2016 IM^{2}C
International Judges' Commentary

The IM^{2}C Judges would like to congratulate the students who participated in IM^{2}C 2016. We considered the problem to be very challenging as it required the modeling of breaking a world record at a specific track event (an event involving chance behavior), and the decisions to be made by both the insurance companies to set an appropriate insurance price (premium), and the decisions of the organizing committees to buy the insurance, self-insure, or perhaps rely upon a loan for each of perhaps many track events. We were quite amazed at the large variety of creative approaches to modeling each aspect of the given scenario.

Characteristics of the Better Papers

What general characteristics distinguished the better papers? First, the better papers demonstrated excellent 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 approach taken, but also serves as an invitation to the reader to study the paper itself. An example of an excellent summary can found in the Meritorious Paper 2016025. The summary gives an excellent overview of the work in a well-structured manner that invites the reader to read the details of the complete work. It is also important to address the strengths and weaknesses of the model you construct. All models have limitations and it is important that you recognize and state those limitations.

We strongly recommend that you read paper 2016026 which was awarded the designation of Outstanding and demonstrates the use of mathematics appropriate to the team's assumptions, combined with some very good writing skills. It's the combination that makes them outstanding!

Second, the better papers resulted as teams developed and presented their models in a very logical manner. They moved from the rather 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 for which they could find appropriate data. They performed tests to determine how the conclusions changed based upon changes in their data thereby identifying the most important variables.

Meritorious paper 2016036 is an example of presenting a model in a very logical and reasoned manner. Each question is addressed by reference to the model they developed from their assumptions.

Meritorious paper 2016004 is an example of excellent mathematics but needed greater attention by the authors to their explanation of why the mathematics is appropriate to a model developed from their assumptions, even though their examples are quite good.

Probability of Breaking the World Record

There was great variety in modeling the probability of setting a world record at a particular event in a given track meet. Some papers used a simple approach estimating the trend in time intervals between world records. Others considered the historical records of specific athletes and determined the probability of a specific athlete breaking the current world record. Those athletes who had a reasonable chance of breaking a record were then placed in a group of "top athletes." They then considered the number of top athletes attending an event and the probability that none of these athletes would break the record. Some weighted recent data more heavily and examined the recorded times of the athlete versus their age and other variables.

Paper 2016021 which was awarded the designation of Outstanding uses a simple approach to the probability by estimating the number of races before a record is broken. Paper 2016026 which was also awarded the designation of Outstanding examines particular athletes and computes the probability of that athlete breaking the record based upon his recent performances in the event and the current world record. They then compute the probability that no top performer attending the race will break the record. Paper 2016033 which was awarded the designation of Outstanding tested 2 approaches. The first is based upon assuming that participants have equal probability to break the record each year. The second is based upon assuming the world record will be broken at an interval within a range. After testing, they chose the second approach.

The Decisions of the Insurance Companies

A wide variety of approaches were used to model the decisions of the insurance company: how would they price the insurance premium to cover their operating expenses, make a profit exceeding alternative investments, yet at a price attractive to organizing committees?

Meritorious paper 2016015 presents a unique method that is reasonable to employ. They also excel at communicating their ideas and justifying their assumptions.

The Decisions of the Organizing Committees

We saw many approaches to the decision of the organizing committees. What were the short-term and long-term goals of the committee? What long-term and short-term risks were involved in accomplishing their goals if they did not buy the insurance? What does "bankruptcy" mean for a particular organizing committee?

Papers 2016021, 2016026, and 2016033 were all awarded the designation of Outstanding and employ distinct objectives for the weighting of short-term and long-term risks and the weight placed on avoiding bankruptcy. They then develop decision models to achieve their stated objectives.

Advice to Teams Participating in Future IM^{2}C competitions

Our advice to future contest participants is to allow plenty of time to construct a report. In fact, consider working on the report as soon as you begin work as communicating your ideas and approach is critical in this challenge. Remember that the judges are all from different countries. Explain your work using universally understood language. Also, the judges are not familiar with the curricula of each school district. Thus, you should build a structure which allows you to present the development of your model in a logical and easily understood fashion. The judges are not looking for the papers using the most sophisticated mathematics – this is a mathematical **modeling** competition. Rather, they expect you to use the mathematics you already know in a logical manner to reach conclusions from your assumptions. Typically, simpler is better.

Similarly, present the analysis and conclusions of your model in a manner that can be easily understood by a wide audience. Consider who will use the model you have built and explain your model to that audience as well as to the judges. Use graphs, charts, networks and other appropriate visualizations where possible to aid understanding. An excellent example of incorporating graphs intelligently and conveniently for the reader is contained in Meritorious paper 2016025.

We strongly suggest that teams clearly answer each specific question in the problem. The use of headers helps the judges understand which aspect of the given problem the team is currently addressing.

In summary, we were quite impressed with the quality of each entry and urge each team to continue to improve your modeling capabilities and participate in the IM^{2}C and eventually undergraduate modeling competitions, and hone your ability to use the mathematical modeling reasoning process in your daily, and eventually professional, life.