MEMORANDUM

To: WPI Material Selection Project Teams in ES 2001
From: New England Yacht Club
Date: March 15, 2017
RE: **Choice of material for lightweight rod rigging**

The New England Yacht Club is replacing the standing rigging on one of its racing yachts. We want to take the opportunity to improve the boat's performance through material selection.

As background, *standing rigging* refers to wire or rods which are in fixed position supporting the mast. (In contrast, running rigging moves while under sail.) The arrow in the photo below shows the "forestay" which is one component of standing rigging. Wire is used in recreational sailboats and some low-end racers, but rod is used in higher performance applications—hence the term *rod rigging.* Because of its higher stiffness, rod transfers more power from sails to the boat instead of being lost in deforming the rig. Currently our standing rigging is stainless steel wire. We want to change to rod for better performance.

Photo by Stephane FRANCOIS. Creative Commons 1.0 Generic license.

We have requirements for strength and stiffness of the rigging. We estimate that the rods will experience a uniaxial tensile load of 2000 lb, which includes a safety factor. The material should not experience permanent deformation under that load. We also want to ensure that, under that same load, the rod does not stretch elastically more than 1 inch over its length of 50 ft. The diameter of the rod is not constrained—it can be adjusted to whatever is necessary to meet the strength and stiffness requirements.

Our primary objective for the new rod rigging, aside from meeting those minimum requirements for strength and stiffness, is to *minimize weight*. In the racing community there is increasing belief that "weight reduction aloft" improves performance.

We are contacting you because one of our members heard that WPI students have access to a reliable database of material properties and attributes. We would be grateful if you could provide your recommendation for the rod rigging material in the form of a 2-minute video pitch.

Advice on use of CES EduPack

- Decide as a team whether to use the minimum, average, or maximum values of properties. There is no "right answer"; just be able to explain and justify your decision.
- There is no requirement for use of a specific database(s). Think from the perspective of your customer while also putting reasonable bounds on the project.
- You should consider other properties and attributes aside from those directly mentioned by the customer. Use the scientific notes in CES EduPack to learn about the meanings of properties we have not discussed in class.

Project Timeline

Date	What's Due	What We'll Do in Class
Wed Mar 22	Individual analysis of one material. Submit on Canvas AND bring to class on paper	Peer check of individual analysis Introduction to performance indices
Thu Mar 23	Individual analysis of one material (final). Submit on Canvas	Introduction to value propositions using the NABC model and to De Bono's Six Thinking Hats
Sat Apr 1	2-minute video pitch (value proposition). Upload to Ensemble and embed link in Piazza post	
Apr 2 - 4	View assigned videos on Piazza, provide feedback using Six Thinking Hats, vote for best.	
Wed Apr 5		Video showcase, debrief

Rubric for Project Evaluation

Each person's work on this project will be graded out of 45 points using the following rubric. Note that there are both individual and team deliverables.

CRITERION	POINTS		
1A. Evaluation process for strength and stiffness constraints (INDIV) Initial submission on Mar 22 for peer check	**10**	**5**	**0**
The appropriate material properties, analysis, and critical thinking are utilized such that both strength and stiffness specifications are considered and met.	Complete	Submitted but incomplete	Did not submit
1B. Evaluation process for strength and stiffness constraints (INDIV) Final submission on Mar 23	**10**	**7**	**5**
The appropriate material properties, analysis, and critical thinking are utilized such that both strength and stiffness specifications are considered and met.	Scientifically sound and accurate.	Process is sound but there are calculation errors.	Flaws in the evaluation process
2A. Communication Effectiveness of Value Proposition (TEAM)	**10-9**	**8-7**	**6-4**
Team delivers 2-minute pitch using hook-NABC-action model, with all team members participating	All elements of hook, NABC, action are included	One missing or very weak element	Multiple missing or weak elements
2B. Technical Quality of Value Proposition (TEAM)	**10-9**	**8-7**	**6-4**
Appropriate material properties or attributes are considered beyond customer requirements. Elements of pitch are put in quantitative terms where possible and appropriate.	Meets this criterion at a high level.	One or more key properties is not considered or well supported.	Recommended material is inappropriate.
3. Feedback on Other Teams' Videos (INDIV)	**5**	**3**	**0**
For EACH video in assigned cluster, at least two constructive comments are made using at least two different Thinking Hats (specify your hat).	Feedback is complete.	Feedback is incomplete.	No feedback is provided.

BONUS POINTS AND DEDUCTIONS

+2 points for best video pitch in each group (voted by peers)
+2 points for best video pitch in class (voted by instructors)

-1 point for each 10 seconds over time
-2 points for late submissions