Integrated project Engineering Technology

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Automatic tube straightener for multiple sizes welded steel tubes

Glenn Thijs & Nicolas Thomas

Bridging programme for Master of Electromechanical Engineering Technology

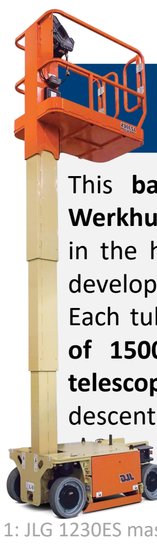

Figure 1: JLG 1230ES mast lift [1]

Situation

This **bachelor thesis** is being conducted in collaboration with **Werkhuizen Hengelhoef**, a mechanical engineering company active in the heavy industry. The company was commissioned by **JLG** to develop an **indoor lift** consisting of three steel tubes, made of ST52. Each tube consists of two welded-together U-profiles, has a **length of 1500 mm** and a wall **thickness of 3 mm**. The lift works **telescopically**, whereby the tubes slide into each other during descent.

Problem

During the welding process, the heat causes **the weld** connection between the U-profiles **to bend** (±10 mm), making it difficult for the steel tubes to fit into each other.
Therefore, there is need to design a machine that can bend the tubes back into their **original size**. To achieve this, a significant force must be applied to cause plastic deformation.

Design Criteria

To have an acceptable design, the following criteria need to be met:

- Standalone machine
- Automatic feed and discharge
- 2x2 m floor dimensions (bending installation)
- Cycle: 50 pcs/hour
- Tolerance after bending: ± 1 mm
- Electrical and/or hydraulic powered

Main Components

Straightening Mechanism

To straighten the tubes a hydraulic mechanism is pushed thru the tube. This mechanism is power by a hydraulic cylinder, with a force of up to 8 kN.

By regulating the pressure in the cylinder, the force on the walls can be adjusted to limit the deformation.
This also makes it possible to use this mechanism for multiple sizes of tubes, smaller tubes will take less stroke length while keeping high pressure.

Figure 2: Detail view of Straightening mechanism

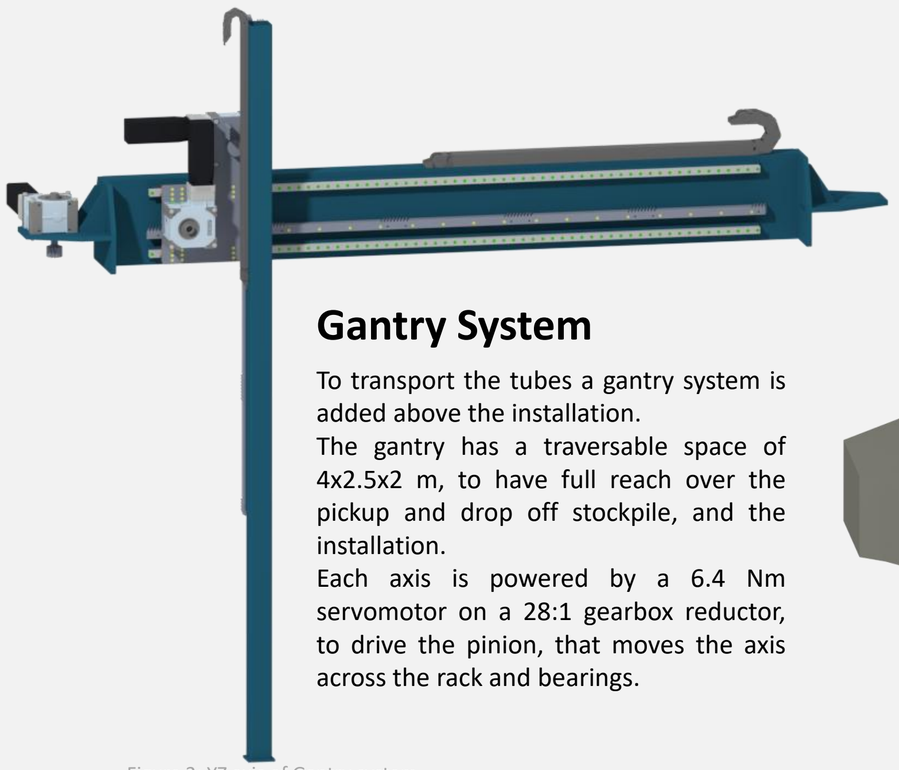

Figure 3: YZ axis of Gantry system

Gantry System

To transport the tubes a gantry system is added above the installation.
The gantry has a traversable space of 4x2.5x2 m, to have full reach over the pickup and drop off stockpile, and the installation.
Each axis is powered by a 6.4 Nm servomotor on a 28:1 gearbox reductor, to drive the pinion, that moves the axis across the rack and bearings.

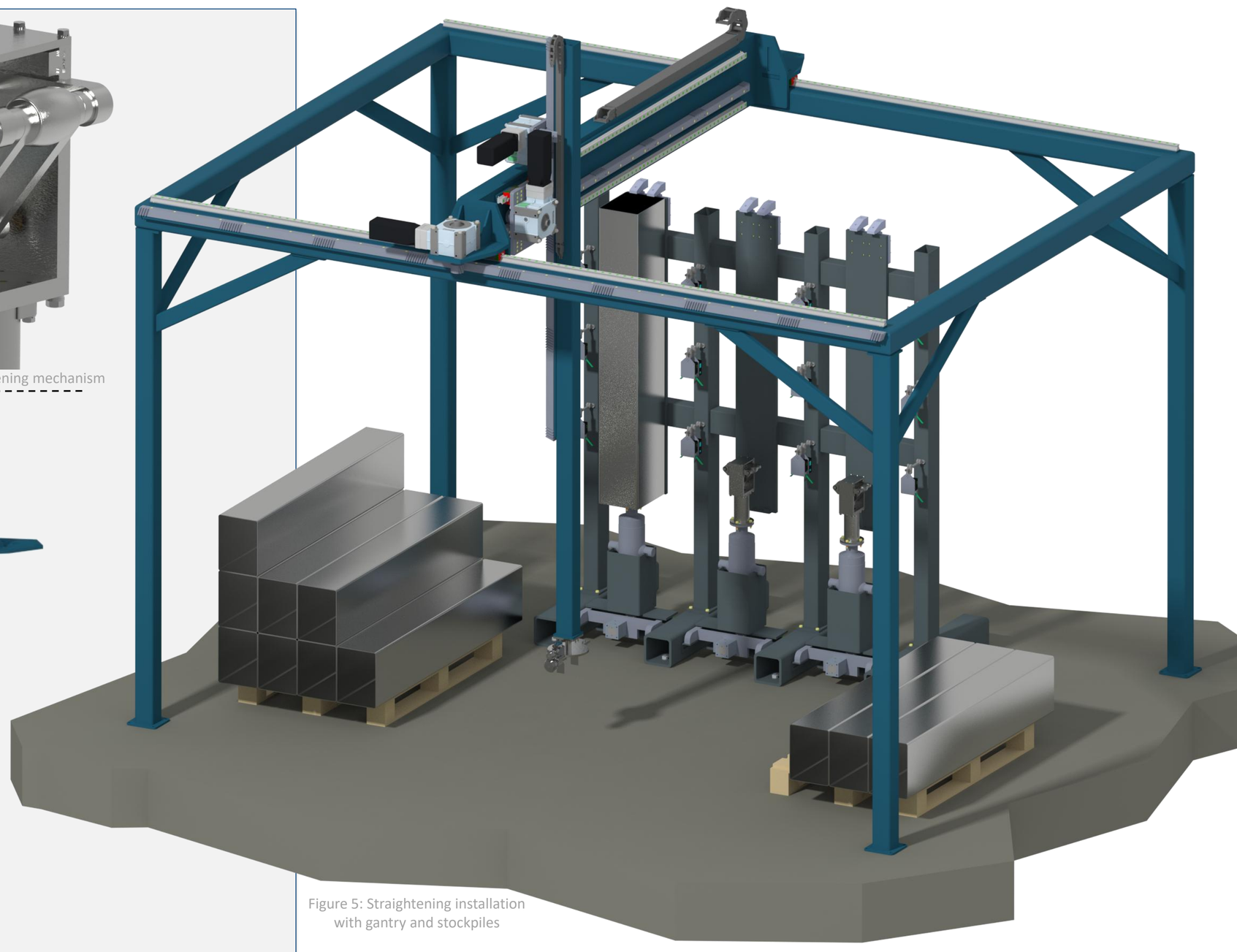

Figure 5: Straightening installation with gantry and stockpiles

Wrist Mechanism

The wrist handles pickup, drop-off, and positioning of the steel tubes. It features a servomotor for Z-axis rotation and a lightweight (0.53 kg) servomotor mounted on the main rotation disk to rotate two ferromagnetic plates via a 1.6:1 gear reduction. The plates move along a fixed path using magnetic force, eliminating extra weight and cabling on the first axis.

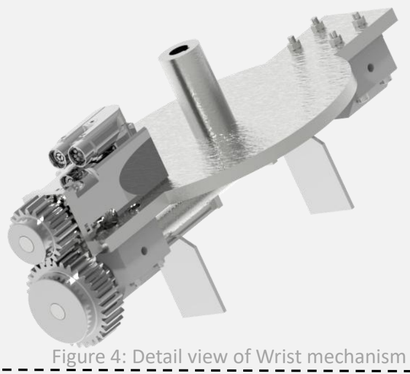

Figure 4: Detail view of Wrist mechanism

3D Model

View the model in 3D with AR

1) Scan the QR code
2) Install the Vuforia View App
3) Scan the QR code again
4) In the app scan the second code
5) Take a few steps back, and see the full model in AR

Conclusion

The final design successfully meets the essential design criteria outlined above. But some features are still missing from the design, such as cameras for the positioning of the steel tubes, and safety and electrical equipment.

Supervisors / Co-supervisors / Advisors:

John BIJNENS
Michaël DAENEN
Jef HOSTE (extern)
Karel KELLENS
Jeroen LIEVENS

[1] "1230ES Vertical Mast Lift", JLG.com https://www.jlg.com/en/equipment/vertical-lifts/driveable-vertical-mast-lifts/1230es (accessed May 5, 2025)

WERKHUIZEN HENGELHOEF

De opleiding industrieel ingenieur is een gezamenlijke opleiding van UHasselt en KU Leuven

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