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Preface

Notations

Example:

**Roman upper case letters**

 Variable notation for something

 Variable notation for something

 Variable notation for something

**Roman lower case letters**

 Variable notation for something

 Variable notation for something

 Variable notation for something

**etc**

# Introduction

## Objective

Need for longer combination trucks- briefly into advantages- stress on limitations of the initiative- concerns about meeting performance demands- introduce the idea of hybridization of the trucks-the potential benefits through added propulsion but how added costs may deter customers- Thus establishing a need to develop a tool to provide a way to arrive at the most productive solution if hybridization was to be considered.

## Statement

Just the project statement.

## Scope

Here mainly a look into what the report will cover and what it will not- How the tool will be used primarily to study trends helping us identify the components that most affect the productivity-thus the model of the truck was not intended for complexity

## Outline

Provide a layout or overview of the project report by outlining the sections: productivity, vehicle model and optimization tool.

# Literature Review

## Hybrid Powertrains

### Topology

#### Parallel

#### Series

#### Plug-In

### Feasibility

Talk about the existing projects of hybrids on heavy trucks

## Energy Management Strategy

### Heuristic Control

### ECMS

### Predictive Control

### Optimal Control

## Productivity

## Optimization

# Vehicle Model

## Driving Cycle

Give an idea about the Malmo-Got cycle with fig, why it was chosen for the study.

## Model Structure and Function

The vehicle model was constructed to be represented as a combination of a number of sub structures, each of which encapsulated certain functionality and properties. This was done to maintain the real world relation between the various components. Traction requests that are demanded from the trucks flow down the structure till they are represented as individual requests from the machines. It also allows for future work on the model to modify components separately.

### Units

The overall truck was represented as a collection of 4 units- the tractor, first semi-trailer, dolly and the second semitrailer. The properties that are associated to the units and which vary between them are the overall units load, the battery or fuel tank associated to the units, total number of axles and the number of driven axles. When a traction request is provided to the unit it done so with information on how to distribute this between the driven axles of that unit.

### Axles

The individual axle loads are defined for each axle which provides information on the tractive capabilities of that axle through a check for grip limitation. Each axle is either non-driven or is linked to a transmission and machine which may either be a motor or an engine in the case of the tractor unit axles. In this case it also has the final drive ratio associated with it which is used to gear down the wheel speeds to a machine speed as according to equation (?)

So when a traction demand passes down to an axle and clears the grip limitation check it is sent to the transmissions as in equation ()

### Transmission

The transmission linked to the axles possess the same structure regardless of the machine. The only property that varies is in fact the number of gears. The functionality associated at this level is simply to encapsulate the gear losses and reduction effects so as to arrive at the machine torque and speed given the selection gear as can be seen in equations (?)

<info about transmission models>

### Machines

At the machine level the torque requests are checked against the maximum torque capabilities regardless of whether it is positive propulsion torque or in the case of an electric motor, negative regenerative torque. If it within acceptable limits the power to be demanded from the associated buffer is calculated as

### Buffer

The buffers associated to the machines are a fuel tank in the case of an engine and a battery when the machine is an electric motor. They are provided with information of the power demand along with the electric machine efficiency or the brake specific fuel consumption of the engine for that operation point of that machine respectively. The energy demand for that particular instant is calculated by assuming that the power is constant for a fixed time interval that the whole cycle has been discretised into (1 second by default).

#### Fuel Tank

On receiving the power demand, the amount of fuel to be consumed from the fuel tank to provide the power is calculated for that instant as shown below

The overall fuel level is then reduced by this instantaneous value.

#### Battery

The properties associated with the battery are the current state of charge (SoC) , the total battery capacity and open circuit voltage. The SoC of the battery plays a vital role in determining the torque request to the associated motors as it is essential that the SoC is kept within safe limits of operation. This will be explained in more detail in Section 3.4.

When power is demanded from the battery information of the operating efficiency of the machine is also sent. This helps calculate the total charge demanded at each instant.

This demand whether positive or negative will in turn append the overall SoC as shown

## Driver Model

Accounts for explanation of the cruise controller and predicted acceleration torque and the gear shifting strategy

## Energy Management Strategy

Ref. of road load and predicted acceleration then give a representation of the general rules in fig. followed by an explanation the choices made.

Information about predictive depth of discharge would also be provided in this section

# Validation

## Variants

### Truck Variants

Different axle loading, GCW

### Engine Variants

Both this and the ones below contain specs of individual in a tabular format followed by explanation of the choices made

### Motor Variants

### Battery Variants

This part will incl. the calculation of what charge capability was reqd and how the battery choices were arrived at from there.

## Model Validation Results

**<The existing results report shown earlier will be inserted within this section>**

# Results and Discussion

Start with optimization parameters chosen

## Productivity Trends

Productivity trends recorded for changes over time w.r.t. fuel prices, driver wages, battery prices etc.

# Conclusion

# Scope of Future Work

This section will capture the limitations of the existing study and propose new directions to investigate

# References

Familyname1, X., Familyname2, Y. (YEAR): Name of paper. *Name of Journal*, Vol. xx, No. yy, {month} year, pp. xx-yy.

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# Appendix