



Energy Efficient Safe SHip OPERAtion

TuD Engine Dynamics

WP4 – 4.4

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- **The Diesel Engine Model**
 - **Overall System Model**
 - **Diesel Engine Individual Models**
 - **Collaboration with Duisburg University**

Developed by:

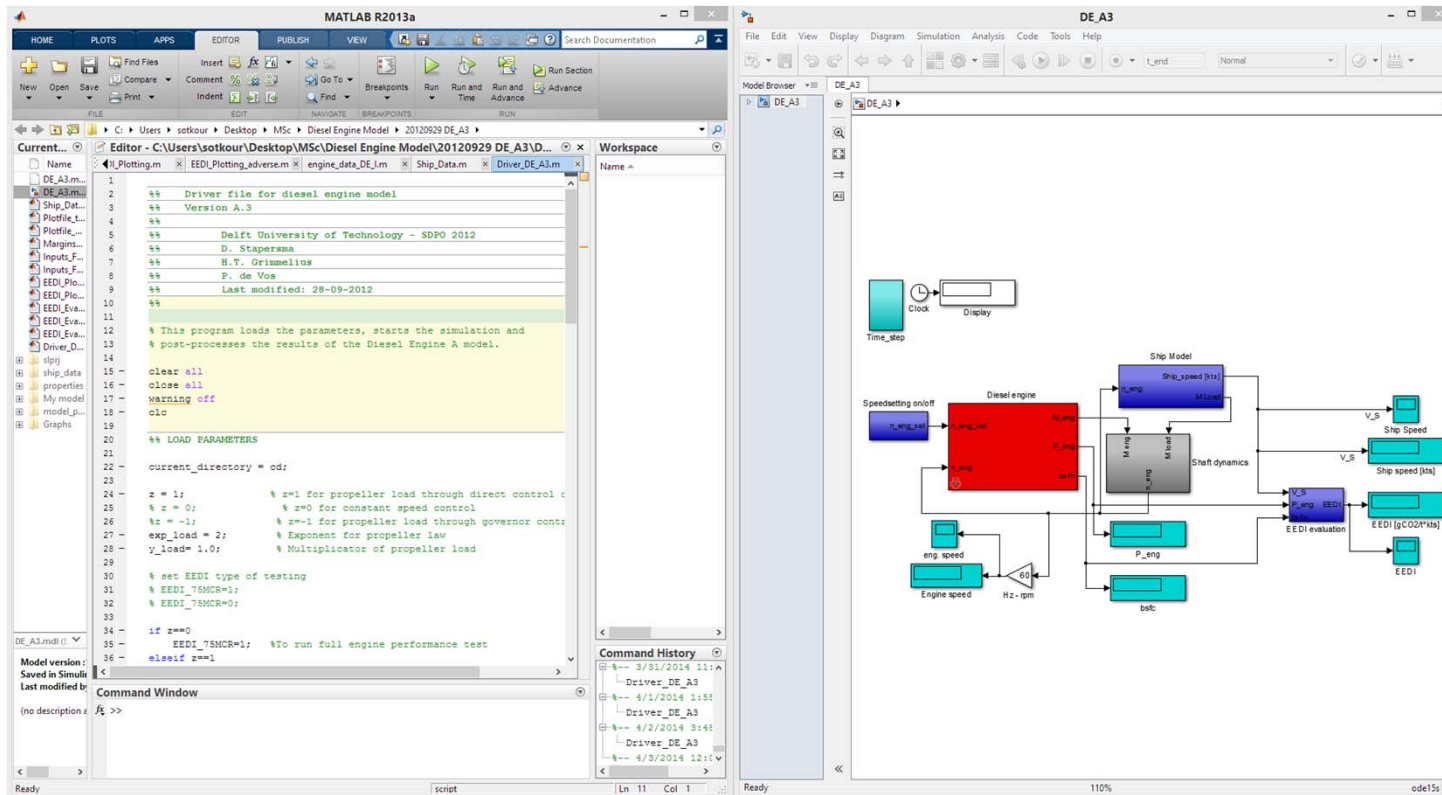
- Prof. D. Stapersma
 - Dr. H. Grimmelius
 - Ir. P. de Vos
-
- Mean value modeling
 - First principle

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- Engine design parameters from Matlab script
 - Any number of cylinders
 - Any cylinder size
 - 4-stroke and 2-stroke
 - Engine limitations from operating envelope

Contains:

- Shaft and transmission dynamics
 - Constant propeller characteristics (No 4-quadrant CPP)
 - 1D ship motion
 - List of added resistances
 - EEDI evaluation
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- Non- linear simulation
 - Variable time steps due to solver

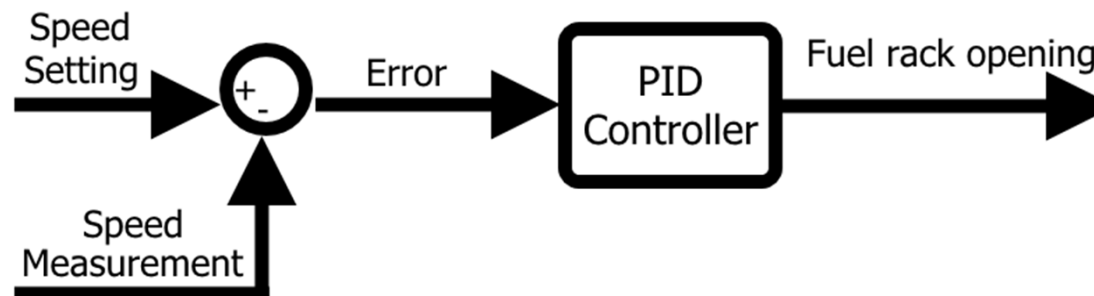
- Data loaded from Matlab code
- Simulation in Simulink environment



The image displays two side-by-side screenshots from a computer screen. The left screenshot shows the MATLAB R2013a environment with the Editor window open to a file named 'Driver_DE_A3.m'. The code in the editor includes comments and MATLAB commands for loading parameters, starting a simulation, and post-processing results. The right screenshot shows the Simulink environment for the 'DE_A3' model. The block diagram includes a 'Clock' block connected to a 'Display' block, a 'Speedsetting on/off' block, a 'Diesel engine' block, a 'Ship Model' block, 'Shaft dynamics' blocks, and various output blocks for 'Engine speed', 'Ship speed', and 'EEDI evaluation'.

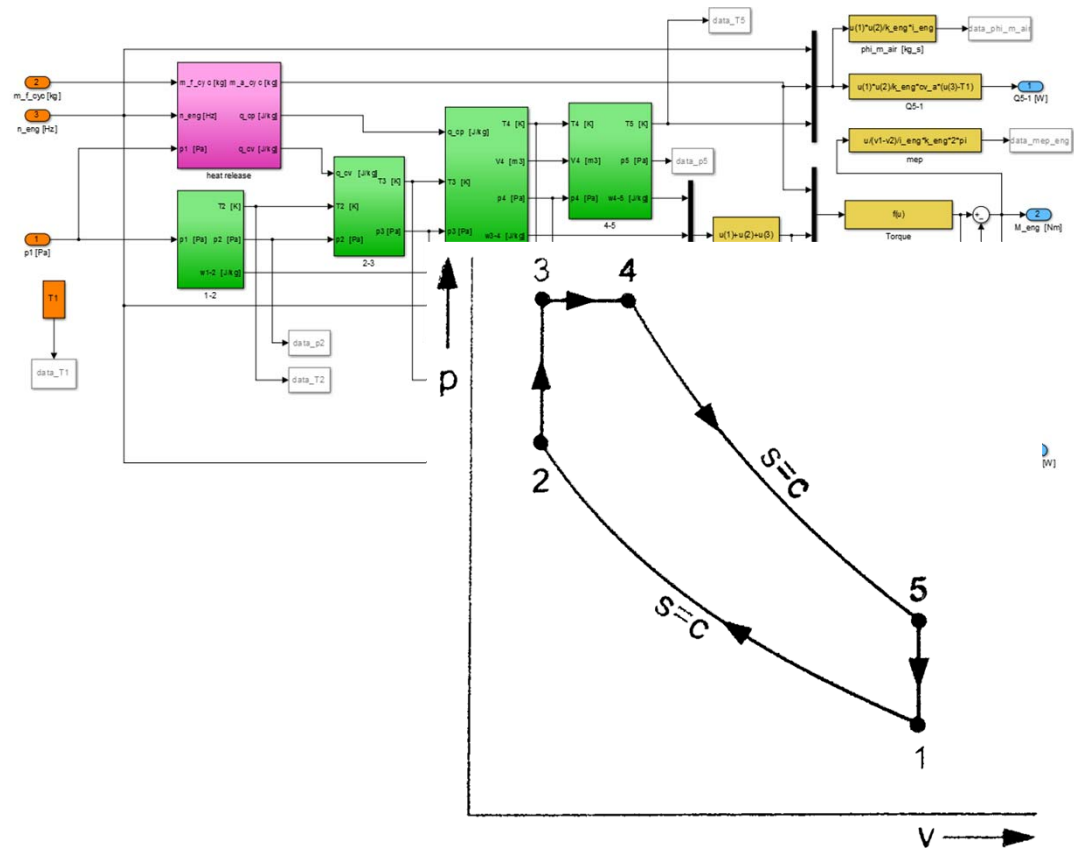
Governor

- Observes speed change and regulates fuel added
- PID Control



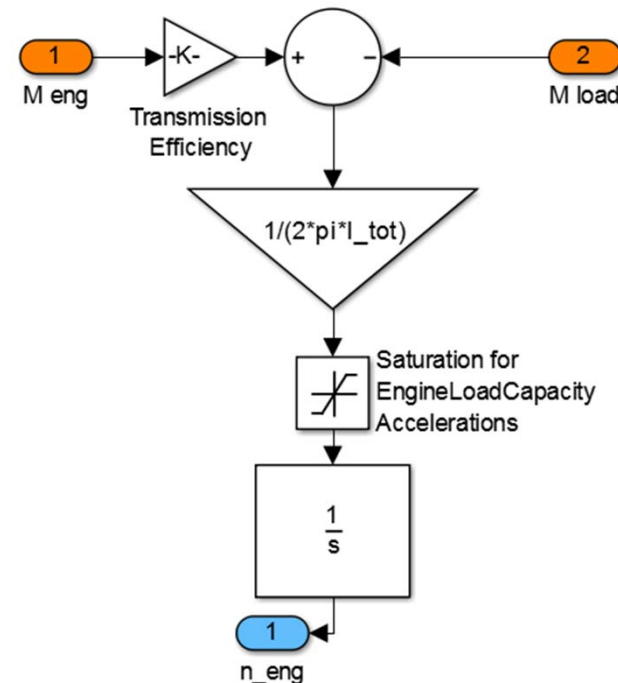
- 5-point Seiliger cycle
- First, isochoric heat addition
- Then, isobaric heat addition

5-Point Cycle



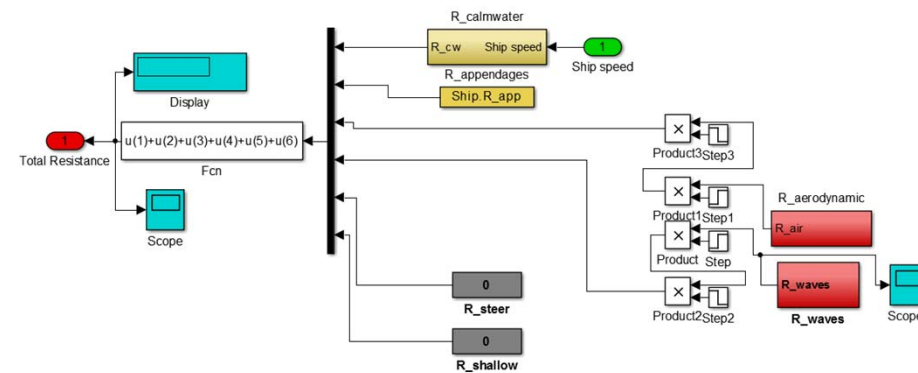
The Shaft Dynamics

- Speed and torque-related losses
- The load torque input can also be the outputs of the CFD simulations



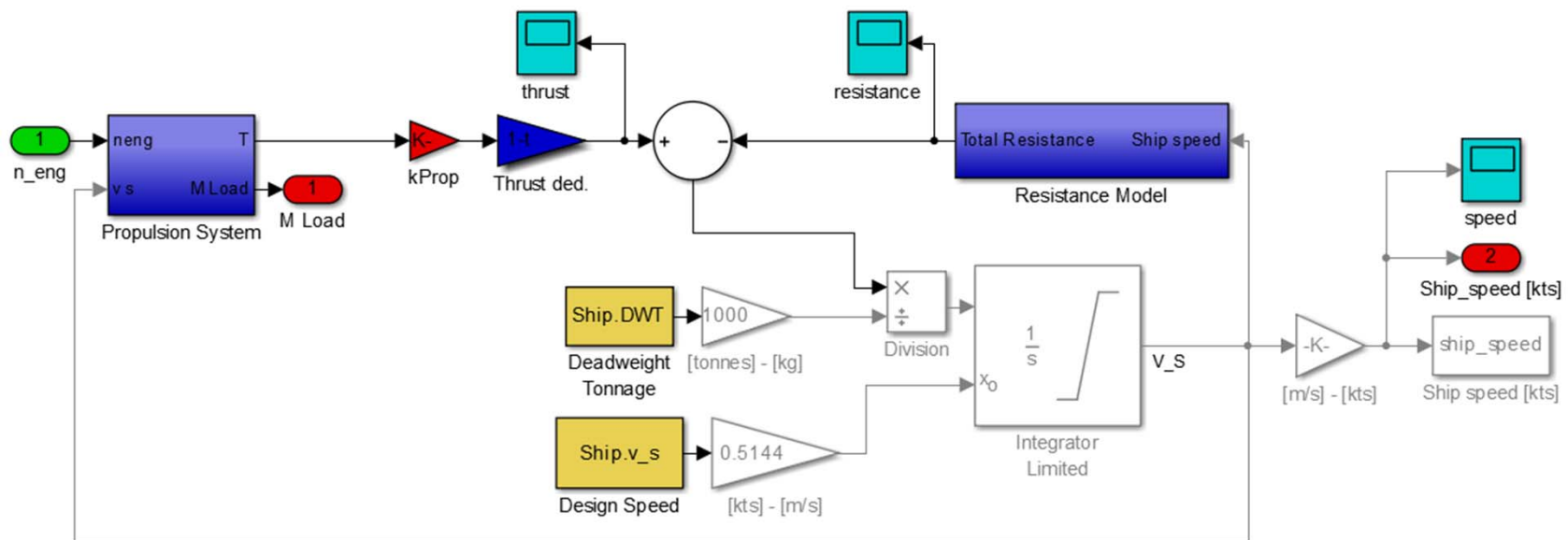
The Resistances

- Speed dependent calm water resistance
- Constant appendages resistance
- Sinusoidal added wave and wind resistances



The Ship Motion Dynamics

- 1D motion
- No turning, rolling or pitching



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- Create simplified engine dynamics in the form of a function
 - Implement variable shaft speed in CFD models
 - The output of CFD simulations to be used for condition evaluation of the engine by Delft (thermal overloading, increased wear, shutdowns)