



THE CONSORTIUM FOR
MATHEMATICS AND
ITS APPLICATIONS

2019 ICM Problem D **Triage Judging Guidelines**

Purpose and Background

The Mathematical Contest in Modeling (MCM) and *The Interdisciplinary Contest in Modeling (ICM)* both rely on a Triage Judging and Final Judging process to identify seven classes of participant performance – Disqualified, Unsuccessful Participant, Successful Participant, Honorable Mention, Meritorious, Finalist, and Outstanding – based on the technical reports submitted under the MCM/ICM contest rules (<http://www.comap.com/undergraduate/contests/mcm/instructions.php>).

Final Judging is the culminating process whose purpose is to identify the papers that will be designated as Finalist or Outstanding. Prior to this event, Triage Judging in the United States and China efficiently ranks and categorizes each MCM/ICM submission based on desirable characteristics and content established over years of MCM/ICM operations, and upon the peculiarities of each problem.

Overall, the MCM/ICM supports and advocates an iterative mathematical modeling process consisting of major elements that include:

- Problem Restatement,
- Assumptions & Justifications,
- Model Construction and Application,
- Model Testing and/or Sensitivity Analysis,
- Analysis of Strengths & Weaknesses.

Papers that contain major elements in sufficient detail to address the problem posed receive higher recognition from judges.

The triage process relies on the professional expertise, experience, and judgment of academic faculty and industry professionals supporting the administration of the MCM/ICM to read and recognize key quality indicators in team papers – proper applications of mathematics and science, depth of exploration, completeness of a recognized modeling process, proper reliance upon and documentation of supporting research, innovative and insightful modeling approaches, and clear and concise exposition, among others. As noted frequently in UMAP Journal articles, elements such as these are universally valued among modelers, and are hallmark ingredients expected of top papers,.

While it is impossible to list all potential contributors to such quality, it is possible to note items that, if not present, will limit a paper's quality from the viewpoint of the MCM/ICM. While not claiming to be all-encompassing in its attempt to identify such limiting criteria, this memo will hopefully provide enough information to create a consistency in judgment despite extreme geographical and temporal separation of triage sites.

Triage Judging

In the Triage round we seek to cull out papers that do not have a chance at being Meritorious or Outstanding. In general we have percentage target levels we are planning to keep for final judging, but we always have to make some adjustments as we go through the process.

The judging of student team submissions uses seven paper classifications: Disqualified, Unsuccessful Participant, Successful Participant, Honorable Mention, Meritorious, Finalist, and Outstanding. The classification for each MCM/ICM paper is relative to the pool of papers received each year.

General guidelines and percentages for each category are as follows.

Disqualified (DQ) (% as warranted): the team's paper was found to be in violation of the contest rules. The rule violation should be noted in the comment column (e.g. "plagiarism," "same as paper xxx") and scored as 0. The MCM/ICM contest directors will review and verify all papers designated as disqualified (DQ).

Unsuccessful Participant (UN) (% as warranted): the team's paper did not respond to any of the requirements of the contest problem, but did not violate any of the contest rules. A simple explanation of the failings should be noted in the comment column (e.g. "No modeling") and scored as 0. The MCM/ICM contest directors will review and verify all papers designated as unsuccessful (UN).

Successful Participant (P) (% as warranted): the team made an attempt at the problem and successfully submitted their paper. However, their overall paper is best described as fair to average, and possibly contains an incomplete modeling process or solution, and mathematical or logical errors. Scored as a 1 or 2.

Honorable Mention (HM) (% as warranted): the team submitted a complete, acceptable modeling approach and solution, but their solution contains at least one detractor, deficiency, or error that prevents it from being classified as Meritorious or Outstanding. Scored as 3, 4 or 5.

Meritorious (M) (10%): the team's paper represents an exemplary modeling approach, but their solution may contain minor errors or issues in logic, calculation, modeling, or assumptions. Scored as a 6 or 7.

Finalist (F)/Outstanding (O)(<1%): the team's paper represents an excellent modeling approach and a solid solution, including demonstrating an ability to clearly and concisely communicate their process, results, and conclusions. Scored as a 7.

7	}	Possibly Outstanding or Meritorious
6		
5	}	Probably Honorable Mention
4		
3		
2	}	Successful
1		

Triage judging sessions are designed to accomplish a crude categorization of the papers. In the time allotted to each paper (no more than 15-20 minutes and 10-15 minutes on average), judges assess whether the required elements of the modeling process are addressed, and whether the teams have answered the questions posed in the problem statement. Judging during the triage sessions use a 7-point scale shown to the left to achieve the desired categorization. What makes this possible is the mindset of triage judges to primarily look for the very top papers and not try to fully evaluate every part of

every paper. Don't be afraid to establish separations between quality levels with these numerical scores. Each paper is given 2 reads during the triage judging, so each judge is responsible for half the triage decision to have the paper forwarded to final judging or not.

The head judge culls approximately 60-80% of the papers after the triage round and take the remaining papers to final judging.

Triage Judging Notes

If you find a paper you are assigned to read is missing, damaged or incorrect, note the paper number and notify your head judge so that COMAP can check for the correct paper.

If you find that a team included any distinguishing information such as school name or student names, read the paper as normal and grade as normal, but add a note to the comment column (e.g. “includes school name on page xxx,” “includes student name on page yyy”).

If you find that a paper has gone over the assigned paged limit, read the paper as normal and grade as normal, but add a note to the comment column (e.g. “paper exceeded the assigned page limit”).

Triage judges are encouraged, but not required, to include comments on their grading sheet. It could be as simple as a few words (e.g. “great assumptions”), or a sentence justifying the papers score (e.g. “fatal logic flaw on page zzz”).

Problem Specific Guidance: Problem D (2019):

The main thrust of ICM problem-grading is judging the team’s performance of basic modeling that uses good science and leads to measurable outcomes and analysis. In this year’s problem, you should see model development and analysis for emergency evacuation of the Louvre that allows the museum leaders to explore a range of options to evacuate visitors from the museum, while also allowing emergency personnel to enter the building as quickly as possible.

Obtaining or constructing good data could be a challenge for this problem so using verified data for validation is not required. Constructing reasonable data to represent the physical structure, the number of visitors, and the specific locations of exits and passageways is fine to enable their modeling. As you read, consider the team’s performance in relation to the following specified tasks:

- 1) Do they model the flow of people during the evacuation? Do they identify the key factors (physical space, location of incident(s), number of visitors, location of exits, time of day, day of week, etc.) that will be important as they plan out the evacuation? Do they develop a means for implementing the factors and principles they identify as important? Does their one-page summary convey their modeling work and results?
- 2) Do they build a good basic dynamic model for the evacuation? Does their model take into account (or help to identify) potential *bottlenecks* that may limit movement towards the exits? Do they find, create, or use a scenario to test their model and do they provide a visualization of their model dynamics and results of their tests or simulations?
- 3) Does their model allow emergency planners to adapt to situations that can address a broad set of considerations and various types of potential threats? Does their model consider threats that have the potential to alter or remove segments of possible routes to safety?
- 4) Do they propose policy and procedural recommendations for emergency management of the Louvre that include crowd management and control procedures necessary for the safety of the visitors?
- 5) Do they discuss how to adapt and implement their model(s) for other large, crowded structures?
- 6) Do they discuss basic elements of modeling: assumptions, measures, strengths/ weaknesses, and sensitivity of their models?
- 7) Is their report less than or equal to 20 pages (not including their cover sheet, summary, references and appendices)?

Additionally, you may find that the team considered some of the following **optional** items. Even though not required, addressing some of the following items could be an indication of good interdisciplinary modeling:

- Do they describe how long it will take to evacuate the museum using only the four available public exits? Do they describe how time of day and/or time of year impacts the evacuation? Did they note that the Louvre is typically closed on Mondays and holidays?
- Do they recommend locations for additional public exits? Do they demonstrate how and when these additional exits could be used to assist in the evacuation? Do they update their model and report how long it will take to evacuate the museum using all additional exits?
- Do they describe how the visitors be guided to the exits? Do they recommend specific crowd control measures and describe how to implement these measures? Do they recommend the use of technology?
- Do they consider individuals trying to find their group prior to evacuating? Do they demonstrate the impact this will have on their evacuation model? Do they identify ways to mitigate the impact?
- Accessibility for visitors with disabilities is one of the Louvre's main priorities. Do they describe how their evacuation model accounts for museum visitors with disabilities?
- As visitors exit the building, emergency personnel must be able to enter the building. Do they identify where and how emergency responders should enter? Do they demonstrate how this affects their model and the time it takes to complete the evacuation?
- Do they describe what happens once visitors exit the building? Do they describe how far away from the museum visitors should go?

After a quick (10-15 minute) read, assign a score (1-7), 1 is poor (low potential for outstanding), 7 is excellent (high potential for outstanding). When appropriate, please add a one sentence comment to explain the grade. Plagiarized papers will be disqualified with a 0 score and papers with essentially no relevant work will be given a score of 0 for unsuccessful participation. Please explain why a 0 score was given – plagiarism or very little work or modeling.

We will be much more careful to evaluate the student work of the surviving papers during the final judging, but your roles in triage grading make our system work well. Thank you for performing this grading and contributing to the success of the ICM.

The Final Judging Sessions (for information only for triage graders)

The final judges develop a rubric for each problem and customize it to the problem being judged and the set of papers present. After the triage event, judges have a better idea of how the top papers they have read are addressing the problem and what elements are evolving to set papers apart from each other. This knowledge provides the basis for refining the rubric prior to the last judging session to pick the Outstanding papers. We usually have 4 or 5 rounds of final judging where approximately 50% of the papers are culled in each round.



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