



3D Printing Competition: Bridging the Future

2023 Rules and Requirements

Competition Rules Committee led by the New Jersey Institute of Technology

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1. Welcome

The American Society of Civil Engineers (ASCE) supports and encourages a fully inclusive culture that celebrates individual uniqueness, engenders a sense of belonging, and promotes equitable opportunity for all people to participate in the 3D Printing Competition. (See ASCE [Policy statement 417 - Justice, equity, diversity, and inclusion.](#)) Participation should be inclusive, open, and fair to all interested and eligible students. Welcome!

2. About the Competition

Three-dimensional printing (3DP) is an emerging construction technology. 3DP operates by adding sequential layers of material to create a solid object, which saves labor cost, minimizes material waste, and optimizes building time. While 3DP has been used to create prototypes and small-scale models of the built environment for some time, the technology has advanced to the construction of houses and bridges.

The goal of the 3D Printing Competition is to promote the application of 3D printing technology in the field of civil engineering. For students, the goal is to design an aesthetically-pleasing, strong, and stiff bridge that will take the least amount of assembly time and meets the geometric requirements.



Figure 2: The world's first [3D printed footbridge](#), 2021, Amsterdam, the Netherlands (Ana Fernandez/SOPA Images/LightRocket via Getty)



Figure 1: [First 3D-printed home in the United States](#), 2021, Williamsburg, VA (Alquist 3D)

Students must pay attention not only to the design, but also the details of the print, which play a significant role in the shape, tolerances, and strength of the bridge. Students will demonstrate teamwork, organization, analytical skills, and creativity throughout the process of the competition.

The 3D Printing Competition has its origin at the New Jersey Institute of Technology's inter-collegiate competition in November 2021. ASCE gratefully acknowledges NJIT's efforts in creating the competition and working to expand its reach among civil engineering students.

3. Participation and Eligibility

a. Student Requirements

Students must be undergraduate students, members of an ASCE Student Chapter in good standing, and Society Student Members of ASCE. (Society student membership is free; be sure to [join](#).)

b. Team Requirements

It is an expectation that teams will reflect diversity, foster an inclusive culture, and treat everyone with dignity and respect.

Only one team per ASCE Student Chapter may compete in the competition. A student chapter may compete in only one ASCE Student Symposium. The teams shall consist of undergraduate students enrolled during all or part of the current competition academic year. Graduate students may serve as advisors. Each team must have at least one captain. Conference assignments and student symposium host chapters are listed [here](#).

ASCE Student Chapters hosting symposia may invite Official Guest teams, which are teams from Region 10 colleges or universities that have an official ASCE Student Chapter that is not yet assigned to any Student Conference. Official Guest teams may compete in only one student symposium per year and are eligible to place and receive awards at the student symposium competition (if they meet the other requirements, including eligibility requirements). ASCE Student Services shall be notified by the ASCE Student Symposium host school of an Official Guest team prior to the start of the student symposium via email to student@asce.org.

An ASCE Student Chapter team wanting to enter a competition that is NOT being hosted at their assigned student symposium, may request to compete at another ASCE Student Symposium as a guest team. If the student symposium host grants permission, the guest team may compete. The guest team will be scored but shall not win awards at the student symposium competition.

c. Student Chapter Eligibility

Eligibility criteria for the Student Symposium Competition are shown in Appendix A.

d. Intent and Eligibility Acknowledgement Form

Teams shall submit an Intent and Eligibility Acknowledgement Form (see Appendix B), no later than 5:00 p.m. Eastern on January 31, 2023. By completing this form, a student chapter states their intent to have a team participate in the competition at their assigned student symposium as well as acknowledges the eligibility requirements for student symposium competition participation. The form must be signed by the Team Captain, ASCE Student Chapter Faculty Advisor, ASCE Student

Chapter President, and Competition Team Faculty Advisor (if different than ASCE Student Chapter Faculty Advisor).

The team captain shall upload the Intent and Eligibility Acknowledgement Form to ASCE's Cerberus files transfer protocol (ftp) server. Refer to Appendix C for upload directions.

4. Ethics and Required Conduct

This competition is to be conducted with the highest regard for ethical responsibility per [ASCE's Code of Ethics](#). All members of ASCE, regardless of their membership grade or job description, commit to all of the ethical responsibilities in this Code. All ASCE members should make themselves familiar with ASCE's Code of Ethics.

All participants shall act professionally and respectfully at all times. Failure to act appropriately may result in sanctions, disqualifications, and loss of invitations to future symposia competitions or Society-wide competitions. The inappropriate use of language, alcohol, or materials, uncooperativeness, and general unprofessional or unethical behavior will not be tolerated.

5. Safety

Safety is the highest priority and risk of personal injury will not be tolerated. Judges and student symposium hosts are empowered to prohibit any activity which is deemed to be hazardous.

Participants acknowledge that there are risks to be considered when creating and testing 3D printed structures. Bridges should be printed in a well-ventilated area, and care should be taken to avoid injury when working with a 3D printer. Connections that are 3D printed are prone to some error, and participants are encouraged to print tests of connections to account for tolerancing issues. If any parts need to be filed or cut, participants need to ensure proper caution as well as hand and eye protection are used. In the testing of bridges, participants must be cognizant of PLA's brittle nature. Bridges can fail suddenly and even explosively. Only participants actively involved with the testing of bridges should be near the loading apparatus and should wear eye protection as well as work gloves if handling the bridge or the loading apparatus during testing. Participants should consistently use the safety features included in the loading apparatus (e.g., plexiglass shield).

All participants are responsible for complying with all campus protocols and procedures including but not limited to COVID-19 guidelines related to in-person meetings, masking, social distancing, etc., at all times in connection with planning, preparation, or participation in the competition.

Given the continually changing environment surrounding COVID-19, virtual competition provisions may be provided and may be activated in coordination with ASCE.

6. Bridge Dimensions

The bridge must span an open length of 24 inches (610 mm). The total bridge length can be no longer than 28 inches (711 mm) for a 2-inch (51 mm) bearing support on each side, no taller than 8 inches (203 mm), and no wider than 6 inches (152 mm). The bridge structure can extend no more than 2.5 inches (64 mm) below the piers and no more than 6 inches (152 mm) above the piers. The clear volume through the bridge must be greater than 3 inches by 3 inches (76 mm x 76 mm) area through its entire length to allow a test vehicle of those dimensions to pass easily through. This volume must not be interrupted by structural elements. The clear volume should be 1.5 inches (38 mm) above the piers and should be underlain by a deck for a vehicle to pass over (see Figure 3 and Figure 4).

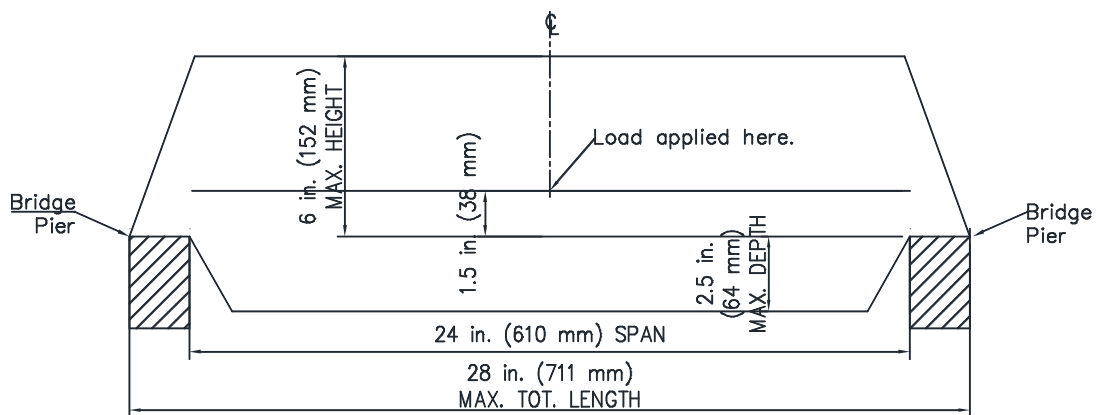


Figure 3: Elevation View of Bridge

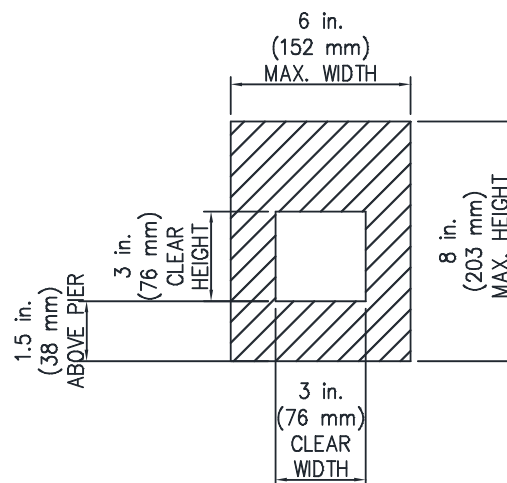


Figure 4: Section View of Bridge

7. Bridge Parts

- a. All parts must be printed with 100% Plain PLA (Polylactic acid). No other material fill allowed.
- b. The maximum allowed bridge weight is 17.6 ounces (or maximum mass is 500 grams).
- c. All parts together must fit into a box 8.7 in. (220 mm) wide, 8.7 in. (220 mm) long, and 6.5 in. (165 mm) high.
- d. Only mechanical connections (no adhesive allowed).
- e. No unextruded filament may be used in the bridge.
- f. There is no limit on testing of parts and bridges before competition.

8. Tips

- Make sure that all parts you design can fit within the bed of the 3D printer you are using.
- 3D printed sockets tend to be slightly smaller than designed, so be sure to adjust your designs to accommodate shrinkage as the filament cools during printing. Test printing small samples of the connections will help you calibrate connection fits with your printer/filament.
- Check the fits of all components before the day of the competition as much as possible.
- Ensure the length and width of your bridge match the specifications so that your bridge qualifies and can be tested.
- It is important to engage the entire superstructure in supporting the load—not just the bridge deck or the point at which the load is applied, so make sure the deck is well connected to the superstructure.

9. Scoring

There are five weighted metrics which will be added in aggregate to determine the teams' overall scores. The metrics and their weighted contribution are shown below in Table 1. In addition to receiving a single score which will be the basis for winning 1st, 2nd, and 3rd place overall, the top two teams in each category will be separately recognized for their superior performance in that category.

Adherence to the rules is crucial to ensuring a fair competition. Teams will be subject to deductions determined by the judges for deviations from the rules as they relate to each category. Information on each category is detailed in the following sections.

Qualitative categories (Aesthetics & Presentation) will be determined by a simple ranking system, and quantitative categories (Load, Stiffness, Assembly Time) will be based on a proportional ranking system. The last-place team in a given category will receive 1 point, and the first-place team

will receive the full points (e.g. 50 points for highest vertical load). The remaining teams will be allocated points based on linear interpolation. For example, if four teams compete and have vertical loads of 260, 160, 140, and 100 lb., the first team will receive 50 points, the second team will receive 19.4 points, the third team will receive 13.25 points, and, and the fourth team will receive 1 point.

Table 1: Overall Category Score Weighting

Vertical Load	Vertical Stiffness	Assembly Time	Aesthetics	Presentation
50	20	10	10	10

a. Assembly Time

- i. Each team is to have one or more representatives work together to assemble the bridge.
- ii. The time is multiplied by the number of members working on assembly.
- iii. Teams taking 15 minutes or longer to assemble will receive the minimum score in this category.

b. Vertical Load

- i. The load will be applied vertically at center span, with maximum points awarded to the bridge supporting the largest load at failure.
- ii. The bridge must be able to support at least 50 lbs.

c. Vertical Stiffness

- i. Stiffness will be judged at the same load for all bridges (50 lb.) by measuring the vertical deflection at center span.

d. Aesthetics

- i. The aesthetic theme for this competition is nature. Additive manufacturing is the technique that biology uses to create with minimal waste and is a good source of inspiration.
- ii. Judges will rank bridges based on their correspondence to an inspiration the team chooses from nature.
- iii. Include information about the design inspiration in the presentation.

e. Presentation (Poster Board)

- i. Each team will present in five minutes or less a poster board (24 inches x 36 inches) outlining:
 1. Team composition
 2. Design inspiration for bridge

3. 3D images of bridge
4. Print details
- ii. Judges will rank presentations based on:
 1. Readability of poster
 2. Aesthetics of poster
 3. Adherence to the 5-minute time limit
 4. Presentation mechanics (projection, pace, facing judges, etc.)

f. Structural Calculation Accuracy

- i. Teams will be required to predict the ultimate load based on structural calculations.
- ii. The two teams whose ultimate failure load is closest to their calculations will be honored with separate prizes (this is not included in the overall score).

10. Requests for Information (RFIs)

Requests for information (RFIs) regarding the 2023 competition should be sent to student@asce.org with the subject line “**2023 3D Printing Competition RFI**”. Clarifications will be posted at the [ASCE 3D Printing Competition Collaborate Site](#) approximately one week after being received starting January 27, 2023 until March 31, 2023. The cutoff date for submitting a RFI is Wednesday, March 29, 2023 at 11:59 p.m. Eastern. Those received after this date will not be acknowledged or addressed. **Teams are strongly encouraged to submit RFIs to avoid misinterpretation of the rules. All RFIs will be made public.** All teams are responsible for all information provided in the Rules and Requirements and RFI responses posted to the Collaborate site.

11. Timeline

- Intent and Eligibility Acknowledgement Form - due by 1/31/23 at 5:00 p.m. Eastern
- Last day to submit a RFI – 3/29/23
- Symposium dates vary – early March through end of April 2023
- Awards for 2023 ASCE 3D Printing Competition – Student symposium awards ceremony

12. Awards

- a. Recognition awards will be awarded for categories (1st and 2nd):
 - i. Largest Load,
 - ii. Fastest Assembly Time,
 - iii. Stiffest Bridge,
 - iv. Best Aesthetics,

- v. Best Presentation, and
- vi. Best Estimate of Ultimate Load
- b. The team that gets the highest overall score will be awarded the best overall award.
- c. The teams that get the second and third highest overall scores will be awarded second and third place.

13. Judging

The student symposium host shall recruit judges. The judging panel, consisting of a minimum of three judges, shall be composed of industry professionals or educators familiar with bridge design and/or 3D printing.

Judges should be well versed in the rules and RFIs posted on the Collaborate site. The Head Judge is required to attend the Head Judge Webinar hosted by ASCE in February 2023.

Scoring data shall be recorded for each team that competes. Official judging forms shall be used and will be provided by the competition rules committee prior to the symposia. The information from the judges' data sheets is entered into an official scoring spreadsheet which tabulates the official results of the competition. A summary report will be provided to each symposium host for their records and distribution.

At the end of the student symposium competition, the head judge shall promptly upload the completed official scoring spreadsheet for a student symposium competition to ASCE's Cerberus ftp server. ASCE will provide the head judge a secure submission link for ASCE's Cerberus ftp server in February 2023.

Appendix A - Eligibility for Student Symposium Competition

Invitations to Student Symposia Competitions are a privilege, not a right. Failure to act professionally can result in letters of reprimand, mandatory behavior management plans, and loss of invitations to further competition for individual institutions and/or entire conferences.

Eligibility for Student Symposium Competition

The following qualifications are required of all ASCE Student Chapters to compete at the Student Symposia Competitions:

An ASCE Student Chapter must:

1. Be in good standing with ASCE:
 - a. Have paid their annual dues, as received by ASCE, **no later than February 1, 11:59 p.m. EST**
 - b. Have submitted their student chapter's full Annual Report or EZ Annual Reporting Form **no later than February 1, 11:59 p.m. EST**

Questions regarding eligibility should be directed to student@asce.org.

Appendix B – Intent and Eligibility Acknowledgement Form

2023 ASCE 3D Printing Competition Statement of Intent and Acknowledgement of Eligibility Requirements for Student Symposium Competition Participation

Teams shall submit an Intent and Eligibility Acknowledgement Form, **no later than 5:00 p.m. Eastern on January 31, 2023**. By completing this form, a student chapter states their intent to have a team participate in the competition at their assigned student symposium as well as acknowledges the eligibility requirements for student symposium competition participation. The form must be signed by the Team Captain, ASCE Student Chapter Faculty Advisor, ASCE Student Chapter President, and Competition Team Faculty Advisor (if different than ASCE Student Chapter Faculty Advisor).

The team captain shall upload the Intent and Eligibility Acknowledgement Form to ASCE's Cerberus ftp server. The main folder contains a sub-folder for each Student Symposium. (Note: This is a pilot competition. Please verify that your student symposium host is conducting this competition prior to completing this form and if not, consider the guest team option.) This is a Read/Write link (no delete). Refer to Appendix C – How to Navigate Folders and Upload Intent and Eligibility Acknowledgement Form for directions.

File names shall be in the form of "School Name – 3D Printing Intent and Eligibility Acknowledgement Form Year" (example: NJIT – 3D Printing Intent and Eligibility Acknowledgement Form 2023).

Click this hyperlink to submit the Intent and Eligibility Acknowledgement Form:

<https://upload.asce.org/public/folder/FIjFVZz2HUmJS7hi05BD5Q/ASCE%203D%20Printing%20Competition>

Late and/or incomplete submission of this form may be subject to deduction.

School/University Name

ASCE Student Chapter Name

Assigned Student Symposium Name

Statement of Intent

It is the intent of our student chapter to have a team participate in the 2023 ASCE 3D Printing Competition at our assigned Student Symposium.

Acknowledgement of Eligibility Requirements for Student Symposium Competition Participation

ASCE 3D Printing Team Captain (TC) and ASCE Student Chapter Faculty Advisor (FA), please initial next to each statement below to indicate your acknowledgement and understanding of that item. If you have questions about any statement, please contact us at student@asce.org.

	TC	FA
1. We have read the 2023 ASCE 3D Printing Competition Rules and understand the following:		
a. The <u>student requirements</u> of registered participants per Section 3.a of the Rules.		
b. The <u>team requirements</u> per Section 3.b of the Rules.		
c. The student chapter eligibility requirements to participate in the <u>ASCE Student Symposium Competition</u> per Appendix A of the Rules, specifically: An ASCE Student Chapter must: 1. Be in good standing with ASCE: a. Have paid their annual dues, as received by ASCE, no later than February 1, 11:59 p.m. EST b. Have submitted their student chapter's full Annual Report or EZ Annual Reporting Form no later than February 1, 11:59 p.m. EST		
2. Submitting a student chapter annual report is typically the responsibility of the student chapter officers. As team captain and faculty advisor, ASCE suggests that you connect with your student chapter officers early in the academic school year to discuss the annual report and deadline.		

I have read and understand the student symposium competition information stated above, including eligibility requirements for student symposium competition participation.

Team Captain

ASCE Student Chapter Faculty Advisor

Date

Date

Email Address

Email Address

Signature

Signature

ASCE Student Chapter President

ASCE 3D Printing Competition Faculty Advisor (if different than ASCE Student Chapter Faculty Advisor)

Date

Date

Email Address

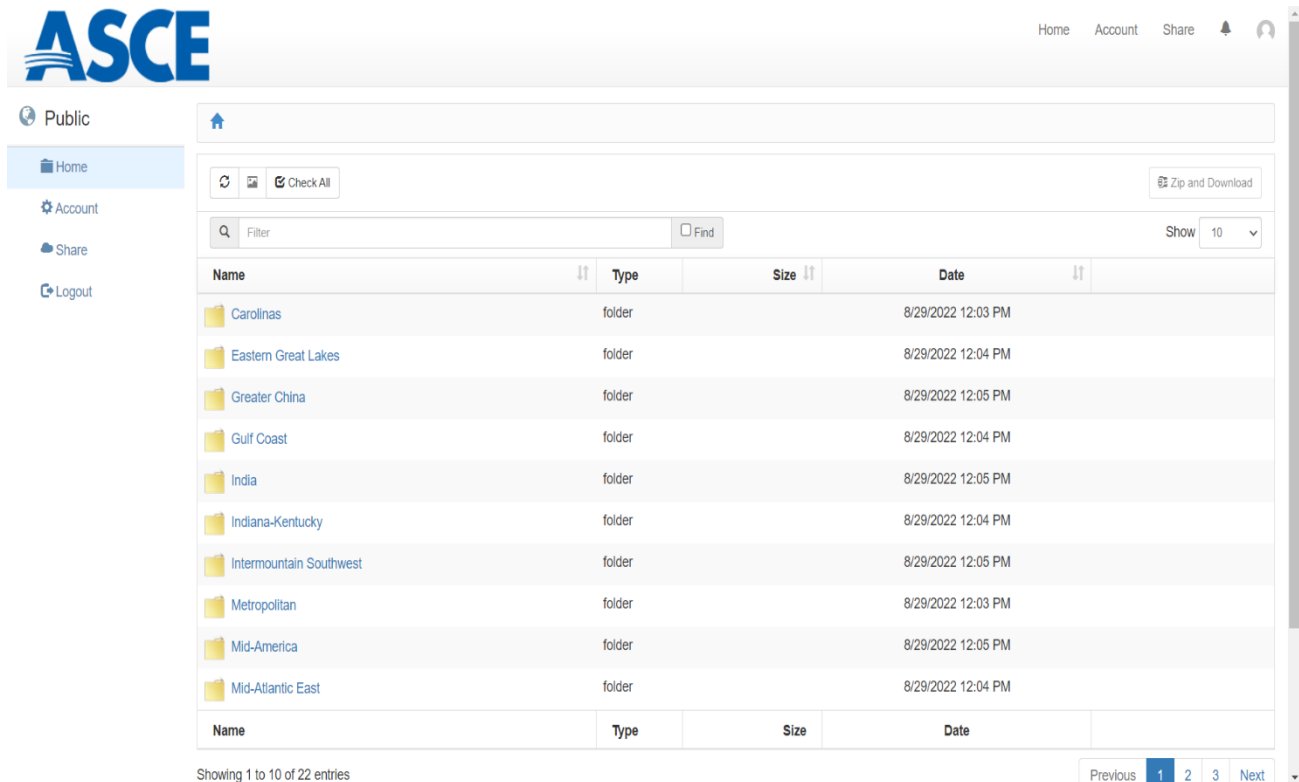
Email Address

Signature

Signature

Appendix C – How to Navigate Folders and Upload Intent and Eligibility Acknowledgement Forms

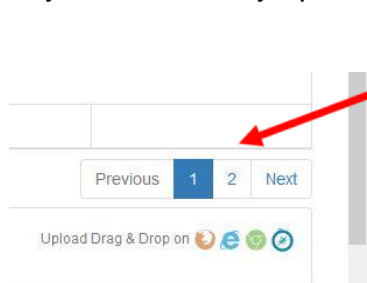
When you first arrive at the upload site, you will see folders labeled for each Student Symposium:



The screenshot shows the ASCE upload site interface. The ASCE logo is in the top left. The top right has links for Home, Account, Share, and a notification bell. On the left, there is a navigation menu with Home, Account, Share, and Logout. The main content area shows a list of folders for various Student Symposia. The folders are: Carolinas, Eastern Great Lakes, Greater China, Gulf Coast, India, Indiana-Kentucky, Intermountain Southwest, Metropolitan, Mid-America, and Mid-Atlantic East. Each folder entry includes its name, type (folder), size, and date. The date for all folders is 8/29/2022. Below the list, there is a page navigation bar with 'Showing 1 to 10 of 22 entries' and buttons for Previous, 1, 2, 3, and Next. A red arrow points from the text below to the '2' button in the page navigation bar.

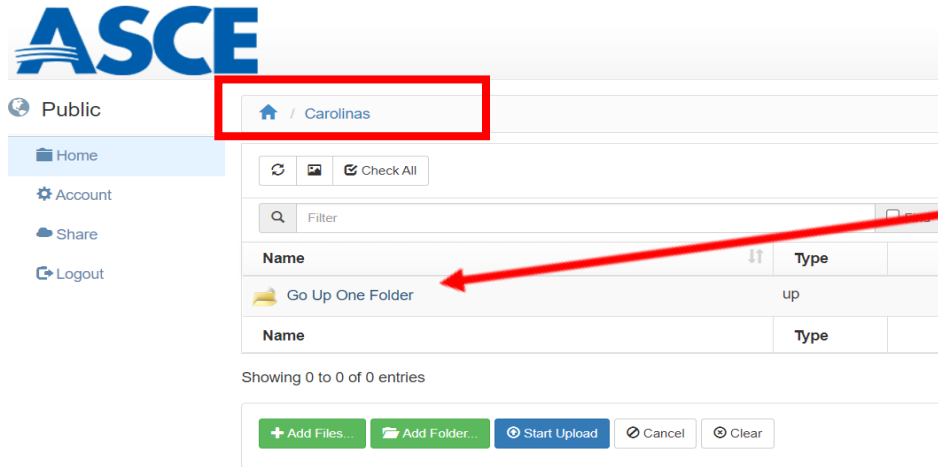
Name	Type	Size	Date
Carolinas	folder		8/29/2022 12:03 PM
Eastern Great Lakes	folder		8/29/2022 12:04 PM
Greater China	folder		8/29/2022 12:05 PM
Gulf Coast	folder		8/29/2022 12:04 PM
India	folder		8/29/2022 12:05 PM
Indiana-Kentucky	folder		8/29/2022 12:04 PM
Intermountain Southwest	folder		8/29/2022 12:05 PM
Metropolitan	folder		8/29/2022 12:03 PM
Mid-America	folder		8/29/2022 12:05 PM
Mid-Atlantic East	folder		8/29/2022 12:04 PM

Locate your Student Symposium and click the folder to open it. If you don't see the name of your Student Symposium, click the page navigation to move to the second page:



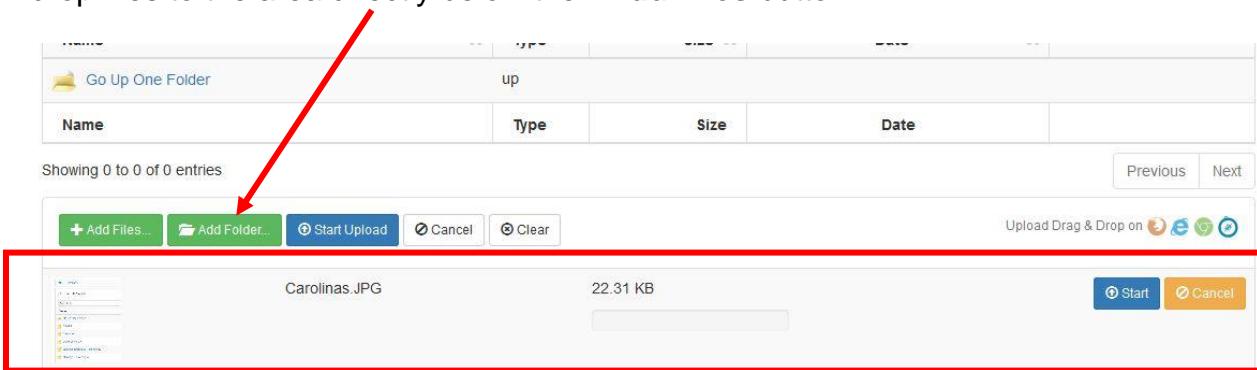
This close-up shows the page navigation bar with buttons for Previous, 1, 2, 3, and Next. The '2' button is highlighted in blue, indicating the current page. A red arrow points from the text above to the '2' button. Below the navigation bar, there is an 'Upload Drag & Drop on' section with icons for various file upload methods.

When you have opened the folder for your Student Symposium, double-check that you are in the correct location before you begin uploading your files (In this case, **The Carolinas Student Symposium**):



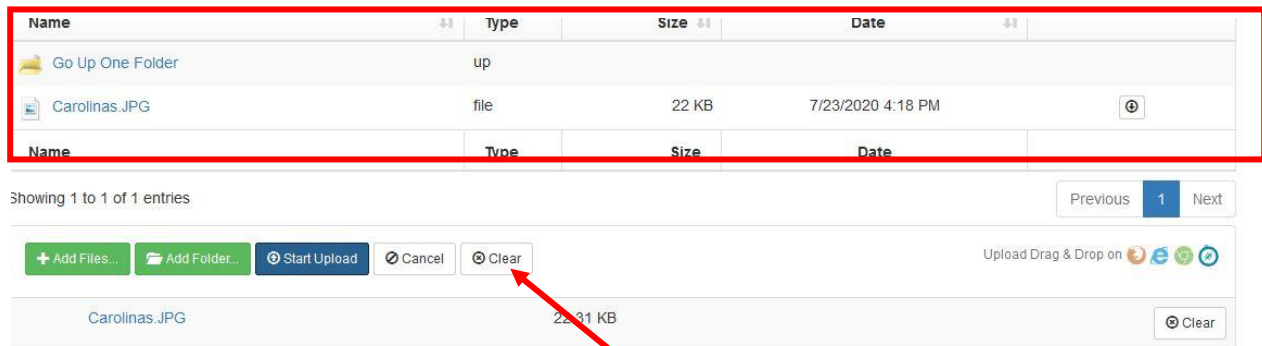
If you accidentally open the wrong folder, you can “back up” by clicking the **Go Up One Folder** folder and navigate correctly.

When you have confirmed that you have navigated correctly to the proper folder, you can either click the **+Add Files** button and then browse to find the files to upload, or drag and drop files to the area directly below the **+Add Files** button.



The selected (or dragged and dropped) files will appear in the upload area. To upload the file into the folder, click **Start Upload**.

When the file has been successfully uploaded, the name of the file will appear under the **Go Up One Folder** folder



Name	Type	Size	Date
Go Up One Folder	up		
Carolinas.JPG	file	22 KB	7/23/2020 4:18 PM

Showing 1 to 1 of 1 entries

+ Add Files... + Add Folder... Start Upload Cancel Clear

Upload Drag & Drop on

Carolinas.JPG 22.31 KB Clear

To clear the uploaded file from the upload area, click **Clear**.

Need help?

If you uploaded a file to the wrong folder, or want to replace an uploaded file with a corrected version, send an email to jupmeyer@asce.org and ask that the incorrect file be deleted. Include both the location (folder path) and **exact name** of the file you want deleted. (Files cannot be moved – you will have to upload the file again to the correct folder after it has been deleted).

Reminder

Please ensure you have uploaded to the correct folder for your symposium and school. Submissions outside of your own symposium folder will be considered non-responsive and will not be considered.