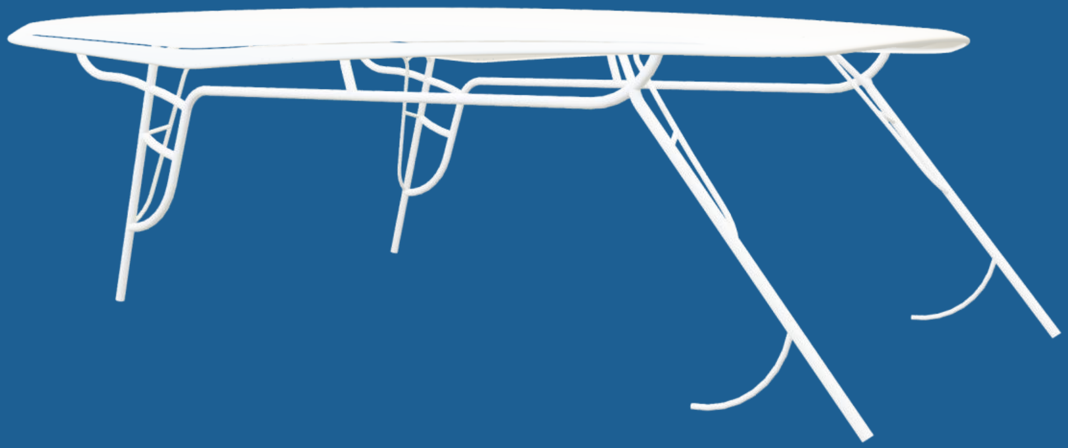
Team 511: Intrepid



Juan Tapia John Karamitsanis Cory Stanley Erika Craft

Intrepid - Redesigned Hardtop
Team 511

Materials Engineer
Juan Tapia

Lead Engineer
John Karamitsanis

Mechanical Design Engineer
Cory Stanley

Marine Design Engineer
Erika Craft

Cory Stanley

Sponsors, Advisor, & Coordinator

President
Ken Clinton

V.P. of Engineering
Richard Ahl

Academic Advisor
Dr. William Oates

Senior Design Coordinator
Dr. Shayne McConomy

Cory Stanley

Project Recap

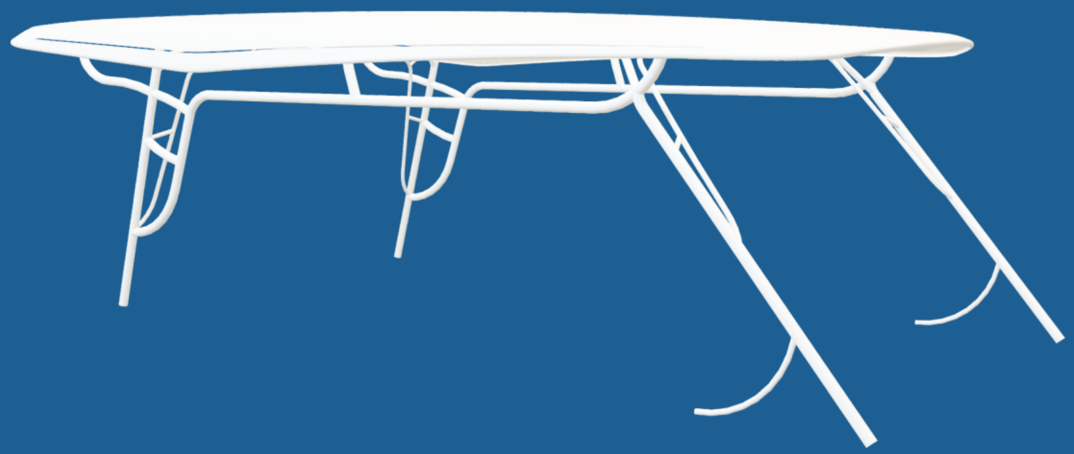
- Description
- Objective
- Key Goals

Moving Forward

- Aerodynamic Calculations
- Future Work

Cory Stanley

Description



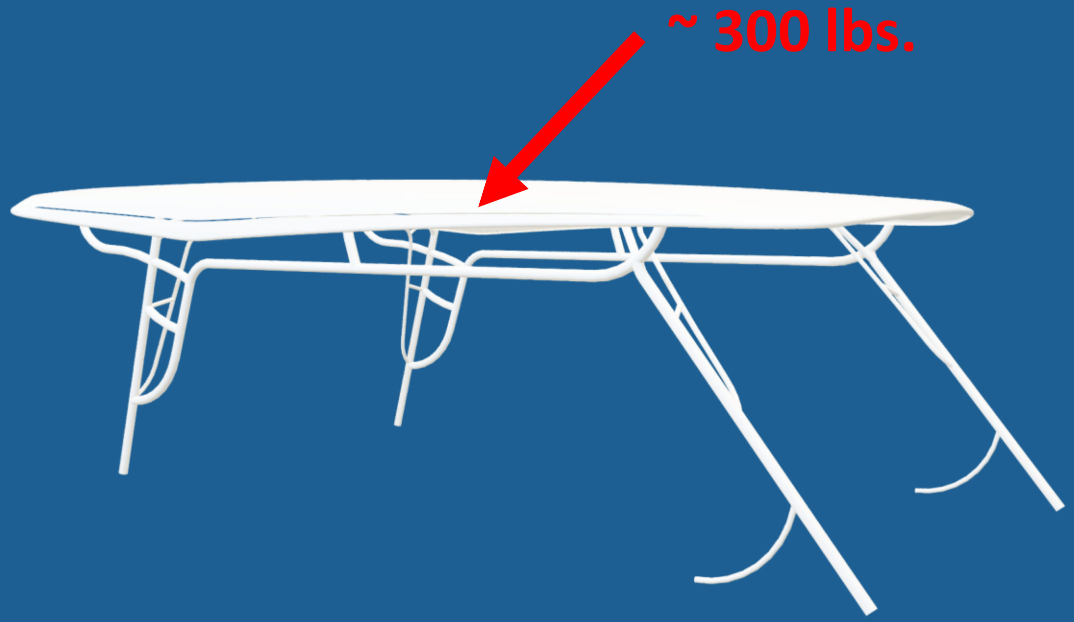
Intrepid wants to improve vessel performance

The current hardtop is heavier than desired

Improving the hardtop can solve Intrepid's problem of improving performance

Cory Stanley

Description



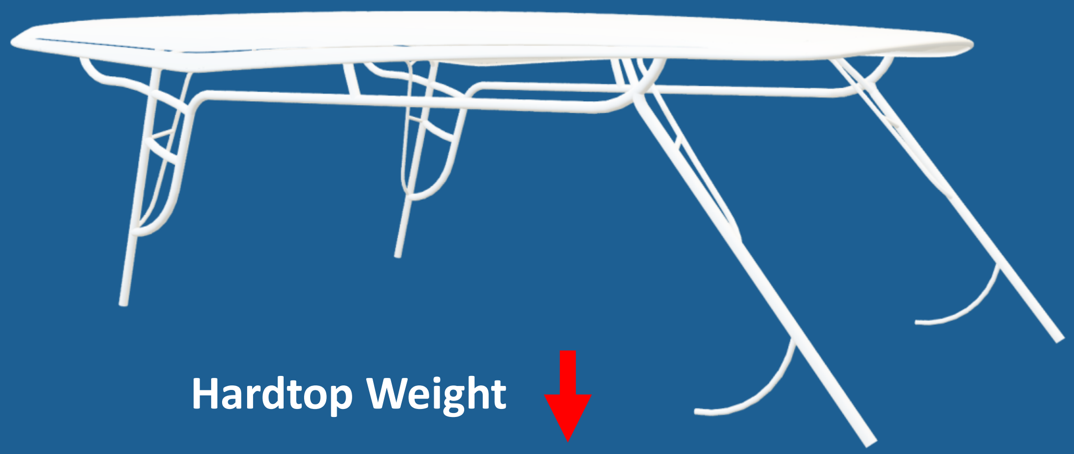
Intrepid wants to improve vessel performance

The current hardtop is heavier than desired

Improving the hardtop can solve Intrepid's problem of improving performance

Cory Stanley

Description



Hardtop Weight ↓

Lift ↑

Drag ↓

Intrepid wants to improve vessel performance

The current hardtop is heavier than desired

Improving the hardtop can solve Intrepid's problem of improving performance

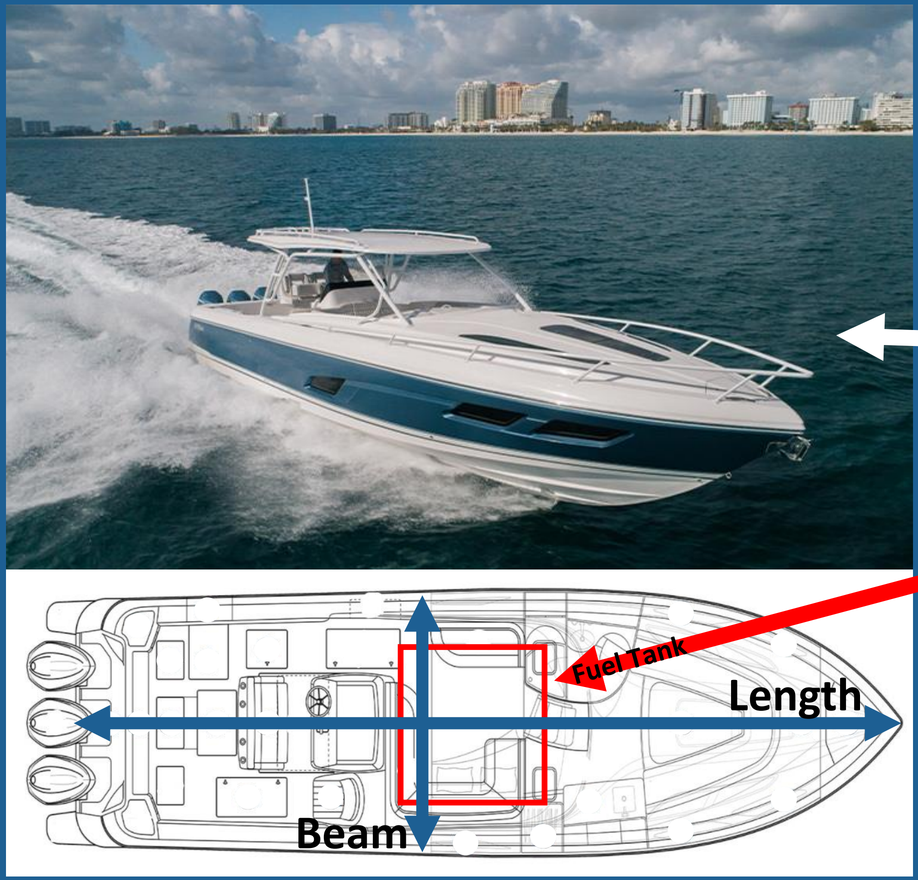
Cory Stanley

Objective

To improve the on-water performance of the Intrepid 409 Valor

John Karamitsanis

Objective



To improve the on-water performance of the Intrepid 409 Valor

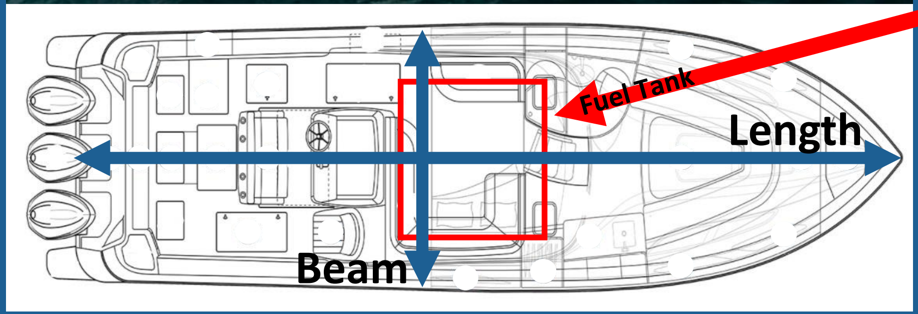
Intrepid 409 Valor

Length:	40’ 0”
Beam:	11’ 1”
Fuel Capacity:	438 Gallons
Top Speed:	70+ mph

John Karamitsanis

Objective

To improve the on-water performance of the Intrepid 409 Valor



<u>Intrepid 409 Valor</u>

Length:	40’ 0”
Beam:	11’ 1”
Fuel Capacity:	438 Gallons
Top Speed:	70+ mph
Range:	

Increase in Lift
Reduction of Drag
Reduction of Weight

John Karamitsanis

Key Goals

Improve boat on water performance

Improve fuel efficiency

Analyze and enhance aerodynamics

Keep the design manufacturable

John Karamitsanis

Key Goals

Improve boat on water performance

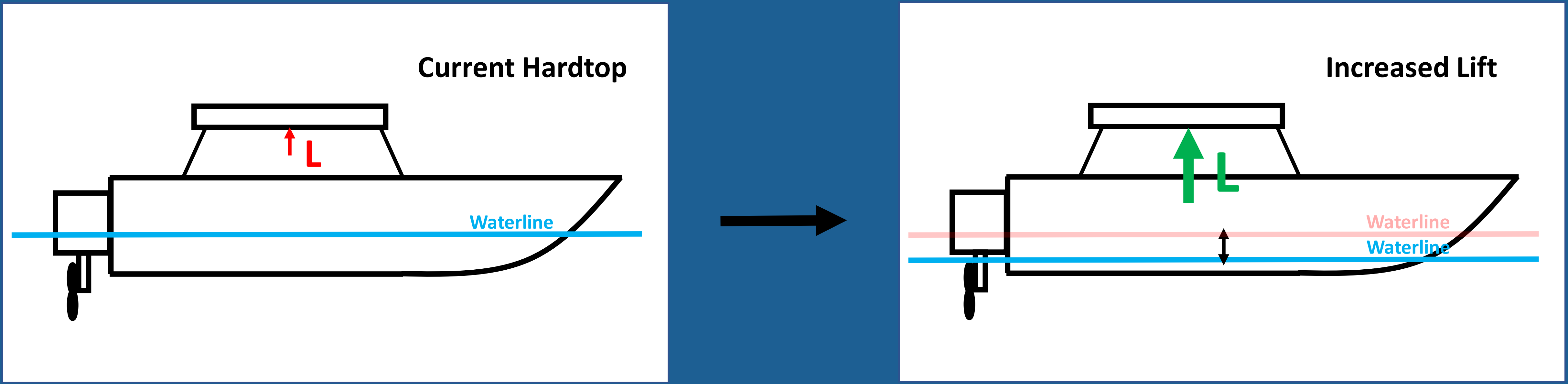
Increasing stability at higher speeds can help achieve this goal

John Karamitsanis

Key Goals

Improve boat on water performance

Increasing stability at higher speeds can help achieve this goal

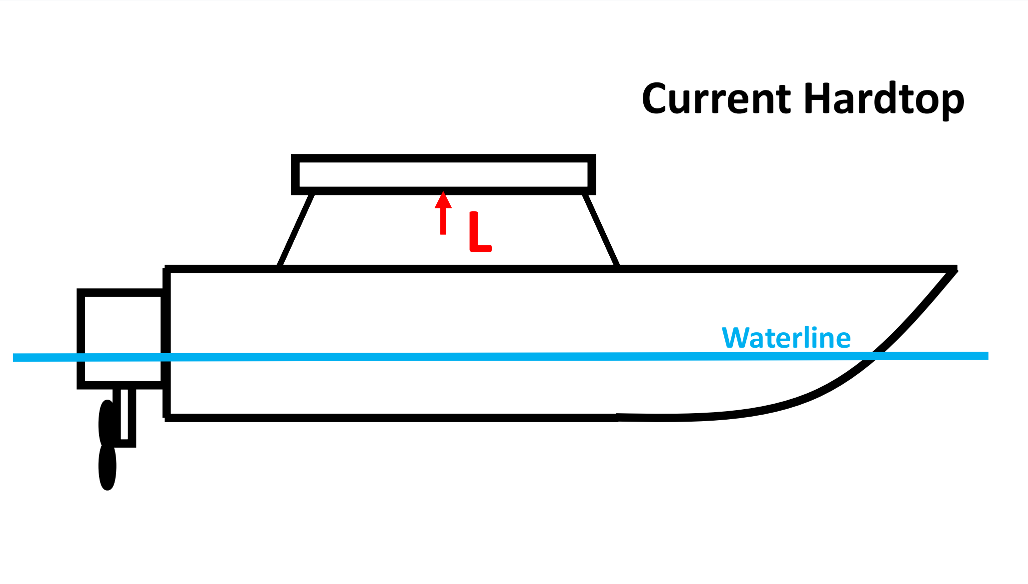


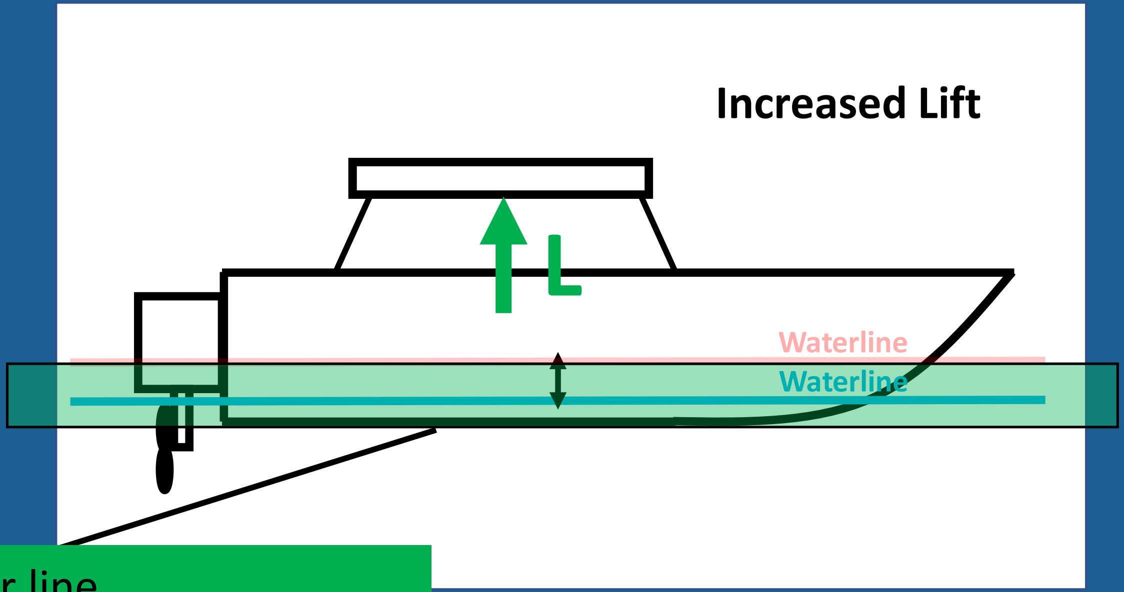
John Karamitsanis

Key Goals

Improve boat on water performance

Increasing stability at higher speeds can help achieve this goal





Lower water line
- Less friction/water resistance
- Air cushion provides stability

John Karamitsanis

Key Goals

Improve fuel efficiency

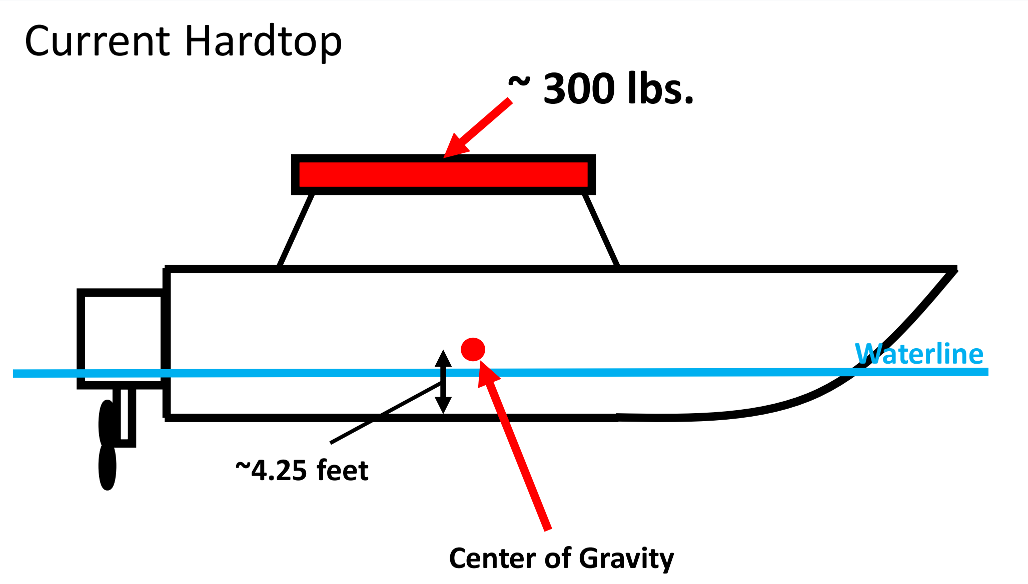
Reducing hardtop weight reduces thrust required to travel a certain speed

John Karamitsanis

Key Goals

Improve fuel efficiency

Reducing hardtop weight reduces thrust required to travel a certain speed

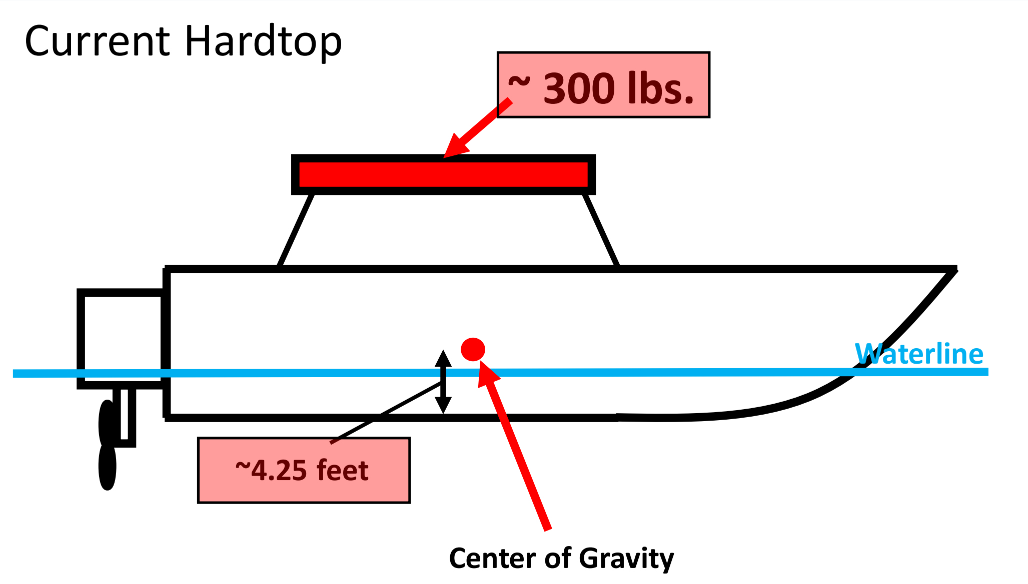


John Karamitsanis

Key Goals

Improve fuel efficiency

Reducing hardtop weight reduces thrust required to travel a certain speed

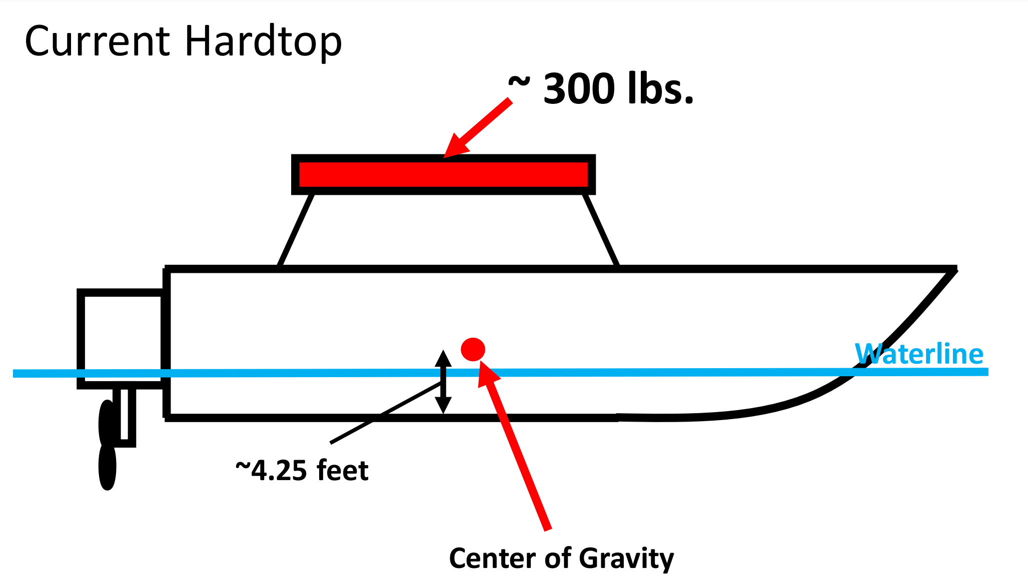


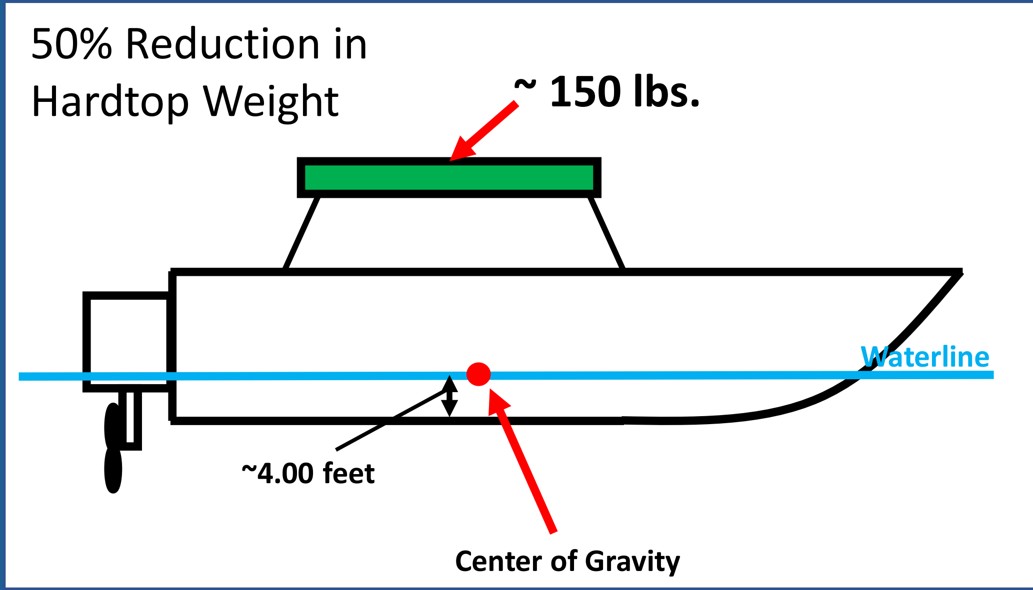
John Karamitsanis

Key Goals

Improve fuel efficiency

Reducing hardtop weight reduces thrust required to travel a certain speed



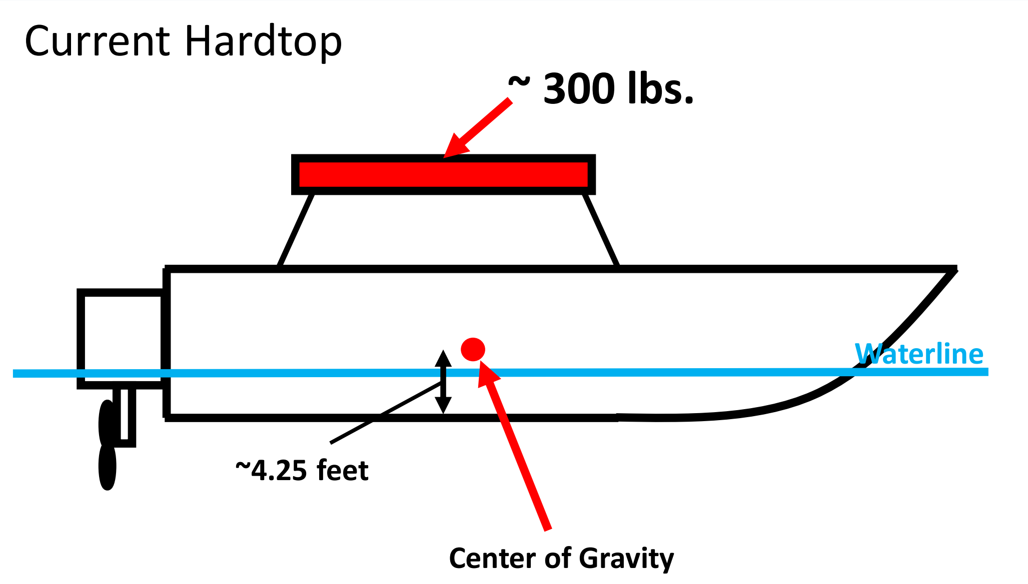


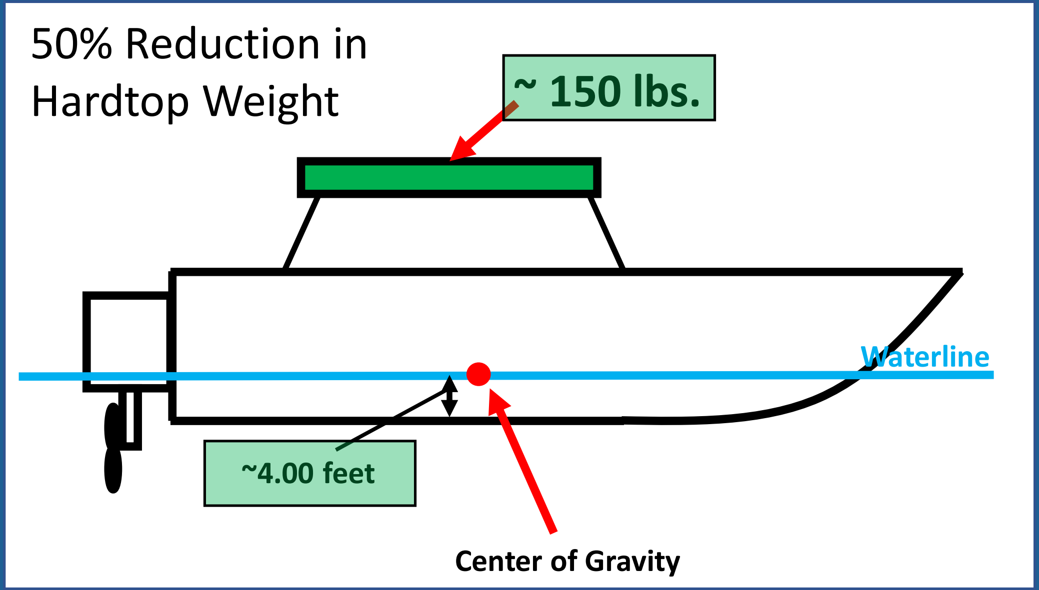
John Karamitsanis

Key Goals

Improve fuel efficiency

Reducing hardtop weight reduces thrust required to travel a certain speed

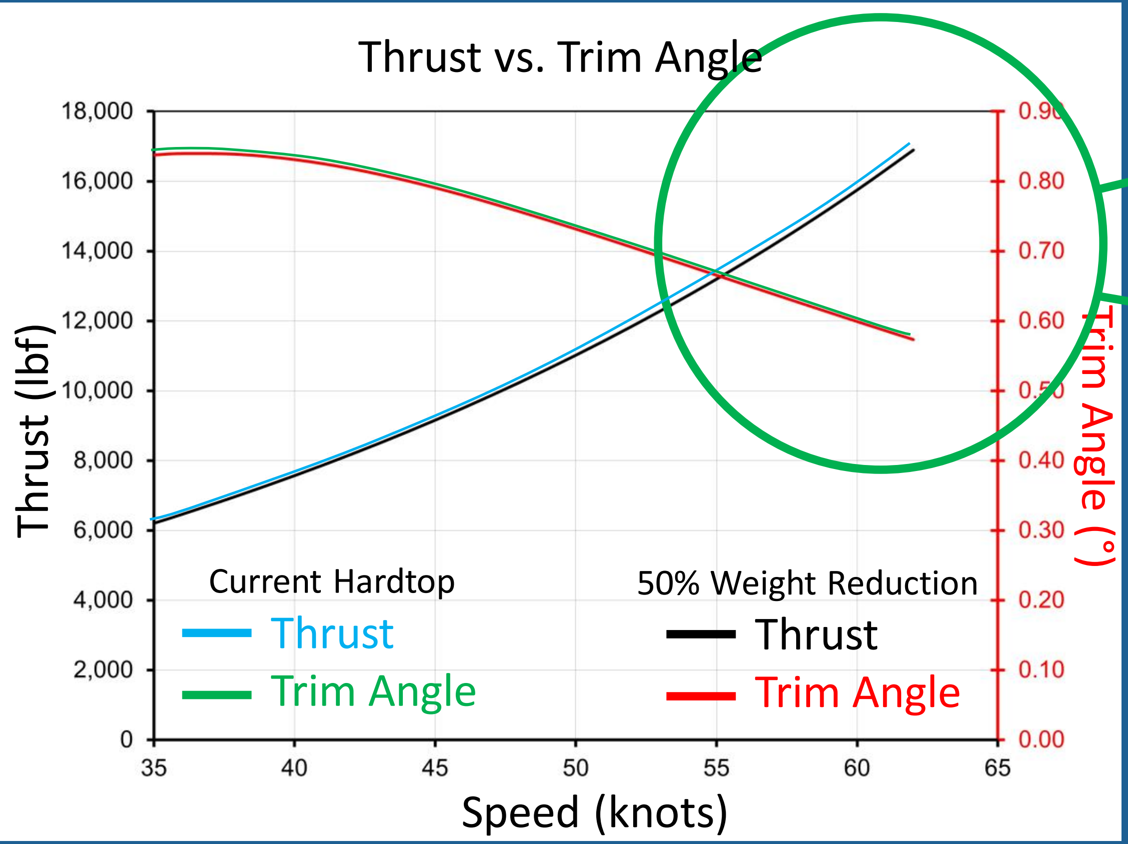


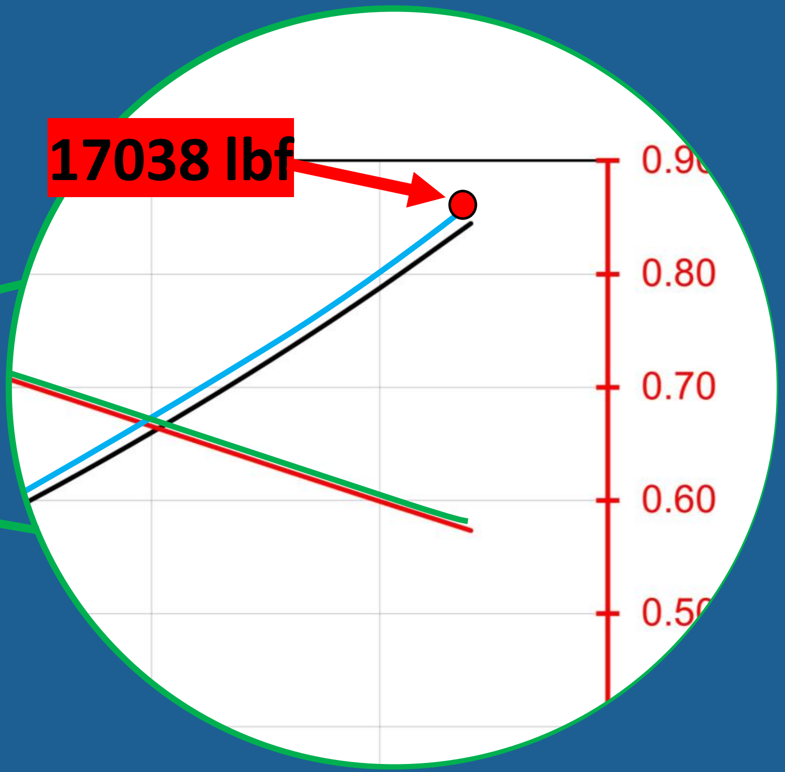


John Karamitsanis

Improve fuel efficiency

Key Goals

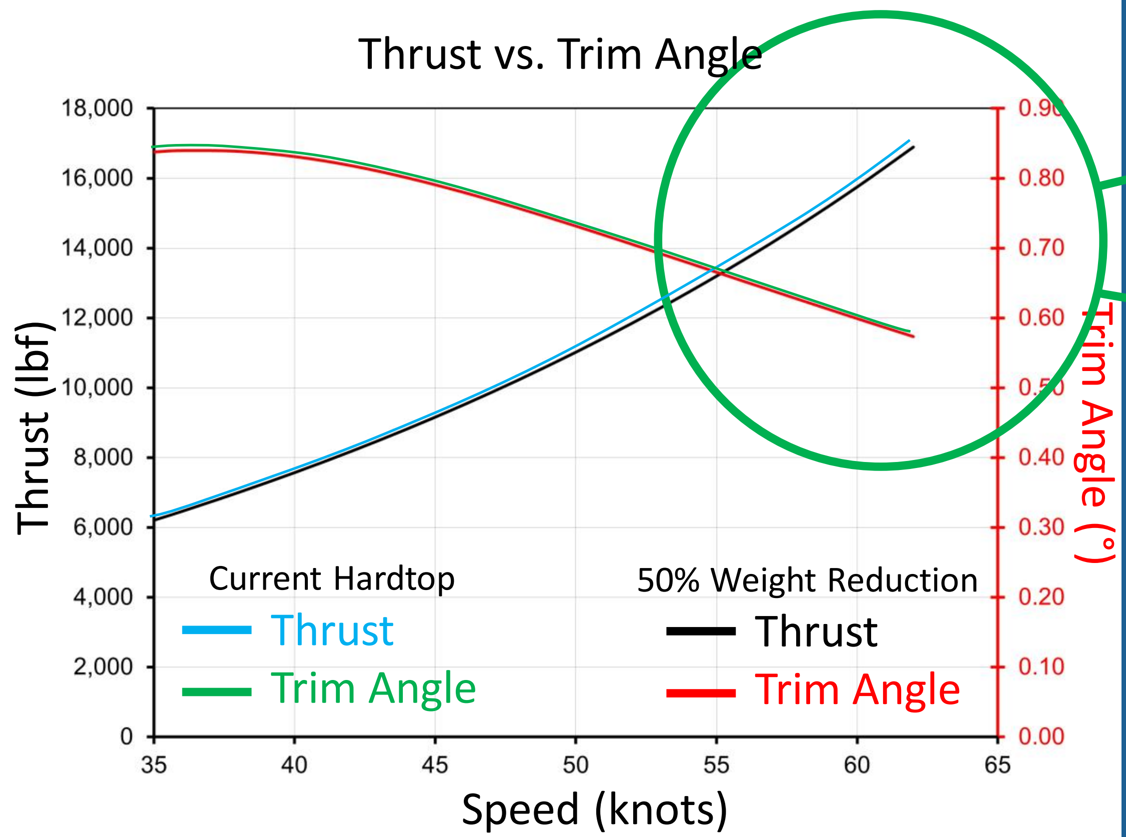


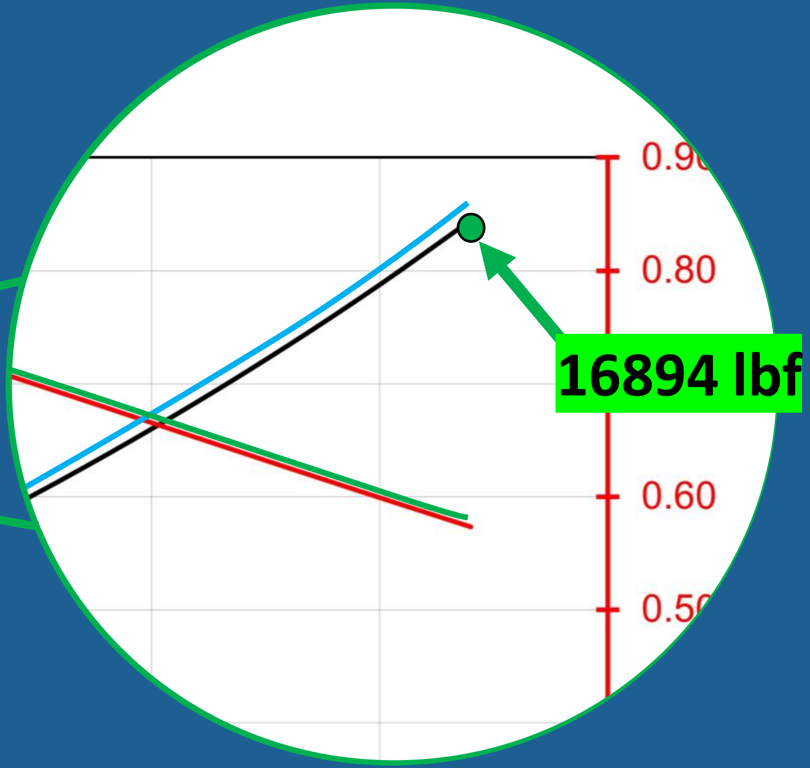


Thrust required is higher throughout powerband with current hardtop

John Karamitsanis

Improve fuel efficiency — Key Goals





Thrust required is lower throughout powerband with lighter hardtop i.e. Fuel is saved

John Karamitsanis

Key Goals

Keep the design manufacturable

Changes can be made to the current lamination schedule for lightweighting

Current Lamination Schedule

Gelcoat

1 oz CSM

1208

¾” core

1” core

1208

1 oz CSM

John Karamitsanis

Key Goals

Keep the design manufacturable

Changes can be made to the current lamination schedule for lightweighting

Current Lamination Schedule

Gelcoat
1 oz CSM
1208
¾” core
1” core
1208
1 oz CSM

John Karamitsanis

Key Goals

Keep the design manufacturable

Changes can be made to the current lamination schedule for lightweighting

Current Lamination Schedule

Gelcoat

1 oz CSM

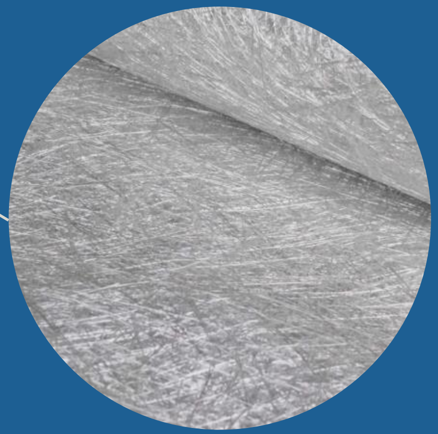
1208

¾” core

1” core

1208

1 oz CSM

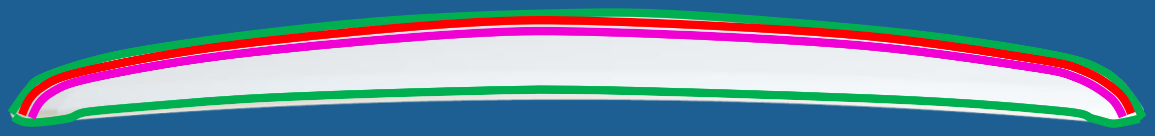


John Karamitsanis

Key Goals

Keep the design manufacturable

Changes can be made to the current lamination schedule for lightweighting



Current Lamination Schedule

Gelcoat

1 oz CSM

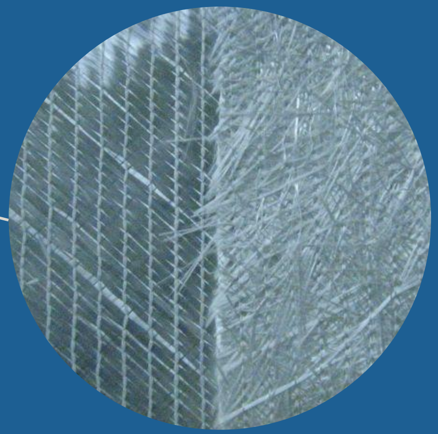
1208

¾” core

1” core

1208

1 oz CSM

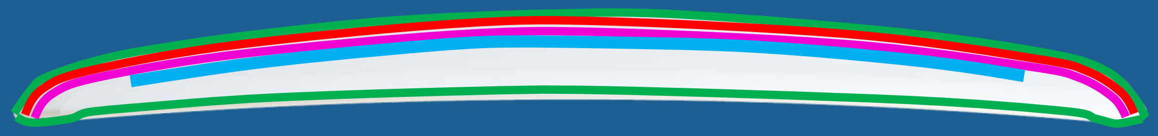


John Karamitsanis

Key Goals

Keep the design manufacturable

Changes can be made to the current lamination schedule for lightweighting



Current Lamination Schedule

Gelcoat

1 oz CSM

1208

¾" core

1" core

1208

1 oz CSM

John Karamitsanis

Key Goals

Keep the design manufacturable

Changes can be made to the current lamination schedule for lightweighting

Current Lamination Schedule

Gelcoat
1 oz CSM
1208
¾” core
1” core
1208
1 oz CSM

John Karamitsanis

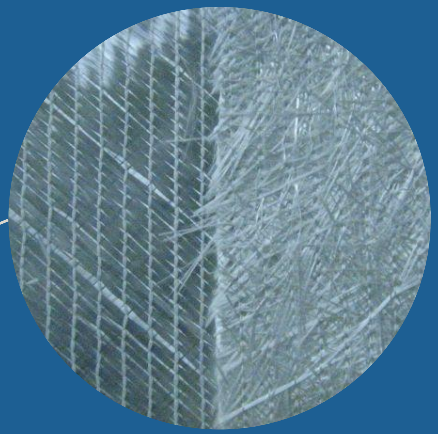
Key Goals

Keep the design manufacturable

Changes can be made to the current lamination schedule for lightweighting

Current Lamination Schedule

Gelcoat
1 oz CSM
1208
¾" core
1" core
1208
1 oz CSM



John Karamitsanis

Key Goals

Keep the design manufacturable

<u>Changes can be made to the current lamination schedule for lightweighting</u>

Current Lamination Schedule

Gelcoat

1 oz CSM

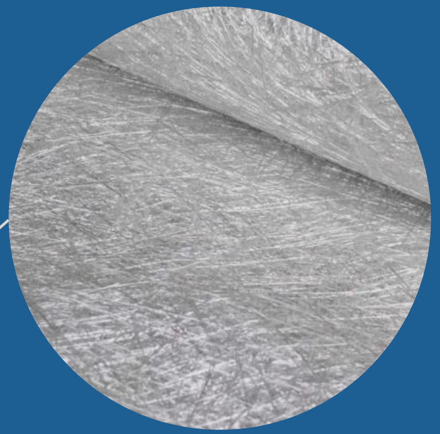
1208

¾” core

1” core

1208

1 oz CSM



John Karamitsanis

Key Goals

Keep the design manufacturable

Changes can be made to the current lamination schedule for lightweighting

Current Lamination Schedule

Gelcoat
1 oz CSM
1208
¾” core
1” core
1208
1 oz CSM

Need Less Dense Materials

John Karamitsanis

Aerodynamic Calculations

$$L = \frac{1}{2} C_L \rho V^2 A$$

$$D = \frac{1}{2} C_D \rho V^2 A$$

→

$$\frac{L}{D} \ Ratio$$

Cory Stanley

Aerodynamic Calculations

$$L = \frac{1}{2} C_L \rho V^2 A$$

Increase (C_L)

$$D = \frac{1}{2} C_D \rho V^2 A$$

→

Maximize (L)

$$\frac{L}{D} \ Ratio$$

Cory Stanley

Aerodynamic Calculations

$$L = \frac{1}{2} C_L \rho V^2 A$$

Increase

$$D = \frac{1}{2} C_D \rho V^2 A$$

Decrease

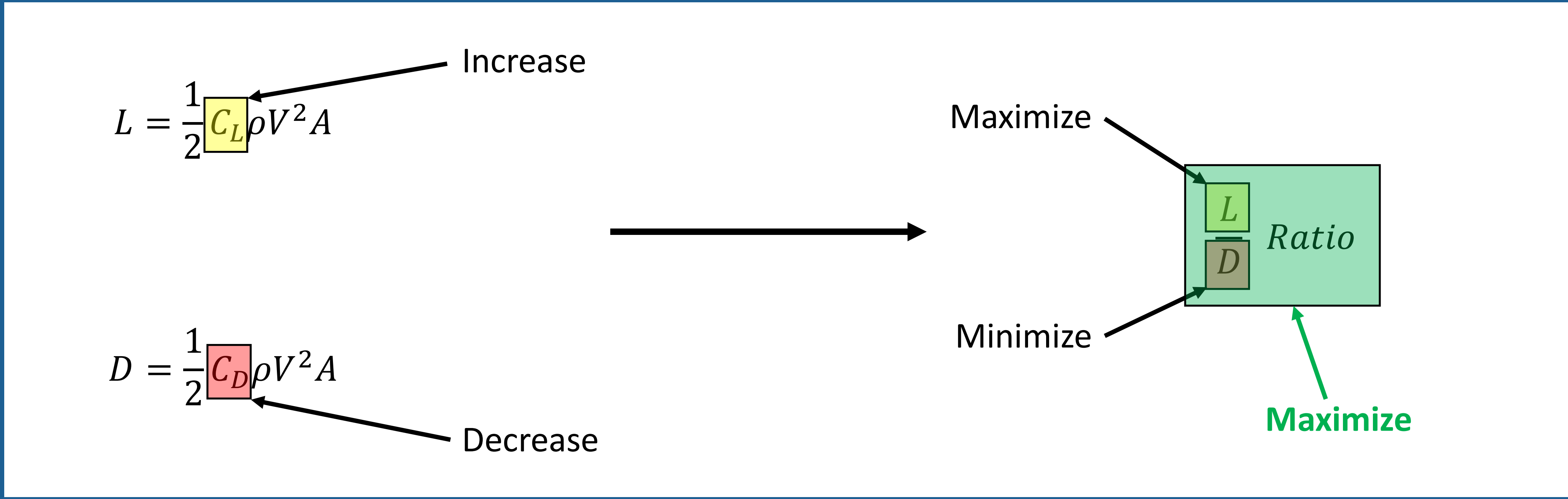
Maximize

$$\frac{L}{D} \; Ratio$$

Minimize

Cory Stanley

Aerodynamic Calculations

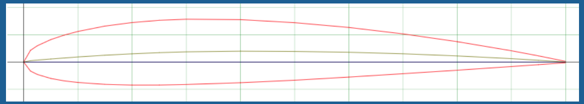


Cory Stanley

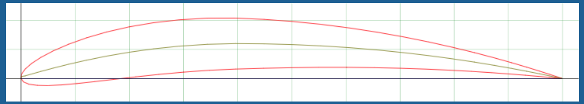
Aerodynamic Calculations

Tested Geometries:

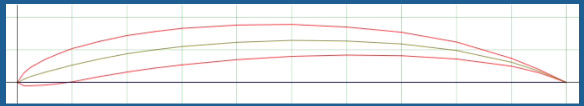
Flat Plate



NACA 2412

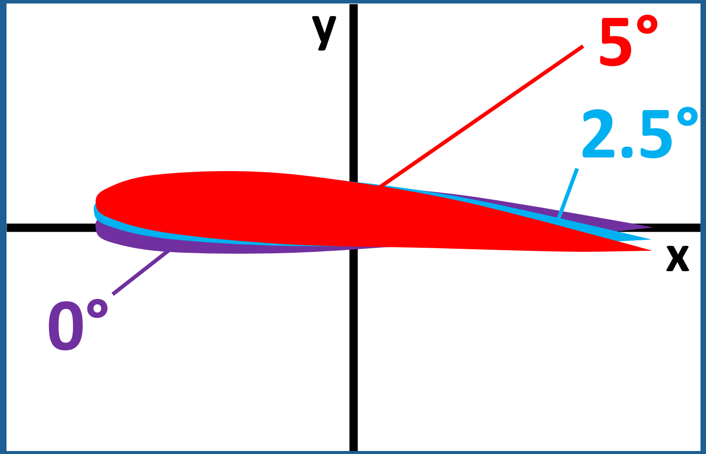


NACA 6409



EPPLER 58

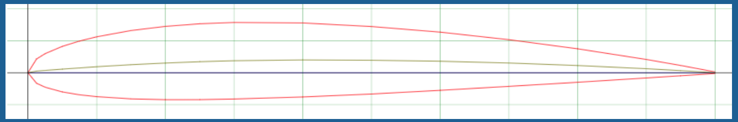
Tested Angle of Attacks (α):



Tested Velocities (m/s):

Cory Stanley

Aerodynamic Calculations



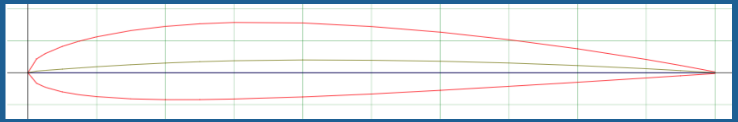
The NACA 2412, when compared to the current hardtop, provides:

A 16% increase in lift generation

An 84% decrease in drag

Cory Stanley

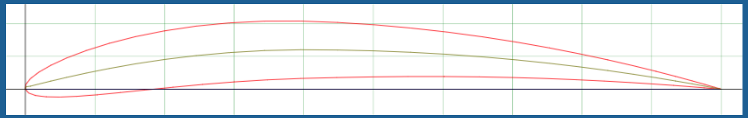
Aerodynamic Calculations



The NACA 2412, when compared to the current hardtop, provides:

A 16% increase in lift generation

An 84% decrease in drag



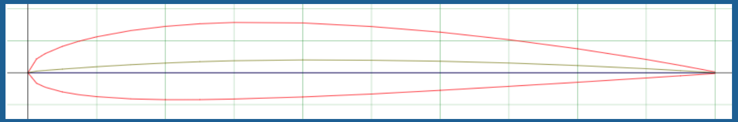
The NACA 6409, when compared to the current hardtop, provides:

A 70% increase in lift generation

An 84% decrease in drag

Cory Stanley

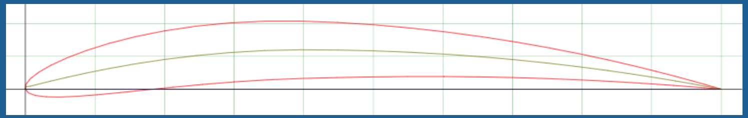
Aerodynamic Calculations



The NACA 2412, when compared to the current hardtop, provides:

A 16% increase in lift generation

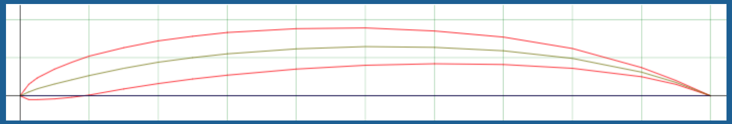
An 84% decrease in drag



The NACA 6409, when compared to the current hardtop, provides:

A 70% increase in lift generation

An 84% decrease in drag



The Eppler 58, when compared to the current hardtop, provides:

A 92% increase in lift generation

An 71% decrease in drag

Cory Stanley

Future Work

01/21/21

January
- Add complexity to current simple model

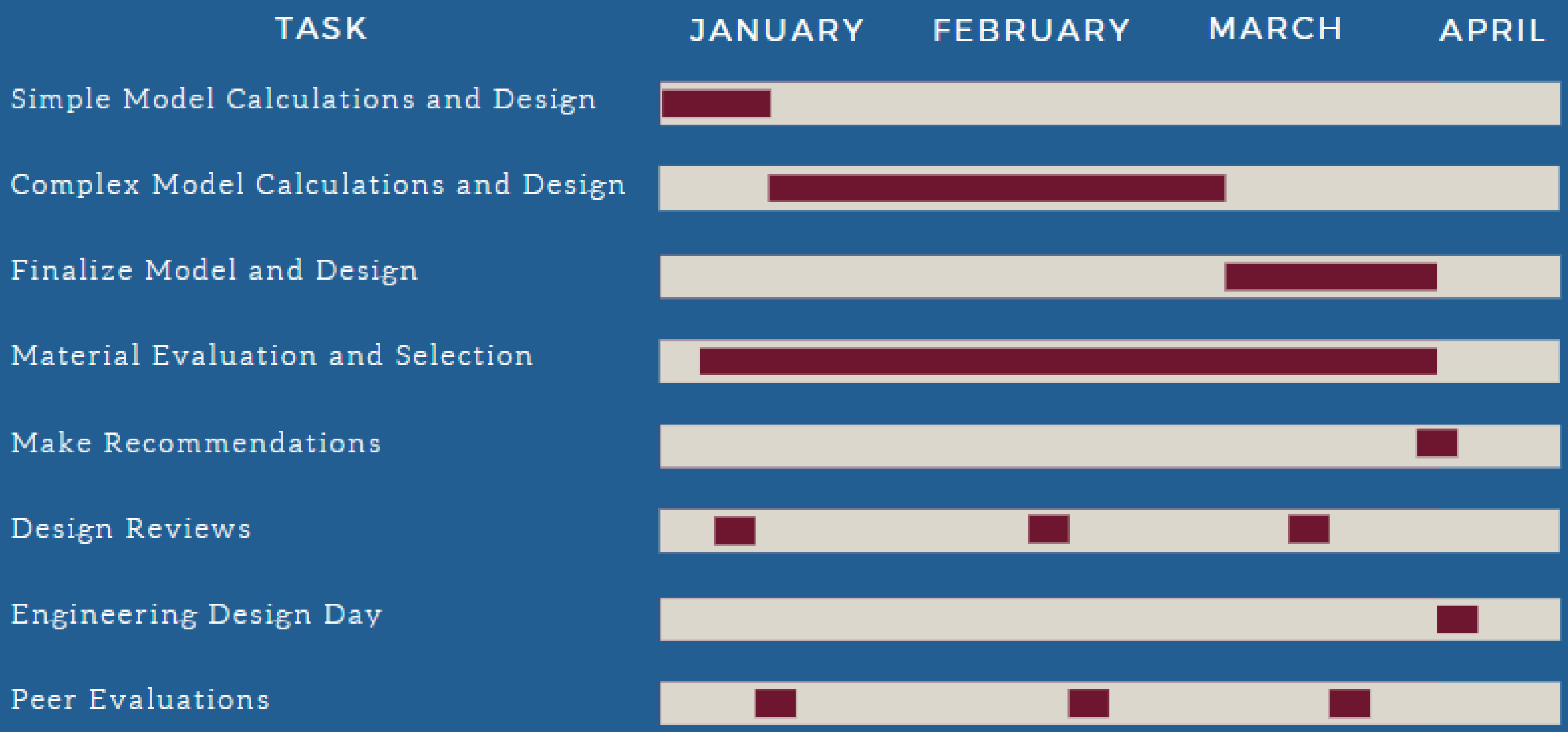
February
- Iterate and improve on complex hardtop model

March
- Validate final design

April
- Make recommendations

Cory Stanley

Future Work



Cory Stanley

FAMU-FSU College of Engineering

Department of Mechanical Engineering

Erika Craft,
Undergraduate Student,
Materials Track

P: 561-227-9849

E: epc16@my.fsu.edu

FAMU-FSU College of Engineering

Department of Mechanical Engineering

John Karamitsanis,
Undergraduate Student,
Thermal Fluids Track

P: 813-992-0152

E: jhk16c@my.fsu.edu

FAMU-FSU College of Engineering

Department of Mechanical Engineering

Cory Stanley,
Undergraduate Student,
Aeronautics Track

P: 850-566-4472

E: cps18u@my.fsu.edu

FAMU-FSU College of Engineering

Department of Mechanical Engineering

Juan Diego Tapia,
Undergraduate Student,
Materials Track

P: 850-273-3139

E: jdt16b@my.fsu.edu

References

409 Valor. (n.d.). Retrieved October 15, 2020, from https://www.intrepidpowerboats.com/boats/409-valor/

McConomy, S. (2020, October 6). Retrieved October 15, 2020, from https://famu-fsu-eng.instructure.com/courses/4476/discussion_topics/18526

Tweedie, Dingo (2021, January 15). Retrieved from Savitsky Power Prediction | Page 6 | Boat Design Net

Knit, 1208 Biax (fiberglassflorida.com)

Chopped Strand Mat (fibreglast.com)

Gelcoat Product – Grainger Industrial Supply (grainger.com)

Foam Core Board, Uline Board (uline.com)

Backup Slides

Aerodynamic Calculations

	A	B	C	D	E	F	G	H	I	J	K	L
1										cL	@ 0 deg	@ 5 deg
2	LIFT		Flat Plate	2412	NACA 6409	EPPLER 58				Flat Plate	0	0.7
3	0 deg	35	0	408 N	1135 N	1536 N				NACA 2412	0.2442	0.8089
4	0 deg	70	0	1632 N	4540 N	6146 N				NACA 6409	0.679	1.1928
5	5 deg	35	1170 N	1352 N	1994 N	2239 N				EPPLER 58	0.9192	1.3395
6	5 deg	70	4680 N	5409 N	7975 N	8956 N						
7												
8	DRAG		Flat Plate	2412	NACA 6409	EPPLER 58						
9	0 deg	35	0	9.5 N	12 N	10 N						
10	0 deg	70	0	38 N	47 N	40 N		A = 11.148 m^2		cD	@ 0 deg	@ 5 deg
11	5 deg	35	84 N	13 N	13 N	24 N		V = 15.6464 m/s		Flat Plate	~0	0.05
12	5 deg	70	334 N	54 N	54 N	96 N		V = 31.2928 m/s		NACA 2412	0.00568	0.00804
13								rho = 1.225 kg/m^3		NACA 6409	0.007	0.0079
14	We are using L = (1/2)*(cL)*rho * V * V * A							rho is STP		EPPLER 58	0.0059	0.01428
15	We are using D = (1/2)*(cD)*rho * V * V * A											

Thrust Calculations – 4 ft CoG

INPUT								This spreadsheet was written by Dingo Tweedie, October 2004.
								Dit rekenblad werd deur Dingo Tweedie, oktober 2004, geschreven.
Hull	Length of Waterline	L_{WL}	40.00	feet	=	12.192	metres	*Versie 1.2.1*
	Beam	B	11.08	feet	=	3.378	metres	
	VCG	VCG	4.00	feet	=	1.219	metres	
	Displacement	Δ	20,000	lbf	=	9,072	kg	
	Deadrise @ Transom	β_T	10.00	°				
	Deadrise @ Amidships	$\beta_{)0(}$	10.00	°				
	Distance to Amidships	$L_{)0(}$	20.000	feet	=	6.096	metres	
		θ	0.000	°				
	Angle of Thrust Line	ε	0.00	°				
		f	0.00	feet	=	0.000	metres	
	Minimum Speed	V_{min}	6.7	kn	=	11.3	feet/s	This is the minimum speed valid for this analysis
	Maximum Speed	V_{max}	145.4	kn	=	245.5	feet/s	This is the maximum speed valid for this analysis
S/Str.	Length Overall	LOA	40.00	feet	=	12.192	metres	
	Maximum Beam	B_{max}	11.08	feet	=	3.378	metres	
	Moulded Depth of Hull	Z	11.67	feet	=	3.556	metres	
	Height of House	H_{SS}	0.00	feet	=	0.000	metres	
	Breadth of House	B_{SS}	0.00	feet	=	0.000	metres	
	Frontal Area of House	A_{SS}	0.00	$feet^2$	=	0.000	m^2	
Number	Number of Propellers	N	3					
Trim Tab	Chord	c_F	1	feet	=	0.305	metres	
	Span Ratio	σ	0.333	(<= 1)				
	Deflection Angle	δ	2	°				
Rudder	Chord	c_{rudder}	0.00	feet	=	0.000	metres	
	Thickness	t	0.00	feet	=	0.000	metres	
	Area	A_{rudder}	0.00	$feet^2$	=	0.000	m^2	
	Centrepoint	x_c	0.00	feet from transom	=	0.000	metres	(+ve fwd)
		y_c	0.00	feet from baseline	=	0.000	metres	(+ve up)
Shaft	Diameter of Shaft	Φ_{shaft}	0.00	feet	=	0.000	metres	
	Length of Shaft & Hub	*l*	0.00	feet	=	0.000	metres	
	Centrepoint	x_c	0.00	feet from transom	=	0.000	metres	(+ve fwd)
		y_c	0.00	feet from baseline	=	0.000	metres	(+ve up)

Strut	Chord	c_{strut}	0.00	feet	=	0.000	metres	
	Thickness	t	0.00	feet	=	0.000	metres	
	Area	A_{strut}	0.00	$feet^2$	=	0.000	m^2	****
	Centrepoint	x_c	0.00	feet from transom	=	0.000	metres	(+ve fwd)
		y_c	0.00	feet from baseline	=	0.000	metres	(+ve up)

OUTPUT

Go

V	LCG		τ	D		T		$P_{effective}$		h		τ_{cr}		Comments	λ
[kn]	[ft]	[metres]	[°]	[lbf]	[kN]	[lbf]	[kN]	[ehp]	[ekW]	[ft]	[metres]	Lew.[°]	Angeli [°]		
35	29	8.839	0.84	6,201	27.6	6,202	27.6	666	497	1.19	0.363	3.23	2.12	Note: not planing	5.6630
36	29	8.839	0.84	6,459	28.7	6,459	28.7	714	533	1.19	0.363	3.08	2.04	Note: not planing	5.5945
38	29	8.839	0.84	6,996	31.1	6,997	31.1	816	609	1.16	0.354	2.83	1.90	Note: not planing	5.4736
40	29	8.839	0.83	7,566	33.7	7,567	33.7	929	693	1.14	0.347	2.60	1.77	Note: not planing	5.3743
42	29	8.839	0.82	8,172	36.4	8,173	36.4	1,053	786	1.12	0.341	2.41	1.66	Note: not planing	5.2951
44	29	8.839	0.80	8,818	39.2	8,818	39.2	1,191	889	1.09	0.332	2.24	1.56	Note: not planing	5.2351
46	29	8.839	0.78	9,505	42.3	9,506	42.3	1,342	1,001	1.06	0.323	2.09	1.47	Note: not planing	5.1925
48	29	8.839	0.76	10,237	45.6	10,238	45.6	1,508	1,125	1.03	0.314	1.95	1.39	Note: not planing	5.1658
50	29	8.839	0.73	11,017	49.0	11,017	49.0	1,691	1,262	1.01	0.308	1.83	1.32	Note: not planing	5.1537
52	29	8.839	0.71	11,847	52.7	11,848	52.7	1,891	1,411	0.98	0.299	1.72	1.25	Note: not planing	5.1552
54	29	8.839	0.68	12,732	56.7	12,733	56.7	2,110	1,575	0.96	0.293	1.62	1.19	Note: not planing	5.1689
56	29	8.839	0.65	13,675	60.9	13,676	60.9	2,350	1,754	0.93	0.283	1.53	1.14	Note: not planing	5.1946
58	29	8.839	0.63	14,679	65.3	14,680	65.3	2,613	1,950	0.91	0.277	1.45	1.09	Note: not planing	5.2312
60	29	8.839	0.60	15,750	70.1	15,750	70.1	2,900	2,164	0.89	0.271	1.38	1.04	Note: not planing	5.2792
62	29	8.839	0.57	16,894	75.2	16,895	75.2	3,215	2,399	0.87	0.265	1.31	1.00	Note: not planing	5.3390

Thrust Calculations – 4.25 ft CoG

INPUT

This spreadsheet was written by Dingo Tweedie, October 2004.
Dit rekenblad werd deur Dingo Tweedie, oktober 2004, geschreven.
Versie 1.2.1

Hull	Length of Waterline	L_{WL}	40.00	feet	=	12.192	metres	
	Beam	B	11.08	feet	=	3.378	metres	
	VCG	VCG	4.25	feet	=	1.295	metres	
	Displacement	Δ	20,000	lbf	=	9,072	kg	
	Deadrise @ Transom	β_T	10.00	°				
	Deadrise @ Amidships	β)0(	10.00	°				
	Distance to Amidships	L)0(	20.000	feet	=	6.096	metres	
		θ	0.000	°				
	Angle of Thrust Line	ε	0.00	°				
		f	0.00	feet	=	0.000	metres	
	Minimum Speed	V_{min}	6.7	kn	=	11.3	feet/s	This is the minimum speed valid for this analysis
	Maximum Speed	V_{max}	145.4	kn	=	245.5	feet/s	This is the maximum speed valid for this analysis
S/Str.	Length Overall	LOA	40.00	feet	=	12.192	metres	
	Maximum Beam	B_{max}	11.08	feet	=	3.378	metres	
	Moulded Depth of Hull	Z	11.67	feet	=	3.556	metres	
	Height of House	H_{SS}	0.00	feet	=	0.000	metres	
	Breadth of House	B_{SS}	0.00	feet	=	0.000	metres	
	Frontal Area of House	A_{SS}	0.00	$feet^2$	=	0.000	m^2	
Number	Number of Propellers	N	3					
Trim Tab	Chord	c_F	1	feet	=	0.305	metres	
	Span Ratio	σ	0.333	(<= 1)				
	Deflection Angle	δ	2	°				
Rudder	Chord	c_{rudder}	0.00	feet	=	0.000	metres	
	Thickness	t	0.00	feet	=	0.000	metres	
	Area	A_{rudder}	0.00	$feet^2$	=	0.000	m^2	
	Centrepoint	x_c	0.00	feet from transom	=	0.000	metres	(+ve fwd)
		y_c	0.00	feet from baseline	=	0.000	metres	(+ve up)
Shaft	Diameter of Shaft	Φ_{shaft}	0.00	feet	=	0.000	metres	
	Length of Shaft & Hub	l	0.00	feet	=	0.000	metres	
	Centrepoint	x_c	0.00	feet from transom	=	0.000	metres	(+ve fwd)
		y_c	0.00	feet from baseline	=	0.000	metres	(+ve up)

Strut	Chord	c_{strut}	0.00	feet	=	0.000	metres	
	Thickness	t	0.00	feet	=	0.000	metres	
	Area	A_{strut}	0.00	$feet^2$	=	0.000	m^2	****
	Centrepoint	x_c	0.00	feet from transom	=	0.000	metres	(+ve fwd)
		y_c	0.00	feet from baseline	=	0.000	metres	(+ve up)

OUTPUT

Go

V	LCG		τ	D		T		$P_{effective}$		h		τ_{cr}		Comments	λ
[kn]	[ft]	[metres]	[°]	[lbf]	[kN]	[lbf]	[kN]	[ehp]	[ekW]	[ft]	[metres]	Lew.[°]	Angeli [°]		
35	29	8.839	0.83	6,221	27.7	6,221	27.7	668	499	1.19	0.363	3.23	2.12	Note: not planing	5.6885
36	29	8.839	0.83	6,480	28.8	6,480	28.8	716	534	1.18	0.360	3.08	2.04	Note: not planing	5.6207
38	29	8.839	0.83	7,021	31.2	7,022	31.2	819	611	1.16	0.354	2.83	1.90	Note: not planing	5.5018
40	29	8.839	0.82	7,596	33.8	7,597	33.8	932	696	1.14	0.347	2.60	1.77	Note: not planing	5.4039
42	29	8.839	0.81	8,207	36.5	8,208	36.5	1,058	789	1.11	0.338	2.41	1.66	Note: not planing	5.3265
44	29	8.839	0.79	8,858	39.4	8,859	39.4	1,196	893	1.09	0.332	2.24	1.56	Note: not planing	5.2683
46	29	8.839	0.77	9,552	42.5	9,553	42.5	1,348	1,006	1.06	0.323	2.09	1.47	Note: not planing	5.2276
48	29	8.839	0.75	10,291	45.8	10,292	45.8	1,516	1,131	1.03	0.314	1.95	1.39	Note: not planing	5.2031
50	29	8.839	0.73	11,079	49.3	11,080	49.3	1,700	1,269	1.01	0.308	1.83	1.32	Note: not planing	5.1933
52	29	8.839	0.70	11,919	53.0	11,920	53.0	1,902	1,420	0.98	0.299	1.72	1.25	Note: not planing	5.1969
54	29	8.839	0.67	12,815	57.0	12,816	57.0	2,124	1,585	0.96	0.293	1.62	1.19	Note: not planing	5.2135
56	29	8.839	0.65	13,769	61.3	13,769	61.3	2,366	1,766	0.93	0.283	1.53	1.14	Note: not planing	5.2417
58	29	8.839	0.62	14,788	65.8	14,789	65.8	2,632	1,964	0.91	0.277	1.45	1.09	Note: not planing	5.2826
60	29	8.839	0.59	15,875	70.6	15,876	70.6	2,923	2,182	0.89	0.271	1.38	1.04	Note: not planing	5.3343
62	29	8.839	0.57	17,038	75.8	17,038	75.8	3,242	2,419	0.87	0.265	1.31	1.00	Note: not planing	5.3983