Troitsky Competition Official Rulebook
2024

“It is more than bridge building... it is bridging the gap between the theoretical and the practical”

SUMMARY OF CHANGES

This section contains a list of the major changes between this, 2023, 2022's as well as 2020's edition of the Troitsky rule book. In the event of discrepancy between this list and any relevant section in the rule book, the section in the body of the rulebook shall have precedence.

Since 2020:

- Change in the eligibility criteria for undergraduate students (Section 3.2);
- Clarification regarding the Load Prediction Form (Section 3.3.1);
- Change regarding the pre-fabrication of popsicle sticks (Section 4.1);
- New deliverable, called "Sample of Materials", is added (Section 4.1);
- Change to the penalties for smoothness (Section 5.4.2);
- Clarification regarding the Entry/Exit and Loading Plate Dimensions (Section 5.4.3 and 6.3);
- Redefined the evaluation criteria for Team Spirit (Section 6.2.2);
- Change in the contact information of the Director of Sponsorships (Section 8.2).

Since 2022:

- Moving Load evaluation criteria has been removed (Section 6.3);
- Awarded points for the Presentation have been revised (Section 6.2);
- Awarded points for Team Spirit have been revised (Section 6.2.2);
- Table for Summary of Evaluation is updated (Section 6).

Since 2023:

- Change in the eligibility criteria for coaches (Section 3.2);
- Introduction of regulations regarding the use of clamps (Section 4.3);
- Introduction of penalties that ban participants from receiving points for specific criteria if certain rules are not followed. Affected criteria include Section 5.2.1.1, 5.2.1.2, 5.2.3.1, and 5.8. These bans were introduced mainly to replace some disqualifications.
- Change in the penalty points incurred for the following sections: 5.2.1.1, 5.2.1.2, 5.2.2.3, 5.2.3.1, 5.4.1, 5.5, 5.7.
- Introduction of Section 5.2.2.2 (Deck Height (above deck)). This is partially to replace Section 5.4.3 (Entry & Exit Points) in the 2023 Rulebook;
- Update in Figure 2;
- Minor changes in Section 6.2 (Presentation):

o Participants can present in English or French;

o Participants can send their presentation slides if they have;

- Increase in the number of points awarded for Section 6.5 (Predicted Ultimate Load Carrying Capacity)
- Removal of Section 6.6 (Predicted Mode of Failure) (from the 2023 Rulebook);

Table of Contents

1 DEFINITIONS

This section contains a list of the definitions that are relevant to the Troitsky Bridge Building Competition. The list is by no means exhaustive and should only be consulted as a quick reference for the relevant definitions. In the event of discrepancy between this list and any relevant definition in the rule book, the definition in the body of the rule book shall have precedence.

A	Amps
AC	Advisory Circular
Clear Span	The shortest longitudinal distance between supporting parts of the bridge touching the table.
Coach	A coach is a team or university delegate representative and they do not actually compete and cannot help with the build on competition day.
Organizing Committee	Consists of any and all representatives of the competition, be it directors and executives working under the ECA.
OTR	Official Troitsky Rulebook

2 FORMATTING

Great care has been put into this rule book to make it as easy to read as possible. As such, a specific formatting style has been adopted to allow for information to be found rapidly.

2.1 Points

All aspects awarding or removing points will be underlined. Examples can be seen below.

A maximum of 5 points can be awarded for this section of the rulebook.

Any bridge not respecting this rule will incur a penalty of 5 points.

2.2 Bans

Some rules, if not followed, result in a ban from receiving points for other criteria. This will be indicated with the word "banned" underlined in bold and orange. An example can be seen below.

In addition to this, the team will be **banned** from obtaining points for sections 6.3, 6.4, and 6.5 (Ultimate Load Carrying Capacity, Structural Efficiency, and Predicted Ultimate Load Carrying Capacity).

2.3 Disqualifications

Some rules, if not followed, result in disqualification. This will be indicated with the word "disqualification" or "disqualified" in bold and red. Examples can be seen below.

Teams not respecting this rule will be **disqualified**.

The non-respect of this rule will result in **disqualification**.

2.4 "Rule of Thumb" Boxes

"Rule of Thumb" boxes are yellow boxes that appear throughout the document and provide a layman's explanation of the rules described above. **They do not consist of the official interpretation of the rules and should not be considered as so.** They serve to provide a quick and easy "Rule of Thumb" to check for rules in the rule book. In the event of discrepancy between a "Rule of Thumb" and the relevant definition in the rule book, the definition in the body of the rule book shall have precedence.

Rule of Thumb:

If it is in a "Rule of Thumb" box, it is not an official rule. It instead acts as a quick reference for other rules in the rule book.

3 REGISTRATION

Registration will not be finalized until payment, in the form of a cheque, is received and processed. For mailing address information, please refer to Section 8. When payment transactions are finalized, the participant(s) will be added to the list of teams.

3.1 Team Composition

A team consists of four (4) to six (6) eligible students as specified above. Each team has the option to also have a coach present for the duration of the competition. A coach cannot compete and may not assist in the build of the bridge on the day of the competition. A maximum of six (6) coaches are allowed per university and no more than 1 coach per team. Should your university send a delegation of two (2) teams, for example, a minimum of zero (0) to a maximum of two (2) coaches will be allowed to register.

3.2 Eligibility

Upon registration for the competition, students must be enrolled in a full-time STEM field undergraduate program at a registered university or in a STEM field program at a registered college/CEGEP. Coaches could also be graduate students in a STEM program or have been an Alumni for a maximum of 2 years. All students must be at least 18 years of age.

3.3 Required Documentation

An official document shall be required from the participant's university or college, clearly indicating that the participant is registered in a STEM undergraduate program (or graduate program for coaches). This document

must be received at the latest one (1) month prior to the first day of the competition.

Note:

- Any late submissions (submitted less than 30 days prior to the competition) will result in an ineligibility to compete with no refund;
- Accepted official documents include transcripts or signed documentations. Student IDs are not accepted.

3.3.1 Load Prediction Form

The load prediction form will be provided after the payments are received. They need to be filled out and returned prior to the first day of the competition. No extensions will be awarded for late submissions and a score of zero for Section 6.5 will be awarded.

4 GENERAL CONSTRAINTS

4.1 Permitted Materials

All bridges competing in the Troitsky Competition must be made entirely from the following materials:

- Wooden Popsicle sticks (~ 11.5 cm long, ~ 1 cm wide, ~ 0.2 cm thick);
  - Only commercially available Popsicle sticks are permitted.
- Wooden Toothpicks (non-coloured);
- White all-purpose/multi-purpose glue or equivalent substitute.
  - Lepage or Elmer's white glue are accepted.
  - Epoxy, carpenter's glue (**if it says "carpenter's glue" or "ideal for wood" it is not allowed**), cyanoacrylate or any other glue of this type will not be accepted.
- Dental floss
  - Waxed dental floss is permitted.
  - String or anything that is not branded as dental floss is forbidden.

A sample of all the materials used should be provided for testing. Teams using any unapproved materials will be **disqualified**.

4.2 Pre-Fabrication

Sections of the bridge shall be built in advance in pre-fabricated components. Each component must fit in a box of dimensions (L) 500 x (W) 400 x (H) 300 mm. No part may protrude from the box. The pieces will be tested to fit dimensional constraints one at a time. A piece that does not fit the dimensional requirements cannot be used for the design. No exceptions will be made. Note that the directors will be testing the pieces with their own boxes to ensure consistency and precise adherence to the dimensional constraints.

Rule of Thumb:

Make sure the pieces/sections of the prefabricated bridge are measured during and after prefabrication at your respective workshops prior to arriving at the competition. To avoid any undesired dimensions, it is recommended to build and use a box of dimensions mentioned above to insure the pieces' qualification.

4.3 Assembly

Sections of the bridge that were built in advance and approved for assembly shall be assembled within a three (3) hour period on the day of the competition.

All sections of the bridge must be joined into one continuous solid structure. Any pieces not physically attached to the overall structure and that can be easily removed will be removed and cannot be used. This includes, but
is not limited to:

- Supports that are being used as rests or to elevate the bridge;
- Platform(s) that can slide off or be lifted off;
- Extensions, beams and/or pillars that can be easily separated from the bridge.

Rule of Thumb:

If it is not glued, strung, meshed, etc. chances are it can be removed and will be removed and deemed unusable. No exceptions will be made.

Any assembly or repairs done outside of the three (3) hours will result in an automatic **disqualification**.

Note:

- The bridges will have to be moved from the assembly site to the measuring and presentation rooms, and subsequently to the storage rooms. Participants will be required to handle the transportation and placement of their bridges throughout the competition. They may ask volunteers for help; however please note that the volunteers and organizers are not responsible for any damages that may occur during the displacement of the bridges. No repairs will be allowed in the event of an incident during the displacement of the bridges. No exceptions will be made.

- Clamps can be used throughout the competition except during the measuring phase. Clamps may be used when transporting the bridge to the measuring room; however, once arrived, the clamps must be removed. You may return the clamps once the measuring is complete. Also, note that the bridges will later be stored on the floor to avoid any accidents; therefore, bring appropriate clamps.

4.4 Tools

No power tools are allowed during the 3-hour assembly period on the day of the event. However, manual tools are permitted (i.e. clamps, sandpaper, chisel, etc.).

4.4.1 Permitted Tools

- Hand drills, pin drills;
- Hand saws, razor saws;
- Sanding blocks, sandpaper;
- Knives: pen-knives, utility knives, hobby knives (X-Acto) or single-edged razor blades;
- Other manual tools.

4.4.2 Forbidden Tools

- Power drills;
- Electric saws;
- Power sanders;
- Other power tools.

Rule of Thumb:

If it uses electricity, it is not allowed.

4.5 External Help

No outside help will be accepted during the three-hour assembly time. This includes and is not limited to: non-

participants, coaches, mentors, parents, and friends. Any outside help will lead to an immediate **disqualification**. Take note that you may use your laptops, textbooks or other sources to help you during your construction as well as refer to your coaches for suggestions and verbal help. No “extra hands” during your construction will be permitted.

5 BRIDGE DESIGN

This section outlines the criteria that the bridge must respect in order to qualify and earn points during the competition. To obtain further detail as to how these criteria will be evaluated, please consult the section 6, EVALUATION.

5.1 A-Frame Bridges

A-frame bridge will not be accepted. To elaborate, any bridge whose base/leg/pier is at an angle of more than 90° will be considered an attempt to design an A-Frame or Truncated A-Frame bridge. Teams who are deemed to have built an A-Frame bridge will be **disqualified**. Figure 1 shows examples of what is not being allowed.

(a) Classical A-Frame Bridge (b) Truncated A-Frame Bridge

Figure 1: Examples of A-Frame Bridges

5.2 Dimensional Constraints

The bridge must follow a strict set of dimensional constraints. For all visual references for the dimensions, a figure will be provided at the end of this section summarizing the various constraints.

5.2.1 Length

5.2.1.1 Span Length

- The clear span must be between 1000 and 1200 mm;
- If the clear span is greater than 1200 mm, a penalty of 5 points will be incurred;
- If the clear span is between 950 and 999 mm, a penalty of 5 points will be incurred;
- If the clear span is less than 950 mm, a penalty of 10 points will be incurred. In addition to this, the team will be **banned** from obtaining points for sections 6.3, 6.4, and 6.5 (Ultimate Load Carrying Capacity, Structural Efficiency, and Predicted Ultimate Load Carrying Capacity).

5.2.1.2 Total Length

- The maximum length of the bridge cannot exceed 1350 mm;
- Any bridge exceeding this length will incur a penalty of 5 points;
- Exceeding this length may also result in the bridge not fitting in the hydraulic press, which allows a bridge of maximum 1420mm in length to fit (a bridge cannot be placed diagonally). If the bridge does not fit in the hydraulic press, a penalty of 10 points will be incurred. In addition to this, the team will be **banned** from obtaining points for sections 6.3, 6.4, and 6.5 (Ultimate Load Carrying Capacity, Structural Efficiency, and Predicted Ultimate Load Carrying Capacity).

5.2.2 Height

5.2.2.1 Deck Height

- The maximum height from the ground to the top surface of the bridge deck must not exceed 450 mm;
- Any bridge exceeding this height will incur a penalty of 5 points.

5.2.2.2 Height Clearance Above the Deck

- To take into consideration vehicle passage, the minimum height of the free space above the deck is 45mm;
- Any bridge not meeting this height will incur a penalty of 5 points.

5.2.2.3 Total Height

Points will be awarded for shorter bridge designs. A maximum of 10 points can be awarded for a bridge with a height of 300 mm or less. The maximum height of the bridge cannot exceed 550 mm. Any bridge exceeding this height will incur a penalty of 5 points. Bridges with heights between these two values will receive several points that is proportionally between both extremes, as seen in the scheme below:

Bridge Height	Points Awarded
300mm or less	10
301 – 350mm	8
351 – 400mm	6
301 – 350mm	4
351 – 400mm	2
301 – 350mm	0
More than 550mm	5 points penalty

Table 1: Points Awarded for The Bridge Height

5.2.3 Width

5.2.3.1 Deck Width

- The minimum width of the deck must be at least 150mm;
- If the deck width is between 149 and 91mm, a penalty of 5 points will be incurred;
- If the deck width is less than 90mm, a penalty of 10 points will be incurred. In addition to this, the team will be **banned** from obtaining points for sections 6.3, 6.4, and 6.5 (Ultimate Load Carrying Capacity, Structural Efficiency, and Predicted Ultimate Load Carrying Capacity) since this measurement is needed to place the loading plate of the crusher (see Section 6.4).

5.2.3.2 Total Width

- The maximum width of the bridge must not exceed 350 mm;
- Any bridge exceeding this width will incur a penalty of 5 points;

5.3 Anchorage

No external anchorage of the piers is permitted. Any bridges that are externally anchored will be automatically **disqualified**.

5.4 Deck Design

5.4.1 Continuousness and Smoothness

The deck must be continuous and smooth. It is important to acknowledge that this bridge is made for vehicular traffic. If the deck is made of multiple pieces, all pieces must be connected so that there is a smooth connection and no gaps, dips, or raises measuring more than about 2mm. These could be due to visible lumps from glue, visible surface roughness from improper sanding, or exposed dental floss.

- If 3 to 5 infractions are spotted, a 5 point penalty will be incurred;
- If 6 to 10 infractions are spotted, a 10 point penalty will be incurred;
- If more than 10 infractions are spotted, a 20 point penalty will be incurred.

5.4.2 Use of Glue

Any deck that is strictly made of glue will result in automatic **disqualification**.

5.4.3 Level

The deck must be level. That is, it cannot have any slope in its design along the longitudinal direction. Any bridge that is visibly not level (greater than a 5° inclination) will incur a penalty of 5 points.

5.4.4 Warping

Any deck that is visibly warped (not flat) on its lateral direction will incur a penalty of 5 points.

5.5 Clear Span Test

The minimum unsupported span must allow a 1000 mm long by 150 mm high box to pass freely underneath the bridge. If met with slight resistance (ie. from a fallen floss or a lump of glue), a penalty of 2 points will be incurred. If the box cannot pass, a penalty of 5 points will be incurred.

5.6 Figure of Constraints

Figure 2 shows a graphical representation of the main dimensional constraints. Please note that Figure 2 is for reference use only. The information provided in Sections 5.2.1, 5.2.2, 5.2.3, and 5.5 shall be considered exact and take precedence in the event of any discrepancies between them and Figure 2.

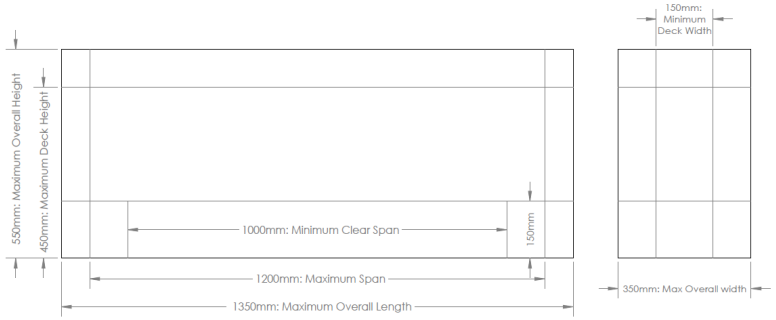

Figure 2: Figure of Constraints

5.7 Mass

The mass of the bridge must be under 6.00 kg. Starting at 6.01 kg, every 500 g (0.50 kg) extra will incur a penalty of 2 point. This can be seen in Table 2 below:

Mass of Bridge	Penalty Points
6.00 or less	0
6.01 to 6.50	2
6.51 to 7.00	4
7.01 to 7.50	6
7.51 to 8.00	8
And so on	…
More than 15kg	50 points penalty

Table 2: Points Awarded for The Bridge's Mass

5.8 Clear Opening

- A clear opening of at least 100 x 100 mm must be located above the centre of the bridge so that the loading jack may be applied at the centre point of the deck. If requirement is not met, the team will be **banned** from obtaining points for sections 6.3, 6.4, and 6.5 (Ultimate Load Carrying Capacity, Structural Efficiency, and Predicted Ultimate Load Carrying Capacity).

5.9 Disclaimer

If any of these constraints are not met, point deductions may be imposed at the sole discretion of the executive committee. These rules are intended to be complete, but the discretion of the committee is reserved at all times.

6 EVALUATION

This section discusses the methods by which the criteria outlined in the BRIDGE DESIGN section, as well as other criteria, will be evaluated during the competition.

6.1 Aesthetics & Originality

To be assessed by the judges (faculty and professionals) based on four criteria, each worth 2.5 points:

- Symmetry of the bridge;
- Visible excess glue;
- Quality of the cuts;
- General appearance.

A maximum of 10 points will be awarded for the aesthetics and originality of the bridge design.

6.2 Presentation

The presentation, which will take place on the day of the bridge building, will give a chance for the participants to show the judges the ingenuity of their bridge. Participants can choose to present in English or French. The presentation will target the students' ability to sell their bridge. The participants must effectively explain the engineering and design behind their bridge during the presentation that will last five (5) minutes. The ranking of this part of the competition is worth a maximum of 12 points and is based on the grading criteria mentioned below, where a maximum of 3 points can be awarded
for each criterion. Here is what the judges will be looking for in your bridge:

- Originality;
- Strong knowledge of engineering principles behind the design;
- Proficiency in public speaking;
- Time constraint: 5 minutes.
  - Penalty of 1 point for every fifteen seconds over;
  - Being under the time limit is acceptable.

There will be access to a computer with internet and PowerPoint. If you have slides to present, we will ask you to send them on the day of the presentation so it could be projected for you once you arrive to the presentation room.

6.2.1 Q&A

After your presentation, the judges will ask you questions regarding your design. Marks will be awarded for the ability to answer questions from the judges during the Q&A period. A maximum of 3 points will be awarded for the Q&A period after the presentation of the bridge design.

6.2.2 Team Spirit

Throughout the whole competition, your team spirit will be evaluated by the volunteers and the judges. Team costumes are accepted during the presentations but are not required. A maximum of 12 points will be awarded for team spirit.

6.3 Ultimate Load Carrying Capacity

The ultimate load capacity of the bridge will be evaluated by a point load at mid-span, distributed by a 90mm (width) x 200mm (length) plate, applied to the deck. The plate has a hemispheric loading point. The ultimate load capacity for a bridge will be taken at the moment of failure.

The bridge is considered to have failed when one of the following four things happens:

- Deflection (The vertical deflection at the mid span exceeds 50mm);
- Contact (The bridge begins to touch the platform of the crusher with anything other than its initial supporting points);
- Shear (including joint failure);
- Instability (failure under self-weight).

A maximum of 30 points will be awarded to the team with the largest ultimate load capacity. The remaining teams will be awarded points based on their bridge's ultimate load capacity as a percentage of the largest ultimate load capacity attained by a bridge on the day of competition.

6.4 Structural Efficiency

The structural efficiency (η_s) will be calculated using equation 6.1.

$$\eta_s = \frac{F_u}{m} \qquad (6.1)$$ Where:

- F_u: Ultimate load obtained in the competition (kgf);
- m = Mass of bridge as measured at the competition (kg).

A maximum of 35 points will be awarded to the team with the highest score in this category. The remaining teams will be awarded points based on their bridge's structural efficiency as a percentage of the largest structural efficiency attained by a bridge on the day of competition. Less than 1kgf (kilogram force) load supported means zero points.

6.5 Predicted Ultimate Load Carrying Capacity

The error in prediction of the ultimate carrying capacity (E) will be calculated using equation 6.2.

$$E = \frac{|F_u - F_{u,p}|}{F_u} \qquad (6.2)$$

Where:

- F_u: Ultimate load obtained in the competition (kgf);
- $F_{u,p}$ = Predicted ultimate load (kgf).

A maximum of 8 points will be awarded to the team of the lowest error, and zero points to the team with the highest error. All other teams will be awarded points based on linear interpolation between these two extremes. The predicted ultimate load shall be submitted in the Load Prediction Form before the competition.

6.6 Summary of Evaluation

Table 3 shows a summary of the maximum possible points that can be obtained for a successful bridge design. Participants are asked to consult sections 6.1 to 6.5 for detailed explanations on the points breakdown. In the event of discrepancy between Table 3 and the relevant sections in the rule book, the points awarded in the body of the rule book shall have precedence.

Aesthetics & Originality	10 points
Presentation	12 points
Q&A	3 points
Team Spirit	12 points
Total Height	10 points
Ultimate Load Carrying Capacity	30 points
Structural Efficiency	35 points
Predicted Ultimate Load Carrying Capacity	8 points
Total	**120**

Table 3: Summary of the maximum possible points obtainable

6.8 Summary of Penalties

Table 4 shows a summary of the possible points that can be lost for not respecting the rules. Note that unlike the summary shown in Section 6.7, there is no limit to the amount of points that can be lost in penalties. Participants are asked to consult sections 5.1 to 5.8 for detailed explanations on the points breakdown. All entries in the table are hyperlinks and can be used to refer to the relevant section rapidly. In the event of discrepancy between Table 4 and the relevant sections in the rule book, the points removed in the body of the rule book shall have precedence.

Aspect	Penalty Points
Span Length	5 to 10 points
Total Length	5 to 10 points
Deck Height	5 points
Height Clearance Above the Deck	5 points
Total Height	5 points
Deck Width	5 to 10 points
Total Width	5 points
Continuousness & Smoothness	5 to 20 points
Level	5 points
Warping	5 points
Clear Span Test	2 to 5 points
Mass	per 500g, 2 points
Presenting Time	per 15 sec, 1 point

Table 4: Summary of Penalties

6.9 Summary of Bans

Table 5 shows a summary of the possible grounds for a ban. Participants are asked to consult the relevant sections of the rule book for detailed explanations on what constitutes each ban. In the event of discrepancy between Table 5 and the relevant sections in the rule book, the descriptions in the body of the rule book shall have precedence.

Aspect	Section
Span Length (too long)	5.2.1.1
Total Length (too long)	5.2.1.2
Deck Width (too short)	5.2.3.1
Lack of Clear Opening	5.9

Table 5: Summary of Bans

6.10 Summary of Disqualifications

Table 6 shows a summary of the possible grounds for a disqualification. Participants are asked to consult the relevant sections of the rule book for detailed explanations on what constitutes a disqualification. In the event of discrepancy between Table 6 and the relevant sections in the rule book, the descriptions in the body of the rule book shall have precedence.

Aspect	Section
Unapproved materials	4.1
A-frames	5.1
Assembly outside of 3 hours	4.3
External help	4.5
Anchorage	5.3
Deck made entirely out of glue	5.4.2

Table 6: Summary of Disqualifications

7 RIGHTS & OBLIGATIONS

7.1 Rights of the Participants

Every team of participants maintains the right, at all times, to challenge the decision of the committee team with regards to the following:

- General Constraints;
- Bridge Design;
- Subsections of Evaluation;

7.2 Contesting Procedure

On the day of the crushing ceremony, a sheet will be distributed by email, as well as available in hard copy at the ceremony, for the various teams to review. It will contain all of the point deductions incurred for all the teams. It is the sole responsibility of the team members to contest any points they think were unjustified or unfair. This must be done prior to the crushing of that team's bridge. Once the bridge is crushed, there will be no review of the deductions as the bridge can no longer be reassessed.

The Troitsky committee shall clearly define each team's period for contesting on the day of the ceremony. The final decision, for any and all contesting, remains at the discretion of the committee at all times and if no decision can be made, the responsibility falls on to the Troitsky Director.

7.3 Code of Conduct

Please review the following codes of conduct to which you will be agreeing to during the registration process. As with every code of conduct, each competitor, captain, coach, participant, representative, judge, volunteer and the committee as a whole are and will be subjected to any and/or all consequences outlined in the following codes:

7.3.1 Concordia

Please read and follow all of Concordia University's codes of conduct.

7.3.2 Troitsky

Please read and follow the Troitsky Code of Conduct.

8 CONTACT INFORMATION

8.1 Mailing Information

Engineering and Computer Science Association

Concordia University

1455 de Maisonneuve West, Suite H-838

Montreal, Quebec H3G 1M8, Canada

8.2 Personal Contacts

President of Troitsky

To be contacted for all questions and inquires you might have. president.troitsky@ecaconcordia.ca

Vice-President of Troitsky Competitions

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Vice-President of Troitsky Logistics

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Vice-President of Troitsky Sponsorships

To be contacted regarding any inquires or questions related to finances and sponsorships.

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Website

For general information on the competition. https://troitsky.ca/