



# ASCE Concrete Canoe Competition



1/c Brenden Kelley, 1/c Nate Crum, 1/c Cory Fagan, 1/c David Kent, 1/c Pat Page, 1/c Rebecca Redstone  
Advisors: Dr. Jackson & LCDR Maggi

## PROBLEM STATEMENT

Design and build a structurally sufficient and positively buoyant concrete canoe, in accordance with ASCE National Concrete Canoe Competition Rules and Regulations, to compete in the regional ASCE Concrete Canoe Competition.

## PROJECT OBJECTIVES

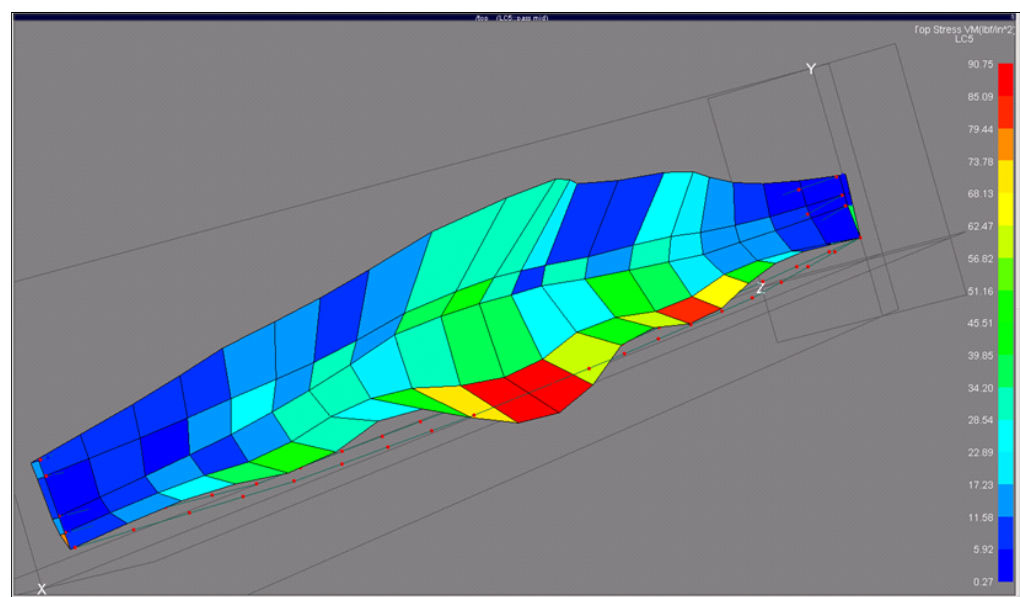
- 1) Design and build a structurally stable and positively buoyant concrete canoe according to ASCE competition rules and specifications.
- 2) Gain knowledge of concrete technology and practical experience utilizing its durability and versatility as a construction material in various applications.
- 3) Practice leadership and effective project management skills throughout the design and construction process.
- 4) Successfully compete at the regional ASCE Concrete Canoe competition.

## PROJECT TIMELINE

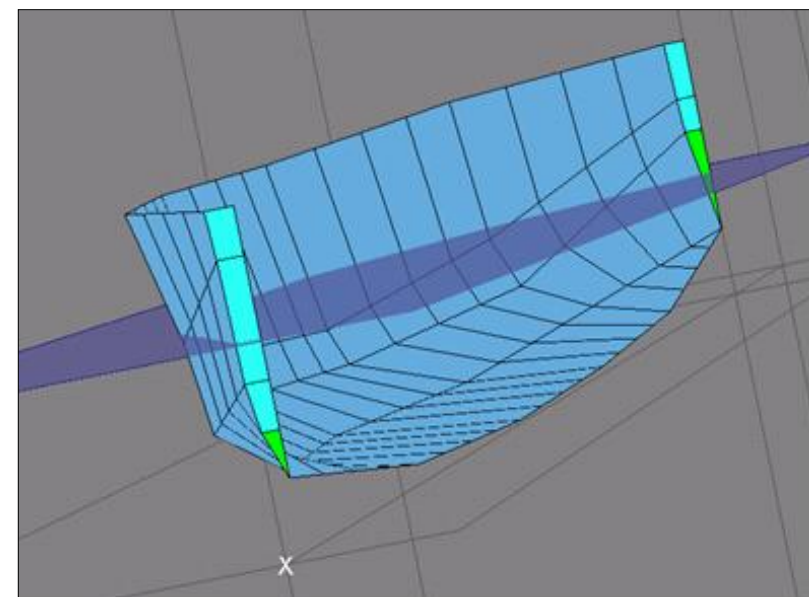
- December 8<sup>th</sup>: Complete individual research assignments regarding various components of canoe design
- January 6<sup>th</sup>: Commence ordering materials
- February 15<sup>th</sup>-25<sup>th</sup>: Concrete mixture testing
- February 23<sup>rd</sup>-26<sup>th</sup>: Form construction
- February 27<sup>th</sup>: Pour day for JACKSON MAGGIC
- March 14<sup>th</sup>: Final Design Report completed and submitted
- March 15<sup>th</sup>-March 29<sup>th</sup>: Sanding of the JACKSON MAGGIC
- April 4<sup>th</sup>-April 13<sup>th</sup>: Staining and sealing of the JACKSON MAGGIC
- April 15<sup>th</sup>: ASCE Regional Competition Day #1: Visual Display and Oral Presentation
- April 16<sup>th</sup>: ASCE Regional Competition Day #2: Swamp Test and Canoe Races
- April 28<sup>th</sup>: Present design and competition results at USCGA Senior Research Symposium

## STRUCTURAL ANALYSIS

•Finite Element Analysis conducted utilizing Maestro 3D, with the assistance of CAPT (Ret.) Simpson, P.E



Stress distribution for 4 person load case: max of 90 psi (T) near center



Wetted canoe for 4 person load case: 7 in freeboard

## CONCRETE MIX DESIGN

### CONCRETE MIX GOALS/OBJECTIVES:

1. Wet plastic unit weight: 55-70 lb/ft<sup>3</sup>
2. ≤50 % cementitious materials from Portland cement
3. ≥50 % aggregates from sustainable materials; 2+ sustainable aggregates

### Specifications Summary

Length	20 feet
Maximum Width	31.25 in
Maximum Depth	16.25 in
Hull thickness	¾ in
Measured Density	60.7 lb/ft <sup>3</sup>
Canoe Weight	165 lbs
28-day Compressive Strength	1690 psi
Primary Reinforcement	Carbon Fiber Grid
Secondary Reinforcement	Nycon PVA Fibers

### DESIGN/TESTING PROCESS:

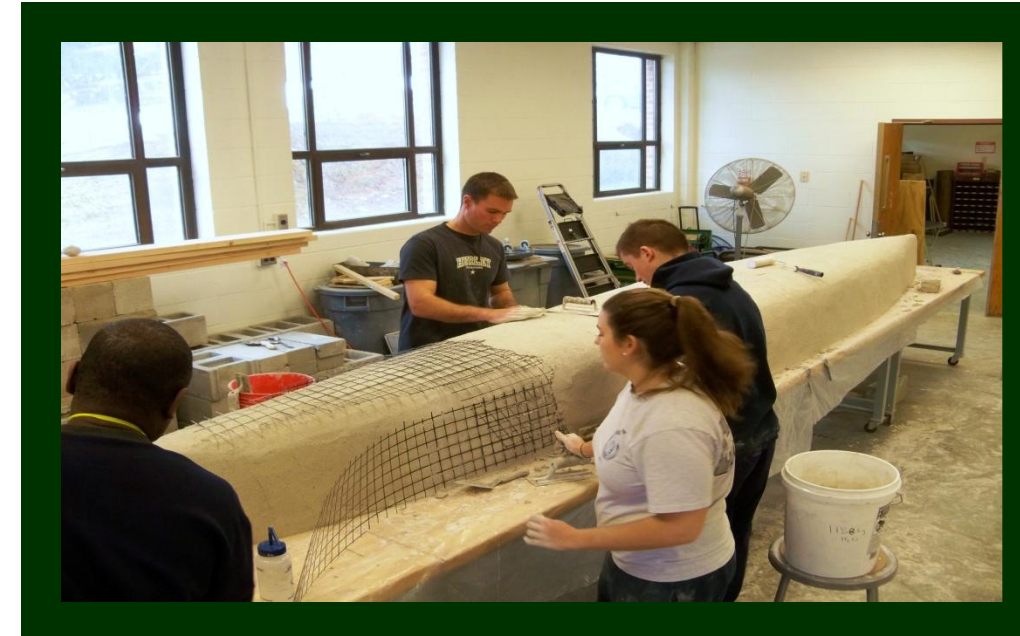
- Based on ACI absolute volume method
- Iterations completed using Excel spreadsheet
- 14 total trial mixes

### Final Mix Design Proportions

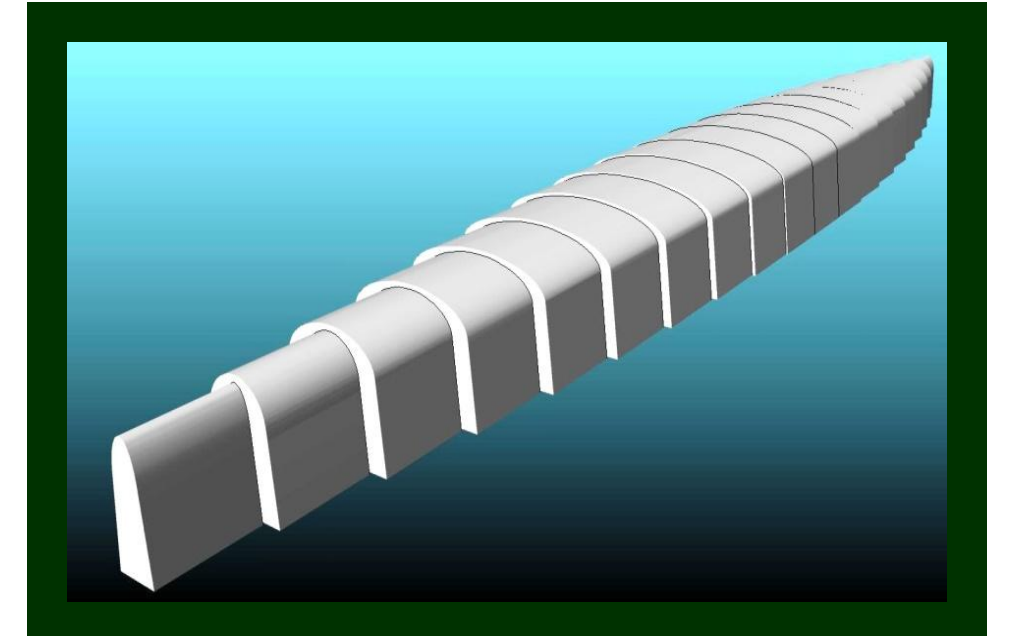
w/cm ratio	0.40
Weight of water	300 lb/yd <sup>3</sup>
Cementitious materials:	800 lb/yd <sup>3</sup>
White Portland Cement	400 lb/yd <sup>3</sup>
Blast Furnace Slag	400 lb/yd <sup>3</sup>
6mm PVA Fibers	0.5 % by volume
8mm PVA Fibers	0.5% by volume
Total Aggregates:	520 lb/yd <sup>3</sup>
Poraver 0.25-0.50 mm	130 lb/yd <sup>3</sup>
Poraver 0.5-1.0 mm	130 lb/yd <sup>3</sup>
Poraver 1-2 mm	130 lb/yd <sup>3</sup>
Extendspheres SG 900	130 lb/yd <sup>3</sup>
Fritz Pak <sup>Supercizer</sup>	14 oz/cwt
Fritz Pak Air Plus	1.25 oz/cwt
Theoretical Density	64.7 lb/ft <sup>3</sup>
Measured Density	60.7 lb/ft <sup>3</sup>

## CONSTRUCTION

- Model of form: 20 one foot sections modeled in Rhinoceros 3D
- Foam Mold: Fabricated using EPS foam by Foamlinx LLC
- Construction and preparation of mold: Mold sanded down to form smooth hull, sections epoxied together, and wrapped in saran wrap
- Pour day: Sunday 27FEB11, 6 hours with 8 workers
- Placement methodology: ¼ inch concrete + 1-2 layers reinforcement + ½ inch concrete



Placement of concrete on pour day



3D rendering of foam mold in Rhino

## FINISHING

- Belt sanding: #80 and #120
- Hand sanding: #320 and #600
- Stains: EcoProducts Soycrete Concrete Stain & Sherwin-Williams HBC Concrete Stain
- Sealant: A-Tech Concrete Sealer



Sanded and stained canoe, starboard beam aspect



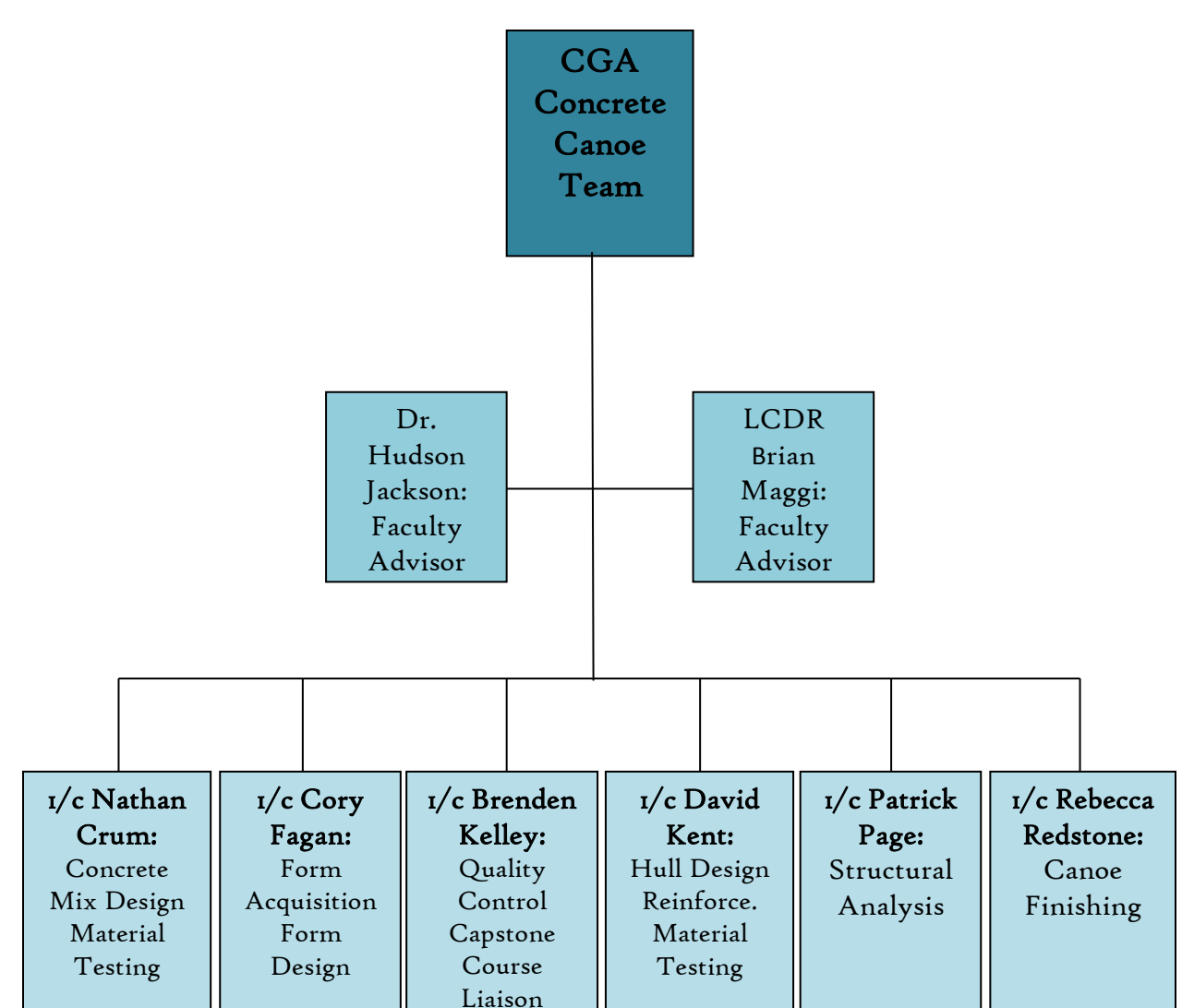
Sanded and stained canoe, starboard bow aspect

## PROJECT MANAGEMENT

- Role of lead engineer rotated on a weekly basis
- Allocated budget: \$5000
- Budget used: \$3009.02 (60.1%)

WORK HOURS DISTRIBUTION	
Design	87 hrs.
Material Testing	40 hrs.
Construction	108 hrs.
Report	75 hrs.
Finishing	150 hrs.
Competition	85 hrs.
Total	545 hrs.

Distribution of work hours



CGA CC Team Organizational Chart

## REGIONAL COMPETITION

- Oral Presentation: 3<sup>rd</sup>/15 teams
- Overall: 4<sup>th</sup>/15 teams
- Distinctions: Only 1<sup>st</sup> year team; ½ as large as next smallest team



The team celebrates a positively buoyant canoe



The team commemorates a successful day