MESA

Maritime Europe Strategy Action

TTG 1 – Energy Efficiency Workshop,

Sub Area 1.1 - Resistance

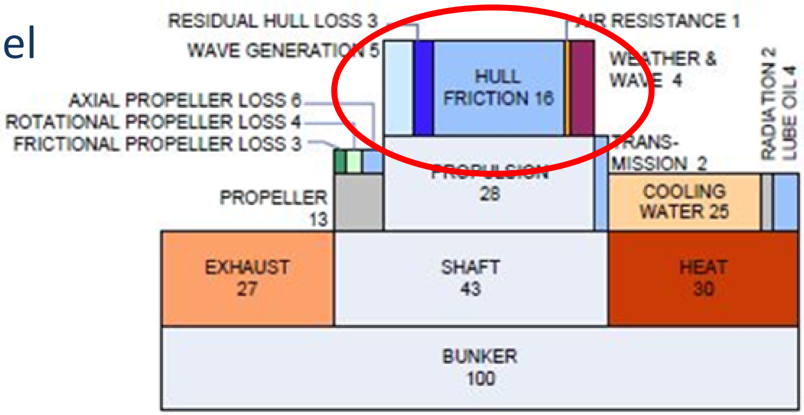
Brüsel, 5 March 2014

MESA – SHIP RESISTANCE

A motivation

Why to look into ship resistance?

- Emissions are directly coupled to energy consumption.
- Up to 85% of all useful energy on board (exhaust and heat losses already subtracted) is typically required to propel a ship and hence related to Hydrodynamics.
- Savings in this place will benefit the whole ship energy household.
- Each kW saved to propel a ship means less fuel consumption.
- … and each ton of fuel saved means 3.7ts of CO_2 not emitted (+ other emissions).
- Drag/Resistance plays an important role.



Resistance - Structure

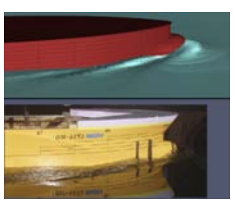
- Two major contributions:
  - Pressure related
  - Viscosity related
- Often different “decomposition” in naval architecture context.
- Resistance should be reduced.
- To do this, we must understand how resistance components work, we need to be able to model and predict them and find ways to influence them.

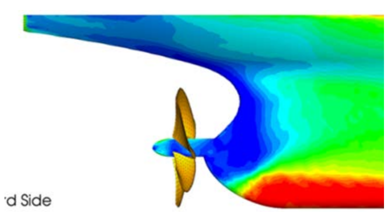
Resistance – Decomposition in MESA

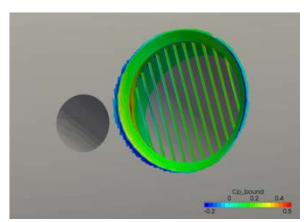
1	Ship Resistance	
	Calm water	**Categorie**
1.1	Pressure related resistance (form)	Tools/ Design
1.2	Viscous resistance (friction)	Tools and (surface) technologies
	Operational conditions	
1.3	Added resistance in seaways	Tools / Design
1.4	Aerodynamic resistance	Tools / Design

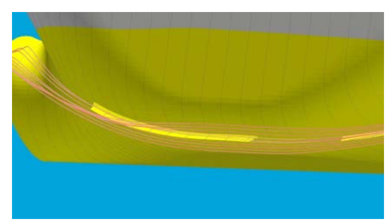
Pressure / Form Resistance

1	Ship resistance	
1.1	Form resistance	Technologies to predict and improve form resistance
1.1.0		general considerations, naval architecture good practice
1.1.1		traditional model testing
1.1.2		Empirical / statistical methods
1.1.3		Theoretical prediction methods
1.1.3.0		analytical methods
1.1.3.1		(non-linear) potential flow codes,
1.1.3.2		RANS codes, w and w/o free surface effects,
1.1.3.3		adjoint methods
1.1.4		(CFD based) Optimisation



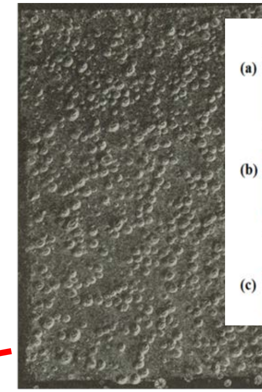


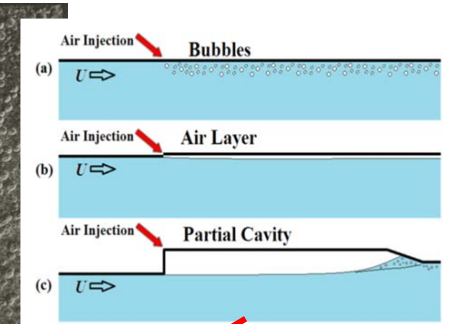


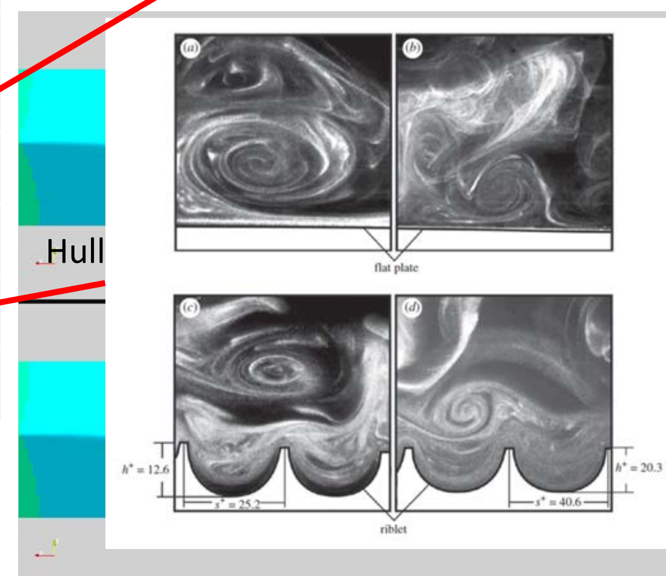


Viscous Resistance

1	Ship resistance
1.2	Frictional Resistance
1.2.1	**General Prediction**
1.2.1.1	ITTC 57 line
1.2.1.2	alternative friction lines
1.2.1.3	Numerical prediction
1.2.2	Surface roughness
1.2.2.1	Measurement techniques
1.2.2.2	Computational approach
1.2.2.3	Fouling
1.2.3	Technologies to influence frictional resistance
1.2.3.1	Coatings / Antifoulings
1.2.3.2	Air lubrication
1.2.3.3	Boundary layer stabilisation

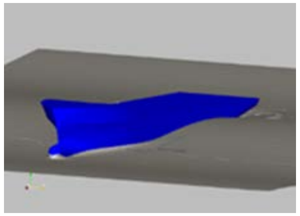

Calcareous fouling
2 to 4 mm

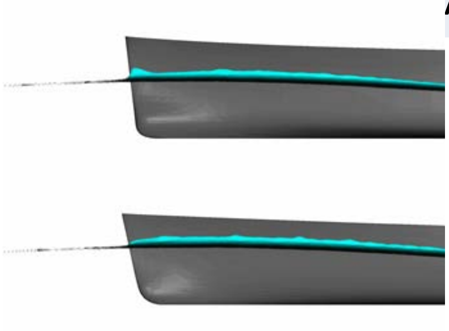


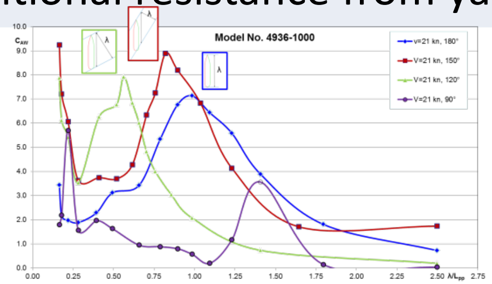


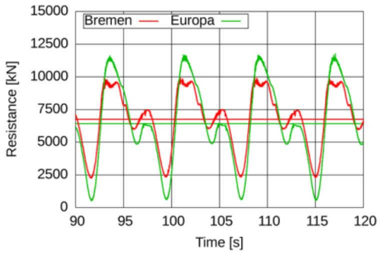
Added Resistance in Seaways

1	Ship resistance	
1.3	***Added resistance in seaways***	**Technologies to predict and improve added resistance**
1.3.0		general considerations, naval architecture good practice
1.3.1		model test
1.3.2		Seakeeping codes
1.3.2.1		based on (non-linear) strip theory
1.3.2.2		3-d panel codes
1.3.2.3		RANS codes
1.3.3		Form optimisation for resistance in seaways
1.3.4		Additional resistance from yawing in a seaway



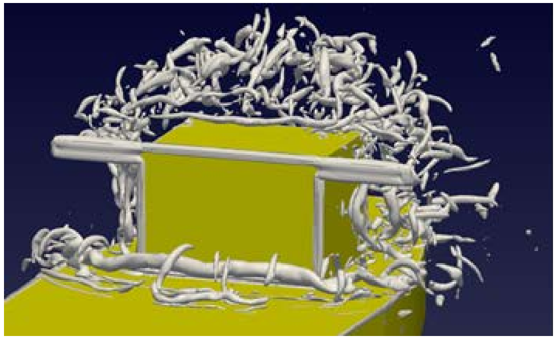


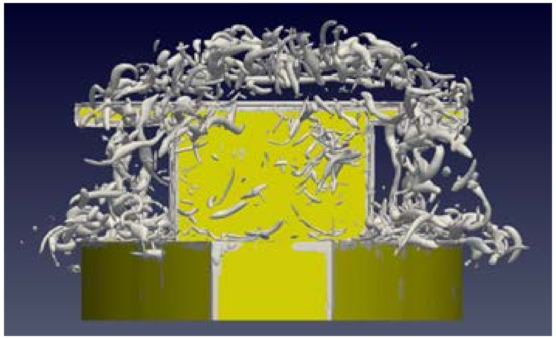




Aerodynamic Resistance

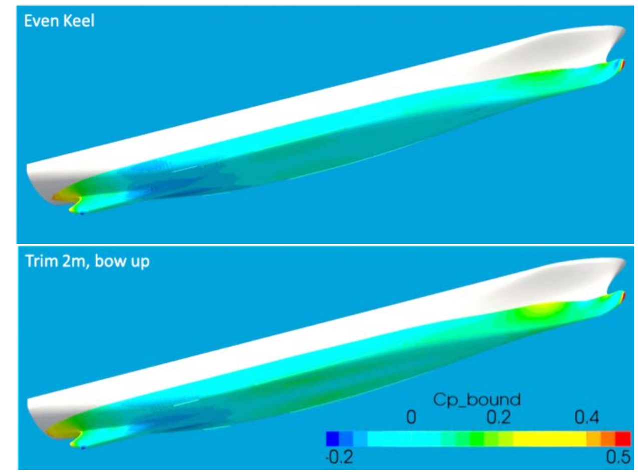
1	Ship resistance	
1.4	***Wind resistance***	Technologies to predict and improve aerodynamic resistance
1.4.0		model tests
1.4.1		statistical methods
1.4.2		computational methods / CFD

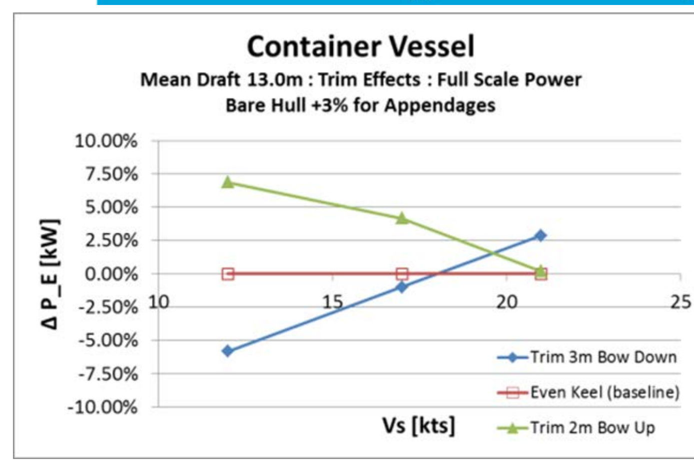




Operational Influence on Resistance

- Trim optimisation is hydrodynamically relevant as it influences the resistance of a vessel.
- These aspects have been investigated in several projects and are today common practice.





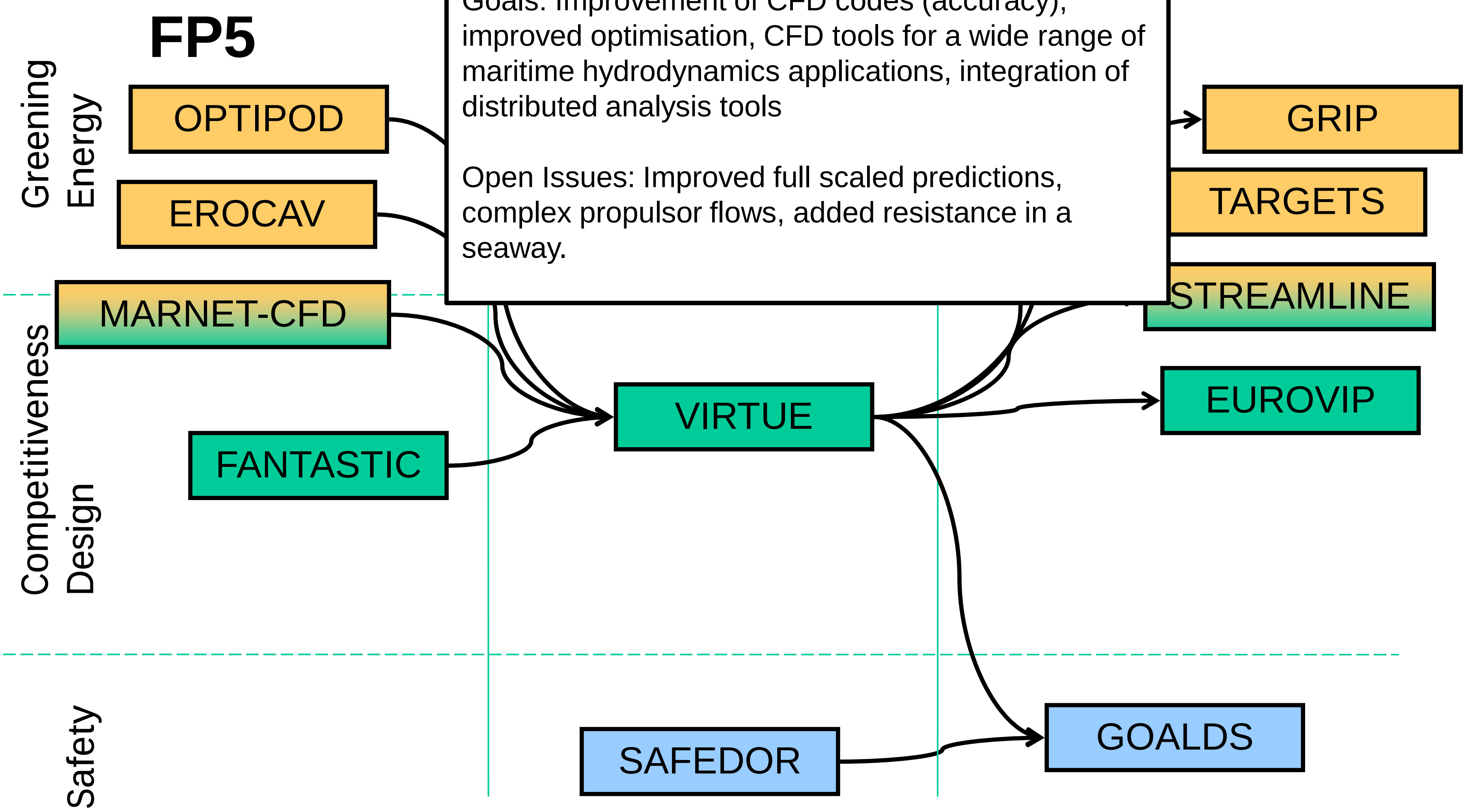
Example line of succ

Name: VIRTUE

Start: 01/2005
End: 05/2009

Goals: Improvement of CFD codes (accuracy), improved optimisation, CFD tools for a wide range of maritime hydrodynamics applications, integration of distributed analysis tools

Open Issues: Improved full scaled predictions, complex propulsor flows, added resistance in a seaway.



Relevant EU Projects
(identified so far)

- CALYPSO
- FANTASTIC
- VIRTUE
- EFFORT,
- STREAMLINE,
- TARGETS,
- GRIP
- SMOOTH
- SHOPERA

Catalogue - Spreadsheet

Link: Spreadsheet

To do:

- Identification of other major FP 6/7 projects,
- Short description of contents,
- (details often difficult to obtain, public reports are sometimes not very comprehensive).

Next Steps

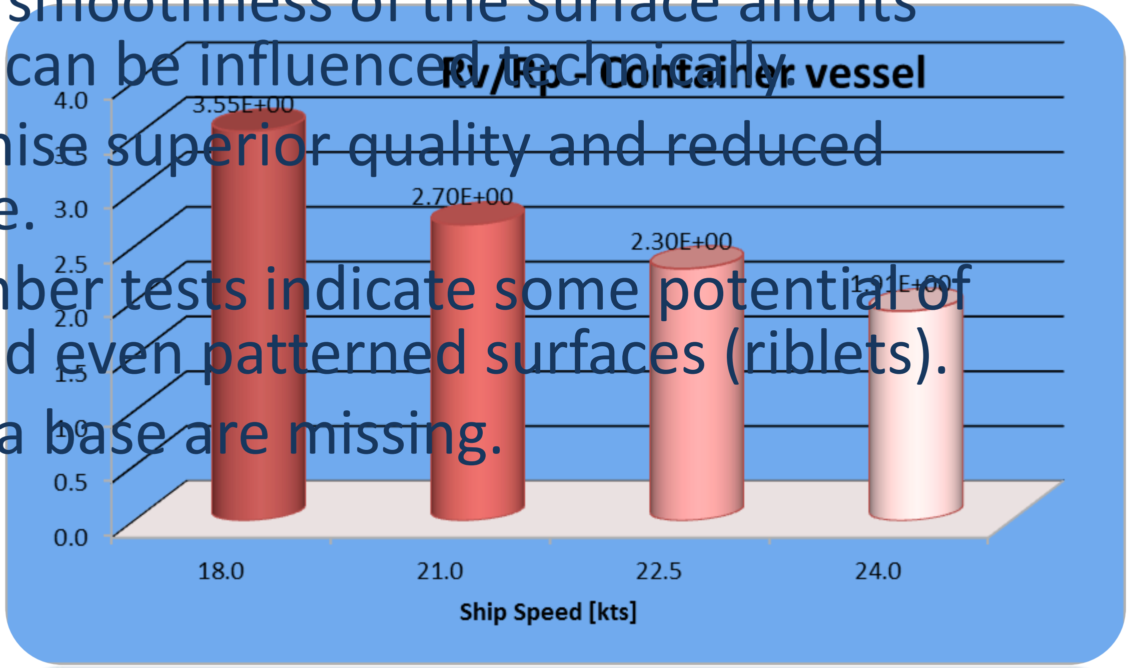
- Definition of (technology) gaps: <= TTG, technology driven.
- Definition of Research needs: <= Strategy Group, market driven.
- Balancing of needs and gaps – based on assessment of technology potential.

Technology Gaps / Needs (I)

identified in TTG 1.1

Viscous resistance.

- Importance of viscous resistance is further pronounced for slow steaming conditions.
- The physical properties of water [ν (t, ρ)]can hardly be influenced.
- … but the quality / smoothness of the surface and its condition (fouling) can be influenced technically.
- New coatings promise superior quality and reduced frictional resistance.
- High Reynolds number tests indicate some potential of several coatings and even patterned surfaces (riblets).
- Tangible data / data base are missing.



Technology Gaps / Needs (II)

identified in TTG 1.1

Better prediction of added resistance in waves.

- Need for f_w factor in EEDI formulation,
- Present guidelines are vague: "f_w to be determined by conducting ship specific simulations or based on guidelines - (Guidelines will be developed)"
- Present Tools (potential flow) are dubious, model test find that added resistance for $\lambda/L < 0.8$ are not useful.
- Full RANS is (presently) to time consuming.