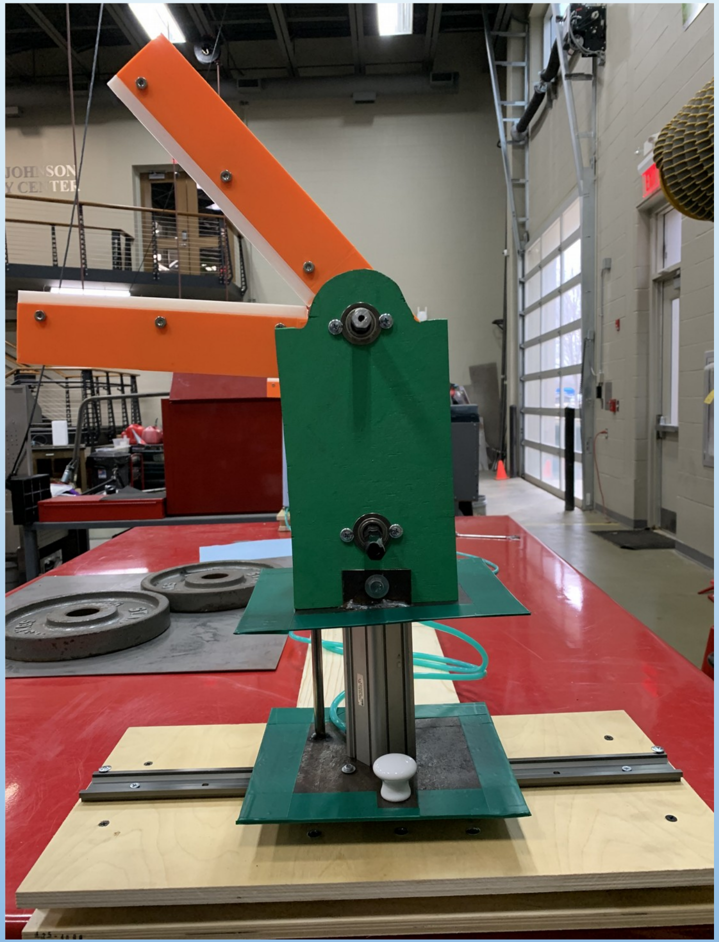
- Construct two stands that are linked by main drive shaft
- 75% scale of actual design

- **Horizontal Motion**
  - Carriage and guide rails
  - Automated manually
- **Vertical Motion**
  - Double acting air cylinders (3" stroke)
  - Using air control value to determine direction of motion
- **Base**
  - Constructed out of wood and metal
- **Mechanical Systems**
  - Vex Robotics (chains, sprockets, ½" shafts, etc.)

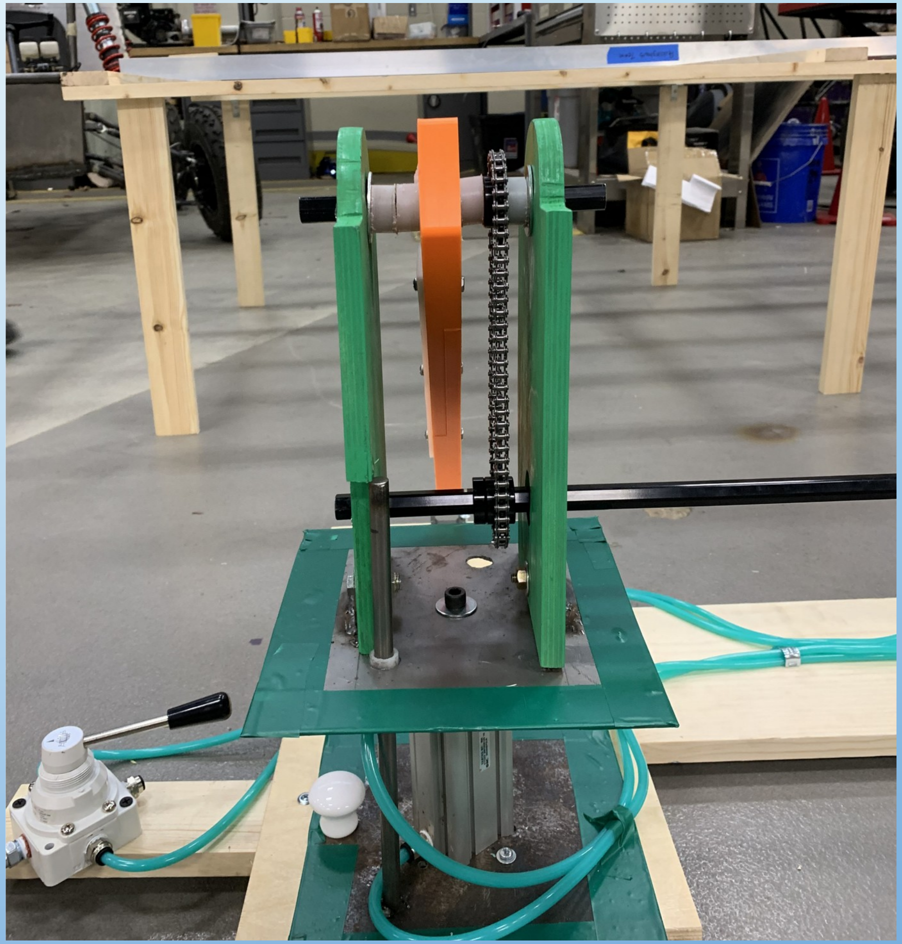
PROTOTYPE

Synchronous Operation

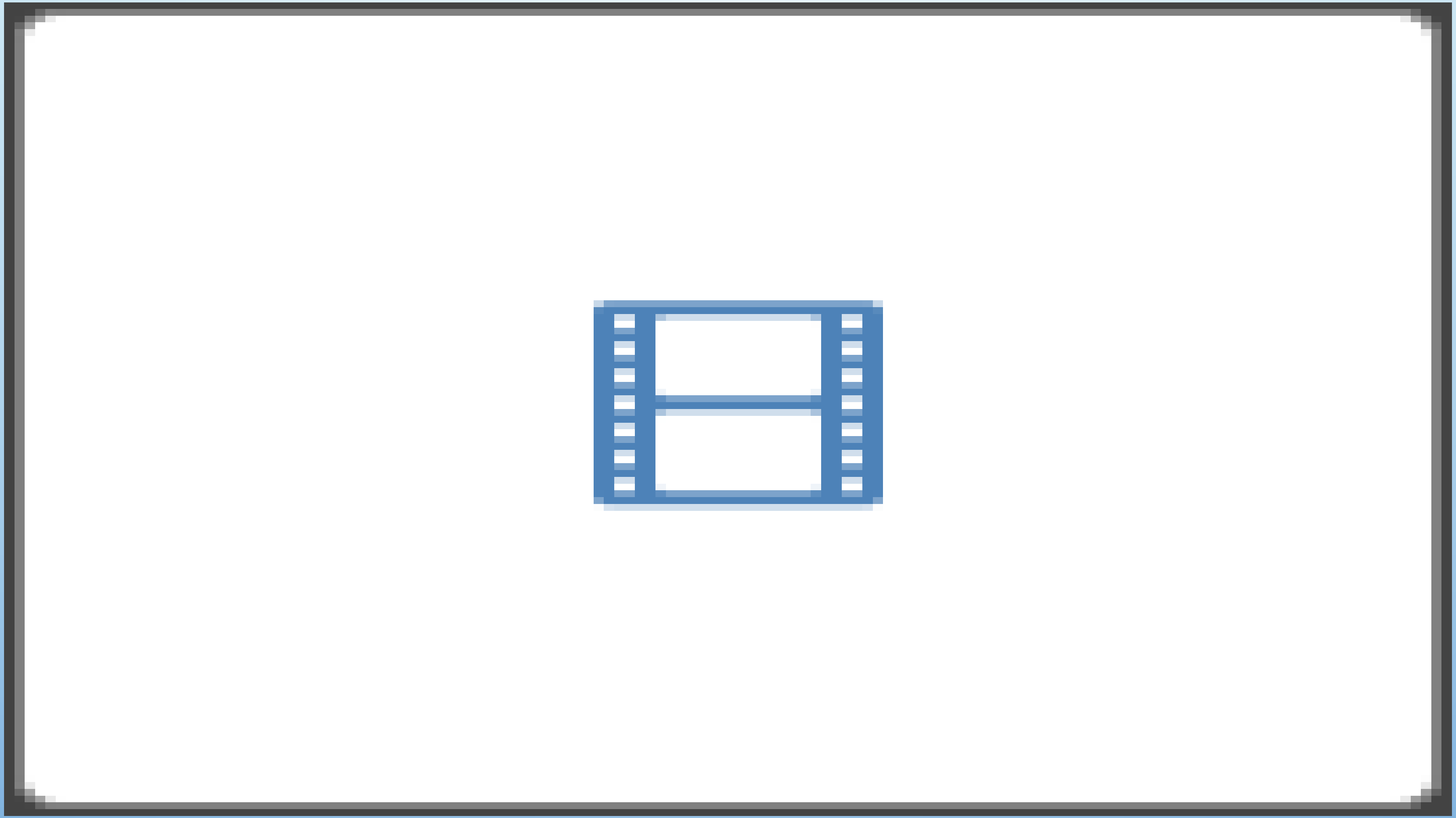
Side View



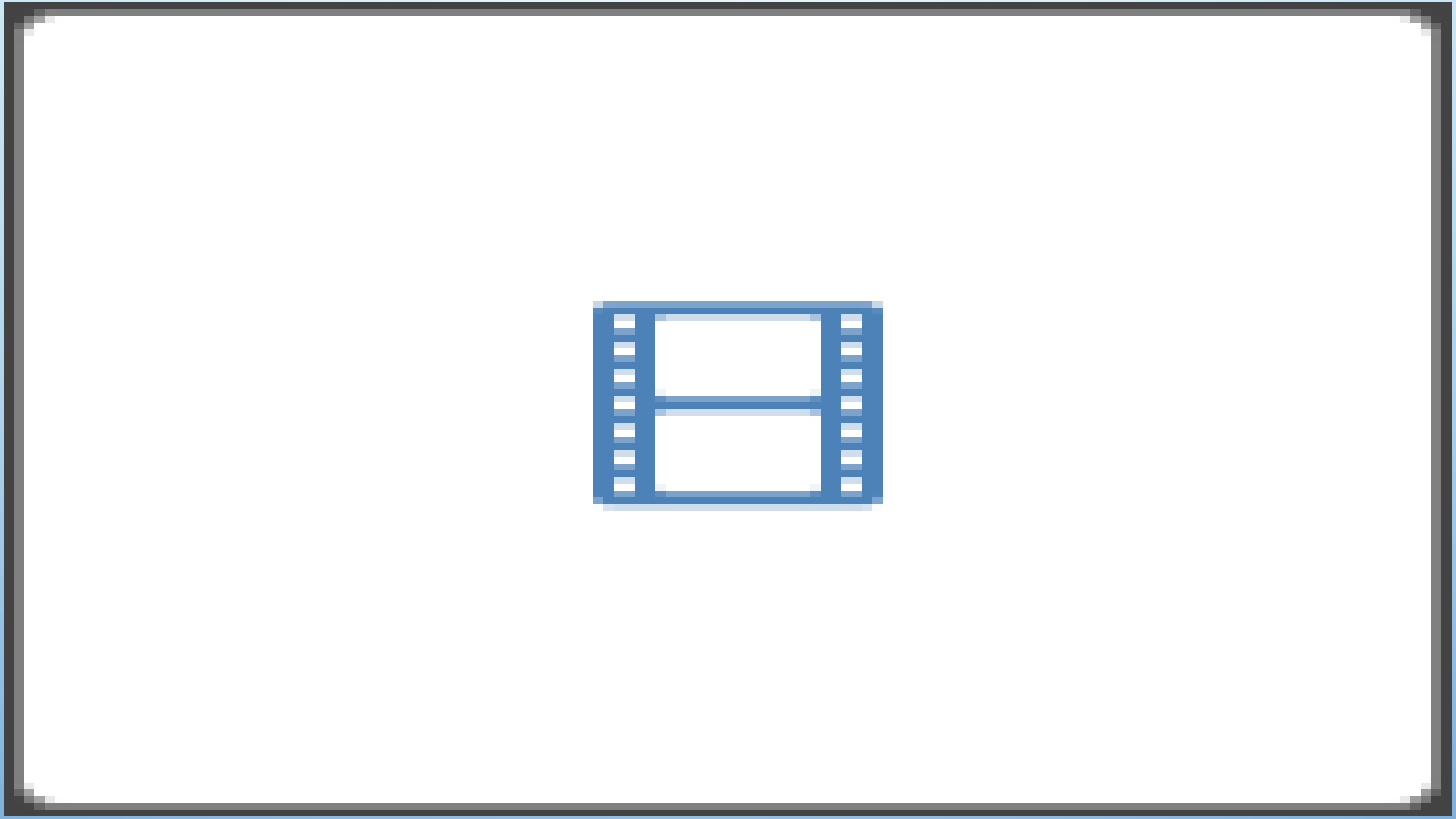
Upper Assembly



PROTOTYPE DEMONSTRATION-FORWARD OPERATION



PROTOTYPE DEMONSTRATION-REVERSE OPERATION



DESIGN VALIDATION

- ❑Rotate Angle Iron from Legs Up to Legs Down - Infeed
- ❑Rotate Angle Iron from Legs Down to Legs Up – Outfeed
- ❑Push Angle to Datum on Infeed
- ❑Synchronous Stand Operation
- ❑Fit within a 22”H x 16”W x 24”D (soft constraint)
- ❑Process a Variety of profiles
- ❑Uneven floors and harsh environments
- ❑User Friendly

BENEFITS TO CLIENT

- User Friendly – One operation
- Removes hazard of manual rotation
- Decreases cycle time
- Frees up lifting equipment or manpower
- Independent System

FUTURE STEPS

- Implementation of controls system
  - PLC and drives
- Implementation of safety system
  - Safety gates, warning signage, rails
- Size reduction
  - Further research in torque reduction
  - Selection of smaller components


QUESTION?
COMMENT?
CONCERN?
We want to hear about it.