Judges' Commentary: The Giordano Award for the River Problem

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Introduction

For the first time in its history, the MCM is designating a paper with the Frank Giordano Award. This designation goes to a paper that demonstrates a very good example of the modeling process in a problem involving discrete mathematics.

Having worked on the contest since its inception, Frank Giordano served as Contest Director for 20 years. As Frank says:

> It was my pleasure to work with talented and dedicated professionals to provide opportunities for students to realize their mathematical creativity and whet their appetites to learn additional mathematics. The enormous amount of positive feedback I have received from participants and faculty over the years indicates that the contest has made a huge impact on the lives of students and faculty, and also has had an impact on the mathematics curriculum and supporting laboratories worldwide. Thanks to all who have made this a rewarding and pleasant experience!

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The Frank Giordano Award for 2012 went to the Outstanding team from Western Washington University (WWU) in Bellingham, WA. This solution paper was characterized by

- a high-quality application of the complete modeling process, including assumptions with clear justifications, a well-defined simulation, a case study, and sensitivity analysis;
- originality and creativity in the modeling effort to solve the problem as given; and
- clear and concise writing, making it a pleasure to read.

The River Problem

This year's problem dealt with scheduling variable-length river trips down a 225-mile stretch of a particular river, using either oar-powered rubber rafts (at 4 mph) or motor boats (at 8 mph). Fixed starting and ending points were specified for all trips, with campsites distributed fairly uniformly down the river corridor. Minimal contact between groups of visitors was desired and no two groups could share the same campsite. The goal was to maximize the number of trips over a six-month period utilizing both types of transportation and allowing for trip lengths of 6 to 18 nights on the river. In addition to the executive summary, teams were required to write a memo to the managers of the river trips, advising them of the carrying capacity of the river and how to schedule trips of various lengths over the six-month period.

The approaches that teams took varied greatly, especially with regard to the number of campsites available. That factor had a significant impact on the number of trips that could be scheduled. Many teams found that the "Big Long River" greatly resembled a stretch of the Colorado River in the Grand Canyon, and some looked at this as a case study for their models.

Simulations for scheduling trips on the Colorado River were available, but teams had to address all the issues raised and come up with a solution that demonstrated their own creativity

The Western Washington University Paper

Executive Summary Sheet and Memo

Although well written, this team's one-page sheet at the start was an abstract rather than a one-page executive summary. Typically, an executive summary contains more information (and often more sensitive information) than the abstract does. This team's one-page summary was too short and did not state results, but, to the team's credit, it did motivate the reader to read on.

Although it should have contained more specifics with regard to the scheduling, the team's memo, written in an appropriate nontechnical manner, was done much better.

Assumptions

One of the first things that made this paper stand out from the others was that assumptions were not merely listed but each one was justified. Assumptions were reasonable, and it was noted how the assumptions were to be used in the algorithm. This is something that is most important in the modeling process, but something that is frequently overlooked, so the team is to be commended for their thoroughness in this regard.

The Model and Methods

The team used a scheduling algorithm. The variables were well-defined; and it was clear how they arrived at their constraints, based on the stipulations stated in the problem. This was one of the few papers that allowed for groups to stay at a camp for more than one night, but that worked well for their algorithm and did not conflict with the problem statement. Using a very specific definition for the priority that one group would have over another group, the team was able to assign campsites in a successful manner. Interestingly, they started at the end of the river; and using the priority list, they placed the groups in campsites each night. One drawback with their model was that they did not consider crossings of groups while on the river.

Testing Their Models

The flowchart for the team's scheduling algorithm was clarified by the use of examples and simulations. The case study, using data from the Grand Canyon, enabled them to validate their model. They considered many different numbers of campsites, ranging from 50 to 235. With regard to the ratio of the types of boats and lengths of trips, they carried out sensitivity analysis, although they limited their trip lengths to 6, 12, or 18 nights on the river. The use of contour maps to demonstrate their results and to observe the "ridge" representing the 1:1 ratio of motor boats to oar-powered rafts was particularly noteworthy.

Recognizing Limitations of the Model

Recognizing the limitations of a model is an important last step in the completion of the modeling process. The students recognized that their algorithm would have to be modified if the river speed were taken into account. They also acknowledged that their carrying capacity for trips might be overestimated and that they had not considered environmental concerns.

References and Bibliography

The list of references was fairly thorough, and it was very good to see specific documentation of where those references were used in the paper.

Conclusion

The careful exposition in the development of the mathematical model made this paper one that the judges felt was worthy of the Frank Giordano Award. The team is to be congratulated on their analysis, their clarity, and using the mathematics that they knew to create and justify their own creative model for scheduling camping trips along the Big Long River.

About the Authors

Rich West is a Mathematics Professor Emeritus from Francis Marion University in Florence, South Carolina, where he taught for twelve years. Prior to his time at Francis Marion, he served in the U.S. Army for 30 years, 14 of which were spent teaching at the U.S. Military Academy. He is currently working on a National Science Foundation Grant on freshmen placement tests. He also serves as a Reading Consultant for AP Calculus and as a developmental editor for CLEP (College Level Equivalency Program) Calculus Exam. He has judged for both the MCM and HiMCM for over 10 years.

Marie Vanisko is a Mathematics Professor Emerita from Carroll College in Helena, Montana, where she taught for more than 30 years. She was also a Visiting Professor at the U.S. Military Academy at West Point and taught for five years at California State University, Stanislaus. She chairs the Board of Directors at the Montana Learning Center on Canyon Ferry Lake and serves on the Engineering Advisory Board at Carroll College. She has been a judge for the MCM for seventeen years and for the HiMCM for eight years.