# Virtual prototyping of fully appended naval vessels by integrating ANSYS-CFX into the hull form optimization process

September 28, 2017 | Tanja Richardt thyssenkrupp Marine Systems



#### Hull form optimization process



## engineering.tomorrow.together.

### Agenda

- Introduction
- Parametric modeling of hull form and appendages
- Integration of ANSYS-CFX in CAESES
- Application
  - Optimization OPV
  - Aft-body parameter variation
  - Interceptor optimization
  - Comparison of different bow shapes
- Conformity to model test results
- Conclusion



#### Hull form optimization process 1 4 Optimization Optimization Parametric Modeling Numerical towing tank (Potential flow) (RANSE) DECK **Basic curves** 0 Variables Automatic mesh Aft-body variation Generated anoration smooth hull form RT [kN] 13.2 0,15 0.05 0.1 0.2 0.25 Interceptorsize [m] Interceptor optimization Pressure distribution **Constraints** & streamlines Variant Bulb 26 [kn] 1.35e+4 1.3e+0 ANSY 1.25e+0 1.2e+4 1.15e+ Variant Steven 26 [kn] Parameter evaluation Result of multi-Comparison of different bow types objective CFD

Results

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optimization

### Parametric modeling







### Parametric modeling





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### Appendages









### Geometry export





### **Geometry export**







### Integration of ANSYS CFX -Exports

Export:

- Solids (Domain)
- Trimesh (Watersurface)
- Surfaces (Brackets)
- Curves (All edge
- Points
- Geometry inform



### Integration of ANSYS CFX – Software connector

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### Integration of ANSYS CFX – Batch file

- ICEM meshing
- CFX Pre generating Input-Files
- CFX Solver steady and transient calculation
- CFX Post Evaluation of results

```
@echo off
3
   cls
   @echo Start Meshing.....
  CALL "C:\Program Files\ANSYS Inc\v161\icemcfd\win64 amd\bin\icemcfd.bat" -batch -script opvCase02.rpl
8
   Gecho CFX PRE....
   "C:\Program Files\ANSYS Inc\v161\CFX\bin\cfx5pre.exe" -batch opvCase02quasi.pre
   @echo CFX PRE....
   "C:\Program Files\ANSYS Inc\v161\CFX\bin\cfx5pre.exe" -batch opvCase02steady.pre
14
   Gecho CFX SOLVE ...
   "C:\Program Files\ANSYS Inc\v161\CFX\bin\cfx5solve.exe" -batch -parallel -partition 4 -par-local -def "opvCase02steady.def" -fullname opvCase02steady 001
16
   Gecho CFX SOLVE ...
18
   "C:\Program Files\ANSYS Inc\v161\CFX\bin\cfx5solve.exe" -batch -parallel -partition 4 -par-local -def "opvCase02.def" -initial opvCase02steady_001.res -fullname
19
  Gecho CFX POST ...
   "C:\Program Files\ANSYS Inc\v161\CFX\bin\cfx5post.exe" -batch opvCase02.cse"
```



# Integration of ANSYS CFX – Mesh generation by





### Integration of ANSYS CFX – CFX POST





### Hull form optimization – OPV (LoA = 91.2 m)

Displacement = 2400 t, v = 20 kn, 26kn

Displacement = 2200 t, v = 28 kn

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2	v_SacCoeffAtFwdBase		0.1	0.13	0.15	×	0				
3	v_maxBeamAtBulbAft		4	4.5	5.2	×					
4	v_SacCoeffAtFosEmerge	*	0.97	0.98	0.983	×			Marchard and a		18.32
5	v_flareDwlMax	*	24	34	38	×	Name	State	Monitored Value	Comparator	Limit
6	v_flareDwlRelXMax	*	0.5	0.675	0.7	×	minDwlBeam		13.45695822	">"	13.2
7	v_dwlAddAreaCoeff		-0.01	-0.01	0.006	×	minKMT		7.75408888	">"	7.5
8	v_dwlAddXCA		-0.0005	0	0	×		-			
9	v_SacDeltaAreaCoeff	•	-0.01	-0.006	0	×	minWeight		2406.40005793	">"	2400
10	weightAtMainFrame		0.84	0.75	0.96	×	minXCA		42.19137394	">"	42
11	v_maxBeamAddAreaCoeff	*	-0.06	0	0	×	v	_			
12	v_halfBeamBulb_diff	*	0	0.2	0.2	×	8				
13	v_maxBeamElevation_diff	*	0	-0.25	0.1	×	8				
14	dv_tipElevation	-	1.8	1.8828125	2	×	8				
15								_			



### **Evaluation of designs**









### Interceptor optimization





### Comparison of different bow types

### at two differnt load cases

### Velocity: 20 kn & 26 kn (Froude 0.34 & 0.26)







# Comparison of calculated values and model test results







### Next step





### Conclusions

- Wide range of hull form variation in a short time frame
- Optimized hull form for different speeds and loads by fulfilling demanding requirements
- Maximum speed within the given cost and engine power and economic use at the operational profile
- Consideration of influence of aftbody variations, appendages and floating position caused by interecptor
- Reliable results in early design
- Minimized risk during the proposal stage
- $\rightarrow$  We can offer optimized hull shapes operating with minimum engine power at maximum speeds within a short time frame.

