

Design of an agricultural machine for laying drainage pipes

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Programme for Bachelor of Electromechanical Engineering Technology

Situation & Problem Statement

The assignment comes from a farm in Beverst. It is a medium-sized family-run business whose main activities are arable farming and the rearing of cows and calves. They have experience in metalworking, so they intend to produce the design themselves.

The soil suffers from excessively high and uneven moisture levels, meaning conditions are not ideal for optimal crop growth. This problem is being addressed by installing drainage hoses to remove excess water.

Currently, these drainage pipes are laid manually. This process is labour-intensive, time-consuming and also requires renting or loaning machinery. As a result, costs are high and the method is inefficient. The farmer would prefer to invest in a machine that makes the installation process cheaper and more efficient.

Objective

The aim of this project is to design a machine capable of automatically laying drainage pipes underground without the need for manual labour. The machine should ensure that the process is carried out more efficiently, reducing both time and costs.

Mandatory requirements

- Max. dimensions: L 3.5 m × W 3 m × H 4 m
- Max. weight: 5.5 tonnes
- Compatible with cat. 3 tractors (160 hp)
- Compatible with GPS control

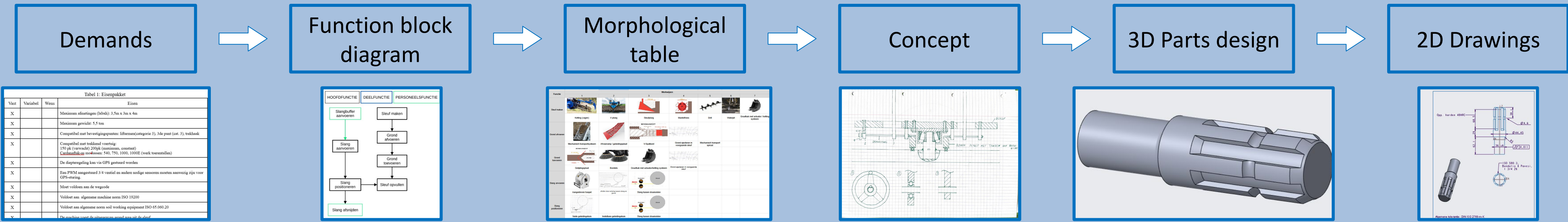
Variable requirements

- Working speed: 0.5 – 0.7 m/s
- Trench depth: 50 – 70 cm
- Variable reel spool for drainage pipe rolls
- Service life: 15 years

Wishes

- Fill trench up again with excavated soil (removable function)
- Easy to maintain and lubricate

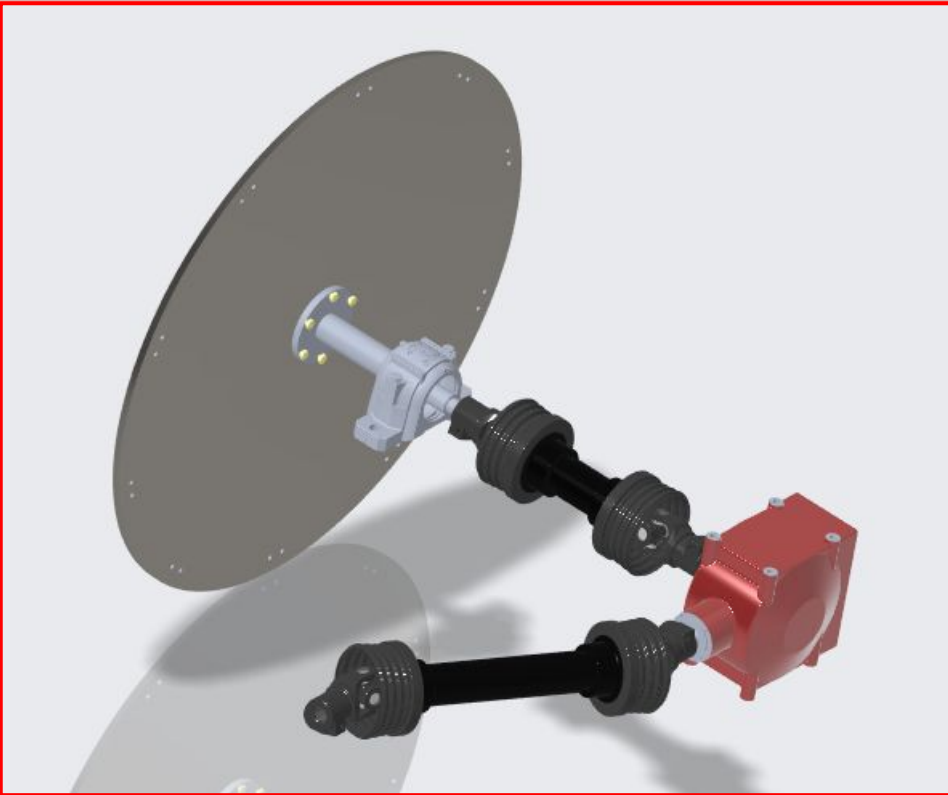
Method using Kroonenberg’s design process



Primary components

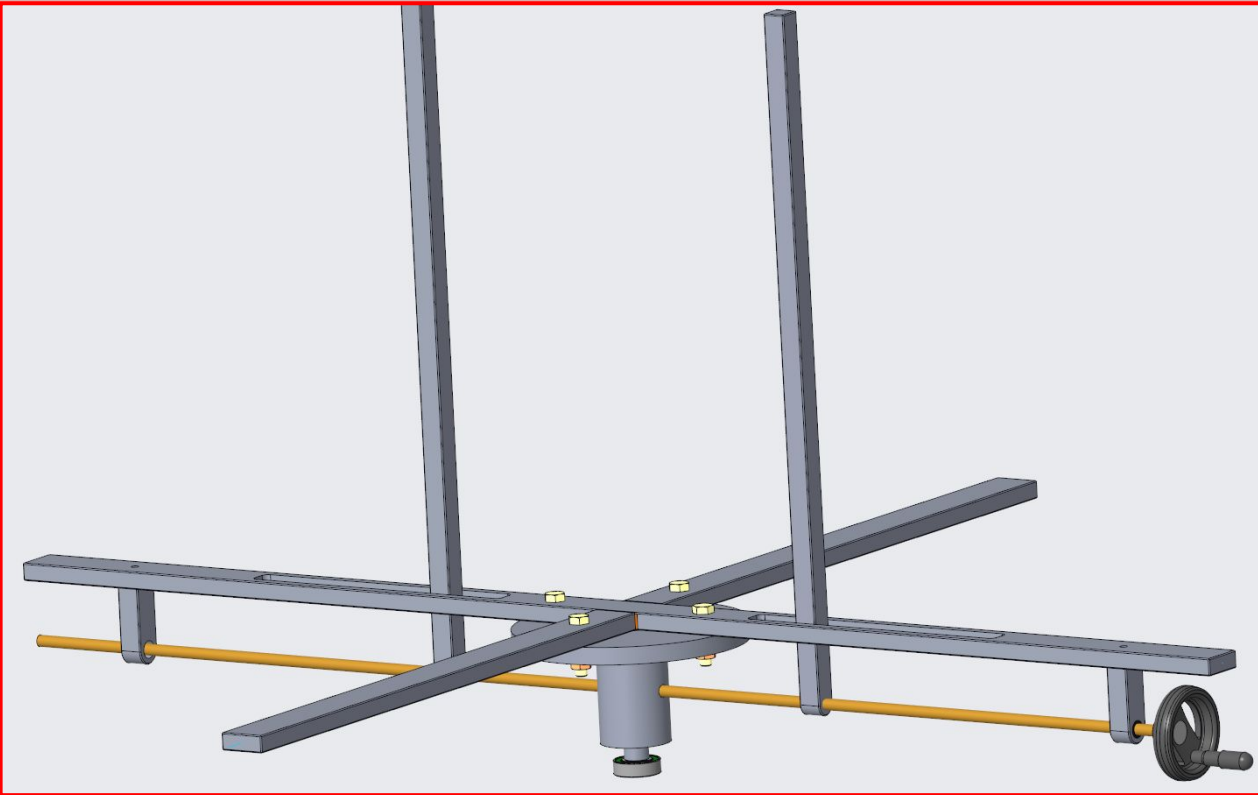
Trenching with a wheel trencher

The trenching wheel digs out the trench by spinning at high speed like a sawblade. An elevation map is entered into the tractors GPS system, and the GPS controls the tractors lift so that the trench depth remains constant relative to the water level. The design choice for a trenching wheel is more simple than a chainsaw trencher and much less power hungry than a plow. A gearbox is used so that the tractor’s power take-off has to transmit less torque.



Laying the drainage pipe

A variable hose reel is used, as drainage hose spools come in a variety of sizes. The drainage hose is placed on the reel before driving. Whilst trenching, the drainage hose is unrolled and laid in the dug trench. The hose is pulled by the weight of the pipe and friction with the ground.



Sealing the trench

Once the pipe has been laid, the excavated soil is pushed back into the trench by use of a ‘plate scoop’. These need to be removable as the farmer would also like to use the machine for digging irrigation ditches, where the trench should stay open.



Conclusion

The developed machine effectively combines the three labor intensive jobs: trenching, laying the pipe and refilling the trench into one job. Work hours and leasing costs are significantly decreased for the farmer. The simplicity of the wheel trencher, hose reel and frame make it easy to self-produce and maintain. GPS usage is well integrated into the design according to the farmers wishes.

The machine offers an innovative solution to the current inefficient process of laying drainage hoses. It is faster, easier, and more reliable. This contributes to more sustainable and productive agriculture.

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