

PRELIMINARY DESIGN REVIEW

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BACKGROUND

- Current insulation techniques include an assembler single-handedly pushing/pulling the seamless insulation over the pipe.
- Issues:
 - Ergonomic Factors
 - Potential damage to insulation or tubing

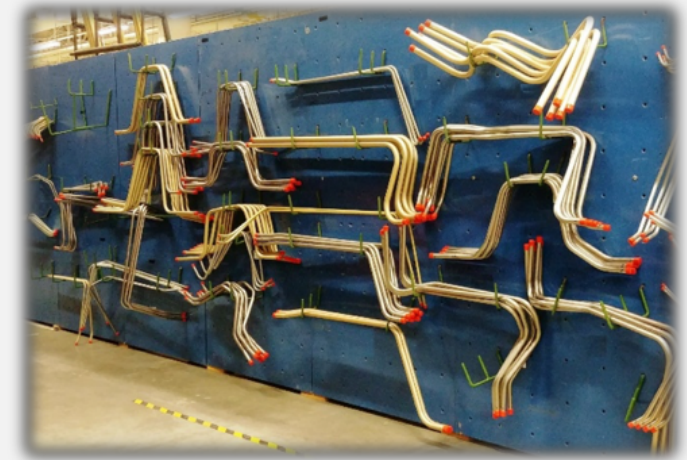


OBJECTIVES

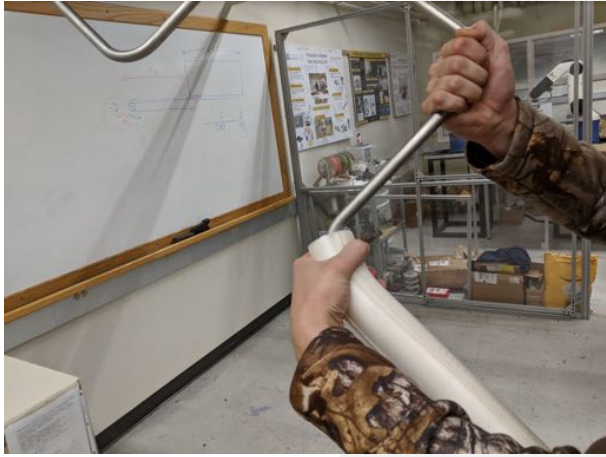
- Design and develop tooling and/or assistive devices to streamline tubing insulation process.
- Improve overall ergonomics and operator friendliness during insulation.
- Insure that tubing installation is defect-free and has consistent outcomes.
- Solicit and incorporate suggestions from the TDRC client team.

REQUIREMENTS & CONSTRAINTS

- Handle a Diameter Range of 0.5" – 1.0" Nom.
- Quantify changes in production time
- Reduce ergonomic issues experienced by installer
- Accommodate complex bends in tubing (multiple 90 degree bends)
- Consider pipes of various diameters (XX" to YY")
- Allow force input from user along with device operation (automation)
- Prevent damage to tubing
- Prevent damage to insulation



DISCOVERIES ABOUT MANUAL INSTALLATION



- Overcoming the first bend by hand is awkward and strenuous, increasingly more difficult the further the user rounds the corner.



- Going into the second 90° bend, there is already a need for a third point of contact on the tube assisting the insulation process.

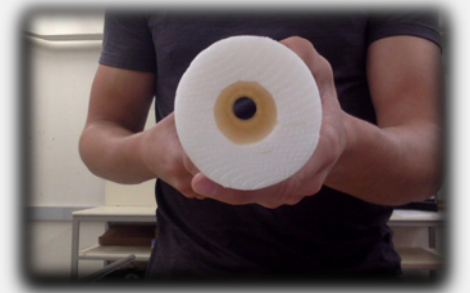
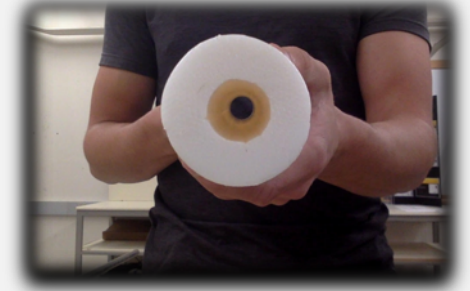


- Eventually reaching the point of passing all four bends, the assembler is forced to using a bunching method while continuing to the end.

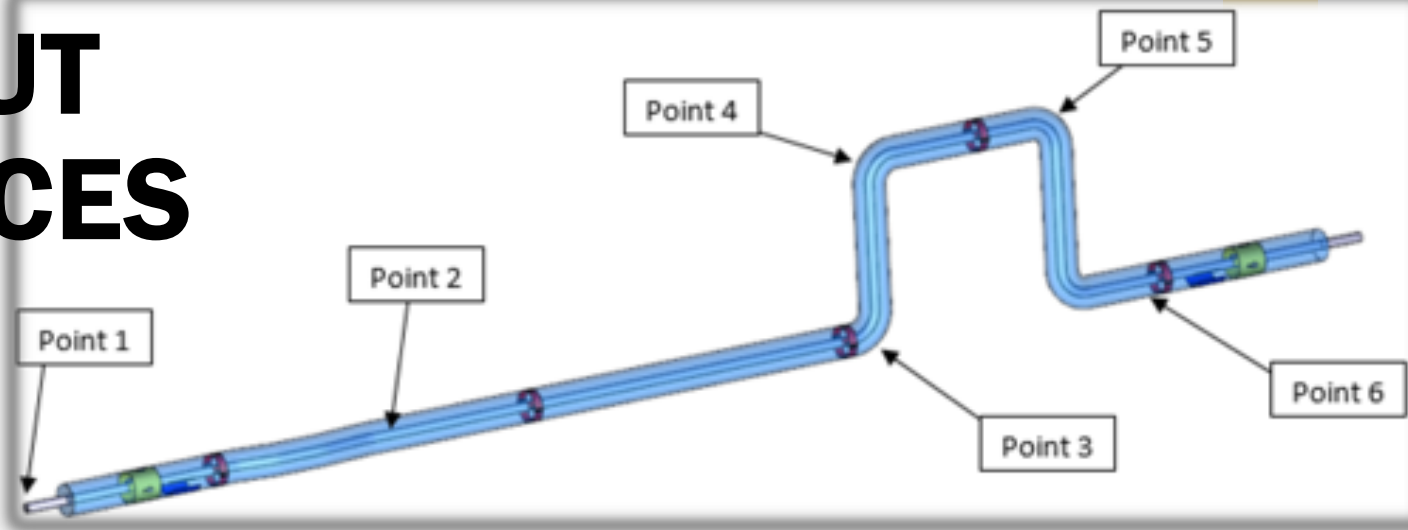
DISCOVERIES ABOUT INSULATION PROPERTIES



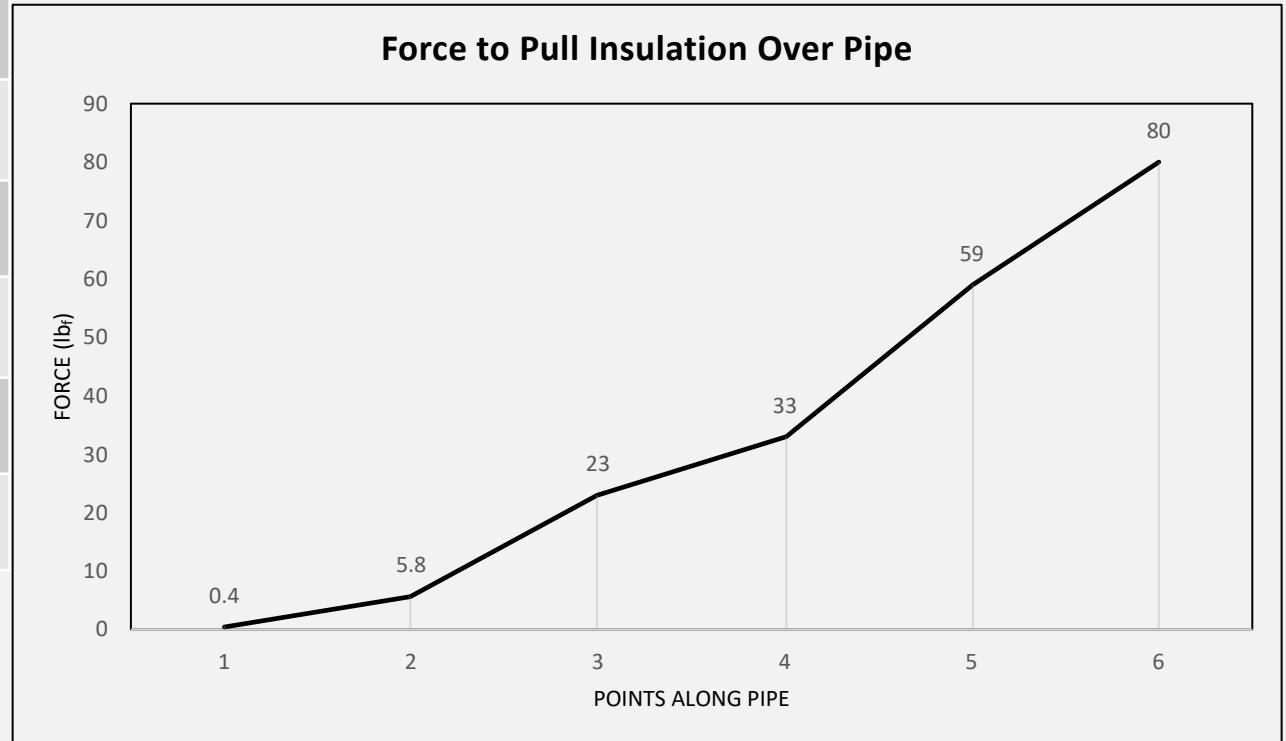
- After applying axial, torsional and bending stresses to insulation, it was determined that the only way to permanently damage the insulation under normal conditions was to cut it with a sharp edge.



DISCOVERIES ABOUT INSTALLATION FORCES



Point	Force (lb _f)
1	.4
2	5.8
3	23
4	33
5	59
6	>80



DESIGN PATHS

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1. Differential Pressure Straw

- Plug/seal and pressurize one end of the insulation (or the tube), open up a valve on the opposing end, causing suction and pulling insulation over the pipe

2. Air Bearing

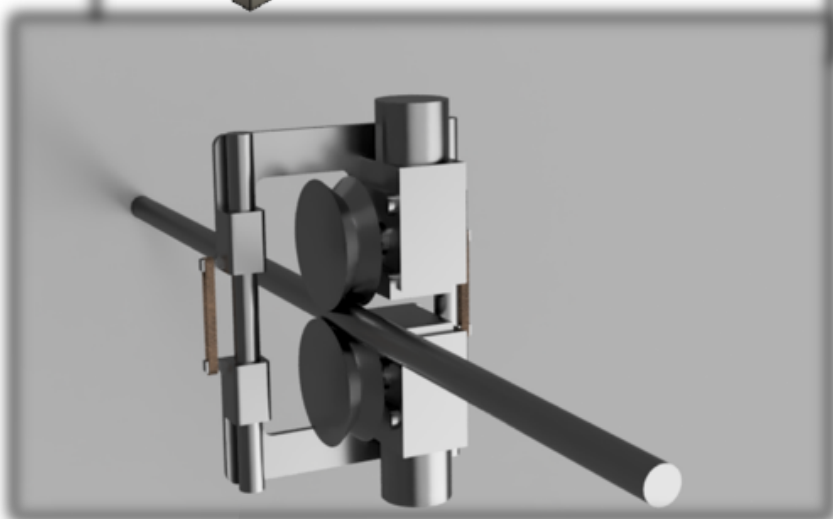
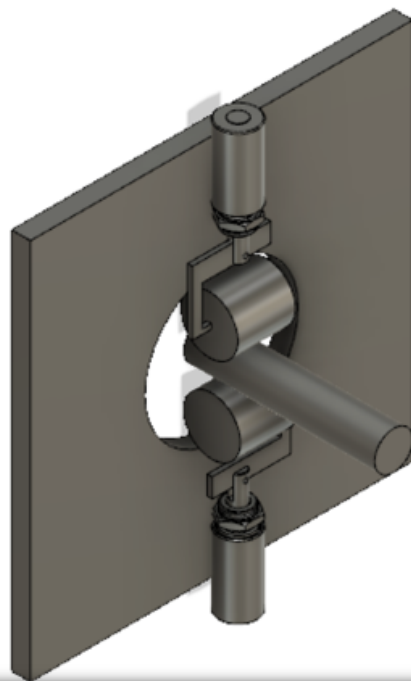
- Blow air between the tube and pipe to create an air bearing

3. Chug & Tug

- Multi-action of pushing the insulation up the pipe while simultaneously pulling the insulation in a different location reduces the required forces significantly



CHUG AND TUG SOLID MODEL



- Selected design is "Chug and Tug" method
- Preliminary models have been developed for proof-of-concept testing
- Concept is for motor-driven rollers to advance along pipe, with insulation proceeding after mechanism.
- The operator will be restraining the tube as well as assisting the device.
- Overall concept still under development

CHUG & TUG PROOF OF CONCEPT

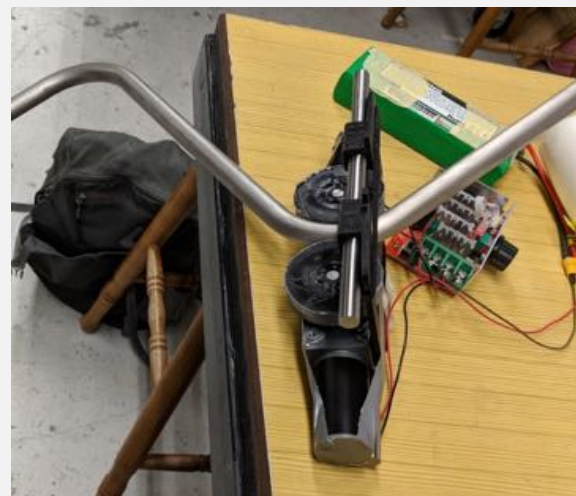
- Device making its way down the pipe approaching first bend.



- Chug & Tug starting around first 90° bend



- Successfully handling the tightest portion of the bend



- Chugging away toward its upcoming challenge





CHUG & TUG PULL TEST



- Motor capability test
- Capable of 15lbs of force
- Too high of a slipping factor
- Not enough friction/grip
- Duck tape—Not so good
- Rubber or a similar material would work much more efficiently.



PIPE PULLER

- Hold onto Pipe Through Insulation
- Assists Tug & Chug
- Facilitates Inchworm-Style Process Used by Boeing Installer
- Boat Plug as Connection to Pipe



RISK MANAGEMENT

- Risks include:
 - Injury to operator
 - Damage to equipment
 - Failure of system
- Necessary steps will be taken to ensure safe operation of equipment
 - Ergonomic factors will be considered in design to mitigate injury to operator
 - Emergency stop/fail-safe design will be incorporated to system to mitigate damage to equipment
 - Fatigue and stress analyses will be conducted on components to determine appropriate operating conditions and maintenance intervals

END OF TERM DELIVERABLE CLARIFICATION

- Chug and Tug Proof of Concept
- Parts for the Chug and Tug Prototype
- Pipe Puller -- Boat Plug Prototype
- Clean pipes out
- Modify and continue developing parts and prototypes
- Finalize the pipe puller
- DFMEA

17 SCHEDULE



- **Fall:**

- Working Prototype Before Thanksgiving Break
- Preparing for Snapshot Day #2

- **Spring Key Dates:**

- 1/28 DUE: Detailed Design Review (w/client & lead instructor)

- 4/26 DUE: Booth Display/Poster at Expo

DUE: Technical Presentation at Expo

- 5/3 DUE: COURSE DELIVERABLES:

Final hardware/software (approved for shipment to client)

Design Report/Project Portfolio (approved by lead instructor)

Wikipage (approved by lead instructor AND Dr. Swenson)

Project Poster (approved by lead instructor and delivered to designated location)

Electronic Archive/File Management (approved by lead instructor)

CLIENT QUESTIONS

- Do you feel like the new developing ideas have potential in the workplace?
- Do you see any potential ergonomic issues with the path we are on?
- What do you see as the greatest advantages/opportunities of the design path we are following?
- What do you see as the greatest challenges associated with the design path we are following?
- What is the maximum amount of tube movement above the work table that is desired/should be allowed?
- What is the maximum amount of force that should be allowed by the operator in assisting the device?
- What is the maximum amount of set-up time that should be allowed before beginning installation?
- What is the configuration of the tubes and insulation before installation?
- How/where are finished products stored with respect to the work cell?