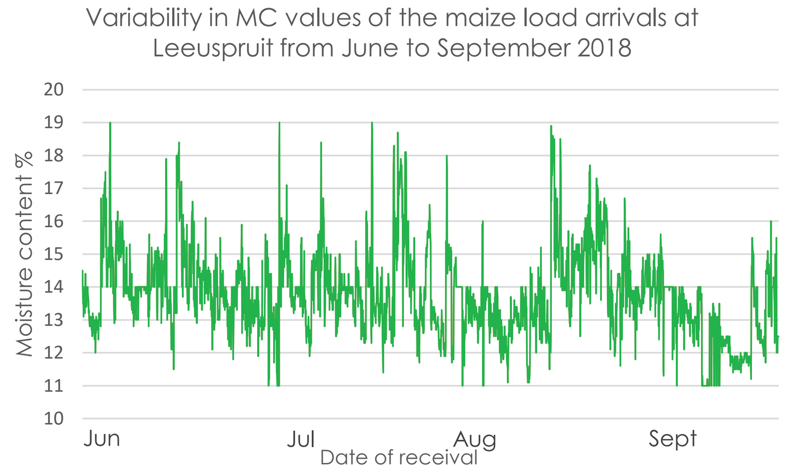
If you can't measure it, you can't manage it

What? Capture nonlinear relationships between moisture content, air, drying rate and discharge rate.

Why? Want to design automatic control system that adjusts discharge rate based on incoming maize moisture content, drying temperature and ambient conditions.

How? Create a System Dynamics simulation model to understand interrelationships and capture overall behaviour of the drying process.

AFGRI is a leading agricultural company specialising in grain management. They store bulk amounts of harvested grain procured from surrounding farmers in their silos. AFGRI receives maize loads with moisture content (MC) values from 11 to 18%. To store maize safely, the MC should range between 11 – 13%. In order to reduce the MC, the maize undergoes rapid drying in a continuous flow grain dryer.



Project background

The Leeuspruit silo site was selected to analyse the grain drying process, located in the Free State (26°52'13.2"S 28°31'14.6"E).

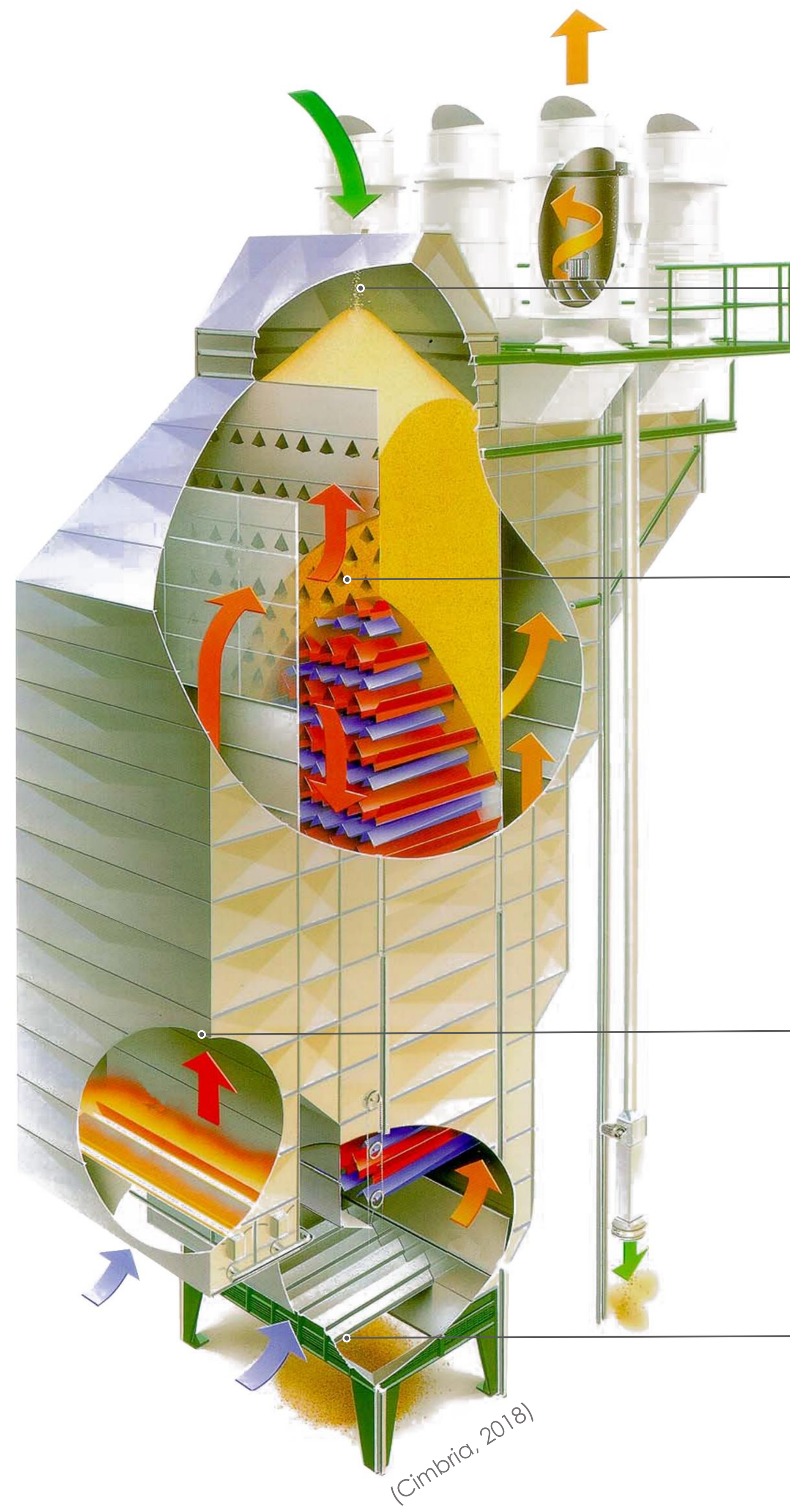
Many decisions made during grain drying are currently left in the hands of the operator.

Due to a general misunderstanding, lack of skills and insufficient monitoring equipment, the drying process is currently not performing efficiently. All of these factors contribute to the high diesel consumption.

In order to target the inconsistent decision making of operators, better control over the drying process is needed. The purpose of this project was to capture the behaviour of the dryer as a whole and furthermore develop a control system that would be able to continually adjust the model as the conditions change.

System Dynamics modelling

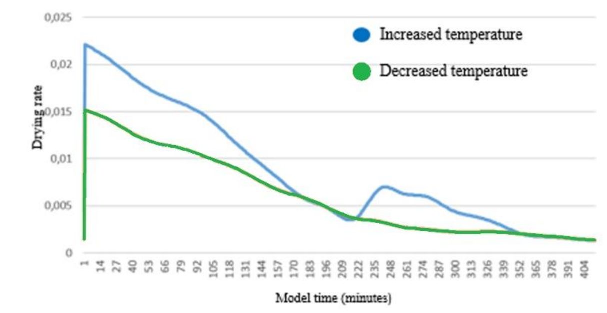
A System Dynamics modelling approach was used to achieve a better understanding of the complex drying process through capturing the interrelationships of all contributing factors. This is the first steps needed to develop an effective control system ultimately.


(Cimbria, 2018)

Changes made to the simulation model

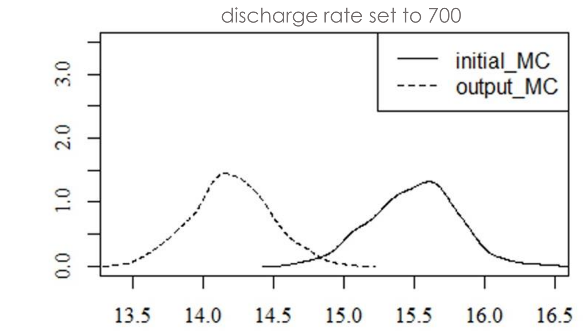
Strategic changes were made to the simulation model to represent an ideal dryer system that were used to determine the effect the following factors have on each other:

- **Wet maize**
  The variability in MC levels of incoming maize makes it difficult to adjust the discharge rate in time to ensure that enough moisture is removed. By installing a sensor to measure the MC of incoming wet maize, the process can be controlled more effectively that results in minimised over drying as only enough moisture is removed for safe storage.
- **Drying air**
  Temperature determines the amount of water that the air can contain. Moisture removed from the maize that moves through the dryer is in the form of vapour that is defined as a relative humidity percentage. The drying rate depends on the MC, drying air temperature and relating humidity levels. Higher drying air temperatures results in faster drying rates.



- **Diesel burner**
  Ambient air is heated as it enters the dryer. The ever-changing ambient conditions cause inconsistent air heating time periods. This results in high diesel consumption and maize that is not always dried effectively since the drying air is not heated to the required temperature of 65°C before it starts moving through.
- **Discharge rate**
  The discharge rate is adjusted by the operator in charge. This is the main contributing factor to under- and over drying. If the discharge rate is set too fast, maize is under dried and must be recirculated. The recirculated maize is then usually over dried, which results in high diesel consumption.

1000 simulation runs of moisture removed with discharge rate set to 700



Conclusion

The simulation model aided in the understanding of the drying process and need for better control. The effects of the contributing factors have been analysed to form the basis from which the future automatic control system will be built on.

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