# 2022

## "American Eagle" Technical Binder







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## **GAME ANALYSIS**



	Awarded for	MATCH Points		Ranking
Award		AUTO	TELEOP	Points
ΤΑΧΙ	each ROBOT whose BUMPERS have completely left the TARMAC from which it started at any point during AUTO	2		
CARGO	each ALLIANCE color CARGO scored in the LOWER HUB	2	1	
	each ALLIANCE color CARGO scored in the UPPER HUB	4	2	
	LOW RUNG		4	
HANGAR (per ROBOT)	MID RUNG		6	
	HIGH RUNG		10	
	TRAVERSAL RUNG		15	
CARGO BONUS	20 or more ALLIANCE colored CARGO scored in the HUB. If at least 5 ALLIANCE colored CARGO are scored in AUTO, called a QUINTET, this threshold drops to 18.			1
HANGAR BONUS	ALLIANCE is credited with at least 16 HANGAR points			1
Tie	completing a MATCH with the same number of MATCH points as your opponent			1
Win	completing a MATCH with more MATCH points than your opponent			2

#### **Rapid React**

Rapid React introduces a new game piece: a large tennis ball known as "Cargo." While initially seen as "just another ball game" this game piece is rather stiff and doesn't handle quite like the foam balls from recent games.

The limit of two Cargo is just complex enough to require planning for storage and indexing of two large game pieces.

Consistent Cargo scoring and a reliable climber will be the keys to our success this season.



After running through some scenarios to play simulated matches, we came to some conclusions:

- Cycling to the Low Goal will be the key to early events
- Scoring from against the Hub's fender is almost as good as having a protecting scoring zone
- Shape and orientation of Hub and Hanger structure will cause vision problems on the field. It will be imperative to keep track of loose Cargo.



The team discusses design on kickoff day

#### **Build and Game Strategy**

Our top priority is to rank as an alliance captain by winning matches and gaining extra Ranking Points. The two extra ranking points are available when:

- At least 15 endgame climb points
- At least 20 Power Cells are scored in the Hub

Therefore, we made two main design decisions:

- Must score Cargo consistently in both low and high goals
- Must climb to at least Mid level for Endgame

#### **Design Priority List**

#### 1. Drivetrain

- a. Fast and powerful
- b. Lightweight but strong
- c. Low center of gravity but adequate ground clearance for Hub cable protector

#### 2. Shooter

- a. Require consistently powered shot
- b. Ability to shoot from protected zones (prefer Trench)
- c. Easy feed from Hopper
- d. Possible turret?

#### 3. Cargo Intake

- a. "Touch-it, own-it" intake. Don't struggle to obtain Cargo.
- b. Over the bumper not through a frame gap
- c. If not using a turret, intake on opposite side from shooter direction

#### 4. Hopper

- a. Must hold two Cargo
- b. Ability to index Cargo

#### 5. Endgame Climb

- a. Mid climb bar is 60.25" from floor will require us to reach up no matter the robot height
- b. Robot max height limit 64"
- c. Low bar is 48" from floor we want to be able to drive under this

## DESIGN



#### Chassis

The drive chassis is constructed in the West-Coast style that we have used in previous seasons. West Coast Drive places the wheels on the outside of the frame. This familiar style provided a design advantage when coupled with wider  $2^{\prime\prime} \times 1.5^{\prime\prime}$  aluminum tubing for the drive rails so that chain and sprocket could be run inside the tubing from the driven axle to remaining front and rear axles. While utilizing the chain-in-tube design that we also used 2016-2020 serves to save space, construction must be precise since the chains are not easily maintained. 5" Colson wheels provide enough height to clear the Hub's cable protector.

Chassis Length: 28" Chassis Width: 24" Chassis Weight: 35 lbs



#### **Custom "Flipped" Gearboxes**

Inspired by a gearbox design from Team 2363 – Triple Helix, we designed and built completely custom flipped gearboxes. Building on a design we used and published in 2020, we also used this style of gearbox in 2018 with great success. Flipping the motors up and over the drive wheels saves crucial interior space.

Gearing: 1<sup>st</sup> Stage: 12:60 2<sup>nd</sup> Stage: 42:60

Overall: 7.1:1

Calculated Speed: 16.3 ft/s



#### **Hopper/Singulator**

The combined hopper and Cargo singulator creates a rather simple handoff between the intake and the shooter. Two arms with vertically mounted wheels help to center the Cargo and pull it into the shooter. Since the total Cargo limit is two, we only need to hold one Cargo inside the shooter and one Cargo in the singulator. Photo eye sensors are used to detect and position the Cargo appropriately and eliminate jamming. The hopper floor is secured with hook and loop for access to the pneumatic components stored underneath. After testing, stretch tubing was added across the top of the hopper to keep Cargo from popping up and out after passing through the intake.



#### **Cargo Shooter**

From lessons learned in 2020, we skipped prototyping of a "pitching machine" style shooter and dove right in on a hooded shooter. The choice was obvious due to the vertical orientation of the Hub goals.

We started moving towards a turreted shooter, something we've never done before, but we weren't fully comfortable implementing the design. We backed up and went with a stationary hooded shooter. After testing with multiple prototypes we found that an approximately 30 degree release angle worked best for our desired shooting positions.

The final Cargo shooter is powered by:

- 2 x NEO 1:1 belt driving a row of four 4"x1" AndyMark Stealth Wheels as the flywheel
- 1 x NEO 1:1 belt driving a row of four 4" x1" AndyMark Compliant Wheels as the index wheel

The single row of index wheels contact the Cargo from the time they enter the shooter from the singulator until the Cargo is picked up by the flywheel. This method saves a ton of complexity in the Cargo path.

The shooter structure is  $\lambda''$  polycarbonate cut by tabletop CNC router in our shop, supported horizontally by churro spacers.



Initial design included a turret





Wooden shooter prototype

Final shooter design



#### **Cargo Intake**

With the initial intake roller design and gearing Influenced heavily from our 2020 intake designs, we had time to design a four-bar linkage to save space. Custom 3D printed pulleys help to reduce the weight and cost of the intake.



Intake retracted



Intake fully extended

#### **Climb Arms**

The climb arm is based on a design we modified from the 2020 season. It utilizes three lengths of nested square aluminum tubing, centered with spacers. Constant force springs cause the arm to want to extend at all times. After cutting all the required parts for the telescoping arm back in 2020, for this season we opted to purchase an off-the-shelf hardware kit to save design and machining time. Less time in the shop due to COVID means every minute saved was important.

We hold the arm in place with NEO motors set to brake mode on MaxPlanetary gearboxes geared down to 60:1. On the end of the arm is a custom double hook cut from .25" polycarbonate and a 1" 3D printed spacer.



## **PROGRAMMING AND CONTROLS**

#### **Communications Schematic**



#### **Programming Highlights**

#### Automation:

Two infrared photoelectric switches control Cargo positioning inside the shooter and singulator. One is mounted on the side of the shooter and the other under the hopper. The combination of feedback from these two sensors determines when the intake, singulator, and index wheels start and stop running in order to reduce Cargo jams and ensure the Cargo don't feed into the shooter flywheel until it is up to speed.

#### Autonomous:

Four autonomous modes exist, with more planned.

- 1. Single Cargo Low Goal
- 2. Single Cargo High Goal
- 3. Double Cargo Low Goal
- 4. Double Cargo High Goal

### **BLACKWATER ROBOTICS**

#### **Accomplishments**

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2021	Aluminum Group – Game Design	Engineering Design Award
2020	FIRST Chesapeake Richmond VA Event	Event Finalist
2019	FIRST Chesapeake Hampton Roads Event	Event Winner
2019	FIRST Chesapeake Central VA Event	Judges' Award
2019	FIRST Chesapeake Central VA Event	Event Finalist
2018	FIRST Chesapeake Hampton Roads Event	Excellence in Engineering
2018	FIRST Chesapeake Central VA Event	Event Winner
2018	FIRST Chesapeake Central VA Event	Quality Award
2017	FIRST Chesapeake Hampton Roads Event	Event Winner
2017	FIRST Chesapeake Hampton Roads Event	Quality Award
2015	Chesapeake Regional	Event Finalist
2015	Virginia Regional	Event Winner
2014	Chesapeake Regional	Event Finalist
2014	Chesapeake Regional	Quality Award
2014	Virginia Regional	Event Winner
2013	Virginia Regional	Event Winner
2007	NASA/VCU Regional	Event Finalist
2006	NASA/VCU Regional	Event Winner
2005	NASA/VCU Regional	Rookie All-Star
2005	NASA/VCU Regional	Highest Rookie Seed

#### **Blackwater Tugboat History**

By Clyde Parker

On Nov. 1, 1937, when Chesapeake-Camp Corp. started producing paper, in Franklin, a newly formed "River Operations" department was organized to help supply the mill with pulpwood, which was to be accumulated at Winton, North Carolina from that area's pine woodlands, by pulling barges loaded with pulpwood up the Chowan and Blackwater rivers to Franklin. Barges were acquired. A tugboat was needed.

In response to that need, in early 1938, a steam-powered tugboat named "Corinthia," built in 1890 in Philadelphia, was purchased and put into action with Harry B. Ward Sr. as its captain. "It was a ragged-looking thing," Harry Ward Jr. recalled for an article in the Spring 1999 edition of Union-Camp's magazine, "The Log." The tugboat had been in disuse for several years prior to being purchased and refurbished by Chesapeake-Camp.

In 1970 a tugboat by the name of "Convoy," originally built for the United States Army Corps of Engineers, joined the Union Camp tugboat fleet. Soon after its purchase, it was re-named the "Cotton J" in honor of J.B. "Cotton" Johnson who was, at that time, manager of Union Camp's Woodlands Division, operating out of Franklin.

Though smaller than its predecessor, the "Cotton J" kept river operations going until 1972 when a newer tugboat, the "Tuscarora," was put into service. It was named after an Indian tribe that lived along the Chowan River.

In early 1973, soon after the "Tuscarora" was put in service, the "**American Eagle**" was added to the "River Operations" fleet. The "Cotton J" was sold later that year.





