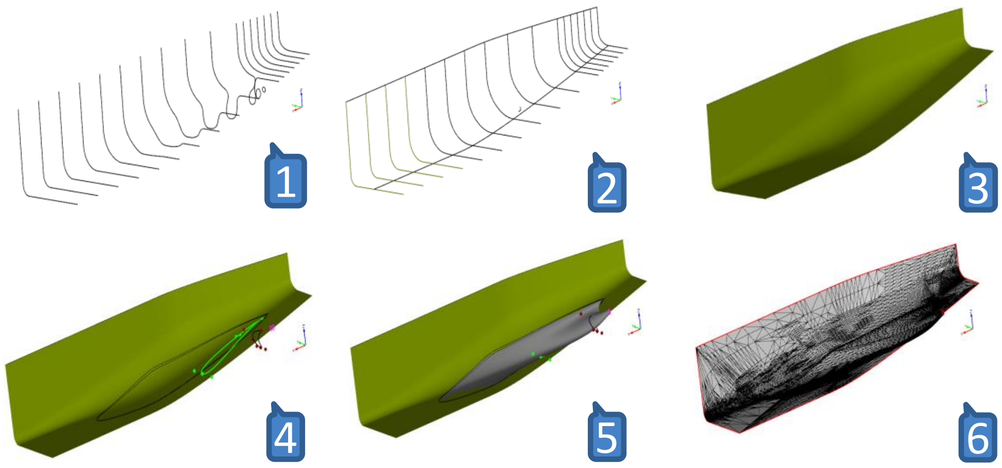
Customer‘s project and technical support (Maritime)

Cooperation : NMRI (Japan) / KRISO (Korea) / FLOWTECH / DNVGL

Daehwan Park (FRIENDSHIP SYSTEMS)

FRIENDSHIP SYSTEMS

Skeg retrofit



Target

- Exchange the fixed skeg with the parametric skeg

Procedure

(1) Import section curves in IGES curves

(2) Cut off the skeg part

(3) Create a barehull

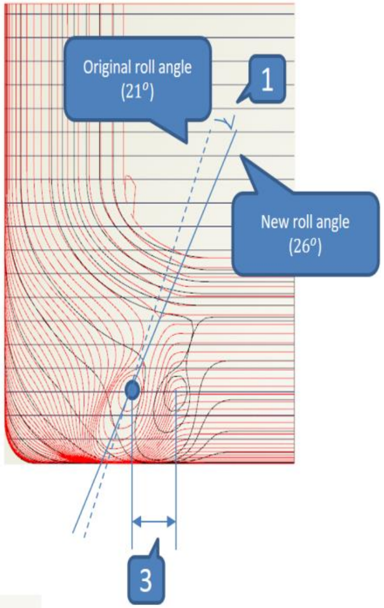
(4) Define 6 control curves

(5) Create Skeg Surface

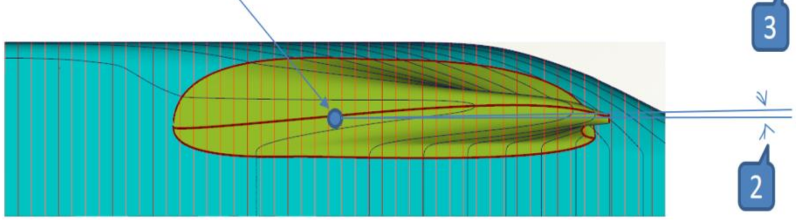
(6) Export STL for STARCCM+ (Or other CFD)

Skeg retrofit

Parameter	Value (Example)	Remark
dAngRoll	5	Design variable of skeg rolling (Degree) <1>
dAngYaw	-3	Design variable of skeg yawing (Degree) <2>
dyShaft	2	Design variable of skeg distance <3>



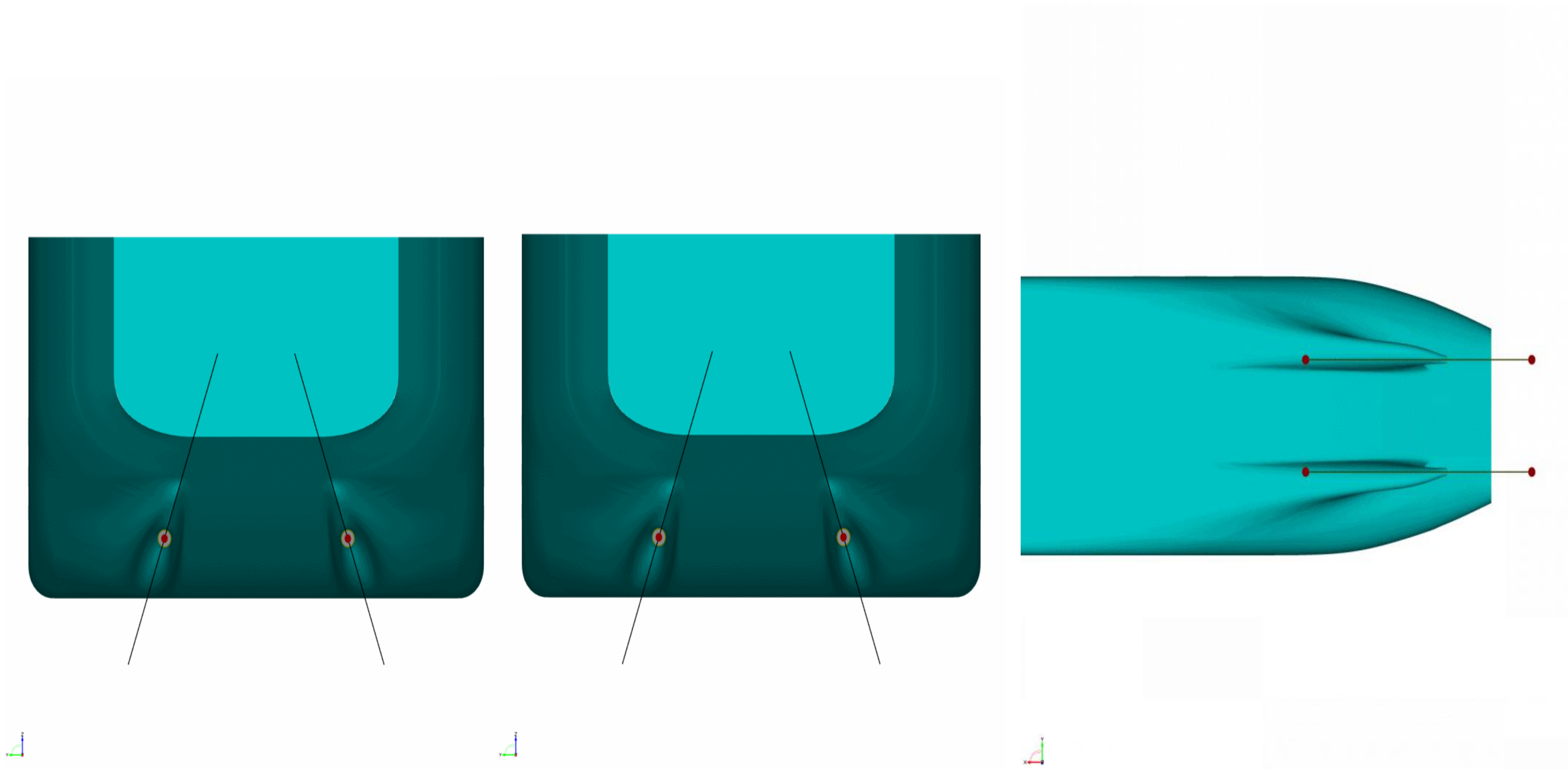
Center of rotation
[xSkegRotationOrigin, yShaftNew, zShaft]



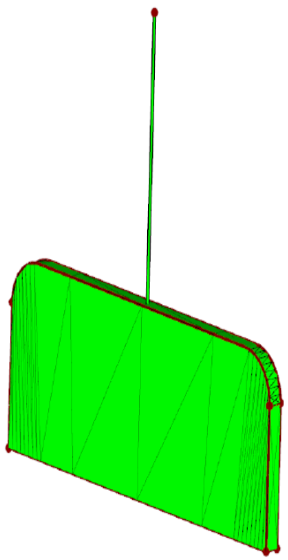
Rotation and distance parameters

- Roll
- Yaw
- Distance

Skeg retrofit

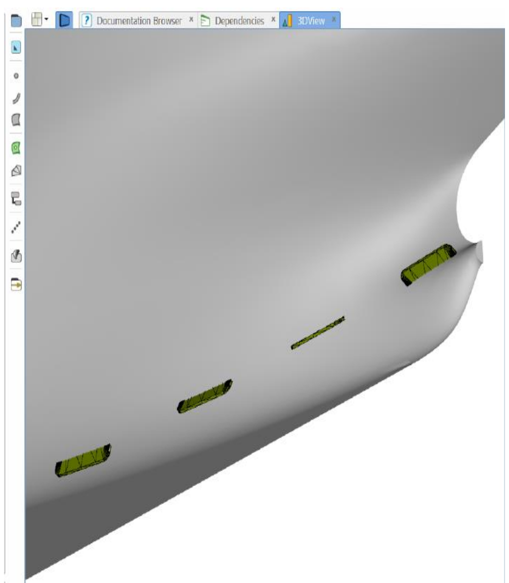


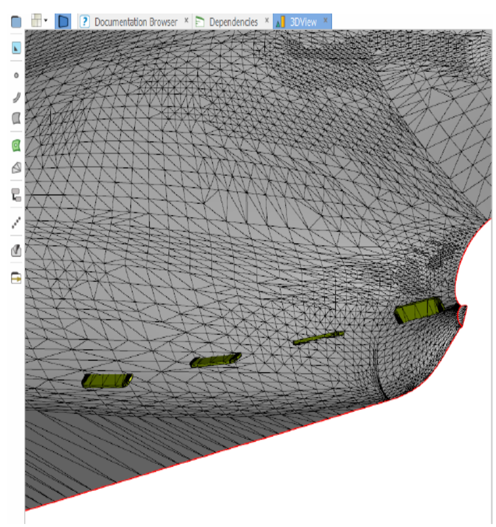
Fin positioning



Target

- Parametric modeling of fin
- Easy positioning
- Keep normal direction from surface
- Watertight STL creation

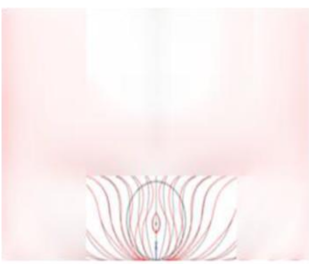




Abdy optimization with Neptune CFD (Japan)

Target

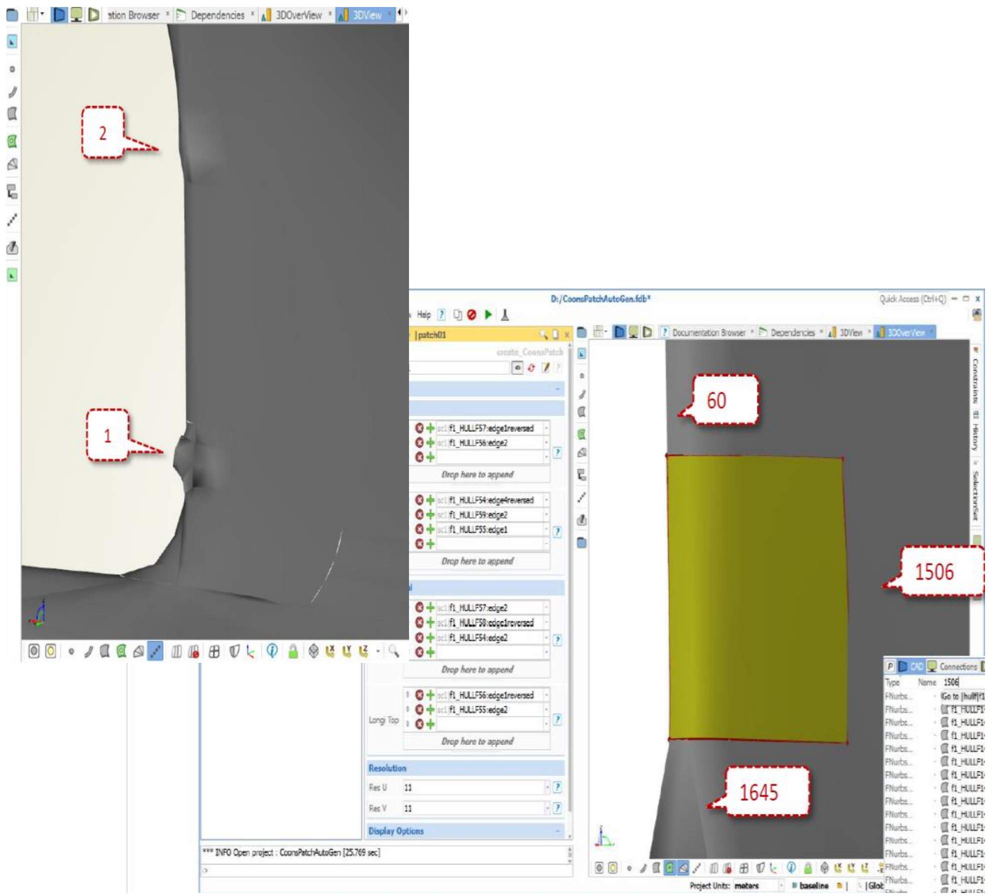
- Feasible study
- Afterbody frame shape optimization
- Software connection with Neptune viscous solver
  - Resistance
  - Nominal wake



	Base design	Modified design	Difference (Diff. Rate to reference)
Vol	67878 m^3	67838 m^3	-40m^3 (-0.06%)
Lcb	2.67%	2.69%	+0.02% (+0.75%)
Cd	1.502e-3	1.5066e-3	+0.0046e-3 (+0.3%)
1-Wn	0.6097	0.5800	-0.0297 (-4.87%)

Large improvement of nominal wake keeping resistance in a small increasement.

Refine destorted surface patches

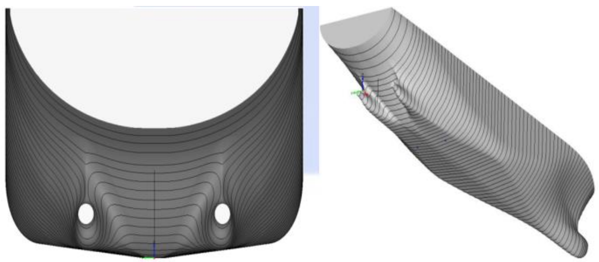


Target

- Exchange the destorted nurbs surfaces with smooth coons patches.
- Easy creation of a coons patch by selecting the boundary curves.
- Save the man-hour outstandingly during time-cosuming pre-processing.

Twinskeg study of research vessle

Vertical skeg with deadrise



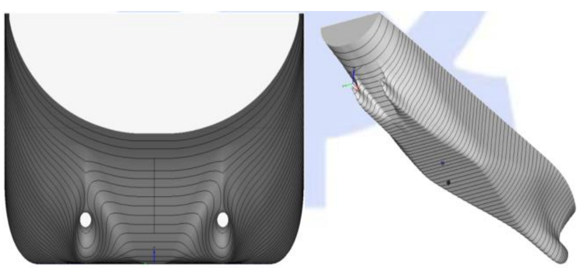
▶ CFD calculation

VS (knot)	Draft(m)	CFD C_T(e-3)	CFD R_T(N)	PE(kW)	PE(kW)+10%	T/PE(kW)
14.0	4.6	7.247	188.11	1367.5	1504.3	1450.0

Target
- Study of
  - Skeg angle
  - Skeg distance
  - Deadrise

- Initial Guess : CAESES + SHIPFLOW (by FSYS)
- Full computation by customer : CAESES + STARCCM+
- Target PE : 1450 kW

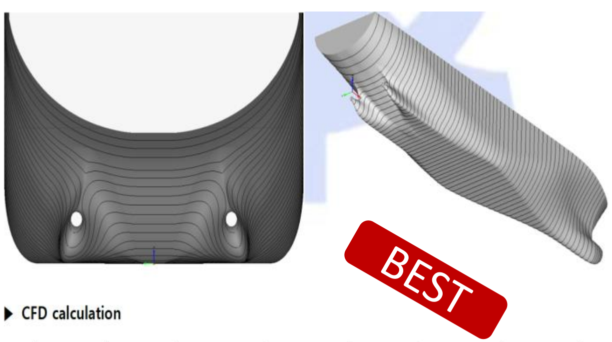
Vertical skeg with flat of bottom



▶ CFD calculation

VS (knot)	Draft(m)	CFD C_T(e-3)	CFD R_T(N)	PE(kW)	PE(kW)+10%	T/PE(kW)
14.0	4.6	7.113	183.33	1331.1	1464.3	1450.0

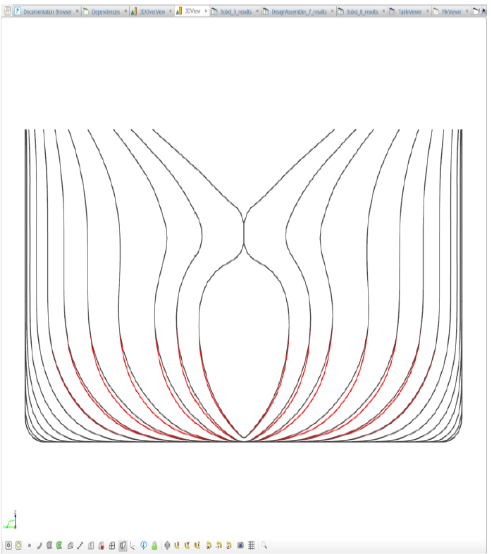
Angled and wide skeg with flat of bottom

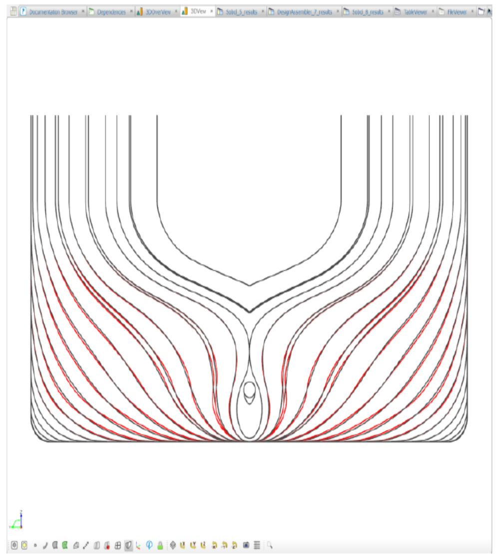


▶ CFD calculation

VS (knot)	Draft(m)	CFD C_T(e-3)	CFD R_T(N)	PE(kW)	PE(kW)+10%	T/PE(kW)
14.0	4.6	6.737	174.76	1262.8	1389.1	1450.0

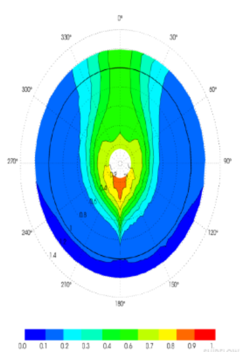
Aftbody study of 300K VLCC



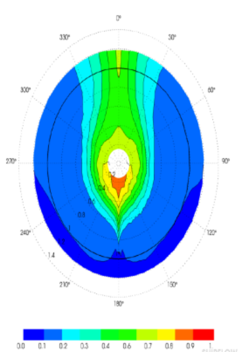


Target
- Optimize forebody and aftbody frame shape.
- Focus on wake property rather than resistance.

Procedure
- 1st optimization with SHIPFLOW
    - FRIENDSHIP SYSTEMS
    - Resistance and Nominal wake
- Final optimization with STARCCM+
    - Customer
    - Starting from the 1st optimized model
    - Self-propulsion condition



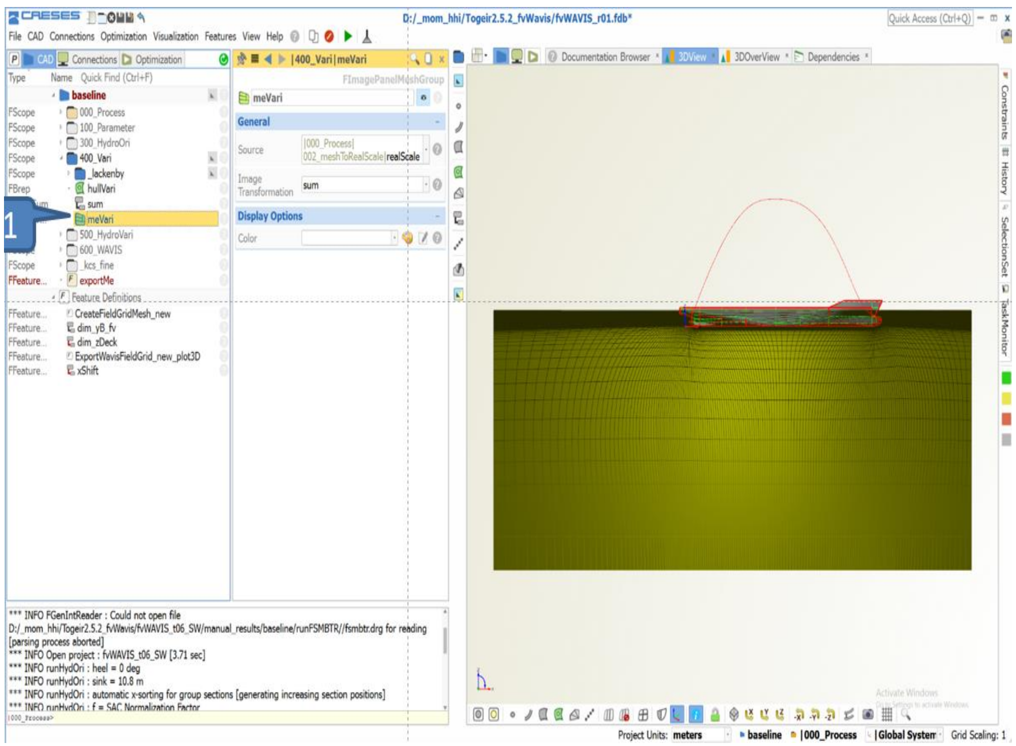
Baseline



COT-R

PD 3.2% saved

Direct variation of mesh



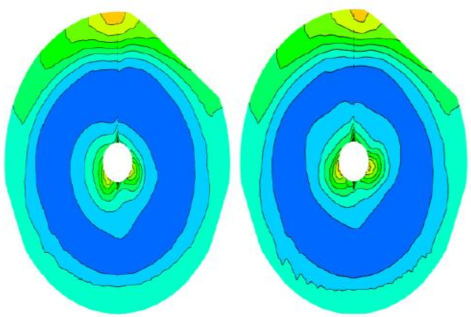
Target

- Direct variation of field grid.
    - Surface grid is also available
- Reuse the good field mesh.
- Save the time for creating field mesh.
- Prevent the failure of mesh generation.

Specification

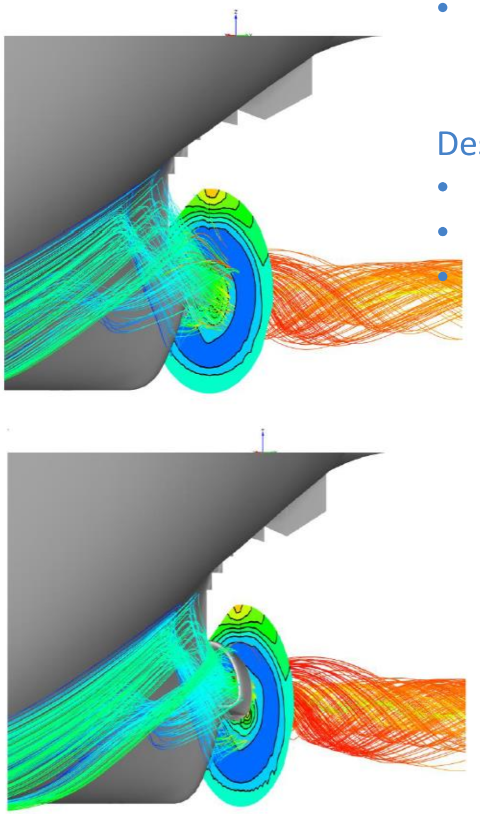
- CFD tested : WAVIS
- This technique could be applied to all kind of „structured mesh“ format.

Half-Circular Duct



Without duct With duct

	PD	%
Without Duct	71.1023	100
With Duct	68.7071	96.62



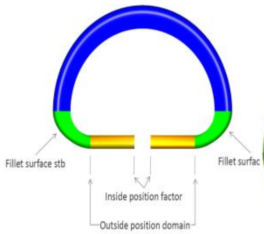
Visualization in CAESES post-processor

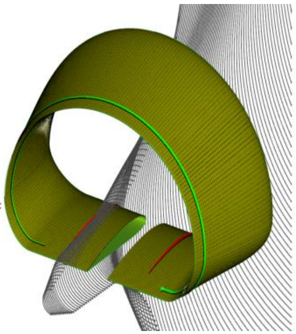
Target

- Evaluation project for SHIPFLOW & CAESES combination for study of energy saving device.

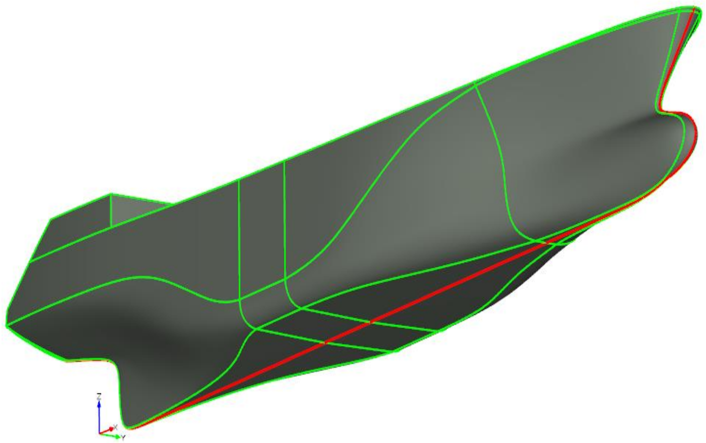
Design variables

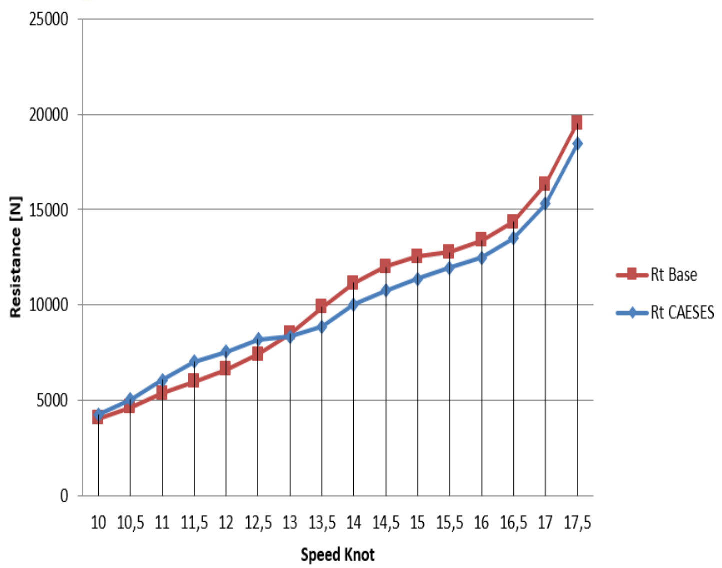
- Stators angle
- Duct position
- Profile shape
  - Angle of attack
  - Thickness
  - Cord
  - Camber





Main dimension optimization of a fishing boat



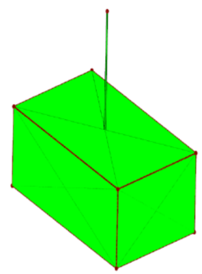


Target
- Find out the best main dimension.

Design variable
- dL
- dB
- Bulb volume

Result
- Initial guess by Fsys SHIPFLOW
- Final full CFD calculation by the customer with STARCCM+ results in 10% improvement of resistance performance at the design speed 15.5Knot.

Zinc Anode Positioning

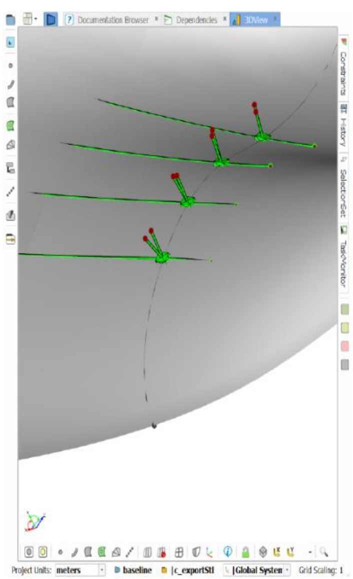


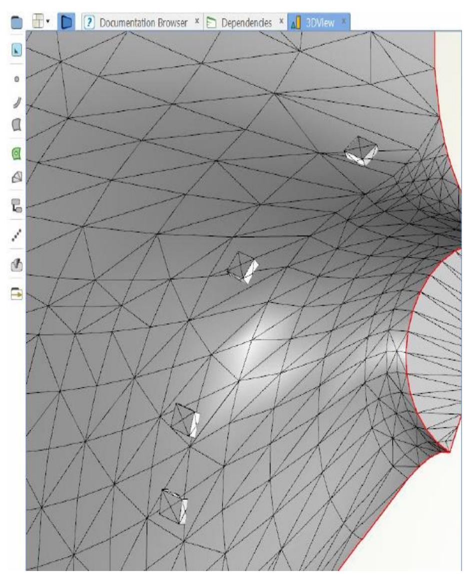
Target

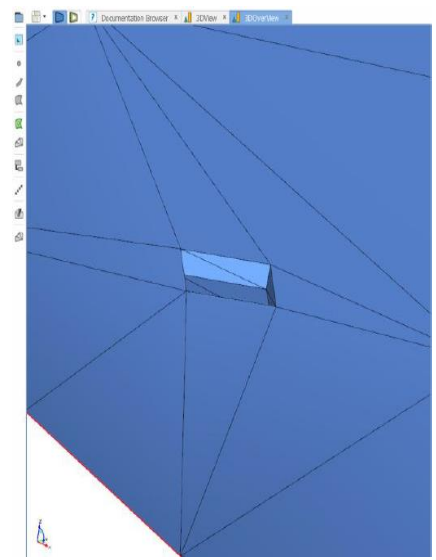
- Parametric model
- Easy positioning
- Watertight STL regarding hull surface.

CFD

Fluent (by Customer)

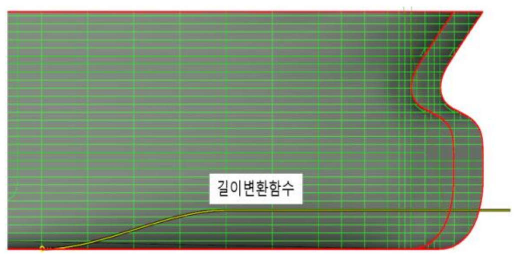


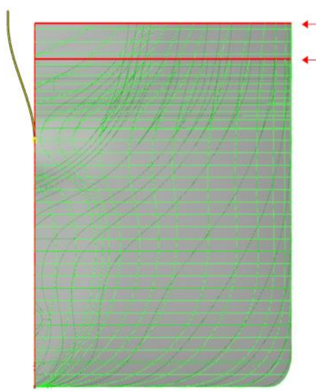




Main dimension study for 300K VLCC regarding LWT

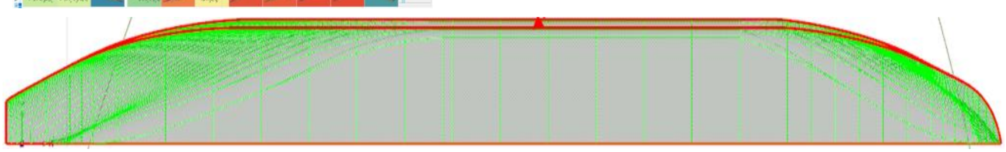
Sensitivity Analysis of 300K VLCC





Resistance calculation

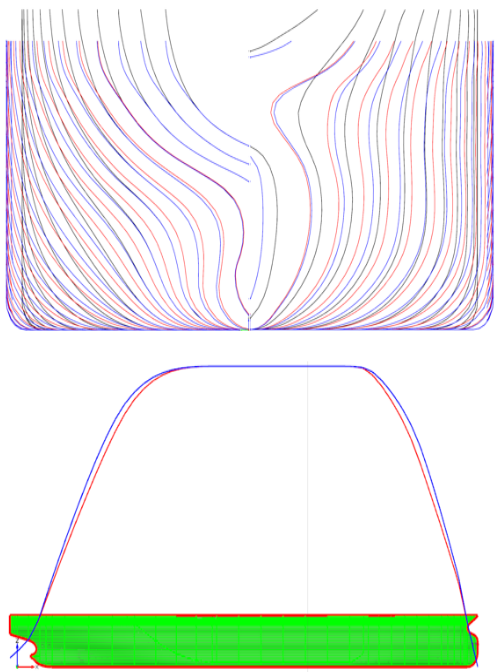
Sensitivity Analysis of 14,000 TEU Containership



Target
- Quick evaluation of best main dimension in early design phase.
- Potential code level computation.
- Considering LWT (Light Weight Ton) to match with target DWT(Dead Weight Ton)
- Define feature definition codes for utilizing the statistical formulars for ship calculation.

Design variable
- Lbp
- B
- Draft
- Depth

Main dimension study for 300K VLCC regarding LWT



BEST

	참고선 (검정)	1차선형 (파랑)	최종선형 (빨강)
LOA [m]	328.44	333.44	333.44
LBP [m]	316	321	321
B [m]	57.6	61.6	61.6
D [m]	30.5	27.5	27.5
T [m]	20.4	22	22
CB [m]	0.7970	0.7962	0.7806
LWT [t]	45844	48950	48950
DWT [t]	258015	3510804	300030
DISP [t]	303859	3559754	348980

Double Ended Ferry

Billion contract for Havyard for ferries

TOPICS: Electrical Ferry Havyard Norway Today

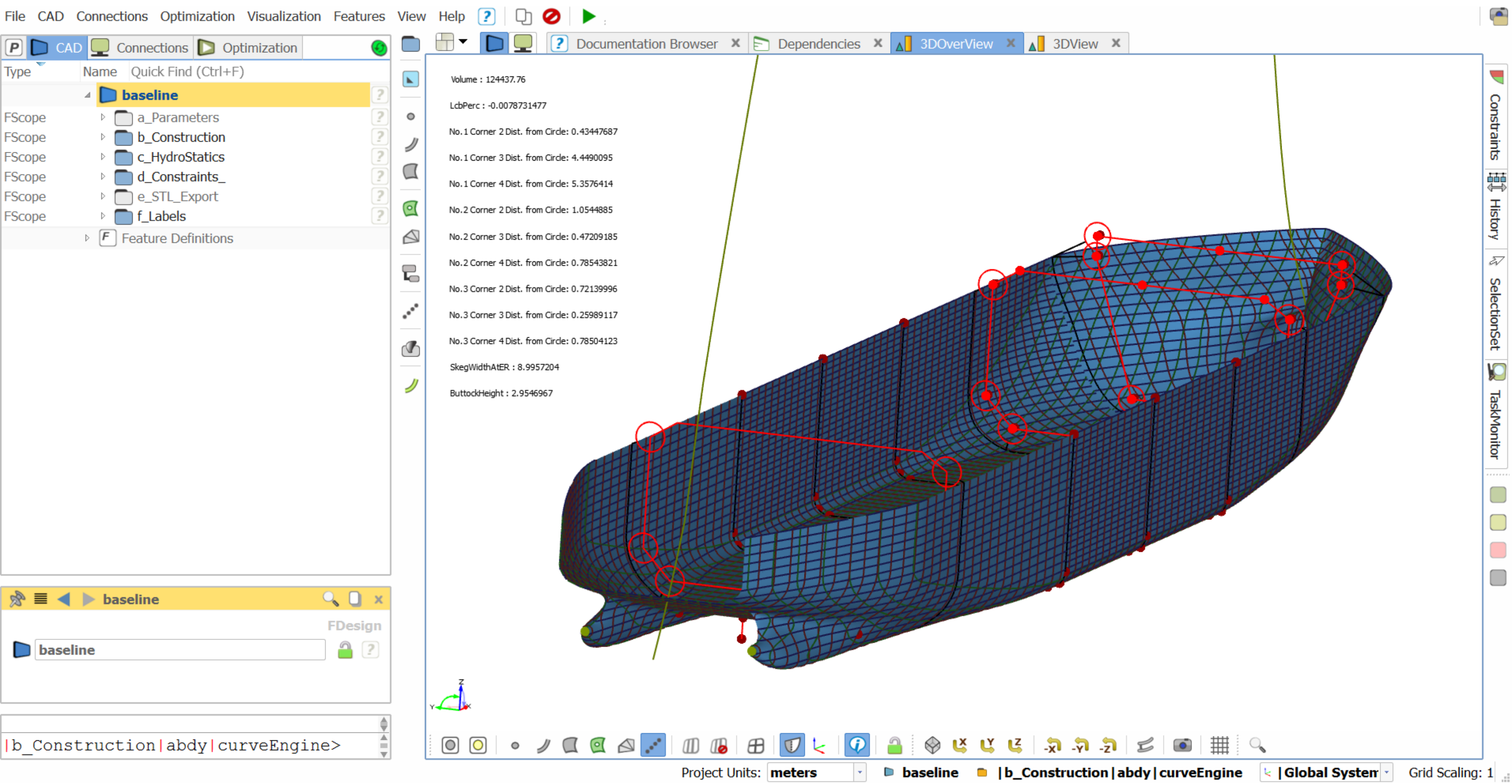
Havyard Ferry. Illustration: Havyard

POSTED BY: PIETER WIJNEN 10. JUNE 2017

Billion contract for Havyard for ferries

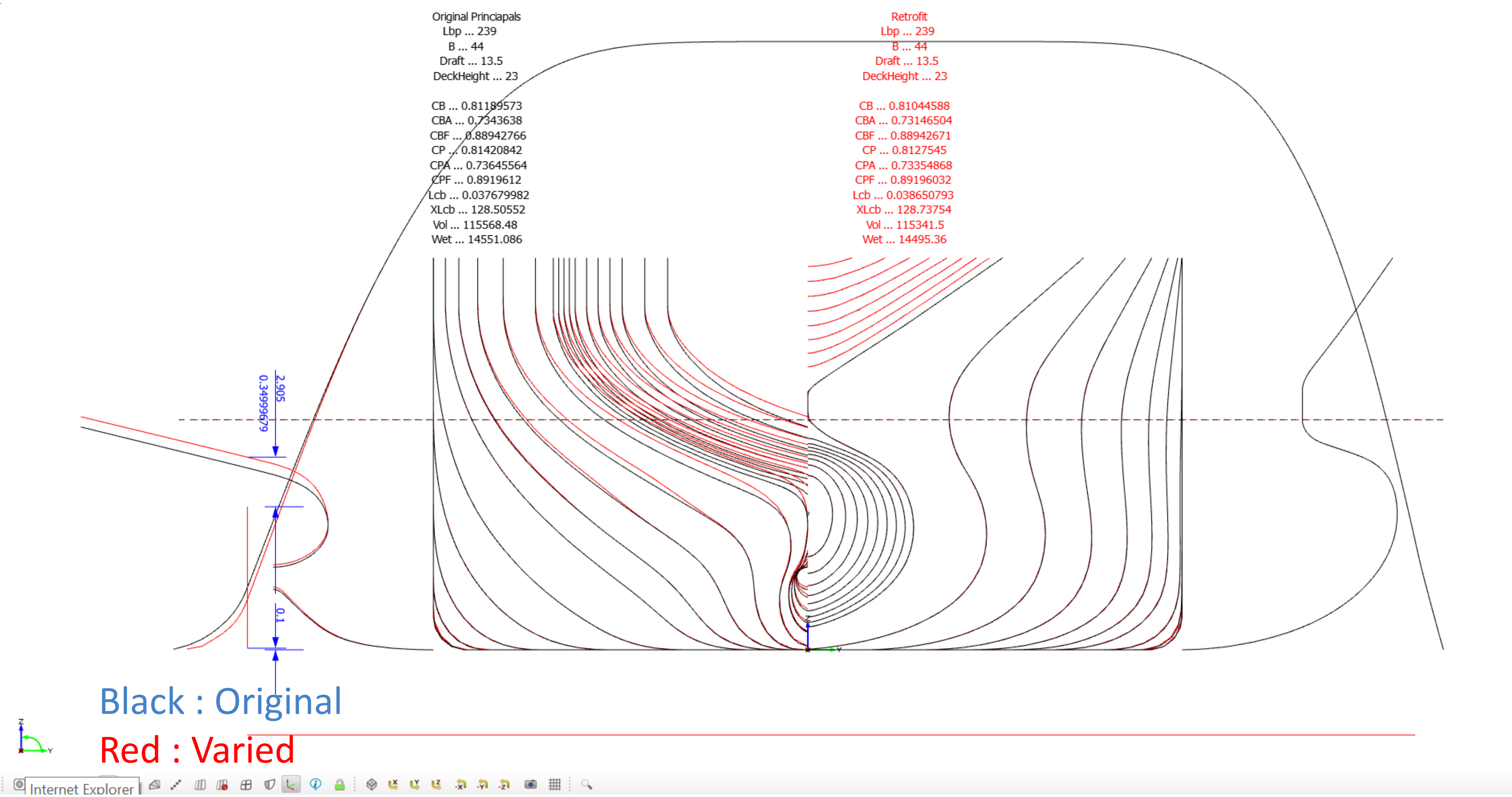
Fjord1 has chosen Havyard to build five of its new ferries to be delivered in 2018 and 2019.

Fully Parametric Hullform Connected with Cargo-hold



Quick Hullform Set-up (Propeller Aperture and Aftbody Profile)

3 Dimensional Continuity from stern to afterbody



Black : Original

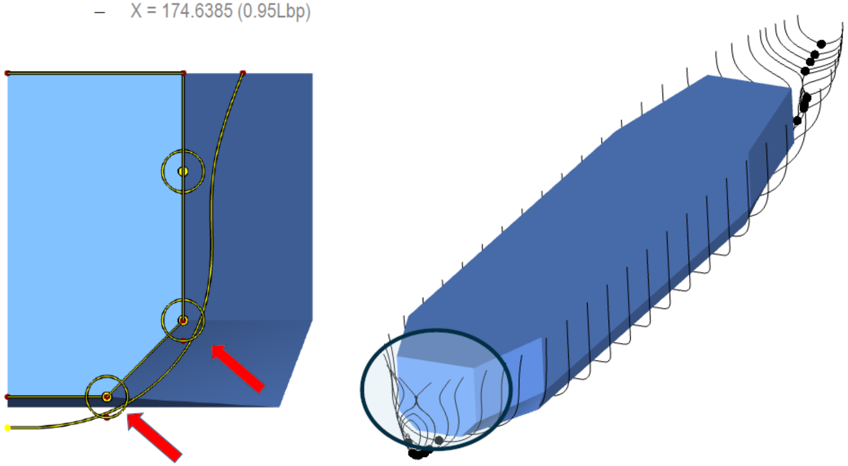
Red : Varied

Quick Hullform Set-up (Cargo Hold)

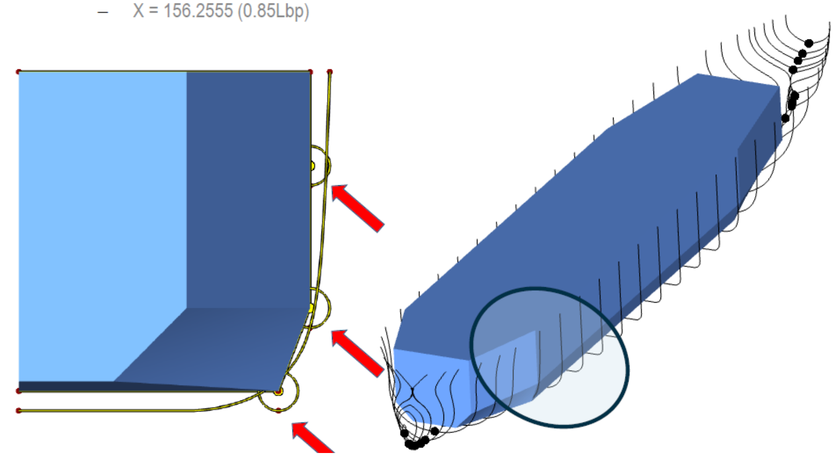
Example | MR Tanker

Hard Point Constraints Check

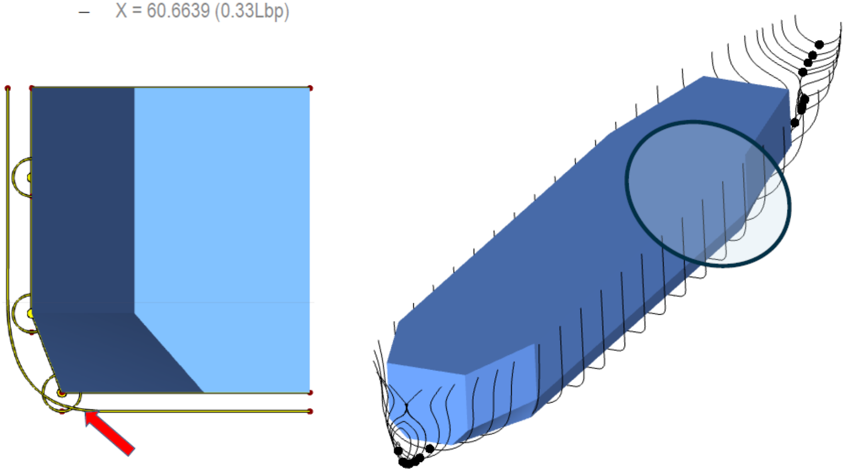
- Bulkhead 1
  - X = 174.6385 (0.95Lbp)



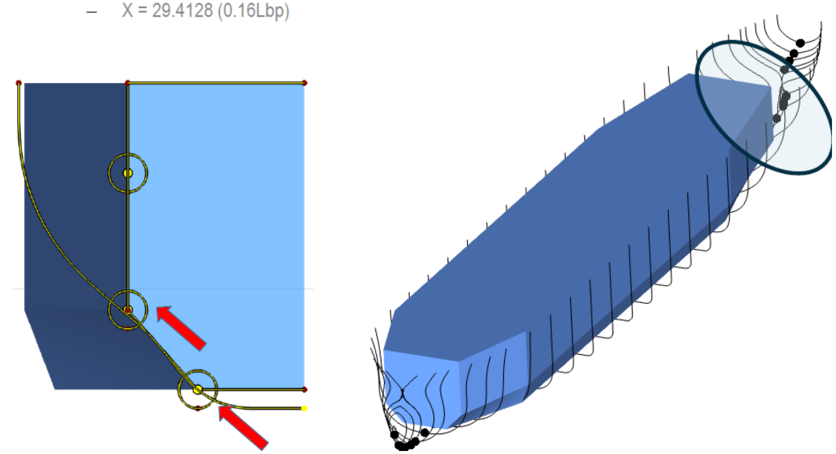
- X = 156.2555 (0.85Lbp)



- Bulkhead 3
  - X = 60.6639 (0.33Lbp)



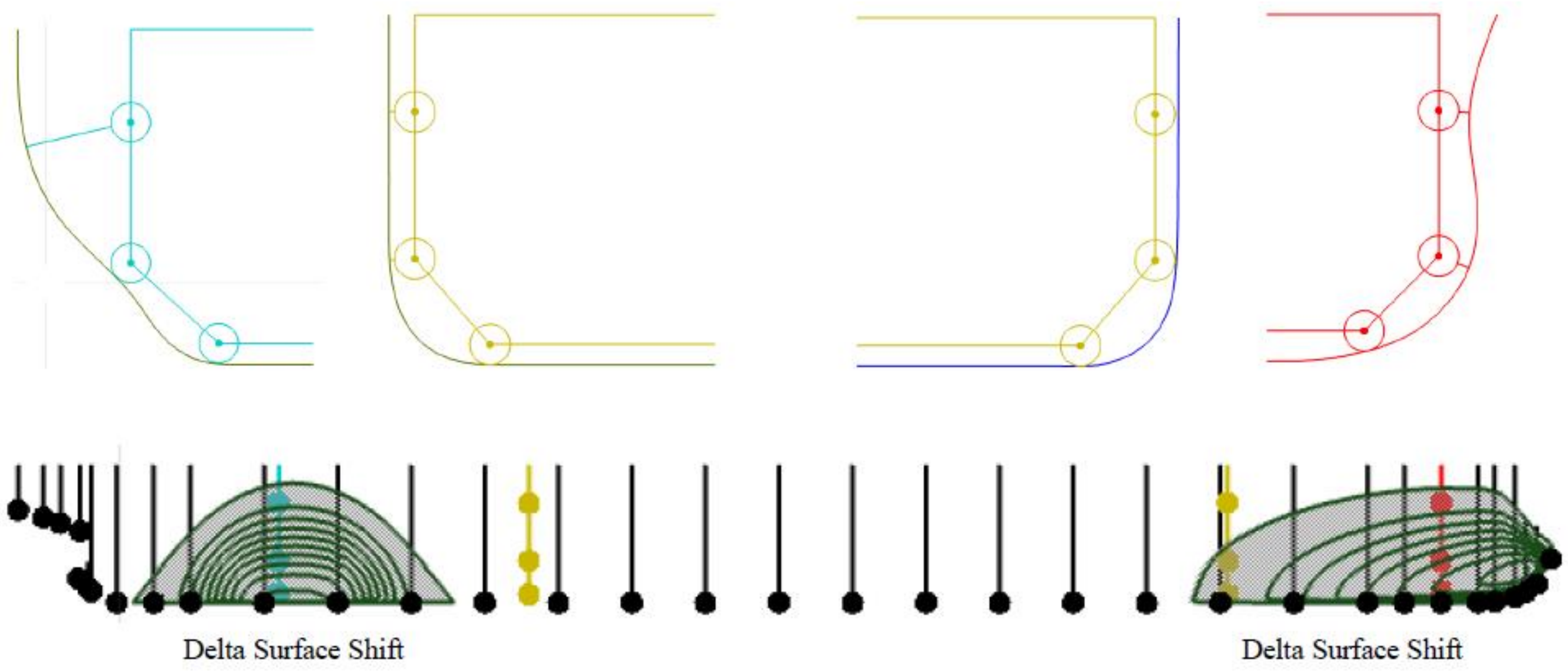
- Bulkhead 4
  - X = 29.4128 (0.16Lbp)



Quick Hullform Set-up (Cargo hold)

Example | MR Tanker

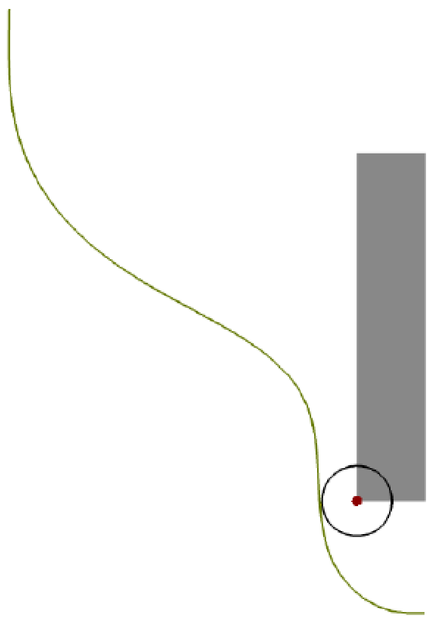
Hard Point Constraints Satisfaction

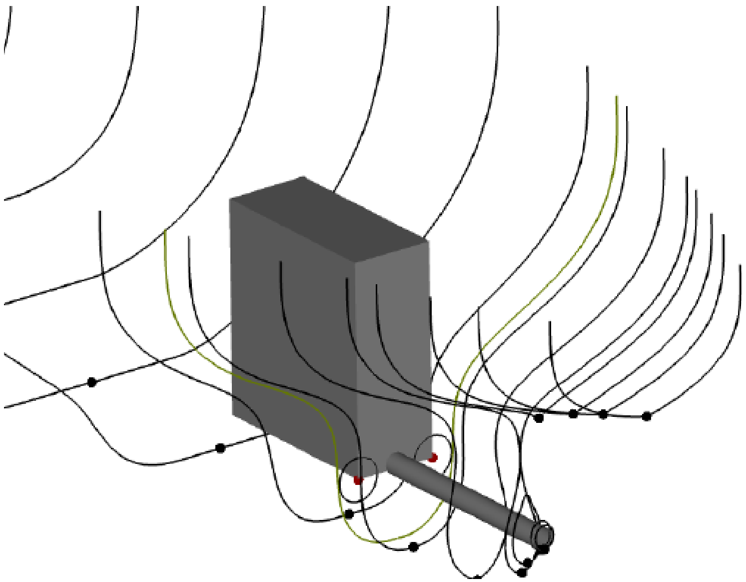


Quick Hullform Set-up (Engine room)

Example | MR Tanker

Hard Point Constraints Satisfaction





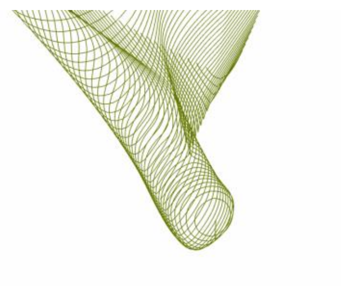
Software connection

AVEVA WIREFRAME (DMP) + CAESES + CFD (WAVIS)

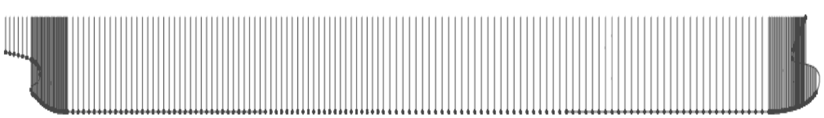
1. Import Wireframe Model

2. Create Surface from wireframe model

3. Hullform Modification

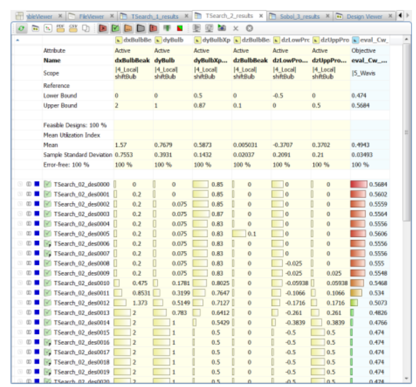


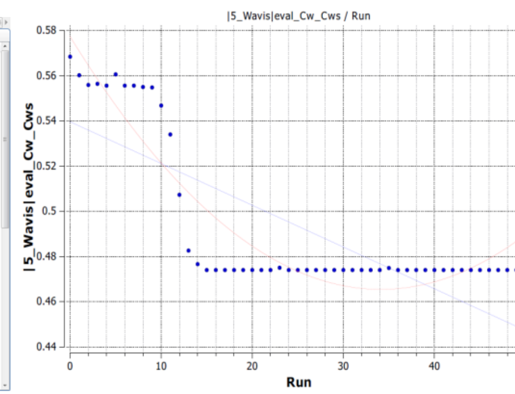
4. Export Offsets for WAVIS (FIX and PRX)



5. WAVIS Integration (Multiple Connection)

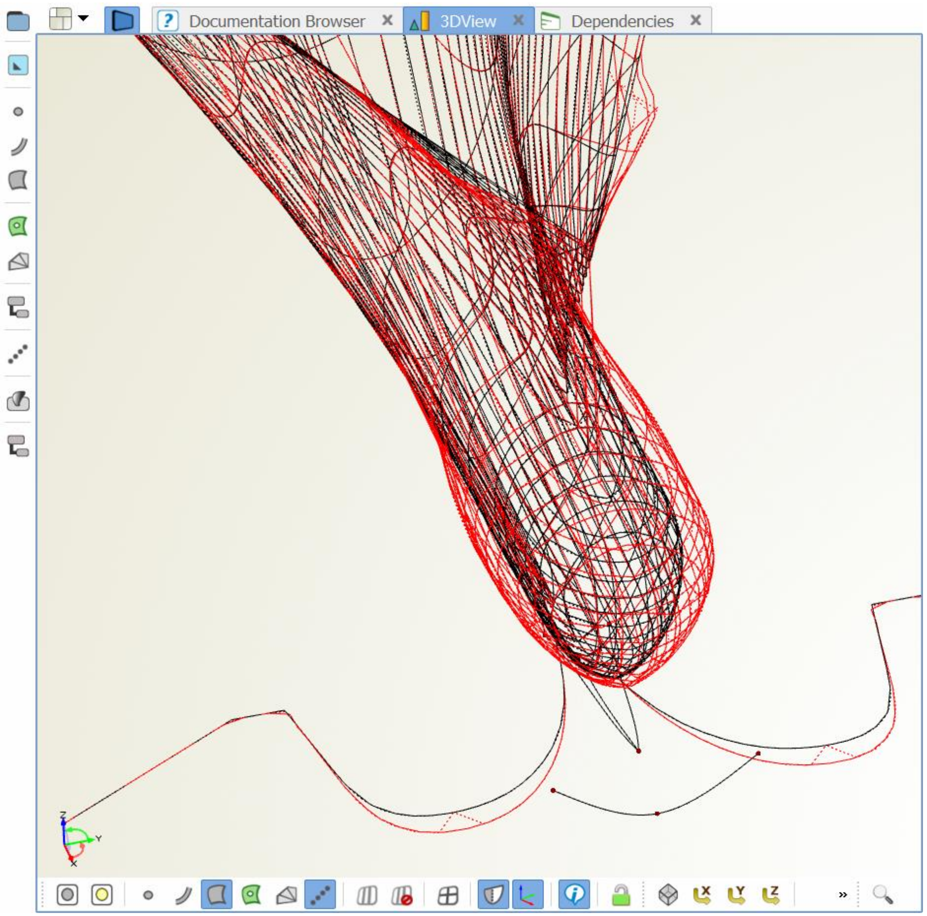
6. Optimization (Minimum Wave Resistance)





Software connection

AVEVA WIREFRAME (DMP) + CAESES + CFD (WAVIS)

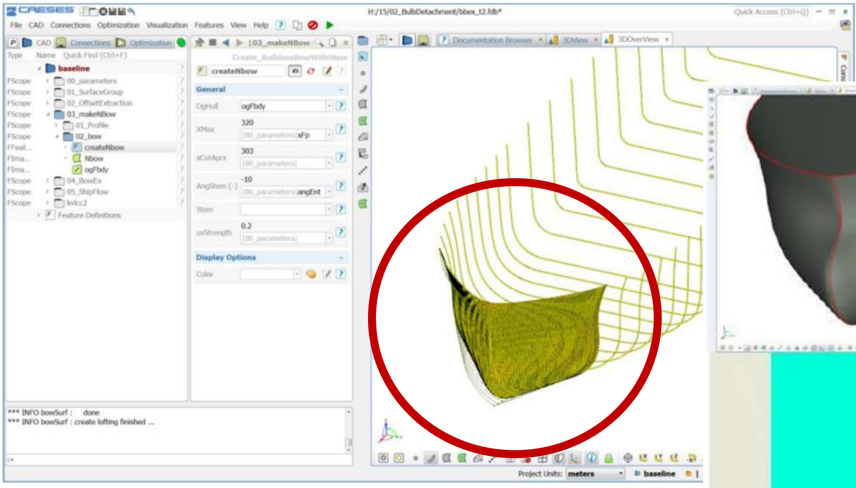


Give the optimized hullform to AVEVA in DMP file format.

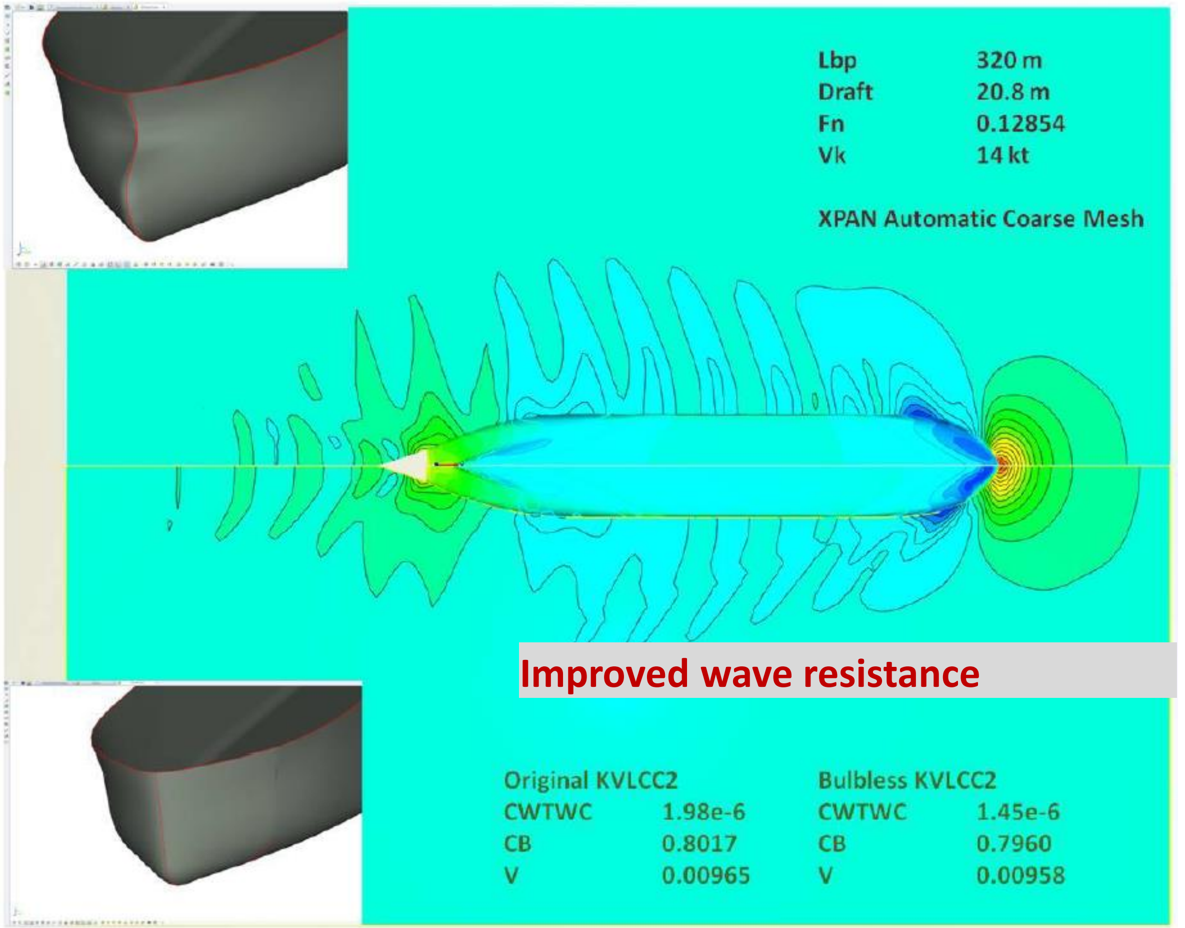
- **Hot issue in 2016.**

Bow Retrofit

Bulb removal



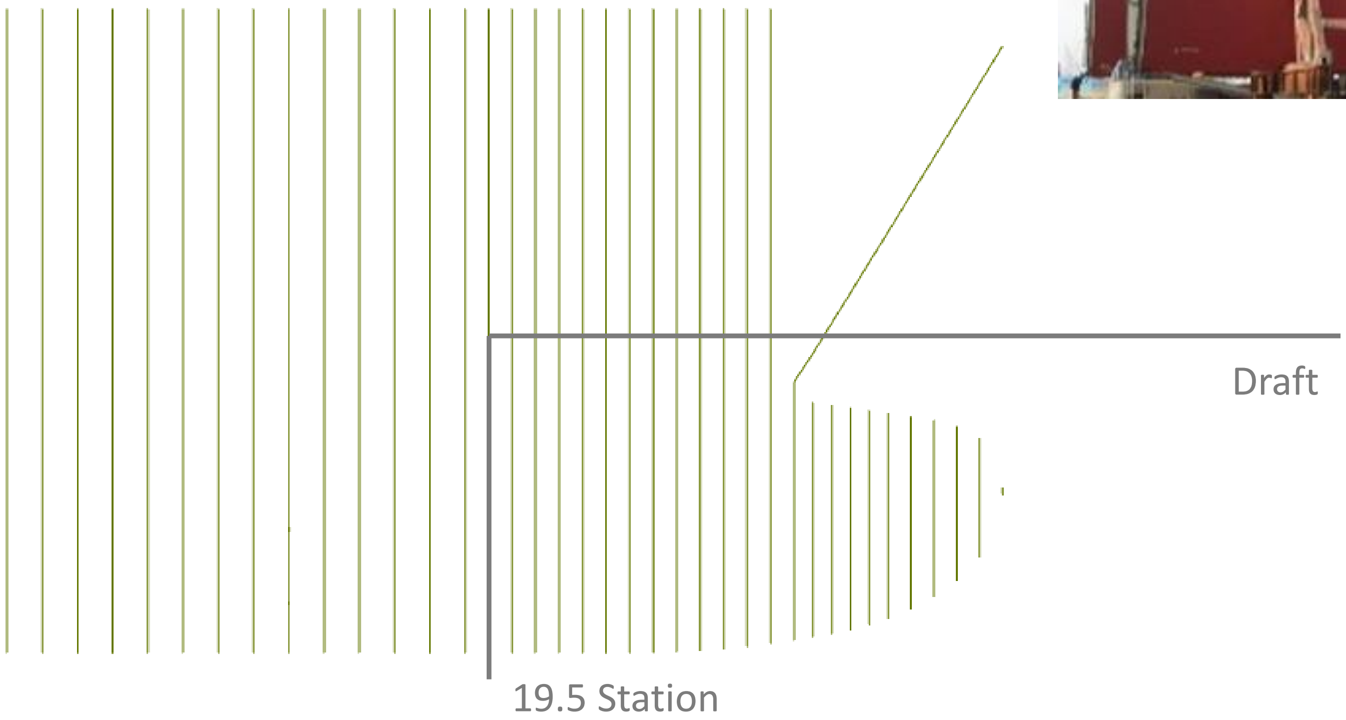
Remove bulbous bow and attach bulbless bow Surface



Improved wave resistance

Bow Retrofit

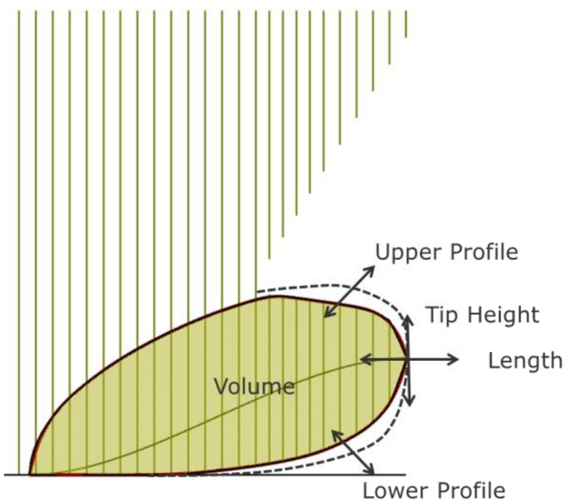
- Bulbous bow retrofit



Bow Retrofit

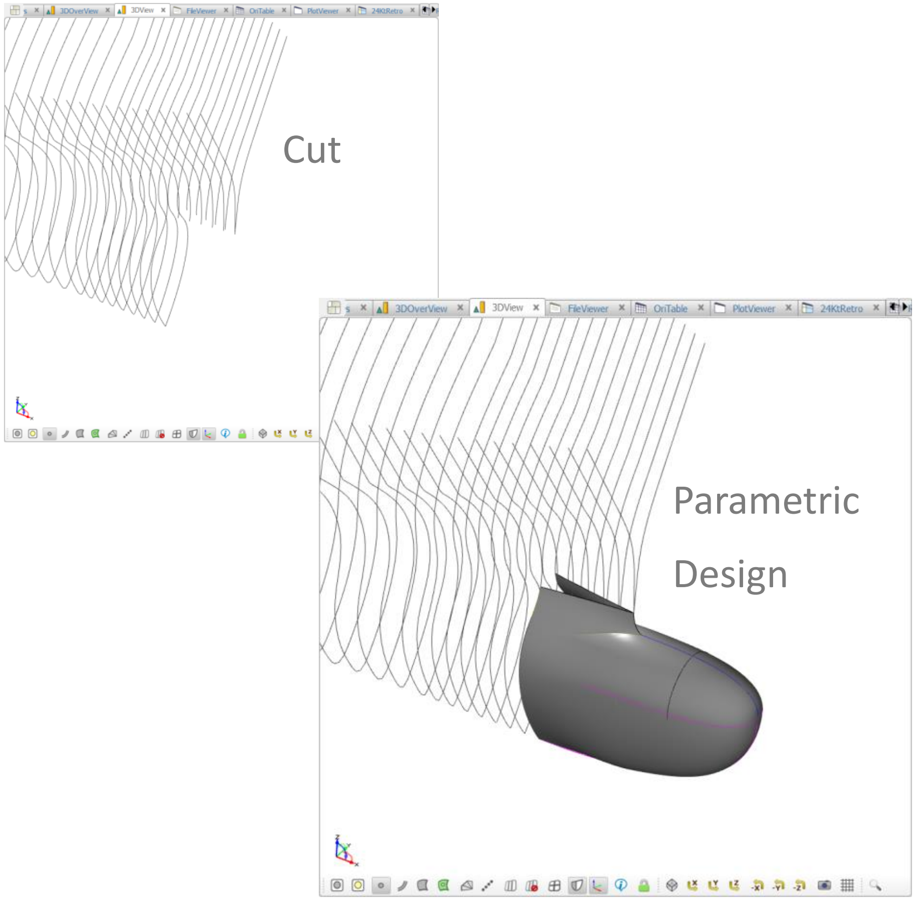
Delta Shift

- Mothership variation.



New Design

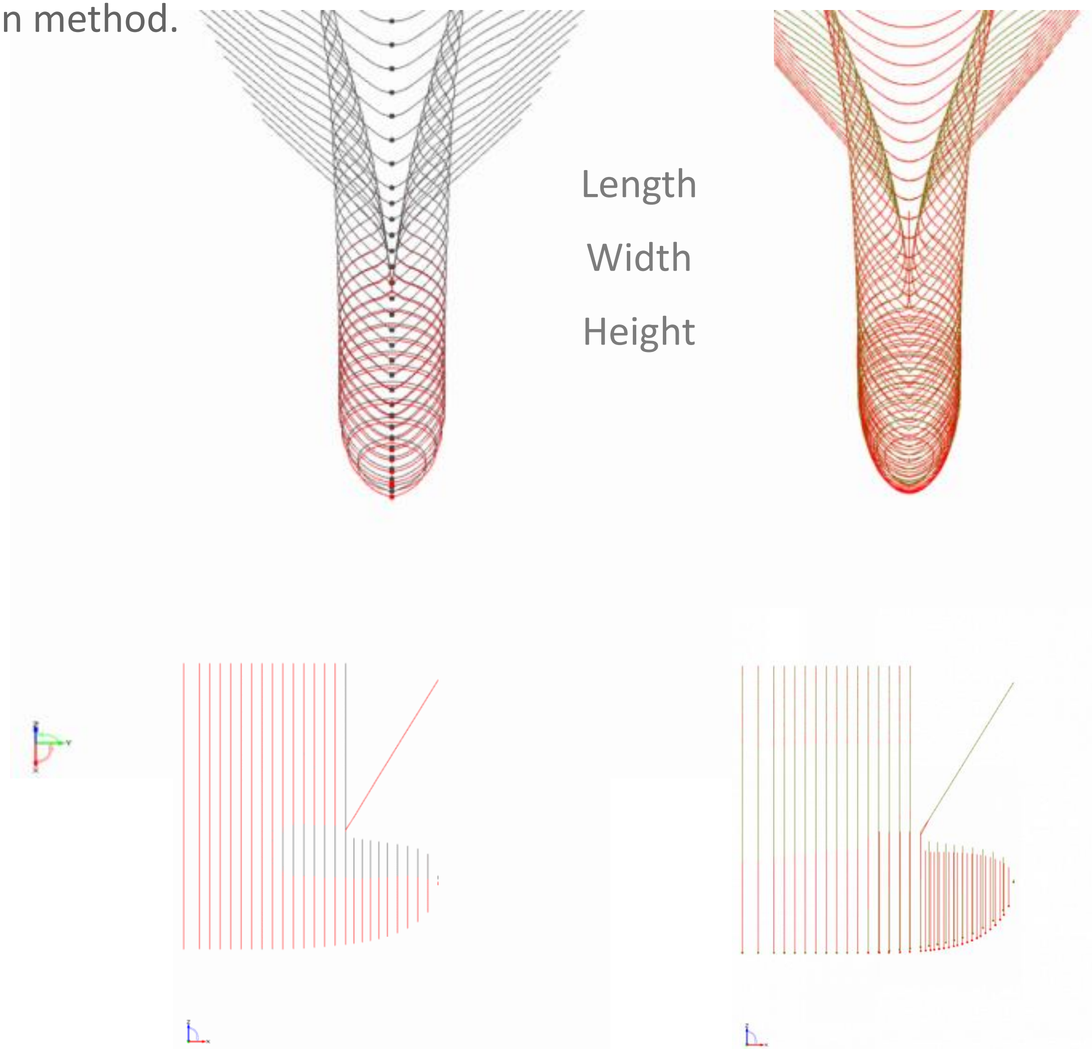
- New Shape creation.



Bow Retrofit

- Select variation method.

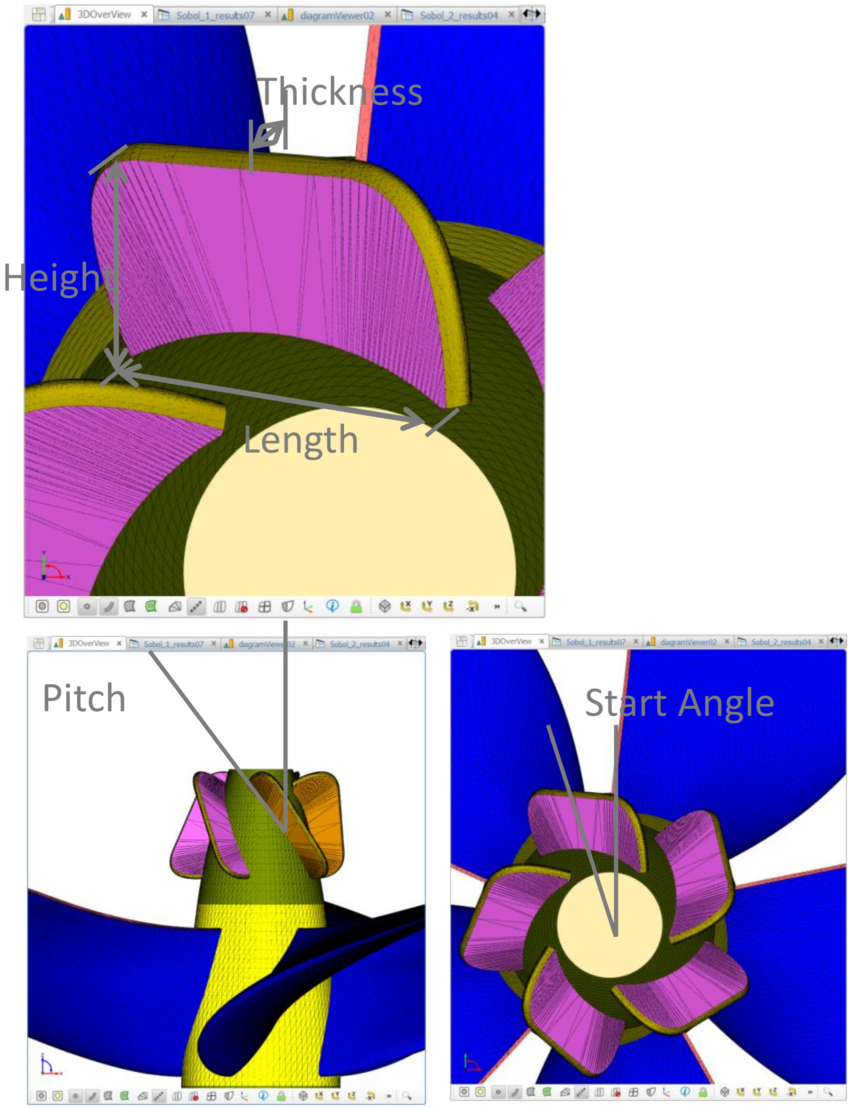
GOOD



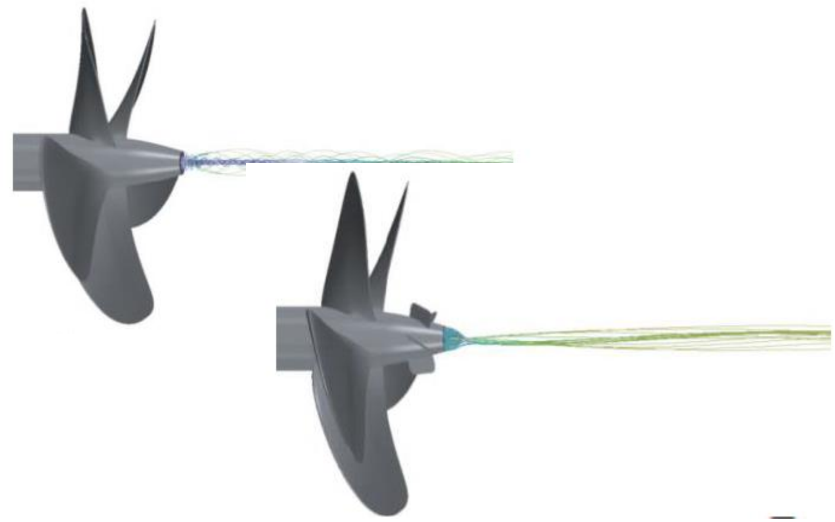
BETTER

ESD Form Optimization

PBCF Form Optimization



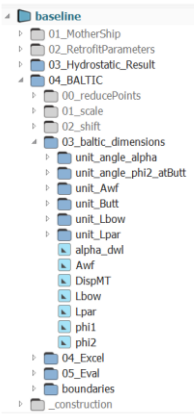
STARCCM+

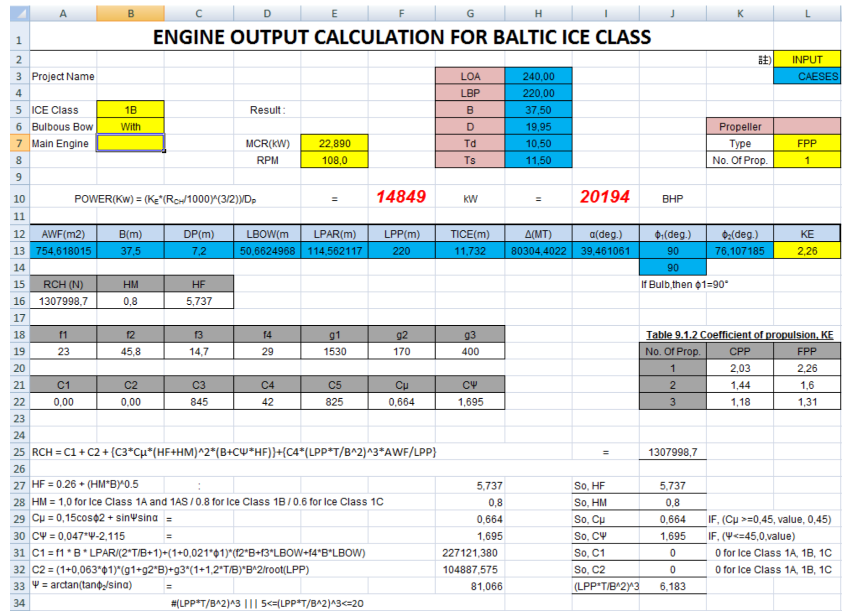


1.3 % Increase of propulsive efficient

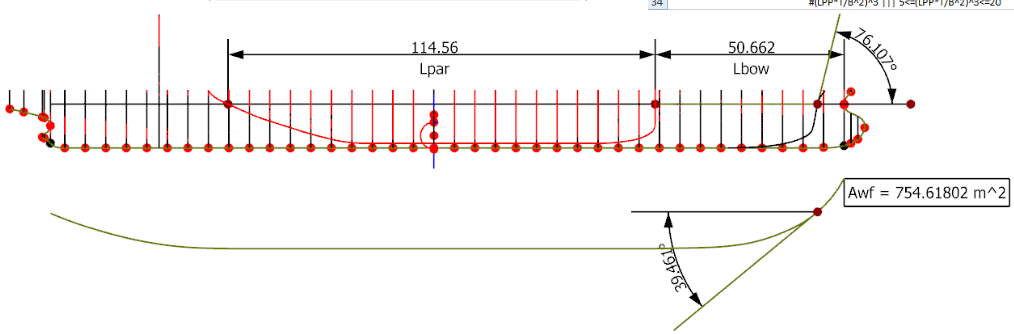
Integration with EXCEL (Finnish - Swedish Ice Class Rule)

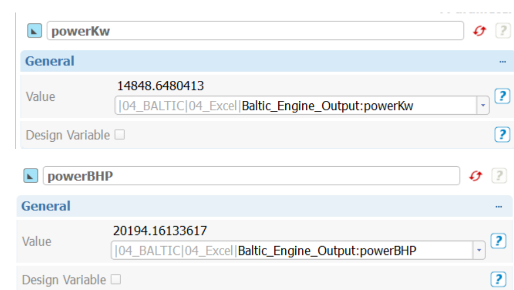
Design Parameters → COM Interface → Excel Calculation → Result Parameters





	A	B	C	D	E	F	G	H	I	J	K	L
1	ENGINE OUTPUT CALCULATION FOR BALTIC ICE CLASS											
2											註)	INPUT
3	Project Name						LOA	240,00				CAESES
4							LBP	220,00				
5	ICE Class	1B		Result :			B	37,50				
6	Bulbous Bow	With					D	19,95			Propeller	
7	Main Engine			MCR(kW)	22,890		Td	10,50			Type	FPP
8				RPM	108,0		Ts	11,50			No. Of Prop.	1
9												
10	POWER(Kw) = (KE*(RCH/1000)^(3/2))/DP				=	14849	kW	=	20194	BHP		
11												
12	AWF(m2)	B(m)	DP(m)	LBOW(m	LPAR(m)	LPP(m)	TICE(m)	Δ(MT)	α(deg.)	ϕ1(deg.)	ϕ2(deg.)	KE
13	754,618015	37,5	7,2	50,6624968	114,562117	220	11,732	80304,4022	39,461061	90	76,107185	2,26
14										90		
15	RCH (N)	HM	HF							If Bulb,then ϕ1=90°		
16	1307998,7	0,8	5,737									
17												
18	f1	f2	f3	f4	g1	g2	g3			Table 9.1.2 Coefficient of propulsion, KE		
19	23	45,8	14,7	29	1530	170	400			No. Of Prop.	CPP	FPP
20										1	2,03	2,26
21	C1	C2	C3	C4	C5	Cμ	CΨ			2	1,44	1,6
22	0,00	0,00	845	42	825	0,664	1,695			3	1,18	1,31
23												
24												
25	RCH = C1 + C2 + {C3*Cμ*(HF+HM)^2*(B+CΨ*HF)}+{C4*(LPP*T/B^2)^3*AWF/LPP}								=	1307998,7		
26												
27	HF = 0.26 + (HM*B)^0.5		:				5,737		So, HF	5,737		
28	HM = 1,0 for Ice Class 1A and 1AS / 0.8 for Ice Class 1B / 0.6 for Ice Class 1C						0,8		So, HM	0,8		
29	Cμ = 0,15cosϕ2 + sinΨsinα		=				0,664		So, Cμ	0,664	IF, (Cμ >=0,45, value, 0,45)	
30	CΨ = 0,047*Ψ-2,115		=				1,695		So, CΨ	1,695	IF, (Ψ<=45,0,value)	
31	C1 = f1 * B * LPAR/(2*T/B+1)+(1+0,021*ϕ1)*(f2*B+f3*LBOW+f4*B*LBOW)						227121,380		So, C1	0	0 for Ice Class 1A, 1B, 1C	
32	C2 = (1+0,063*ϕ1)*(g1+g2*B)+g3*(1+1,2*T/B)*B^2/root(LPP)						104887,575		So, C2	0	0 for Ice Class 1A, 1B, 1C	
33	Ψ = arctan(tanϕ2/sinα)		=				81,066		(LPP*T/B^2)^3	6,183		
34			#(LPP*T/B^2)^3 ||| 5<=(LPP*T/B^2)^3<=20									



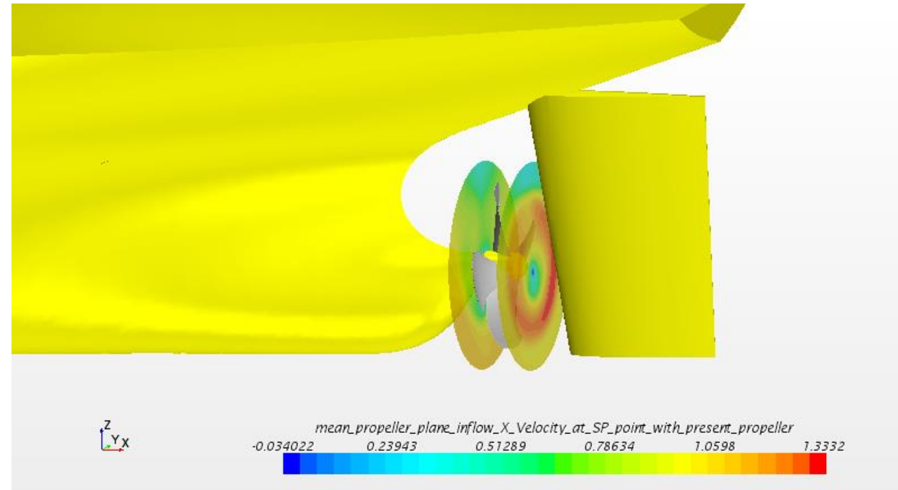


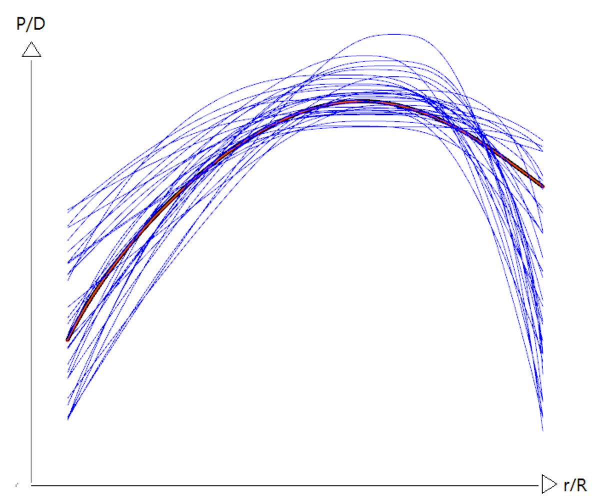
Propeller Optimization in Self-propulsion condition

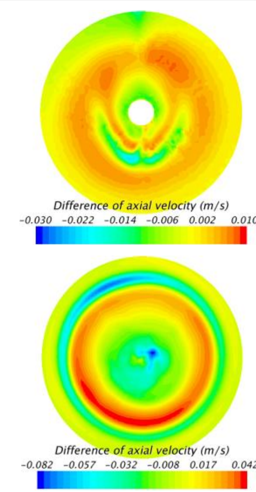
- Approach
  - 1. step with 30 variants
    - Vary pitch distribution
  - 2. step with 100 variants
    - Vary pitch, camber and chord distribution with changing mean pitch, mean camber and expanded area ratio (EAR)
- Objective
  - Lower power consumption 2·π·n·Q

Savings

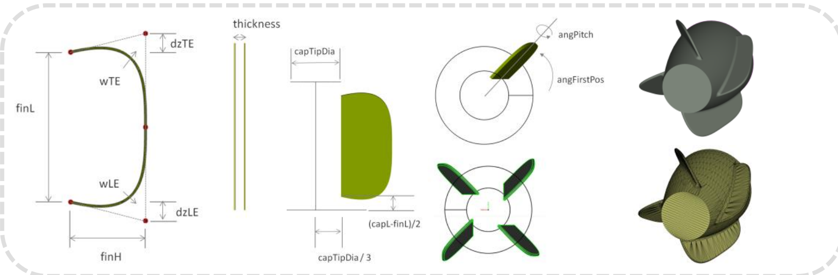
- 1. step: 0.7% decrease of power consumption
- 2. step: 0.9% decrease of power consumption



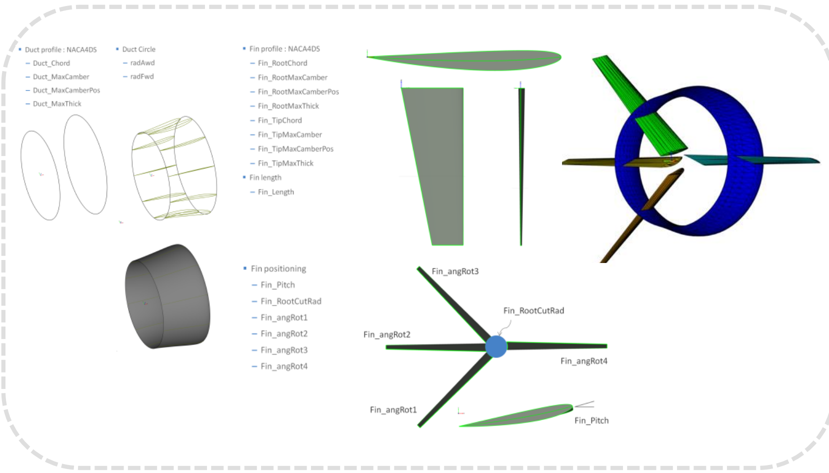




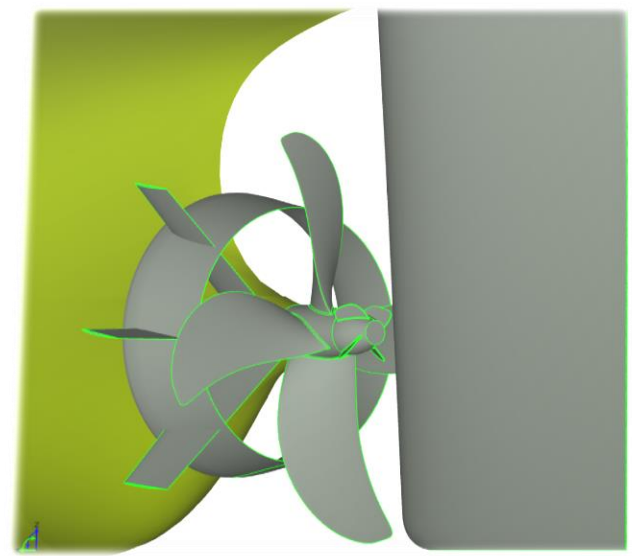
Challenge

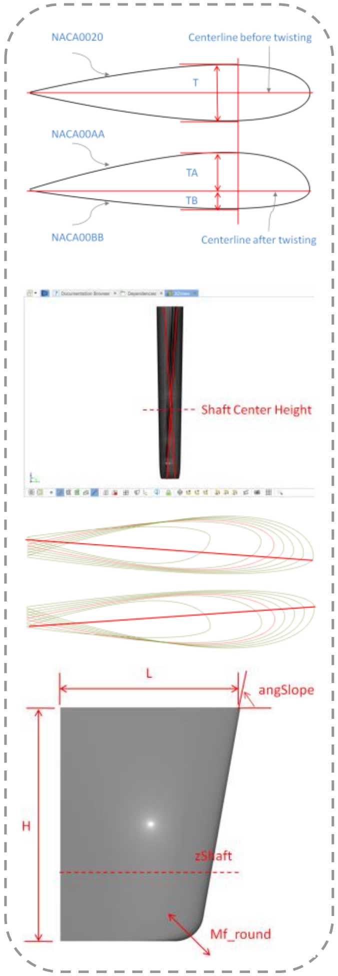


thickness
dzTE
capTipDia
angPitch
wTE
finL
angFirstPos
wLE
dzLE
(capL-finL)/2
finH
capTipDia / 3



Duct profile : NACA4DS
Duct_Chord
Duct_MaxCamber
Duct_MaxCamberPos
Duct_MaxThick
Duct Circle
radAwd
radFwd
Fin profile : NACA4DS
Fin_RootChord
Fin_RootMaxCamber
Fin_RootMaxCamberPos
Fin_RootMaxThick
Fin_TipChord
Fin_TipMaxCamber
Fin_TipMaxCamberPos
Fin_TipMaxThick
Fin length
Fin_Length
Fin positioning
Fin_Pitch
Fin_RootCutRad
Fin_angRot1
Fin_angRot2
Fin_angRot3
Fin_angRot4
Fin_angRot3
Fin_RootCutRad
Fin_angRot2
Fin_angRot4
Fin_angRot1
Fin_Pitch





NACA0020
Centerline before twisting
T
NACA00AA
TA
TB
NACA00BB
Centerline after twisting
Shaft Center Height
L
angSlope
H
zShaft
Mf_round

- Thank you very much !