

2976-Y15-RV23WP

ROBOT REVEAL 2023 TECHNICAL WHITEPAPER

Spartabots 2976
June 2023

ROBOT
REVEAL 2023



THE NAME OF THE GAME IS

BIGGER.

BETTER.

BOLDER.

AND WE'RE HERE TO

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FOREWORD

The production of Reveal 2023 was perhaps the most challenging thing our media team has done in our lives. With over 800 combined hours from our diverse team of filmmakers, editors, and 3D artists (who were all high school students!), we've learned a ton about how to run a live event and plan on putting all of that information into a more accessible document here, known as the whitepaper.

To begin, we'd like to preface this technical deep-dive with a few words of the wiser: Despite the consolidated information bank that we are providing to you in this whitepaper, running an event of similar caliber to Reveal 2023 will not be easy (I mean, just look at the whitepaper – we consider it to be “fairly dense” and it's still about 50 pages long). We do not recommend attempting to replicate our event to its full extent unless you have a team of at least 5 strong creatives who are willing to work for 4-6 months on this project. That being said, we encourage teams to pick and choose elements of our event to incorporate into their own work rather than replicating every aspect of our show at once.

With that, we'll be taking you through the ins and outs of everything we've done to get to where we are. From technology to creative inspiration, we've got you covered. If you've got any questions about anything contained in this document, questions can be directed to us on either Discord (we've got members in the main FRC server who can forward questions to the relevant parties) or via email to skyline.spartabots@gmail.com. Just make sure your subject line makes it clear what you're asking about so we know who to redirect the question to.

Let's **make something incredible** together.



THEMING AND BRANDING

“The essence of the theme exists to unify the event – It’s an at-a-glance representation of what we’re all about.”

Finding an Overall Theme

The event theme is something that we explored for Reveal 2022, but didn’t fully develop as we were pretty tight on time – that year’s event was planned and executed over the course of only 2-3 months so there was far less foresight than 2023 or the upcoming 2024 event. Reveal 2023 is the first year we truly believe we’ve created a real event, and it all starts with the theme.

Reveal 2023’s theme was inspired by 2976’s overall Year 15 design themeboard, which included pillars like “forward thinking” and “boldness.” Developed alongside the Alternate Brand Identity, this event pulls many familiar elements from the branding standard, while evolving and developing its own look to enhance the audience’s experience both in-person and online. It was decided pretty early on that themes should be short and easy to remember – so “Be Bold” was naturally a top contender as it’s a pretty commonly spoken phrase and we felt that our bold and aggressive branding could back it up this year.



Robot Reveal 2023 Themeboard

Deciding on the event color palette was as simple as pulling a few shades from our existing Year 15 palette. The job won’t be as easy in 2024 though – we plan on separating the event’s brand from the

team's brand in the future and it all starts with unique colors. For teams looking to theme their events, we recommend picking out a **single, primary accent color** that you believe will fit well into your assets, and work from there to create a palette around it. We recommend bright, saturated colors as they'll help your physical assets like banners and posters stand out more, and your live broadcast will look a little more vibrant on cheaper or less color accurate displays.

Defining a Visual Identity

Our visual theme for Reveal 2023 is heavily inspired by Riot Games' 2022 League of Legends World Championship. Being our first hybrid (live online and in-person at the same time) event, we wanted to take an approach that we knew for sure would work, so in true FRC fashion, we took from the best and invented the rest.



Reveal 2023 Visual Reference and Theme Wordmark

Unlike our previous brands, we wanted a much more aggressive font at the forefront of our designs, which is why you'll see variations of the Scout font family everywhere in our assets this year. This font family is largely the backbone of the brand, and is where many of our design elements are actually inspired from. Everything from the 8-degree shear to the layout of text is tailored to make Scout look as cool as possible.

SCOUT COND. BLACK

SCOUT COND. BLACK

SCOUT COND. BLACK

SCOUT COND. BLACK

SCOUT COND. BLACK

SCOUT COND. BLACK

SCOUT COND. BLACK

SCOUT COND. BLACK ITALIC

SCOUT COND. BLACK ITALIC

SCOUT COND. BLACK ITALIC

SCOUT COND. BLACK ITALIC

SCOUT COND. BLACK ITALIC

SCOUT COND. BLACK ITALIC

SCOUT COND. BLACK ITALIC

**THE QUICK BLACK ROBOT
SWERVED AROUND THE
LAZY WEST COAST DRIVE.**

***THE QUICK BLACK ROBOT
SWERVED AROUND THE
LAZY WEST COAST DRIVE.***

With that pillar established, graphics were fairly easy to develop. Scout, at its heart, is a font that really likes rectangles (or parallelograms, if it's italic), so we did exactly that. Left-aligned elements were used over more traditional center-aligned layouts, and we matched the shear angles of Scout Italic wherever needed.



Elements with left-alignment and plenty of rectangles

The biggest example of this design language is present in teams' background loops. The elements slide and rearrange around each other, eventually forming the graphic you see above on the left side. We found that enclosing scout in rectangles generally formed compositions that looked organized and clean, so we found every possible opportunity to make it work. With italic variants, we liked to match the shear angle across multiple lines of text, as see in the Sammamish graphic above, where the top 2 lines are not left-aligned, but instead slightly offset so their angles match up.



The event logo is a fairly simple lockup that follows the same design philosophy as the other graphics we created. Since this wordmark layout is something we want to keep through the years, we kept it simple and timeless so that future brands aren't hindered or limited by it. It fits into a parallelogram and the year number has a gradient fill, which are both distinctly "2976" design styles. We expect to just replace the year number and gradient every season from now on, so that the event's logo stays cohesive.

TEAM ORGANIZATION



“While the circus continues, the show must go on!”

Team organization is critical on a production of this scale. We split our team into a couple of distinct roles, listed below with their responsibilities.

Director of Production (D/P)

The DP is equivalent to a Project Manager in the production industry. Sometimes referred to as the Director of Photography, they’re responsible for the coordination of all production elements. They keep the show on track and ensure that deliverables are being produced to the standard required by the client (if any). Our Reveal 2023 DP managed both the offline production and live production teams, but with the expansion of the event going into 2024, we expect to have an Offline DP and Live DP (also called a Technical Director).

Feed Operator (F/O)

Feed Operators are responsible for the direct switching of OBS scenes and sources during the event. They are personally trained by the DP and are the only authorized individuals to touch any of the switcher settings. Often times, FOs are also motion graphics producers who created assets for the show, as they have significant experience with the technicalities of their graphics and how they link together to form a cohesive Infinity Fabric of Scenes (more info about this in the next section). We had a primary FO and 2 backup FOs for Reveal 2023.

Lighting Director (L/O)

Lighting Directors or Lighting Operators manage the programming and Day-of switching of the light shows on set. LOs manage a largely autonomous group that has full control over the stage lighting. They’re given a preliminary test render of all graphics beforehand so they can program the shows accordingly, and they are also responsible for ensuring adequate lighting of presenters when they are speaking on stage. In 2023, we had 2 LOs who worked with a rotating team of interested individuals to program and set up the lighting on stage. Reveal video production also had an LO who was in charge of ensuring the proper equipment was present on production days.

Assistant Camera (A/C)

ACs are an offline production role, responsible for many things from camera operation to the configuration of the production set for reveal videos. They are well-versed in the operation of all equipment that may be in use during production and are a reliable equipment manager. ACs were assigned on a per-production basis in 2023, generally with 2 per production day.

Stage Hands

Stage Hands are aptly named, being responsible for assisting Directors and Operators in any endeavors that may require more hands to complete. Often times, this includes wiring setup, fly operation, and general venue equipment operation that does not fall directly into another category. Reveal 2023 utilized 3 stage hands for the show.

Media Collection

Individuals part of the Media Collection team are responsible for the gathering of media for promotional purposes. The largest of these responsibilities is taking photos and videos on show night. Additionally, they may collect behind-the-scenes footage of production or any other media they may see fit or useful for future promotional material.

Reveal 2023 was produced with a core team of 5 highly talented individuals who each specialized in a critical Craft Area. Alongside them, the Reveal Production Unit, or RPU, also included over 20 other people who provided critical assistance towards the reveal show. The directors are incredibly grateful for the RPU's dedication and willingness to volunteer their time towards the show and we could not have put the reveal together without them.

ASSET PRODUCTION

“The Infinity Fabric of Scenes is the ultimate goal for any live production. You need to make each and every little thing with all potential combinations in mind – the production needs to be flexible enough to adapt to any possible circumstance.”

Live Graphics

The graphics and videos displayed on the screen behind our presenters is not just a PowerPoint – it’s actually the most complex part of the entire show, and we’ve spent months perfecting our craft. The end result is what we like to call the “Infinity Fabric of Scenes.” Despite the goofy name, it does describe the purpose of our assets well. Graphics are displayed to a projector via OBS, and we switch between scenes similarly to how one might swap between PowerPoint slides. With that in mind, each scene’s assets need to be custom-tailored to their purpose, and ensure that transitions in and out of that scene will stay clean. The final product is an OBS scene collection that allows us to swap between any two given scenes at any given time without noticeable cuts or transitions that don’t feel like they belong.

That being said, the majority of these transitions are possible with a simple fade, and that’s what we used for many of our assets. They simply exist as static loops or images and our default OBS transition is set to a 100ms fade that covers most scene switches. The more interesting part of asset production is the development of our dynamic scenes, which included the looping flag animation that played for each team as a dynamic background.

Idle Looping Animations:

By nature, a bunch of waving flags are pretty hard to loop in physics. For that reason, the looping is actually done with a little hack we like to call “half-stitching.” What does that mean? It’s actually quite simple:

STANDARD VIDEO: START TO FINISH



HALF-STITCHED VIDEO: LOOPS WITH TRANSITION IN THE MIDDLE



We simply split each rendered clip in half, and switched the order of the halves so that duplicating the sequence back to back would result in a perfect loop. Then, we used a mask to perform a simple screen wipe to transition across the cut that's now present in the middle of the sequence. This looping approach is most commonly used in short-form content like TikTok, so you've probably seen plenty of tutorials on how to pull it off by now.

The Flag Render:

Every year, we create what we like to call an Idle Render, which is just a cool-looking 3D loop that can be used as video filler footage or looped on a live broadcast as an idle animation. 2022 didn't see much use for an Idle Render, but as a part of our technology upgrade in the 2023 broadcast overhaul, we decided we wanted dynamic backgrounds for presenters to stand in front of, meaning we could finally play the Idle Render in our graphics kit.

Perhaps the most time consuming asset to produce, our 2023 Idle Render was modeled directly after the League of Legends World Championship graphics, which included a similar fabric simulation. We did some pretty extensive research to even figure out how they were made, as our own early attempts didn't end as well as we would have hoped.



Early versions of test renders were made in Blender, and didn't yet have the fabric strips you see today

We initially attempted to recreate the effect seen in [this video](#) in Blender, but couldn't get the simulation to work in a way we liked. While we'd generally prefer to render the yearly animation using Blender given that it's free, we had to pull out the big guns this year to get the render done.

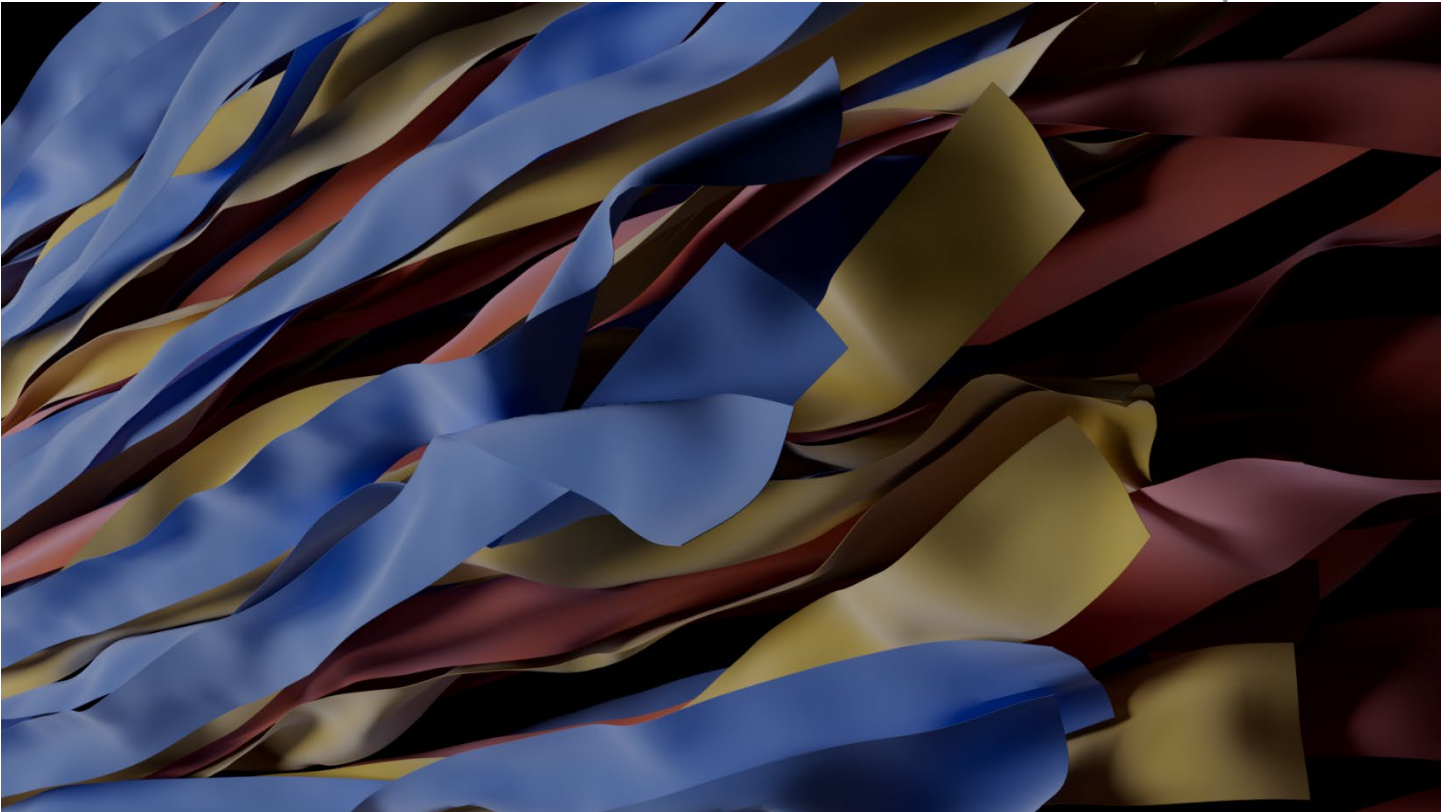
With a little more research, we found out that Cinema 4D has a much more powerful fabric simulation engine than blender, and it's also significantly faster. While we question the legitimacy of the "faster" claim (our physics data took 5+ minutes to bake for a 6 second clip), we can definitely attest to the "more realistic" claim as our renders turned out beautifully once we swapped over to C4D. For those of you looking to recreate the 2023 Idle Render, Cinema 4D is available as a part of the Maxon One Student Package, which you can get for \$6 USD every 6 months. It also includes the Redshift render module, which you'll need in order to properly render the scene. Unfortunately, swapping to C4D sacrifices pretty heavily on storage space. As we came to find out pretty quickly, baking physics data for 30-40 fabric strips generates a ton of data, and each of our Cinema 4D project files is over 2.5GB (We created a file for each different color combination, so in total 7-10 copies of the project were created).



First render made in Cinema 4D

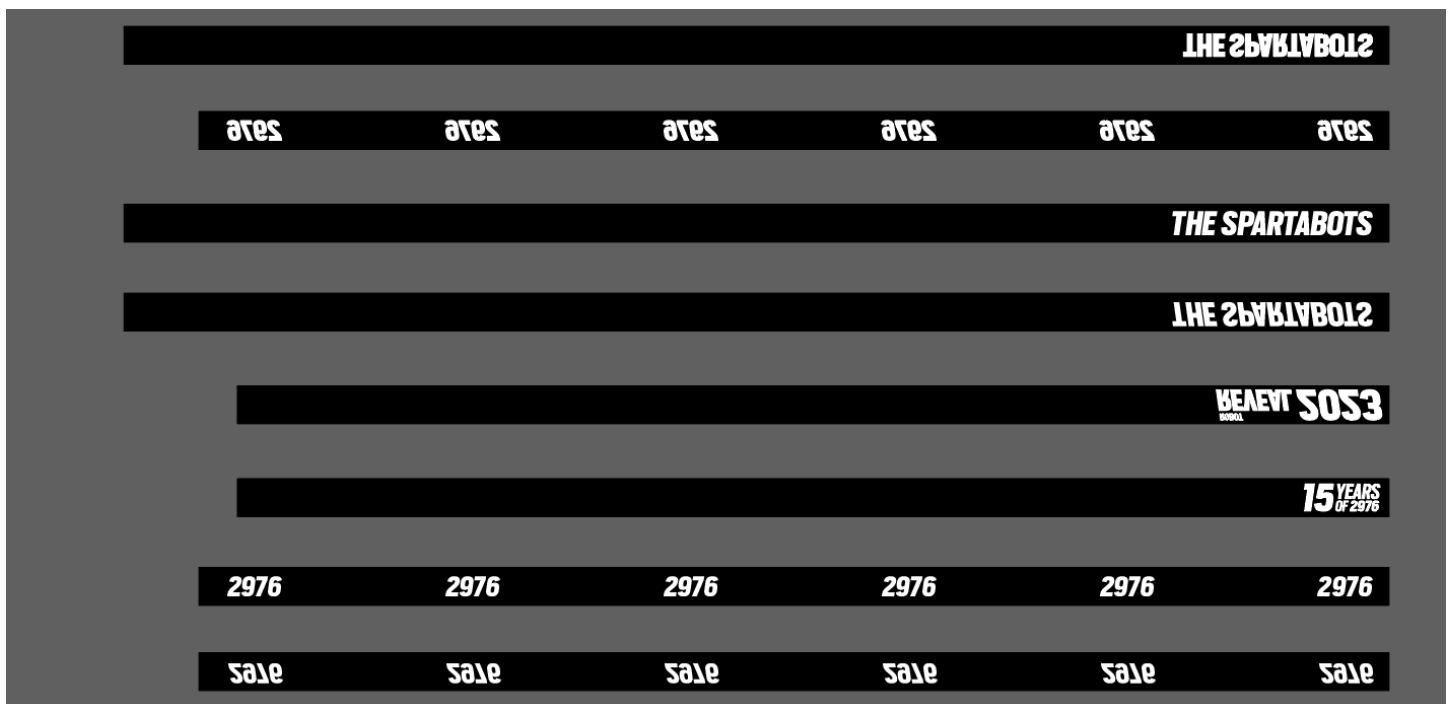
After even more digging, we found a [pretty handy tutorial](#) that pretty much teaches you exactly how to recreate the Worlds 2022 graphic, so we used it as a starting point to create our loop. Now that we had picked the right program, the simulation portion turned out to actually be the easy part – what we didn't see coming was the nightmare of texturing and lighting work that would be to come.

You see, 3D programs generally expect artists to custom-texture each object they create, so there aren't generally spacing options for repeating tiles. That means our wordmarks and labels had to include the whitespace necessary in order to prevent tiling errors. You'll see in later renders what we mean by that. For now, the focus was getting a perfect base fabric texture and lighting setup, which we were able to mostly accomplish with some minor tweaks.



Final lighting setup before texturing work began

Back to the texturing work we mentioned earlier: our flags were created as wide but thin rectangles, and Cinema 4D expected us to provide it with an exact match in texturing files. What does that mean in English? We needed to export all of our wordmarks and texture files as huge rectangles that contained the wordmark in the exact location we needed them in.



Texturing Workboard – Flag dimensions filled in black for visibility, these were transparent in actual exports

As you can see, it took quite a bit of work in Illustrator to get our textures ready for export, as we needed to ensure that each label matched not only the length of the flag it would be on (as we had 3 different lengths in each composition), but also which side it would be on. Since the flags naturally twisted and turned during the simulation, sometimes the backside of some flags would be visible in renders. As you can see below, that caused some issues where labels would end up being upside down in the camera view.



First test with labels – reverse flags still showing upaide-down

To combat this, we needed to texture each side of each flag separately, causing additional headache as we had to not only flip, but also mirror each texture as seen in the workboard. Now armed with the texturing knowledge we needed to know, we began to create final renders, and ran into yet another issue.

While it may seem inconsequential, we found this issue to be deal-breaking for us and had to toss a number of renders that went wrong. Essentially, Cinema 4D renders images in a LOG profile at the GPU stage, then correcting for it with a baked LUT at the end of the render process. Unfortunately for us, the Redshift Photo Renderer did not automatically bake the LUT and we could not find the file to bake ourselves. Luckily, the Redshift Video Renderer and standard Photo Viewer don't have this issue, so the fix was simple: Don't use the Redshift Photo Renderer or else renders will look flat and boring.

Another nuisance we discovered was that our rendered files were not automatically getting file extensions. While it's fairly easy to bulk-rename files, we found it quite annoying that the default render settings can't seem to include a file extension. These are all things to keep in mind if you're looking to recreate this render for your own projects.

Reveal Video to Idle Transition:

A minor but important technical detail that we want to include is how we transitioned from each team's reveal reels to their idle screens. While it may have looked simple, we actually spent more than 2 weeks getting it right since OBS didn't really seem to like the original system we had in place.

Our first approach to the problem was to export each reveal reel in ProRes 4444 XQ, which includes an alpha channel. Below that, we'd loop an h.264 flag loop with a PNG version of the team's number lockup. At the end of the reveal reel, each team's number animation would play, then the video would fade out to reveal the loop below it. This system is entirely viable, however, OBS does not seem to support hardware decoding of ProRes yet, so we were left with CPU encoding only. This left us with significant performance issues and we just couldn't get around them as bringing in a more powerful streaming PC was not something we could do. We'll talk about performance and streaming hardware in the stage technology section, but we can safely recommend here that you **do not use ProRes** unless you have a very powerful streaming encoder and can verify before the show that you won't have performance issues.

With this in mind, we set about remaking every graphic in the show in an h.264-friendly format – this meant that we no longer could use the alpha channel to our advantage as it would instead encode as black in h.264. We settled on using a chroma key instead of an alpha fade, sliding in a magenta matte at the end of each reveal reel to be keyed out in the scene. It wasn't the most elegant solution and we're currently looking into ways we can get hardware acceleration to work with ProRes in 2024 to get around this limitation.

File Formats:

All assets except a select few were exported in h.264 this year, with the following specifications across the board:

- 1920x1080 frame size
- 60p for animations, 59.94p for edited reels
- 40mbps **MINIMUM**
- 8 bit color, Rec.709 color space

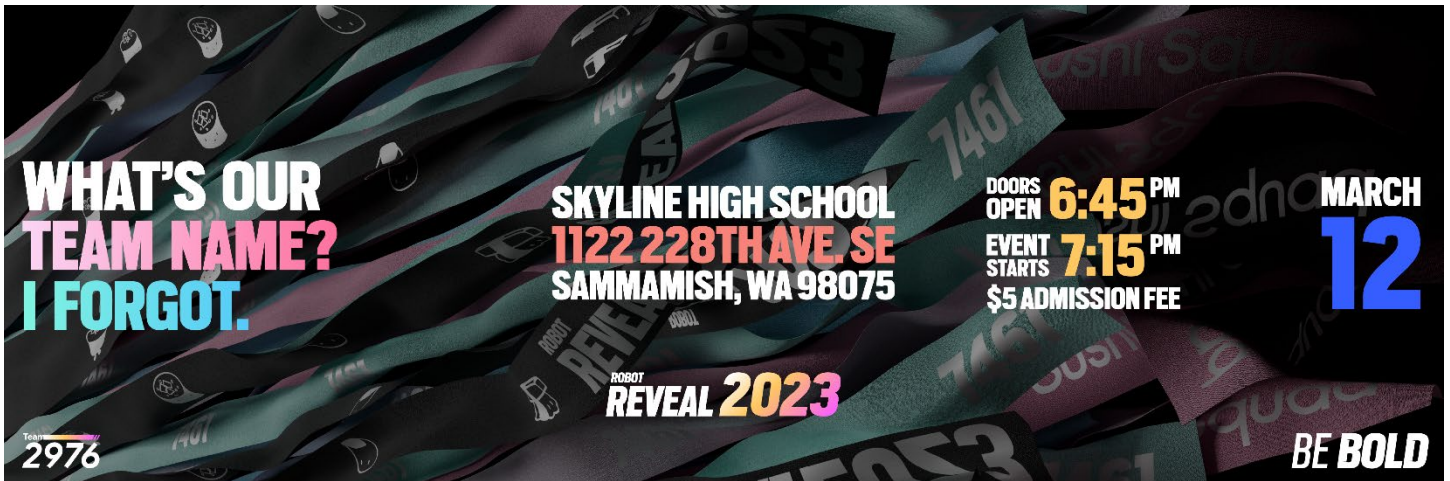
The stinger that transitioned into the "Director of Media" name tag was exported in WEBM, which is an alternative format that supports transparency. We did not use it in a widespread manner as it relies on the VP9 codec which we have found to be unstable with longer videos (not to mention its much slower render speeds when exporting graphics).

Promotional Material

Our non-show graphics were largely produced in Adobe Illustrator, and ranged from physical flyers to digital promotional material that was posted to various Instagram and twitter pages. For this purpose, we developed a second slogan: “Bigger, Better, Bolder” that helped us emphasize the huge increase in production value that we’d be bringing to the table in 2023.



Our social media promos this year were aided by the already-existing flag renders, which served as great backgrounds for the posts and flyers.



The assets seen above were provided to each presenting team to post to their own social media accounts. They were made using each team’s customized flag render and a quick little slogan we came

up with for them. Moving into 2024, we're looking at more integrated marketing efforts with each of our presenting teams and hope to expand the reach of our event farther than ever before.



Special Edition Y15-themed flag render for promos

We also made a specially-recolored version of our flag render to promote our Year 15 Alternate Brand – while this render wasn't originally part of the Year 15 social media plan, it fit the theme and we liked the look of this particular render.

REVEAL VIDEO PRODUCTION



“High-level cinematography, at its core, is a result of meticulous planning and not spur-of-the-moment filmmaking.”

Pre-Production

The quote above says it all. The key to our reels is the planning that goes into them – they aren’t reels that we can create in just a week or two. Pre-production for all 7 (yes, 7) reels began in early November of 2022, when we worked with teams to select soundtracks and get to know their filmmaking capabilities a little better. Given that the actual production of a reveal video requires a very quick turnaround (generally just 3-5 days or less), we weren’t able to go out and film each reel personally. This meant that we had to do our best to train cinematographers from each team to create a reel that would match the energy of the soundtrack they had selected.

To accomplish this, we put together 2 documents for each team: A shot list, and a set of production guidelines that walked teams through a general breakdown of their shot lists to aid them in the actual footage collection process. On the next couple of pages is a sample of a shot list (in this case the first bit of 4131’s reel) as well as parts of the production guidelines document which also includes a kickoff update with Charged Up specific filmmaking tips (Unfortunately the links in these are not clickable as they are images of the original docs).

DYNASTIES AND DYSTOPIA REVEAL

READY FOR PROD.

4131-RV23-DND83

Reference audio/video: [Denzel Curry, Gizzle & Bren Joy - Dynasties and Dystopia \(Edited\)](#)

Main themes: Fast-paced, exciting

INTRO

[B-ROLL]

[0:00 - 0:09]

Cut to shot of team tinkering on robot, different parts on every clap/snare - new direction/panning every shot, consistently high-angle

[0:10 pad hit - 0:11 bass hit]

Full eye-level shot of robot, camera moving backwards

[0:11 - 0:12]

Slow-motion clips of tinkering with robot (screwdriver turning, wires plugging in, etc.) on every 2 bass hits

[0:12 - 0:15 On “Ooh, yeah, he mad...”]

Bird’s-eye view of robot, camera descending while rolling 270° - team of people around the robot working on it, but not in focus

[0:16 - 0:18 On “Throw me in the sky...”]

Eye-level shot of lower half of robot, orbiting robot

[0:19 - 0:20 On “Ooh, yeah, he mad...”]

Clip of robot scoring mechanism functioning (shooter, intake, etc.)

[0:20 - 0:21 On “I’m rockin’ em white diamonds”]

Clip of other robot scoring mechanisms functioning (shooter, intake, etc.)

A Snippet of 4131’s Shot List

2023 REVEAL PRODUCTION GUIDELINES

2976-RV23-PDHB

Welcome to production! We're excited to be working with teams to produce their reveal videos this year - this document will serve as a guide and general handbook for teams to gather their footage and allow us to produce the best possible final reels. We'll start with general guidelines, then each team will have a dedicated special instructions section for their specific reel.

UPDATE January 7th: Game Footage Guidelines

I'm gonna be honest: Charged Up is not gonna be a great game for us media nerds. For event recaps, I can see some good cuts possible but for reveal production, we're left scratching our heads pretty hard. I've done my best below to outline the best shots, but I wanted to preface this update with a short message. Generally, the game footage will have to focus on the intake and placement process of the pieces, but you'll have to get pretty creative with your shots as we can't just show the same angles for 2 minutes straight. I've compiled the best tips our media team could come up with today:

- Use tighter focal lengths - it'll emphasize the motion a lot better but you need to make sure you keep the camera steady as it gets harder to do that the tighter you go
- Try as many angles as you can use - low angles, high angles, close-ups, etc. Anything is fair game and we'll do our best to cut between them in the post-production process.
- If your robot can serialize cones, get some footage of it doing that. We want footage of bots collecting game pieces in every way they can - that means cubes on the shelf, cubes on the ground, cones knocked over, cones on shelves, anything!
- Charging pad footage can be collected as mostly low-angle stationary shots or low-angle orbits - we believe the low angle will be key to actually showing the angle of the pad and giving the entire sequence a more cinematic look (this is speculation, however, and may change in a future update)
- **FOCUS RACKS** - we loved them before this game and we think they'll be the perfect transitional or filler shot this year. We'll collect some focus-racking shots and encourage you guys to do so as well for various field elements and robot mechanisms. Non-robot focus racks will be considered shared footage and may be used in any of the 6 reveals.
- Use 2019 reveals (particularly 118's) as reference - a lot of the motion is somewhat similar but we don't have as much flexibility in showing more vertical movement. To combat this lack of flexibility, we think tracking shots that are closer up will be better.

Overall, the cinematography will certainly be harder than in 2022 this year - it requires a keen eye and a lot of experimentation. We'll keep you posted on the best shots and angles as robots get built and we begin testing, but just know that your team's cinematographer will not have an easy job getting good footage in 2023. Don't worry too much for now, but this update gives teams a little preview into what the cinematography is going to look like for Charged Up and where we're going to be taking the Master Filmmaking Style Standard, or MFSS for short. Full MFSS specifications will be released in February (I hope) and will be your *real* guide to getting game footage in Charged Up.

2976-Y15-RV23WP

Robot Reveal 2023 Whitepaper

General Production Guidelines

Lighting:

While we understand not every team has access to professional lighting, we'd prefer for teams to take 1 of 2 approaches:

- Dramatic Lighting:
 - Keep the room dark, but use bright lights such as softboxes or LED panels to light your robot using a standard 2 or 3 point setup (Google this if you don't know what it is)
 - If you have access to RGB lights or panels, this is a great option - let us know and we'll tell you what colors to set them
 - Keep it bright enough that you don't get insanely noisy footage - ISO 6400 is our personal maximum, but depending on your camera's age and price it may vary. Older Canon DSLR's like the T5i become unusable above around ISO 3200.
- Neutral Lighting:
 - If you don't have access to a dark room, just use any normal well-lit room
 - Try to find a room with neutral colored lights - not too yellow or blue
 - We may specify shots where we still want dramatic lighting, in which case you can turn off room lights and use phone flashlights for harsher lighting

In general, we want teams to prioritize usable footage over anything else. If you find that your dark room shots are looking extremely noisy, switch to a neutral room or use more lights. We'd rather things be visible than noisy hellscapes.

Camera Equipment:

We recommend a camera rental from lensrentals.com if your team or a member is willing to spend about \$100-150 on it. If you choose to do a rental, DM me on Discord with your budget and I'll put together a package for you. **If you already have a pretty decent camera, we strongly recommend a gimbal rental.** Otherwise, anyone on the team with an iPhone should be able to cover most of the shots that we're looking for. Whatever camera you choose to use should be able to record at **1080p 60fps minimum**.

Specific Gimbal Rental Information:

A gimbal is in our own words "the single best way to get better shots" and we stand by it. If you can find a way to put your camera on a gimbal, **do it**. Lensrentals.com has some very affordable options (you can rent a high-end gimbal for a whole week for less than \$70 usually) and we highly recommend it if someone can spare the cash.

Production Days:

If your team plans on coming to a production day at Skyline, you don't need to worry about any equipment-related things - just bring your robot and people who know how to run it. We'll ask your team to do various things with the bot, so be sure that it's at least functional (not necessarily accurate or good). Production days will run from 3-9PM, and I anticipate we should be able to get through 2 teams per day if they're fully ready. The game footage parts will have to be recorded at your local

practice field, however, and getting help from our team is fully dependent on whether we're there on the same days.

Record Settings:

Record everything at 60fps - it is okay to lower your camera's resolution in order to meet this requirement. We ask for this so that we can slow your footage down in post to act as a second safety net of stabilization.

If you're recording on a camera with LOG mode, record in the highest bit depth LOG possible. On newer Canon R-series cameras, this is usually C-LOG 3 at 10 bit. Otherwise, record on Auto color and we'll make final adjustments as necessary. **Record in Manual Mode, and set your shutter speed to 1/125.** Use F-stop and ISO to adjust your exposure as necessary. If you're not confident with manual exposure, just ask us! We're always available to assist with camera settings.

If you have an iPhone on the newer side (12 and up), record at 4K60 **without Dolby Vision HDR**. Feel free to DM me if you don't know how to disable Dolby Vision. For all other brands of phones, record at the highest available resolution that supports 60 fps.

4131-RV23-DND83

We've done an edit to this soundtrack before, so your reference reel (linked in the spreadsheet) will give you a good idea of what vibe your video will exude. For this reel, we have a lot of quick cuts planned, so get shots from as many angles as humanly possible - they don't need as much fancy movement as the other reels, but we need a copious amount of footage from your team to make this edit work. Below are some tips:

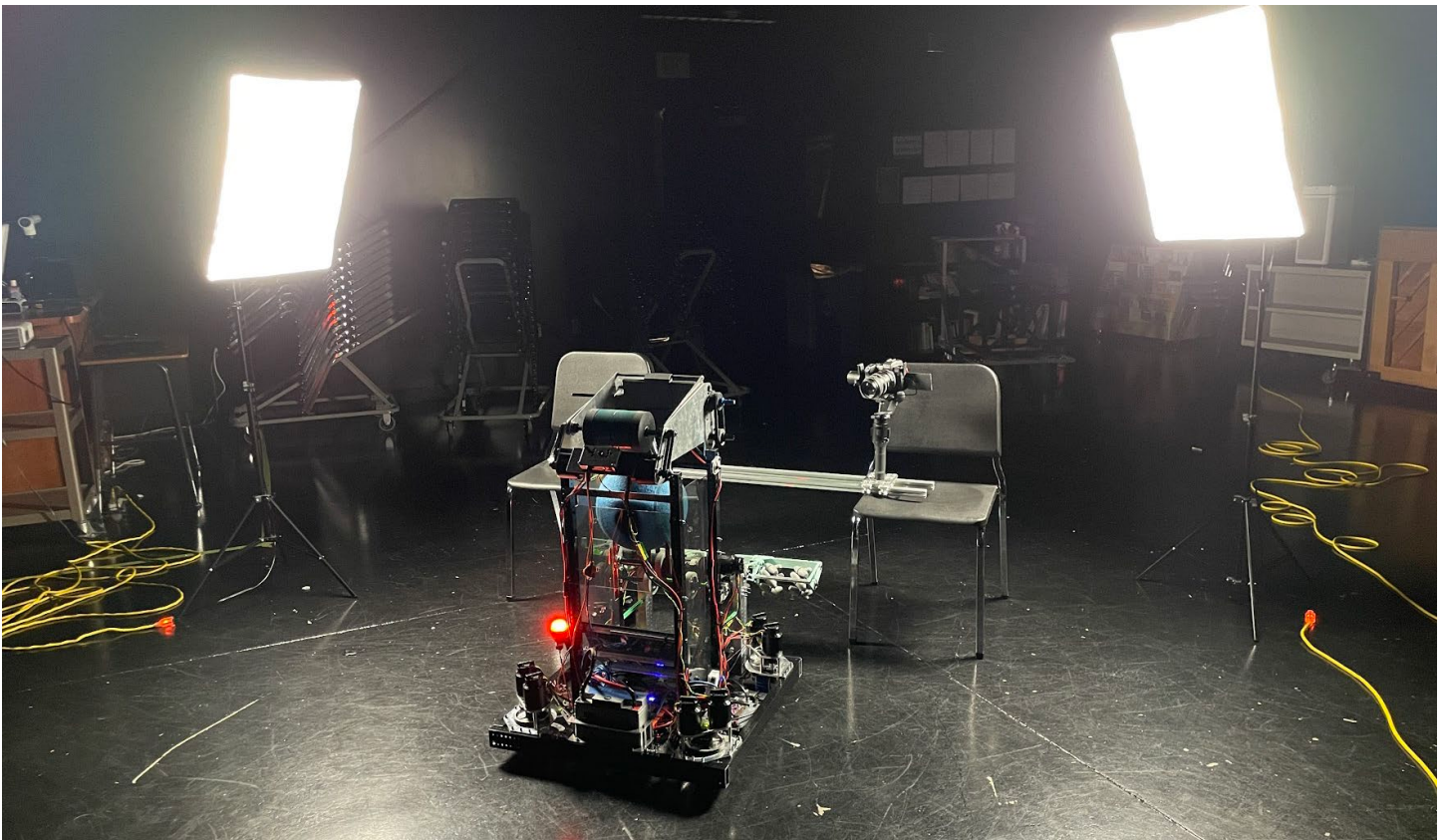
- Above all, make sure your camera isn't shaking in any of your shots - the quick cuts and nature of this reel means camera shake will ruin a lot of what we have planned
 - Use digital stabilization in your camera if you have to, and try to use a body with IBIS and a lens with OIS. If you don't have any of those, use a phone with good stabilization or try to rent a gimbal
- A gimbal will be your friend for this reel - it's definitely one of the higher priority pieces for Dynasties and Dystopia considering the various pulls and slides we're looking for. Gimbal rentals are generally quite cheap if you have a camera you can put on one
- Game footage tips:
 - Your reel is fast-paced, so the game footage should reflect that. Use tighter lenses and fast movements to your advantage to try to give the viewer a sense of speed
 - If it's a shooter game, we recommend a lot of tracking shots of either the robot or the ball, and regardless of the game type, get tons of shots of individual mechanisms spinning up or moving around

4131's Shot List-Specific Guidance, each team had a similar list to follow that was specific to their soundtrack

The Production Guidelines makes mention of the MFSS, which unfortunately for a combination of reasons we can't discuss was never completed nor would we have actually released it (what I CAN say, however, is that it would have outlined pretty much the same information as the kickoff update as we did not really find anything better to share about cinematography throughout the 2023 season). A public version of the MFSS, most likely a more condensed copy that isn't 2976-specific is in the works and will hopefully be released by the time the 2024 season begins.

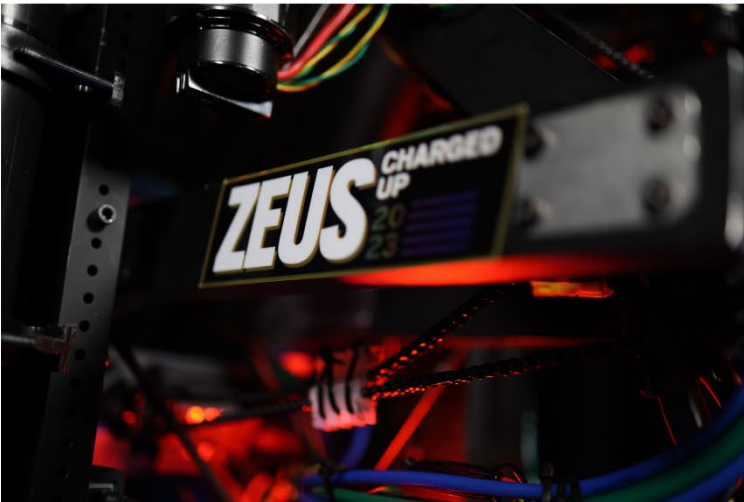
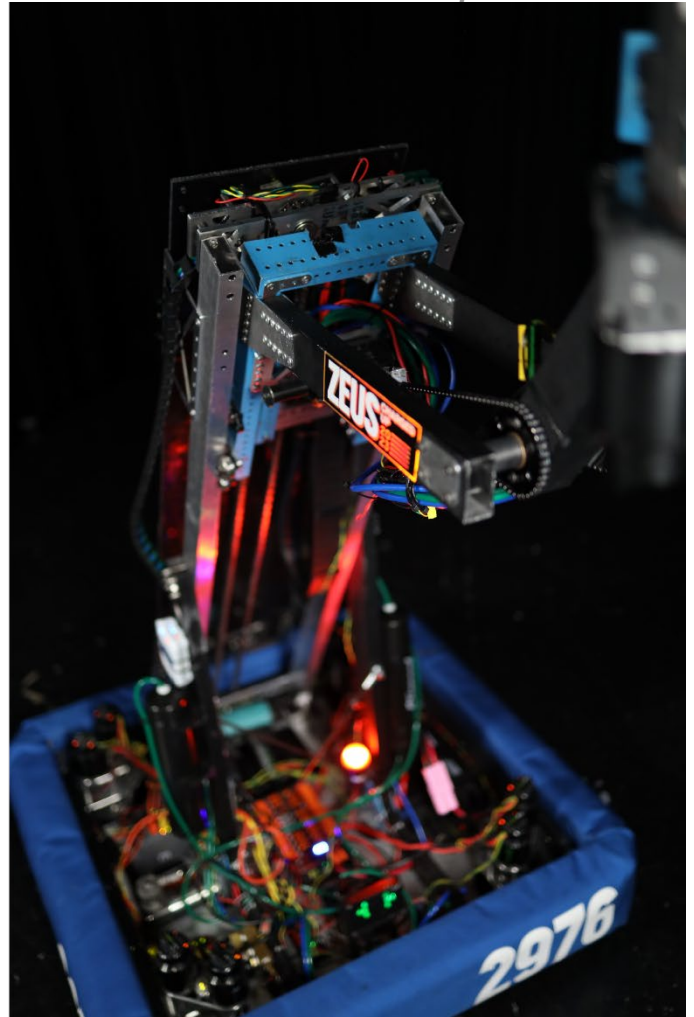
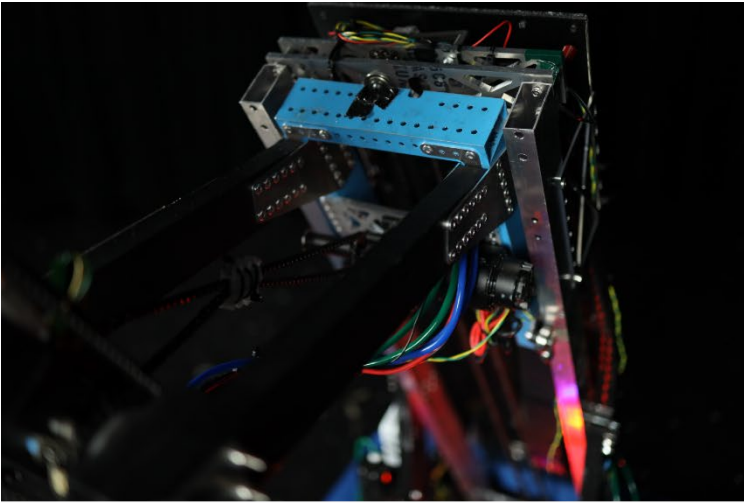
The Set

Our school's drama department black box serves as the B-roll set for our reveal video productions – we generally light the robot with softboxes and utilize a combination of slider-mounted and handheld shots.



Reveal 2022 Production Set – Similar to the 2023 Setup

We like the black box look as it gives us a cleaner background to film on, and makes our photos look a lot more professional – it's similar to 254's white photo box, but inverted to feel a little more cinematic for the reveal video.



Sample Photos from 2023 Production Days

Cinematography

While we can't speak to the equipment used in the footage that we didn't film, we're able to cover some general practices that we like to follow when filming in-house. In 2023, the following reels were shot by us, and all other non-listed reels were shot by their respective team. All reels (no matter who they were shot by) were edited by our in-house post-production team.

- 2976's Robot Reveal
- The 2023 Robot Reveal Intro Reel
- 2976's Team Intro Reel (uses footage from online as well)
- 7461's Robot Reveal
- 5937's Robot Reveal

Equipment:

Our standard run-and-gun rig flies a Canon EOS R on a DJI RS3, generally with an RF 35mm f/1.8 mounted on it. We record with the following settings for almost all footage:

- 1920x1080, 59.94p
- H.264 All-Intra, ~180mbps
- C-Log 1, Rec.709 color space
- YCC 4:2:0 chroma subsampling at 8 bits (we wish the EOS R supported 10-bit but unfortunately we are stuck with 8 bit only with internal recording)

We follow the 180 degree shutter rule and try to shoot with a wide-open iris whenever applicable, adjusting ISO as necessary. If we need to see a deeper focus plane, we'll stop down to the f/4-5.6 range to capture, say, the entire field in focus.

Shooting at 60fps gives us significantly more flexibility in post – it lets us slow down any clip we need by up to 50%, helping to smooth out B-roll or to provide more frames when speed-ramping. We deliver our recaps and event graphics at 60fps, but the reveal videos themselves were edited on a 29.97p timeline that was then exported in a 59.94p container to accommodate the team number stinger graphic that played after each reel. Videos uploaded to Youtube were exported at 29.97p.

On more important shoots, we run the EOS R5C, which we used to rent but recently purchased, so you'll likely see more from that camera in the future. On that camera, we shoot at:

- 3840x2160, 59.94p
- XF-AVC Long-GOP, ~260mbps
- C-Log 3, Cinema Gamut color space
- YCC 4:2:2 chroma subsampling at 10 bit (yay!)

Occasionally, we will shoot at 8K in HEVC codecs to reframe shots as necessary, but we rarely find the need as 8K HEVC files are not easy to work with in post-production. Despite Cinema RAW Light being an option on the R5C body, it'll still cost you about 100GB per 10 minutes. We just don't currently have the infrastructure to support 8K RAW and don't see the need for such resolution when we still deliver in 1080p, so we don't shoot in RAW.

Why deliver at 1080p? We have a diverse range of hardware capabilities on the media team, and while some may be able to handle 4K timelines, others may struggle to even view 4K footage at full speed. Since our edits tend to be quite heavy, with After Effects layers and multiple color grading layers, we deliver all productions at 1080p to standardize the export process and maintain consistency across projects (this also reduces render times for 3D sequences). We expect to fully migrate to 4K timelines by the 2026 season as we start to build the infrastructure necessary to support it. Also by that time, we expect to be shooting footage at either 5.4K or 6K, which maintains our ability to reframe shots in post. To accomplish this, we'll mostly likely shoot on a RED Komodo for general footage and the DJI Air 2S for aerial footage.

Shooting Process:

Robot reveal shoots generally follow a common format. We begin by collecting various B-roll shots in a pre-determined location. This is generally the most involved process, as we are either following a very specific shot list or coming up with sequences that we believe will lead well into the later parts of our reveal reels. This part is where knowledge of film theory and cinematography experience can come in handy. We recommend researching B-roll filming techniques beforehand if you are new to filmmaking. Generally, we prefer to include more than 1 axis of movement and rotation in each shot to give them an organic and fluid feeling. If you're new with a gimbal, we recommend starting simple with 1 axis of rotation or translation first before attempting to complicate your movements.

Gathering footage of your robot in action is the hardest part, but for all the wrong reasons. Unless you're on a team like 118 or 254, it's unlikely that you'll have more than a couple of hours with a fully functional robot before your first event (if at all). This is normal for all FRC teams and working around those limitations is something that can help your video stand out above the rest. Our mantra for this part goes something like: "It doesn't need to work every time – it can die the first 99 attempts but all you need to see is one perfect run to make a compelling film." Basically, film every attempt at everything – auto, scoring, and more. There will be times when you get lucky and something works perfectly when you didn't expect it to, and you'll be kicking yourself later if you don't get it on camera.

Post-Production

Color Grading:

Speaking from a personal standpoint, the color pipeline at team 2976 is nowhere near sophisticated as it should be given our production quality, but, we've established a pretty distinct palette. Losing it now would almost be like losing a part of our identity. That being said, we'll outline our process here along with a recommended pipeline that we believe is more correct than what we do.

To start, C-Log 1 footage is directly translated to our final look via a LUT, with minor exposure and white balance changes applied to stylize the final look. This LUT is what gives us our defined color grade, with the more "teal" blues and "pink" reds.



Ungraded C-Log 1 Look



Stylized LUT applied – final look for C-Log 1 productions

This pipeline is modified for Cinema Gamut footage from the R5C, as the direct translation LUT is not compatible with the flatter picture profile of C-Log 3.

ADJUSTMENT LAYER 2: STYLIZATION

ADJUSTMENT LAYER 1: PROFILE TRANSLATION

**APPLIED IN
LUMETRI COLOR**

FOOTAGE: C-LOG 3 CINEMA GAMUT

We instead developed an in-house stylization LUT designed for Rec.709 footage. This allows us to translate any footage into Rec.709 before applying the final style LUT. In the case of the R5C, we use the Canon-provided translation LUT (65 grid, full-to-full range, Cinema Gamut to Rec.709). The final stylized LUT is still in development (we haven't gotten it to a point where we're fully happy with the results), so unfortunately it cannot be released at the moment.

Recommended Color Grading Process:

The way we grade is not the way we believe most people should approach the art – we happened to stumble upon a look that became iconic so we can't swap away now, but teams without a defined grade can follow the below steps:

- Begin with a basic color space translation, from your Log profile to an applicable working color space. We recommend Rec.709 for the best results on as many screens as possible. This step may be skipped if your camera already records Rec.709
- Match exposure and white balance between shots
- Make changes using Lumetri's color wheels to match shots between location or exposure changes, being sure to use a side-by-side view to help match your colors.
- Apply any final creative LUTs you desire, being sure that they are designed for Rec.709 base footage
- Make further final adjustments to match your desired look, being sure to non-destructively introduce changes so that they can be reverted later

The above process is very similar to our current process, but avoids the "one size fits all" approach that we currently take, allowing for higher quality deliverables that contain a more consistent grade across the entire video. At higher level productions, you'll also need to grade with your desired screens in mind. Events like the robot reveal are displayed on a projector, so we needed to edit the final reels to boost their black points and bring back their highlight rolloffs to prevent the "crunchy" look from happening on our display projector.

Cutting and Transitions:

We are firm believers that a standard jump-cut is a completely acceptable transition, and in most cases is the correct one. Over-editing is a very common pitfall that we've seen people fall into, and we believe it stems from TikTok trends that have been popping up in recent years. The easiest way to avoid making the same mistake is to ensure that any transition effect you are using is there to enhance an already existing transition, and not used to cover up a poor choice of cut.

Cut points are a pretty common area we see editors lacking strength in. To most effectively create a compelling reel, it's important that you cut with the soundtrack in mind. While it may be easy to just cut when the action is over, those points often come when there is not a relevant musical feature to cut to. To combat this, you can use a combination of dead-space (screen time when nothing is really happening but action is about to start or has just finished) or speed-ramping. We almost always film B-roll clips that are much longer than they need to be so that our editors can pick and choose segments of clips that they need in order to fill the time they've set out. To ensure you're cutting on the beat, you can utilize both the Premiere Audio Waveforms and some quick spacebar pressing to find the spot where the hit begins. You can use markers (M) to mark out the beats in a particularly complex sequence so you don't need to find the beats more than once.

Choosing what clips to put in what order can also be a challenge – while it may seem logical to just drop clips into your timeline in chronological order, the motion and content of each clip is actually what matters a lot more. In order to effectively tell a visual story, each clip's meaning should lead into the next. For reveal videos, it matters less, but a very common “story” to use can be to show how a game piece moves through your robot, intercutting between action shots and more glamorous B-roll. Keep in mind the motion in your clips, most specifically camera movement. You should always be considering something we like to call “**follow-through movement**,” which refers to the direction the camera or subject are moving at the end of any given clip. Depending on the magnitude of that motion, it may be appropriate to either match that motion in the following clip or change direction (usually not in the opposite way though) to spice up the sequence. Typically, slower movements in B-roll can switch directions more freely, while quicker motions should be followed through in the following clip to avoid pacing errors that can feel jarring. A very common follow-through sequence you may see in our videos involve pushes and pulls, sometimes with a camera roll as well. We like to use these because it's very easy to match the motion between different shots, angles, or even locations, and it generally produces a very cool result.

Building off of that, your choice of transition effects should match the follow-through movement of your shots – for example, clips that have camera movement going to the right can be aided by a whip pan effect in post if their speeds don't match up properly. We don't believe it's good practice to use transition effects to cover up a bad cut – plan out your entire timeline without effects before adding effects to ensure that your video holds up fundamentally.

At the end of the day, your choices in post-production should be mostly your own, as this is the time where you can really bring out your own unique style. Try to edit in a way that will produce a “signature look” for your team.

STAGE TECH

“This is an industry that keeps their secrets very well hidden. We hate it. So we’re going to show you everything that took us months to work out of people”

The live production industry is perhaps one of the least pleasant to learn about. There is practically zero documentation online and any docs that do exist are highly technical manuals that don’t show people how to actually set something up. While researching for reveal 2023, a few things were listed as production elements that we wanted to include:

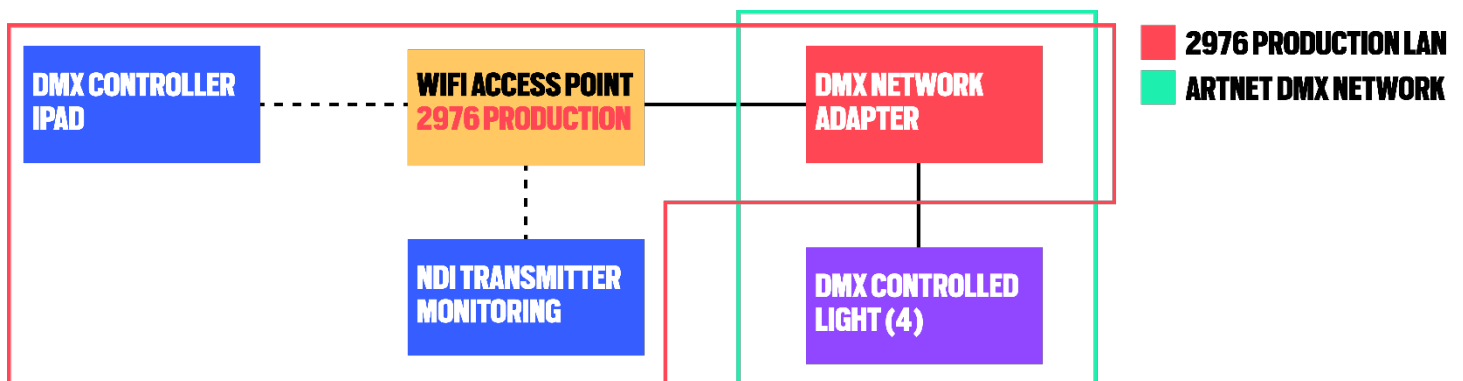
- An LED video wall
- RGB moving lights that we can sync up to the videos
- A Youtube live stream (meaning a camera and a second OBS feed)

The first of these was a long shot request that we knew likely couldn’t happen, and it didn’t. Video walls are insanely expensive and unfortunately, it isn’t in most companies’ interests to lend one to high schoolers with no experience running them. That being said, we’re working on ways we can eventually get one on stage for a robot reveal event.

DMX Network Setup

Stage lights are run with a communication protocol called DMX. Each light is daisy-chained to one another using standard XLR cables (**do not use phantom power cables**), with the first node being the controller.

We very quickly found out that real hardware DMX controllers are not only extremely expensive, but also very hard to get working properly. We’d need to essentially train ourselves to a professional level in just a couple of months. To get around this, we used a virtual controller on an iPad. This meant that we now needed a Production LAN. Below is a network diagram for our production network.



Reveal 2023 Production Network Diagram

As you can see, the systems get pretty complex as you try to move into the industry standard practices, and sometimes we found them to be extremely convoluted for our applications. Unfortunately, these

solutions are designed to be scaled up to massive productions, ones far larger than what we run. This means that when applied to our scale, they feel like incredibly overbuilt solutions. That being said, we don't recommend corner-cutting of any kind when it comes to this kind of work, as scalability is the name of the game (remember Bigger, Better Bolder?). To give you a better picture of the system in play, here's a bill of materials for just the live event side of the production:

Item	Qty.	Cost
RGBW Moving Head Lights	4	\$319.76
RGB Wash Light	1	\$106.99
10ft. XLR Cable	4	\$28.99
25ft. XLR Cable	4	\$40.99
Linksys E5350 WiFi 5 Dual-Band AC1000 Router	1	\$25.00
DMX ArtNet Ethernet Interface	1	\$69.99
Cayer BV30L Fluid Head Tripod	1	\$118.99
LP-E6 Dummy Battery Power Source	1	\$23.99
Canon EOS R	1	\$1799.99
Canon RF-EF Control Ring Adapter	1	\$199.99
Canon EF 50mm f/1.8 Lens	1	\$125.00
Some kind of Hitachi projector (school-owned)	1	???
Razer Blade Advanced 2021	1	\$2399.99
Yamaha QL-5 Mixing Panel	1	\$18,359.00
Sennheiser AVX Digital Wireless Microphone (TX + RX)	1	\$849.00
Sennheiser BA 20 Battery Pack	1	\$49.50
Gaff tape	A lot	\$100
T5 Integrated LED Fixtures	3	\$49.99
iPad Air 3	1	\$499.00
25ft Extension Cable	5	\$105.81
Total		\$25,271.97

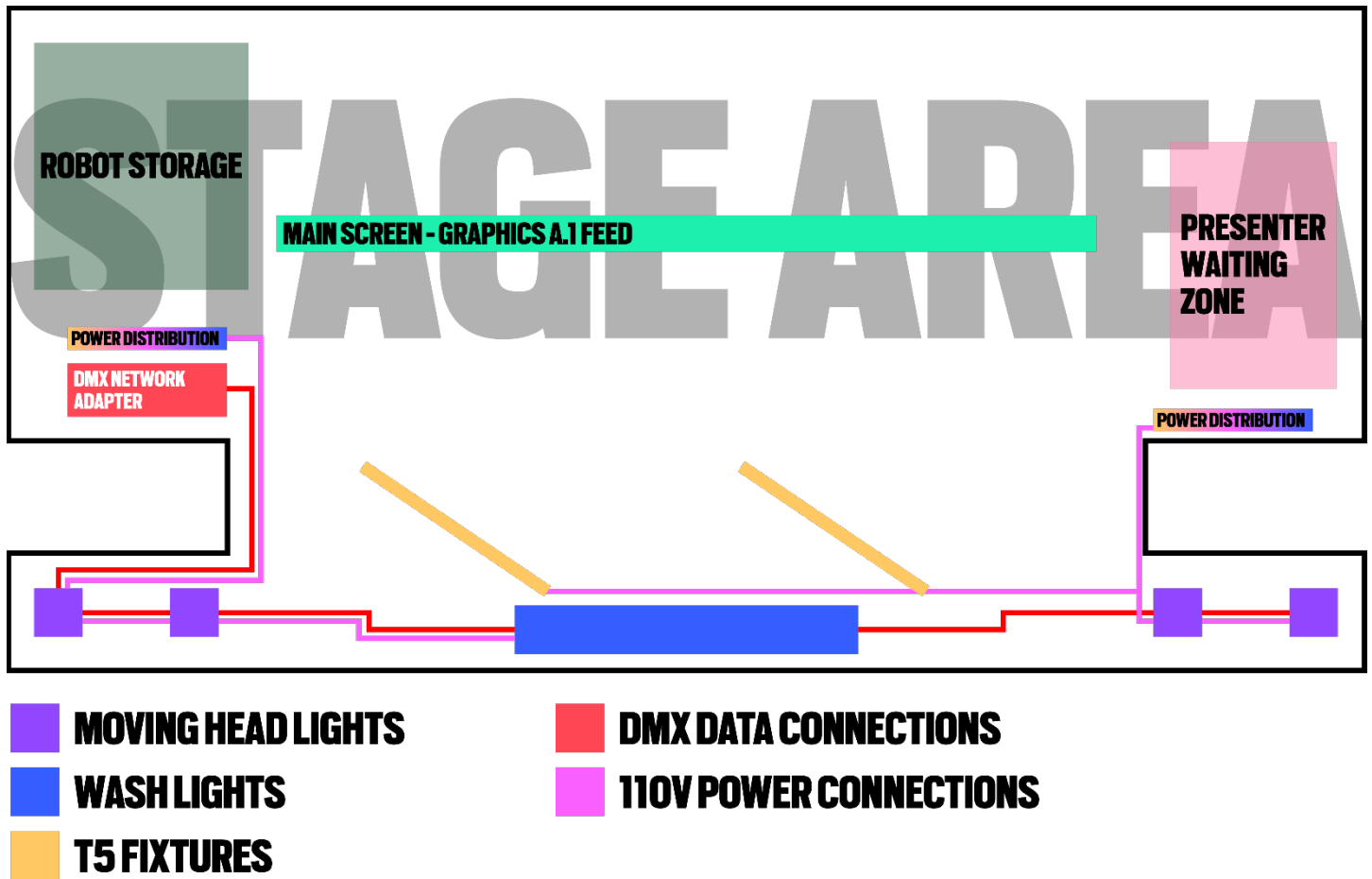
Now, much of this equipment we already owned or rented instead of buying, so the true cost of the event for our team was closer to \$1000. We expect that teams running similar events will also be able to skip on the projector and sound board costs – the mixer was a huge help to us and the event could not have happened without it.

Lighting Layout

This section goes over just the physical stage layout of the lighting – for programming and control information, skip ahead.

Now that you have a general idea of the equipment we were working with, we can get more into the details of how we used all of it. Our lighting setup this year was split into two stage groups: Decorative and Integral. Integral lights included the T5 integrated LED fixtures and the built-in house lights in our school's theatre. These lights provided the core brightness necessary to see the hosts and were not controlled over the Production Network. The Decorative group included all other light fixtures, and was

controlled via a DMX ArtNet network. The network specifics are discussed in the programming and control section. Below is a layout diagram of the stage area:



Stage Area Floor Plan – Not to Scale

We initially planned to only have the Decorative lighting group on the stage, but tech day proved to us that there just wasn't enough light on the stage for the Youtube camera to properly catch a view of the presenters.



Stage With Integral Lights On (Layout different as it was not finalized yet)

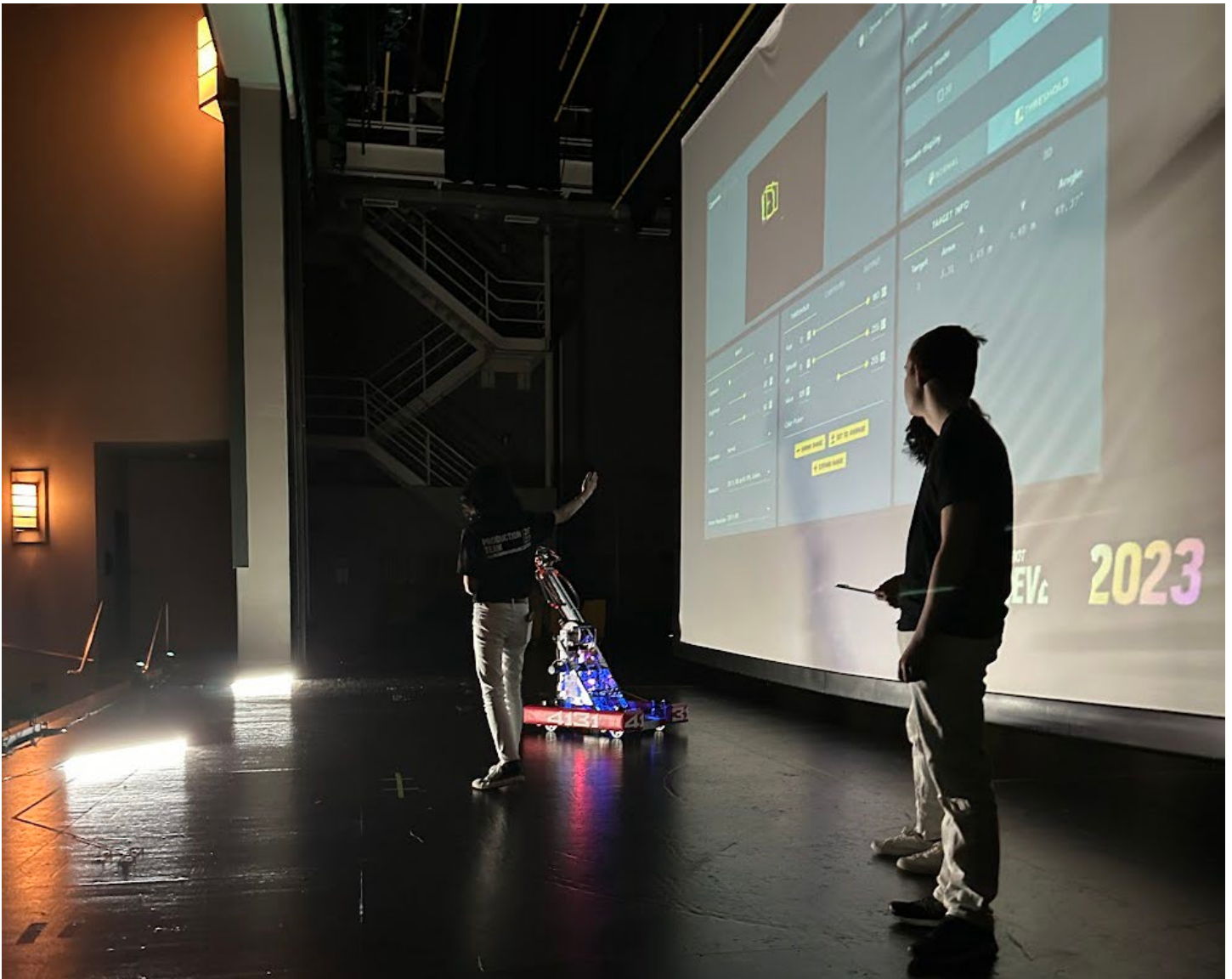
The Integral lights wash out the screen quite a bit, so we had a person manually switch them on and off whenever a reel was playing on the main screen. This was accomplished simply by putting all 3 fixtures on the same circuit and using a power bar to switch it on or off.



Screen Quality With Integral Lights Off

Even without the Integral lighting, the projector we used was quite washed out from years of projecting powerpoints, so we had to modify many of our graphics to include a more subtle highlight rolloff and generally more saturated colors in order to compensate for the color difference. That being said, we couldn't fully correct the error as the same graphics were used for the Youtube stream, and corrections that were too strong would cause the remote broadcast to look weird.

Moving into 2024, we're exploring better Integral lighting systems that will not only be digitally controlled but also provide a fuller lighting volume. The setup in 2023 was put together fairly last-minute, and meant that we were forced to light our presenters from bottom-up. This is generally not good practice, and it's for very good reason. Our presenters had scripts and presentation notes on paper that they were bringing on stage, and those documents tended to block the light from properly hitting their face. While we couldn't find a fix in time for the show in 2023, we're determined to fix the problem in 2024.



Final On-Stage Lighting Layout with Presenters (ft. Team 4131)

You'll also notice on the stage diagram that the main screen is labeled "Graphics A.1 Feed." We labeled each of our video feeds with an admittedly far too robust naming system that will continue to be in use in 2024. The name indicates that it is the A feed for Graphics, and that it takes first priority over all other channels of the Graphics A feed if we have any issues that require us to take any of them down. There were several other feeds. For instance, the Youtube stream was labeled Broadcast A.1, and included the Graphics A.2 and Camera A.1 feeds. Additionally, we had a Graphics B feed for monitoring purposes, sent out over the Production Network for any devices that were connected.

Lighting Control and Programming

The entirety of the Production Network depended on a \$25 Cisco router that we bought on Amazon after clicking on the first link for “WiFi router.” Luckily for us, we didn’t run into any connectivity problems so we are tentatively recommending any available WiFi 5 or 6 router you can get your hands on for a Production Network.

DMX: A Brief Introduction

Standing for Digital Multiplex, the DMX protocol is actually quite similar to the CAN Bus in FRC. Devices are daisy-chained to one another using XLR cables and all signals are transmitted across the entire network. Where DMX differs, however, is its channel system. CAN devices are usually assigned an ID, which is how the controller knows which device is which. DMX networks aren’t as high tech, and instead utilize open channels that all devices can access. A group of 512 channels is typically referred to as a “DMX Universe,” and multiple Universes can be hosted on a single ArtNet. ArtNet is a DMX communication protocol that allows controllers to access a set of channels. It manages the polling of data from devices as well as the distribution of control signals. It is critical that you purchase an Ethernet to DMX ArtNet converter as standard Ethernet to DMX converters are merely designed to convert the signal type from CAT 6 to XLR. ArtNet converters host the network for the DMX signals and allow you to connect to the network for control via Ethernet.

Each DMX device you use will take up a certain number of channels. Many lights have multiple modes that take up varying numbers of channels so you can pick one that fits your needs best. Higher channel modes offer more fine control over your lights’ settings at the cost of taking up precious bandwidth. You’ll assign each device a starting Channel ID, which tells the light what range of channels to look for signals in. For example, a 12-channel light with a starting channel set to 11 will assume that CH11 corresponds to its First Channel signal, and CH22 corresponds to its 12th Channel signal. Our production utilized about 50 channels – our moving head lights were split into 2 groups rather than 4, meaning that each pair of lights on the left or right side of the stage were set to the same starting ID. Unlike CAN, setting devices to the same ID merely instructs them to use the same signals for control. This allows you to mirror your fixtures easily.

Control Software:

As mentioned before, lighting controllers are typically very expensive. Hardware boards can run you thousands of dollars, and many of them aren’t even ready to run out of the box – you need to purchase software to control the controller. While that route offers infinite customizability and incredible potential for light shows, we just didn’t have the cash nor did we want to try to justify spending more on the control system than our lighting fixtures. We eventually settled on a piece of software called Vibrio, which runs on an iPad to transmit ArtNet signals via WiFi. This is why we needed to set up a Production LAN, as it was the most cost-effective way to control our lighting fixtures.

Vibrio offers reasonably advanced control of DMX-capable lighting fixtures, but unfortunately is not as fully-featured as most industry-standard software. For example, its sequencing system is fairly rudimentary – users must create pre-determined scenes that define fixture colors, positions, and brightness before stringing them together in sequences using timers. This approach works well for simple looping, but for our light shows that spanned 3 minutes or more, the interface quickly became cluttered and hard to use.

To set up your own system in Vibrio, you'll need to first connect to your Production Network from the iPad running Vibrio. Then, you'll need to go to the "Stage Groups" tab to configure your light fixtures and channels. If you have lights from more popular brands, they might have existing presets in the app. Otherwise, you'll need to build them out according to your light fixtures' instruction manuals. Once your channels are configured, you'll be able to access your fixture groups from the Scene tab. This is where you'll be able to create static scenes and string them together in sequences. Scenes can also include patterns, which are defined on a per-fixture basis and can include motion, color, or brightness, but not multiple. We're working on a Youtube series highlighting our lighting setup, and hope to have it released over the summer. For now, a demo light show video is available [here](#).

Scene Syncing:

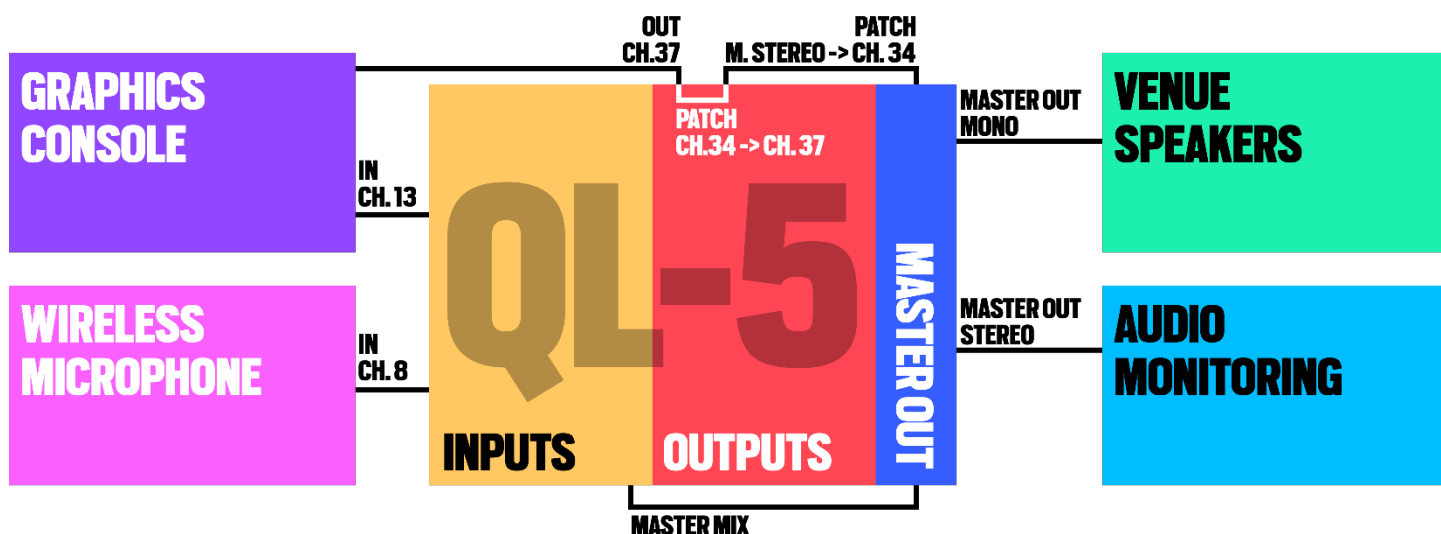
Since our lights and graphics were controlled in 2 separate software environments on 2 separate devices, we had no choice but to sync the light shows to the graphics by good old human coordination. A few solutions were proposed for this task, with the initial winner being a subtle visual cue on screen (that would be rendered as a part of the reveal reels) that would provide the lighting coordinator with a countdown to press their transition button on time. This solution is the most reliable, but would have resulted in a transition time of 3-5 seconds, which is far too long. Constant pauses of that length would create awkward silences and just generally not look good. Instead, we opted to have the Feed Operator and Lighting Operator verbally count down together, and time their respective scenes so that pressing "transition" on both devices at the same time would result in a synced show. With a few hours of practice, our operators were able to have this system down with no issue.

Audio

I want to open this section by mentioning that audio is by far the Craft Area that we are least experienced in – we had no dedicated Audio Technicians and nobody with industry experience to help us out this year. That being said, we're here to at least share what we learned as we inevitably made some mistakes along the way.

We were fortunate to have been able to use a 64 channel mixer that our school already owns. This Yamaha QL-5 would serve as the hub for our audio operations on show night. All EQ settings were already set by the school when we got the panel, so we honestly can't tell you much about how to tune your speakers. We'd be far overreaching our realm of expertise if we tried to explain it anyways. In terms of signal routing, our system is definitely not the most efficient way to accomplish our goal, but it

was unfortunately the only way we could think of to get our setup to work properly without breaking the bank. Below is a signal route diagram:



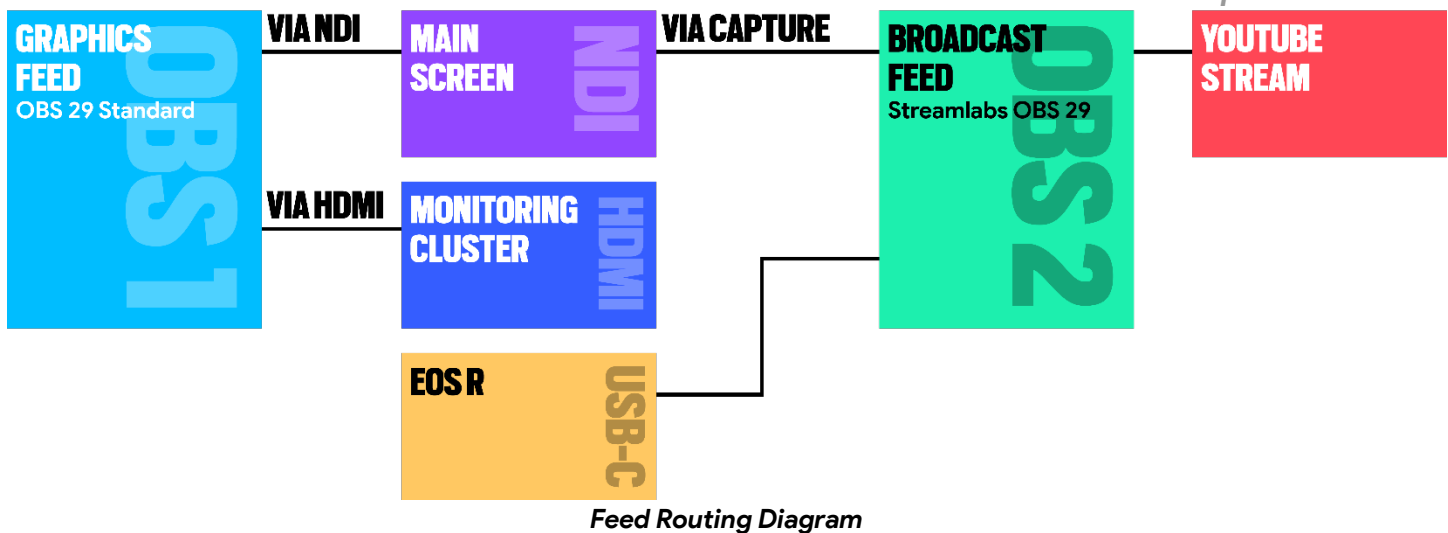
Reveal 2023 Audio Routing Diagram

You'll notice that there's some circular routing going on, and that's intentional. Since our microphones connected directly to the QL-5, there wasn't a good way to get their signal back to the Youtube stream unless we piped the entire master mix back into our graphics console. Unfortunately, the QL-5's master mix had an annoying noise floor that we couldn't get rid of no matter how hard we tried, so the broadcast audio feed wasn't as clean as we would have hoped to have it. All of the patches were made digitally in the QL-5 software, allowing us to mirror inputs and outputs to various channels, making the hardware setup much simpler.

On-Stage Graphics Control

To display our graphics to the stage screen and broadcast to YouTube, we used a virtual switching software called OBS. At this point, we're fairly certain that most people are familiar with the program's basics, so this section will dive deeper into our setup and specific use case. To learn about OBS, check out their website [here](#).

We had originally planned on using OBS 28, but had to upgrade to OBS 29 during Tech Day 1 due to some significant performance issues with the older builds. We also noticed that running 2 instances of OBS can cause video/audio desync on the main graphics screen (we believe this is an issue with the NDI API or Plugin), so we had to run 1 instance of standard OBS 29 and 1 instance of Streamlabs OBS 29. The only plugin we used was the OBS NDI Plugin, which allowed us to send our video feed via the Production Network to... the same computer! The reason why this was necessary was because of the way OBS Audio feeds work – monitoring your audio feeds locally doesn't play audio transitions properly for some reason, your sources simply cut between one another instead of behaving with the intended transition. NDI pulls from the final OBS Output feed, which includes the audio transitions. This simple issue is why we needed such a large workaround. On the next page, you'll find our feed routing diagram for Reveal 2023.



Our main OBS feed was sent via the NDI plugin to another window where both the audio and video played to the QL-5 and the projector respectively. Then, our Streamlabs instance captured the graphics display as well as the QL-5 Master Output to mix them together to the main feed. A secondary scene for the EOS R feed was switched to when presenters were on stage.

Plugin Setup:

The only third-party plugin we needed this year was the OBS NDI integration, which allows you to send your OBS program feed out to the NDI cloud on whatever network you are connected to. In our case, we didn't need to modify any settings on our firewall since we were simply accessing the feed again from the same computer. NDI Studio Monitor is a good option for this – we just pulled up a second window and projected it fullscreen to our graphics monitor.

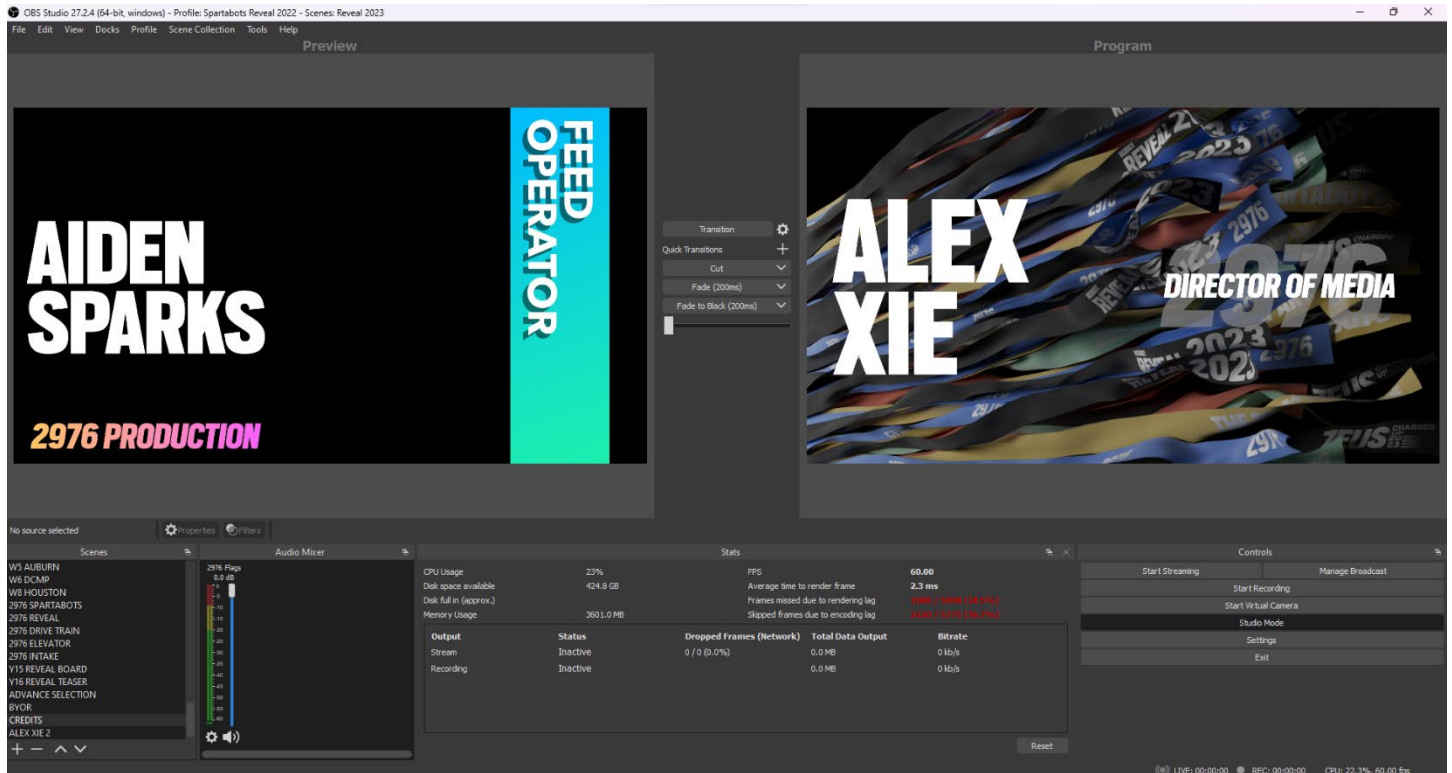
Broadcast Settings:

Youtube can (allegedly) handle bitrates up to 10mbps, so we streamed to our stream key at 10000kbps CBR, with NVENC hardware acceleration. The final output was scaled to 1920x1080 at 60fps. We experimented with 59.94 drop frame codecs as well, but ended up settling for 60 mostly arbitrarily, but also partially due to our After Effects compositions being set to 60p (by definition in branding standards).

Scenes:

Each scene we created was a transitionable module – these modules could be theoretically displayed in any order (despite there being a script) so that we had maximum flexibility in our show night configuration in case something were to go wrong. In the end, we largely succeeded in our goal to create the Infinity Fabric of Scenes, and will be continuing with the same modular system in 2024. All scenes consisted of either a looping graphic or single video with a built-in transition into the loops, and most scenes simply transitioned using a 2-step sequence: fade to black, then fade to next. Notable

exceptions to this general convention include Alex's name tag, which was instead encoded as a stinger transition that was programmed to link with Alex's idle loop scene, and the final credits scene. Any switches to Alex's scene would trigger the stinger instead of the standard sequence, and the credits were designed to start on top of any other scene, so it has a simple cut instead, with the transition built into the video file.



OBS Window Setup

Switching was done in studio mode to prevent accidental scene swaps and to ensure that the F/O could verify that the correct scene was on deck.

Most of the heavy lifting during production was done by our motion graphics designers, who meticulously created animations that would seamlessly line up without any further manipulation in OBS. We encourage you to do the same – the less work you have to do on show night, the better, even if it means days of painfully tedious setup work leading up to the event.

Performance Optimizations and Asset Consolidation:

Asset Consolidation is important for large productions to reduce RAM usage on your broadcast machine – the less total size of assets that need to be loaded, the less likely your stream is to drop frames. While most of the reels were unique in Reveal 2023 and thus had to be loaded separately, each team's flags were rendered as a base loop without any text, and other graphics were overlaid on top as PNG images or persistent video files. By doing this, we could display a number of different graphics with the same flag backgrounds (i.e. 2976's team idle loop and the Director of Media idle loop) while only loading 1 video file and a few images.

Before we ran Reveal 2023, we would have recommended that all assets be rendered in ProRes, preferably a variant that supports the alpha channel (such as 4444 XQ). As discussed in Asset Production, however, we ran into some serious performance issues with ProRes since our broadcast PC was not equipped with a ProRes encoding card. With just CPU encoding, our production ground to a halt with framerates in the 10-20 range. We mentioned the workaround in a previous section about this issue, so flip back over there to see how we transitioned into a primarily h.264 production.

Our Dual-OBS instance setup for both graphics and streaming was, in our opinion, quite annoying and we would recommend 2 broadcast machines for Showrunners looking to stream their events. Despite the Streamlabs OBS workaround, running 2 instances of any broadcast software seemed to cause a plethora of issues for our production. Our recommended solution for dual-broadcast production is as follows:

- Broadcast Machine 1: HDMI Out to Capture Card
- Broadcast Machine 2: HDMI Capture Card in, stream out via Internet
- Capture Card: In from Machine 1, out to Graphics Display

The above solution should eliminate switching issues and also allow you to utilize 2 Feed Operators for your production, splitting the workload more evenly and ensuring a quality experience for both your remote and in-person audiences.

For reference, below are the equipped specifications on our Broadcast Machine (Razer Blade 15 Advanced, Early 2021):

- Intel Core i7 10875H, 8C 16T
- 32GB DDR4-3200Mhz Memory
- NVIDIA RTX 3070, 8GB GDDR6 VRAM

With our GPU-heavy approach to rendering production assets, the Blade was easily able to handle both feeds without dropped frames. However, we noticed that more than a couple of CPU-rendered sources would cause one feed or another to drop frames. If you plan on utilizing software rendering, we recommend a desktop PC with a more robust CPU than a gaming laptop. That being said, our minimum recommended broadcast specifications are listed below:

- 4C 8T CPU with adequate cooling
- 16GB dual-channel memory (generally most recent laptops will tick this box)
- NVIDIA RTX 2060 or equivalent GPU (if your stream is light, you can get away with a GTX 1660 equivalent as well)
 - For mobile GPU variants, we don't recommend any machines equipped with less than a GTX 1660Ti Mobile

A laptop or PC with the above specifications should be able to handle, at the very minimum, a graphics feed for your event. While we can't guarantee performance with more than 1 feed, we believe the above machine could also dual-broadcast (this is based off of our own performance numbers, which indicated our 3070 had quite a bit of headroom). Ensure your broadcast machine has access to fresh air and that its cooling system is free of excessive dust buildup.

SCRIPTWRITING

“We’re here to create a spectacle for the public – don’t you ever forget that. Anything and everything we do needs to interest the audience or show them something new”

Scriptwriting and program design is something that is commonly overlooked in high school presentations and productions like this. Even if they do write a script, event organizers often forget their target audience and create a program that feels disconnected from the people watching. With Reveal 2023, we aimed to train each team’s scriptwriter to create a presentation that not only breaks down their robot into digestible information bits, but also sheds light on a unique concept that the audience had potentially never seen before. To do this, we hosted 2 scriptwriting seminars where we went over previous reveal scripts and directed some advice towards the teams who would be writing a program script (most likely) for the first time. Below are some general points that we emphasized:

- You can be casual – in fact, we encourage your language to be relatively laid back. In an event like this, it’ll help you connect with your audience more and they’re more likely to not get bored if the presenter on stage feels human rather than robotic. That being said, we still strive for professionalism and discourage excessive joking or quips that cross the line.
- Don’t assume anything – for all you know, your audience has no idea what a Swerve Drive is. Explain anything and everything that isn’t common knowledge for people who aren’t engineers or robotics team members.
- It’s okay to stretch the truth a little bit to sound impressive – obviously, don’t speak lies, but a good example of this effect is offhandedly mentioning that a swerve drive (theoretically) has 3200 watts of power going to the wheels. While not wrong, this is obviously an exaggeration for the sake of making the drive system look cool. Don’t rely on this too much but also don’t write it off as a marketing ploy. Marketers do this a lot because it works.
- Try not to dwell on the same topic for too long – our audience is here to see cool robots, not hear about every little issue you encountered while designing an intake. Make big, broad points and include specific details only when they’re particularly interesting or very important to the development of your robot.
- Also consider non-robot topics – talk about your season, your goals, or even other non-robot projects you’re working on. It’ll give your team a little more personality and can help to fill time if you run out of robot content to speak about.
- Don’t bring someone else down to put yourself higher – we haven’t had an issue with this yet, but other sports and competitions (looking at F1 specifically) have a culture of making quips or straight up clowning on other teams for the sake of making one’s own team look better. While it’s an acceptable (and sometimes funny) practice in those sports, we can’t condone it in FRC since one of our key pillars is being Graciously Professional.

Program Design

The order of events is surprisingly important and we decided to block out our time before any scripts were even written. Below is the schedule that was written for Reveal 2023:

2023 ROBOT REVEAL SCRIPT

READY FOR PRODUCTION

Doors open **6:45 PM**, target start time **7:15 PM**

Clean up and out by **10:00 PM**

Order of presenters:

- [15m] Alex: Intro event, thank sponsors, introduce 948
- [15m] 948
- [5m] Alex: Intro 4131
- [15m] 4131
- [5m] Alex: Intro 5937
- [15m] 5937
- [5m] Alex: Intro 7461
- [15m] 7461
- [10m] Alex: Event breakdown, Intro 2976, play 2976 reel
- [15m] Alex: Zeus Reveal
- [15m] Alex: Final things, Y16 teaser, etc.

Target time: 2 hours max, **1:45 target**, suggested times listed above

[LIGHTING CUES IN BLUE]

[OBS CUES IN GREEN]

[STREAMDECK CUES IN RED]

Reveal 2023 Event Breakdown

We decided to interlude each team's presentation with either a quick intro or some other larger program (such as the event list just before 2976 presented). This would serve to refresh the audience's attention span and help reduce the boredom that could arise from 5 presentations in a row.

Finally, you'll notice that there's color coded cue markers at the bottom of the title page. Our script also acted as the master cue sheet. While each team only got a copy of their portion of the script, our Feed Operator and other key personnel got full copies of the master script so they could ensure that every scene change and lighting trigger was initiated on cue. On the next page, you'll find an example of a cue sequence:

02 948 INTRO

Hailing from Newport High School in Bellevue, Washington, the Newport Robotics Group, more commonly known as NRG, will be competing in their 22nd season of FRC this year. NRG is the oldest team here tonight, with a long and storied history, most notably making an appearance in the 2019 Einstein finals. They're an Open Alliance team this year, and have been posting steady progress updates on their robot since kickoff. Today, they're excited to unveil the final product of their work. Please welcome to the field, Dodo!

[SCREEN]

[948 NRG]

[948 SNEAKERS]

[CAMERA]

[948 IDLE ON FINISH]

Scene and Lighting Change Cue Sample

These types of cues were littered across the script and would serve as easy-to-spot reminders for our key personnel. All of the cue names matches the OBS scene names and Vibro scene names exactly, so there was no ambiguity regarding what scene we meant in the cue.

All of this being said, your program design will depend a lot on your intended audience and general event vibe – we left this section intentionally quite vague and expect Showrunners to be able to define their own set of scriptwriting conventions that fit their event.

FINAL THOUGHTS



Consolidating all of this information into just under 50 pages was quite the feat on our end. We hope that this whitepaper will serve as a helpful resource for teams looking to run live events or level up their video production value.

The live production industry is one that we, quite honestly, dislike the culture of. Out of our production hours, the majority were spent researching nuanced issues that had very little public documentation due to the industry's practice of internalizing documents and verbally transferring knowledge. As far as we know, this whitepaper is the first time any live production has released details regarding their setup and design process. All of this is to say that we had no other papers to use as examples and pretty much had to guess on what topics to cover and how to group them. Because of this, we're always open to specific questions via email or on Discord and are happy to help you out if there's something we missed in this paper. We'll be releasing revisions of the whitepaper on regular intervals, at the very least once a year, with any new information we discover or with new production technologies that we adopt. Looking forward to 2024, there's some lighting system changes and 3D rendering techniques that we're looking forward to covering.

One question that we are able to answer right now, however, is “can you release the original file/project file for [x, y, or z]?”

Unfortunately, the answer to that question is almost always going to be no. This is for a number of reasons, mainly because it would be too costly to host these files online (the entire Reveal 2023 project folder is over 293GB, not including event VODs and test renders). Additionally, we're here to promote the creation of unique and original content, so releasing our project files would directly contradict that mission statement. If you're looking for more in-depth tutorials about a specific project or technique, submit a Proguide request to our email and we'll be happy to look into making a video!

Using this document responsibly

By “responsibly,” we mean a couple of things:

- Don't overwork yourself
- Don't plagiarize

We aren't as worried about the second point, but we want to make it clear that replicating events like Reveal 2023 will entail just as much work as we put in (despite this helpful document leading you along) and anyone looking to do so should be prepared with a team of at least 3-5 experienced artists who are willing to put in 200+ hours each across 6-8 production months. We believe that the more responsible use case for this document is to pull elements or specific techniques that you like, and apply them to projects of your own – always ensure that your ambitions entail a workload that is reasonable for your

schedule. That being said, if you DO replicate our event, we want to see it! Tag us on social media or shoot us an email and we'll be sure to check out the stream (if there is one) and help you promote your production.

...now on to the less fun part. We have not seen any plagiarism issues in our history of releasing guides, and we don't expect it to be an issue. That being said, we are by default going to make it clear that these resources are intended to aid you in your own creative process to create something unique and original. We won't come after you unless we see something released with nearly identical features, so don't worry too much about borrowing design elements – after all, we did the same with Worlds 2022. In any case, make sure you know where to draw the line between a “reference” and a “copy.”

Work produced by Team 2976 (The Spartabots) is protected under YouTube's copyright protection policy. All other assets are currently under copyright review as part of application case 1-12616543211 with the United States Copyright Office.

Anyways, with the legal jibber jabber out of the way, we'd like to send you off with a deep thanks from our Reveal Production Unit and the Spartabots Media Team. Reveal 2023 was an effort of more than 10 months in the making and we're incredibly grateful to everyone who supported our event, both in-person and online. We're super proud of our work and are happy to have been able to share the creative process we took to reach the final product. We'll see you around as more information about Reveal 2024 begins to release in the coming months.

So once again,

Let's **make something incredible** together.



ROBOT
REVEAL

2023

ROBOT
REVEAL

2023

Team 
2976

A FIRST® Washington Team

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Teams may take inspiration from this
document to create their own