2015
The International Mathematical Modeling Challenge (IM²C)
Judges' Commentary

The Judges would like to congratulate the students who participated in the first annual IM²C. We considered the **Movie Scheduling Problem** to be very open-ended and difficult to model. We were quite satisfied with the very creative model building that we saw. Devising a practical schedule from the models that typically were developed proved to be an interesting and challenging mathematical problem. Finding an optimal solution to most models that were developed required finding good solutions to computationally complex algorithms, or revising the model to allow an optimal solution to be found.

What characteristics distinguished the better papers? First, the better teams developed and presented their models in a very logical manner. They moved from the very vague scenario they were provided to identifying a problem they could model mathematically. They explained their assumptions very clearly and discussed how well the assumptions were met by the situation they had identified. After analyzing their model for solutions, they tested the model's conclusions against test cases they constructed or found in their research. They performed a sensitivity test to determine how the conclusions changed based upon changes in their data thereby identifying the most important variables.

Team 2015010 succeeded in profoundly developing the building of their model. Step-by-step, they introduce the various elements of their model in a very clear manner that is understandable to a wide audience. Due to time restrictions, they did not succeed in extending this approach through the remainder of the paper, but clearly demonstrated the ability to present their ideas in a clear logical manner. For these reasons paper 2015010 was awarded the meritorious award.

A good example of testing your model can be found in Paper 2015007. This team extracted data by hand from an actual movie, taking the data from the screen. This down-to-earth approach links the model with real-world data and gives a basis for testing and improving the model, a vital step in the modeling process. For these reasons paper 2015007 was awarded the meritorious award.

A good example of sensitivity analysis can be found in Paper 2015005 where a great amount of random data was used to identify the variables to which their conclusions were most sensitive. Team 2015004 provided a methodology for reacting to changes by choosing the objective of

"changing the current schedule as little as possible." Both papers 2015004 and 2015005 stood out above the rest and were recognized as Outstanding by the judges.

Second, the better papers typically developed an optimization problem that generalized to larger data sets: more scenes, more filming sites, more actors with greater restrictions on their availability, and so forth. Typically, the algorithms for solving their optimization models were computationally complex. The better papers used heuristics for finding good solutions in reasonable amounts of time, or adding constraints to their models to reduce the number of possible solutions. Team 2015015 was awarded the meritorious award and used both a heuristics-based algorithm and Kuhn's algorithm (also known as the Hungarian method) that guarantees a globally optimal solution and compared the results of the two methodologies. The better papers generalized to larger problems and tested their models using a case study or a practical example, and carefully presented their conclusions.

Third, the better papers excelled at scientific writing. The papers had a structure that was easy to follow. A very distinguishing discriminator among all papers was the quality of the summary. A good summary provides a very clear overview of what is accomplished in the paper. The summary not only clearly outlines the method of attack, but also serves as an invitation to the reader to study the paper itself.

An excellent example of a well-constructed summary can be found in the work of Team 2015016. The summary gives an excellent overview of the work in a well-structured manner that invites the reader to read the complete work. Because of this paper 2015016 was awarded the meritorious award.

Our advice to future contest participants is to allow plenty of time to construct a report. Build a structure which allows you to present the development of your model in a logical fashion. Similarly, present the analysis and conclusions of your model in a manner that can be easily understood by a wide audience. Use graphs, charts, networks and other appropriate visualizations where possible to aid understanding. Test your model in as realistic a fashion as possible, and clearly state your conclusions. Finally, write a summary that gives an overview of your work that excites the reader to study your paper.

A good example of using visualizations is provided by the Outstanding Team 2015017. The pictures of graphs included in their work clarify the complexity of the making of a film, thereby helping the reader understand the process that will be modeled in the following paragraphs.