PRESIDENT'S Column

Lessons from Baseball

In many ways, baseball is a good metaphor for science. It provides lessons on teamwork, strategies for success, and the importance of metrics. For the non-aficionado, let me first describe the relevant aspects of the game. Baseball is played on a large field subdivided into a vast, lush green outfield and a dusty, diamond-shaped infield with four bases: home plate, 1st, 2nd, and 3rd. Unlike football, soccer, or basketball, only one team is on the field at a time. The "fielding" team's pitcher throws to a batter on the "batting" team who tries to hit the ball. But it isn't easy because it's moving very fast and, like science, the pitcher can deliver "curve-balls" and "sinkers" that take unexpected turns as they approach. Indeed, even the very best players only successfully hit the ball approximately 30% of the time. The success rate for most experimentalists is even lower.

Sandra Schmid

The object of the game is to score more "runs" than the opposition. A run happens when a player traverses all four bases. In science, a "run" creates paradigm shifts, establishes new concepts, or resolves long-running dilemmas. In both baseball and science runs can be accomplished by a single powerful "hit," called a "home run," that sends the ball soaring high and beyond the limits of the field. More frequently, however, runs are scored through a series of "single," "double," or "triple" base hits. Importantly, multiple runs can only be scored from a single hit if there are multiple players "on base." Indeed, if the bases are loaded (i.e., there are players on 1st, 2nd, and 3rd) a run can be scored even without a hit, e.g., if the pitcher walks a batter. A bases-loaded home run, called a "grand slam," will score four runs. Thus, a key to winning baseball games is to have a high on-base percentage.

Baseball games move at a leisurely pace, leaving plenty of time to keep records of all events and hence to gather statistics (referred to as "stats"). Every aspect of an individual player's performance is tracked, giving rise to individual stats, including batting averages, on-base percentages, extra base hitting percentages, home runs, strike-outs, pitching and defensive stats, etc. Wikipedia lists over 70 statistical categories that track all aspects of the game.[1] Over time, these stats can be used to build mathematical models that endeavor to be predictive of success in the game. Indeed, an entire science, called sabermetrics,[2] has developed with this goal in mind. Thus, like cell biology, baseball is becoming increasingly quantitative.

Scientific Teams

Baseball may provide the best model for an effective scientific team. Most team sports require the temporally coordinated activities of multiple team members, but in baseball many plays involve only an individual hitting, throwing, or catching the ball. As mentioned above, the individual's success rates in these categories, in comparison to both teammates and competitors, are monitored, reported, and, importantly, rewarded. Most experimental work is also performed individually. An individual's "batting" average (i.e., publication record) is an important metric, and the successful independent scientist is much heralded. But innovation almost always requires input from multiple perspectives, and the increasing complexity of cell biological problems demands a multidisciplinary approach not possible outside the context of teams. The coordinated efforts of successful scientific teams, like baseball teams, create more opportunities for hits and runs, while still leaving room for individual credit. There are many other tangible benefits to individual members of a consistently successful team/laboratory. For example, success buoys the confidence of all team members, freeing them to take greater risks; it increases the chances of attracting talented individuals with unique skill sets as new colleagues; and a lab's reputation for consistent quality opens doors to numerous opportunities, such as invitations to attend and/or speak at meetings, job interviews, and more receptive journal editors and referees that benefit all members.

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Home Runs: A Game-Winning Strategy?

I equate hits to published papers: singles, doubles, and triples correspond to papers published in increasingly higher-tier journals. American scientists frequently talk about "hitting a home run" when they make an important discovery and publish in a high-impact journal. Scientists, like baseball fans, hold these rare occurrences in high esteem—as they should. However, as I have lamented in a previous President's Column (March 2011), the metaphor was perhaps more accurate before the age of supplemental material. At that time these "home run" papers revealed new concepts and reported singular discoveries analogous to out-of-the-park hits in short three- to five-figure formats. Today, most papers in the infamous top-tier journals represent endurance races with reams of data and supplemental figures: less a home run than a series of base hits, sacrifice flies, and bunts that nonetheless still culminate in only a single run (i.e., paper). Moreover, because real discoveries (home runs) cannot be predicted, time spent on the obvious and often incremental next experiments suggested by well-intentioned referees may prevent or delay a lab from making the next unexpected discovery. Instead, these additional experiments could produce a string of hits resulting in multiple runs being scored. Winning baseball teams have high on-base percentages. Likewise in science, consistent publication of high-quality papers in rigorously peer-reviewed and well-respected journals such as *Molecular Biology of the Cell* is important for both individual and team success. In reality, paradigm-shifting, concept-establishing, controversy-resolving runs most frequently emerge from a coherent series of hits. The infrequent home runs of a team's star batter cannot be counted on to win games; indeed, home-run hitters are also the most likely players to strike out.

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Relevant (and Irrelevant) Stats

In his book *Moneyball*,[3] Michael Lewis describes how the Oakland A's became one of the "winningest" teams in baseball, despite being one of the poorest and having the lowest payroll. His chapter entitled Field of Ignorance bemoans the stats that most teams used to judge players in terms that conjure up the current situation in science today: "What got counted was often simply what was easiest to count"; "statistics were not merely inadequate; they lied. And the lies they told led people.... to misjudge their players, and mismanage their games." When reading this, I immediately thought about "impact factor." This easily measured metric was devised and commercially implemented by Eugene Garfield, founder of the Institute for Scientific Information; now owned by Thomson Reuters. Besides being statistically flawed (it measures average citations and not the median of a highly skewed distribution) and opaque (Thomson Reuters is a private for-profit company that does not freely release the data used to generate impact factors), directly conflating a journal's impact factor to the impact of the individual papers published in it is like saying a hit or run in New York's Yankee Stadium is more valuable than one in Denver's Coors Field! Moreover, just as simply counting hits or runs does not capture the game situation and numerous other variables that influence the result, simply counting citations or impact without considering other factors, such as the nature of the discipline, the multiple preceding hits that set up the run, etc., is meaningless. In an ideal world, we would read all the papers and individually judge their contributions; however, the sheer volume of scientific literature is incompatible with this ideal situation. We need meaningful metrics.

Scientifically minded baseball fans—the creators of sabermetrics—did just this. They collected large amounts of data on all aspects of the game from the Internet and then used this information to create statistics that could be validated and incorporated into models that were predictive. In so doing, they created meaningful statistical information that could improve the game. Scientists know that "impact factor" is woefully insufficient; yet might there be other metrics that more accurately and constructively measure scientific value and quality across disciplines? Certainly we

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can now readily obtain statistics on individual paper citations, but these need to be compared on relative scales within specific areas of research. Moreover, arbitrary page limitations in many print journals lead authors to cite reviews rather than the primary literature, thus lowering the validity of impact factors. It might be more accurate to measure Internet access to abstracts or better yet the frequency of subsequent downloads of full PDFs or views of full html documents as a percentage of abstract reads (i.e., something akin to a "hitting average"). An added benefit of such a metric is that to ensure higher impact papers one would need to publish in open access journals. Scientists need to eschew the commercial monopoly of for-profit journals and Thomson Reuters and use the information freely available on the Internet to develop more meaningful metrics. Let's put our heads together. What would you measure and, thinking as a scientist, how would you validate this measurement? ■

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Comments are welcome and should be sent to president@ascb.org.

References

[1]http://en.wikipedia.org/wiki/Baseball_statistics

[2]http://en.wikipedia.org/wiki/Sabermetric

[3]Lewis MM. (2004). *Moneyball: The Art of Winning in an Unfair Game*. New York: W.W. Norton & Company, Inc.

The ASCB 2011 Call for Nominations

Norton B. Gilula Memorial Award

Who is Eligible: An outstanding graduate or undergraduate student (at the time of nomination) who has excelled in research or first-year postdocs whose work was performed while a PhD or MD/PhD student

How to Apply: The student or advisor should submit a one-page research statement, a CV, a list of publications, if any, the abstract submitted to the current year's Annual Meeting, and the advisor's letter of recommendation. Duplicate applications from graduate students may be submitted for the Gilula and Bernfield Memorial Awards. Nominators must be ASCB members.

Awards: The winner is presented a plaque and a ribbon for his/her poster board. Many expenses to attend the Annual Meeting are paid. Funded by an annual grant from Rockefeller University Press.

Deadline: July 15 (electronic submission preferred)

Merton Bernfield Memorial Award

Who is Eligible: An outstanding graduate student or postdoctoral fellow (at the time of nomination) who has excelled in research

How to Apply: The student or postdoc or his or her advisor should submit a one-page research statement, a CV, a list of publications, a copy of the abstract submitted to the current year's Annual Meeting, and the advisor's letter of recommendation. Postdocs may also submit the recommendation of their graduate student advisor. Duplicate applications from graduate students may be submitted for the Gilula and Bernfield Memorial Awards. Nominators must be ASCB members.

Awards: The winner is presented a plaque and an honorarium and will speak at a Minisymposium at the Annual Meeting. Many expenses to attend the Annual Meeting are paid.

Deadline: July 15 (electronic submission preferred)

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