By Steve Sullivan

UNLESS YOU'RE A RABID SPORTS FAN, YOU PROBABLY DIDN'T HEAR IT. Last July, New York City, WFAN Sports Radio, a little after 2:30 in the afternoon. Oakland Athletics General Manager Billy Beane expounding on his iconoclastic approach to managing a major-league baseball team.

"We just try to use as much data as possible," Beane explains. "We can't predict the future: we're just trying to redefine how we make decisions. If we're going to spend $2 million on a first-round pick, that may be the biggest expenditure we have all year. We're not in a position to walk into a casino and bet all our money on the roulette wheel. We have to go to the blackjack table where the odds are a little bit better."

And then, the clincher.

"It's risk management. It's like an actuary."

Billy Beane is no actuary. He's an ex-ballplayer who, according to the scouts who recruited him out of high school in 1980, was destined for a successful big-league career. They were wrong. During his 10 years in the majors, Billy Beane's vaunted athletic prowess and skill never played out. He looked great on the field—everybody said so—he just didn't play baseball very well.

So in 1990 Beane did the unthinkable for a professional ballplayer in his prime: He voluntarily walked off the field of dreams and took a job in the front office.

Good move. What Beane found there in the Oakland A's clubhouse was a culture that had begun to question the conventional wisdom about baseball, the same wisdom that had predicted he would be a star. And if conventional baseball wisdom could be so wrong about him, maybe it was wrong about a lot of things. Including what makes winning baseball teams.

When Billy Beane became general manager of the Oakland A's in 1997, he set about turning conventional baseball wisdom on its ear. With the second lowest payroll in the major leagues, he put together a team of undervalued rejects who came close to breaking the American League record for consecutive wins in 2002.

He did it not with advance scouting reports or hunches or gut feelings or any of the other trappings so dear to the crusty hearts of old baseball pros. He did it the way any actuary would.

With numbers.

STAT OF THE ART
The Actuarial Game of Baseball
Quantify it and they will come.

MORE THAN MOST OTHER SPORTS, baseball is a game of numbers. The second the ball leaves the pitcher's hand, an almost infinite number of events and combinations of events can happen. Baseball statistics are a way of recording and, theoretically at least, making sense of those events.

Sure, the bottom line is that at the end of the game, one team wins and the other loses. But exactly how did the winner win? What did the loser do wrong? And how can the winner improve his chances of doing it again?

Since the beginning of baseball, statistics have been an imperfectly understood method of answering those questions, if they answered them at all. They could tell you how many home runs a particular player got, his batting average, how many runs he batted in, or a pitcher's earned-run average. Fans and sportswriters learned and recited these statistics endlessly to prove how savvy they were about the game. But nobody really seemed to understand what statistics could tell you about how to win on a baseball diamond. Until Bill James came along.

Thirty years ago, Bill James was just a night watchman at a bean factory in Lawrenceville, Kan., with a lot of time on his hands and a lot of crazy theories about baseball. Basically, his theories boiled down to this: There's more to baseball than what you can see with the naked eye. And there's more in baseball statistics than is dreamt of in the philosophy of even the most seasoned major-league scout or manager.

James published his first *Baseball Abstract* himself in 1977, a mimeographed-and-stapled pamphlet consisting mostly of stats and a few words about his philosophy of baseball. Gradually, the *Abstract* became an annual event. And as his readership grew, so did the philosophical half of the equation. He even
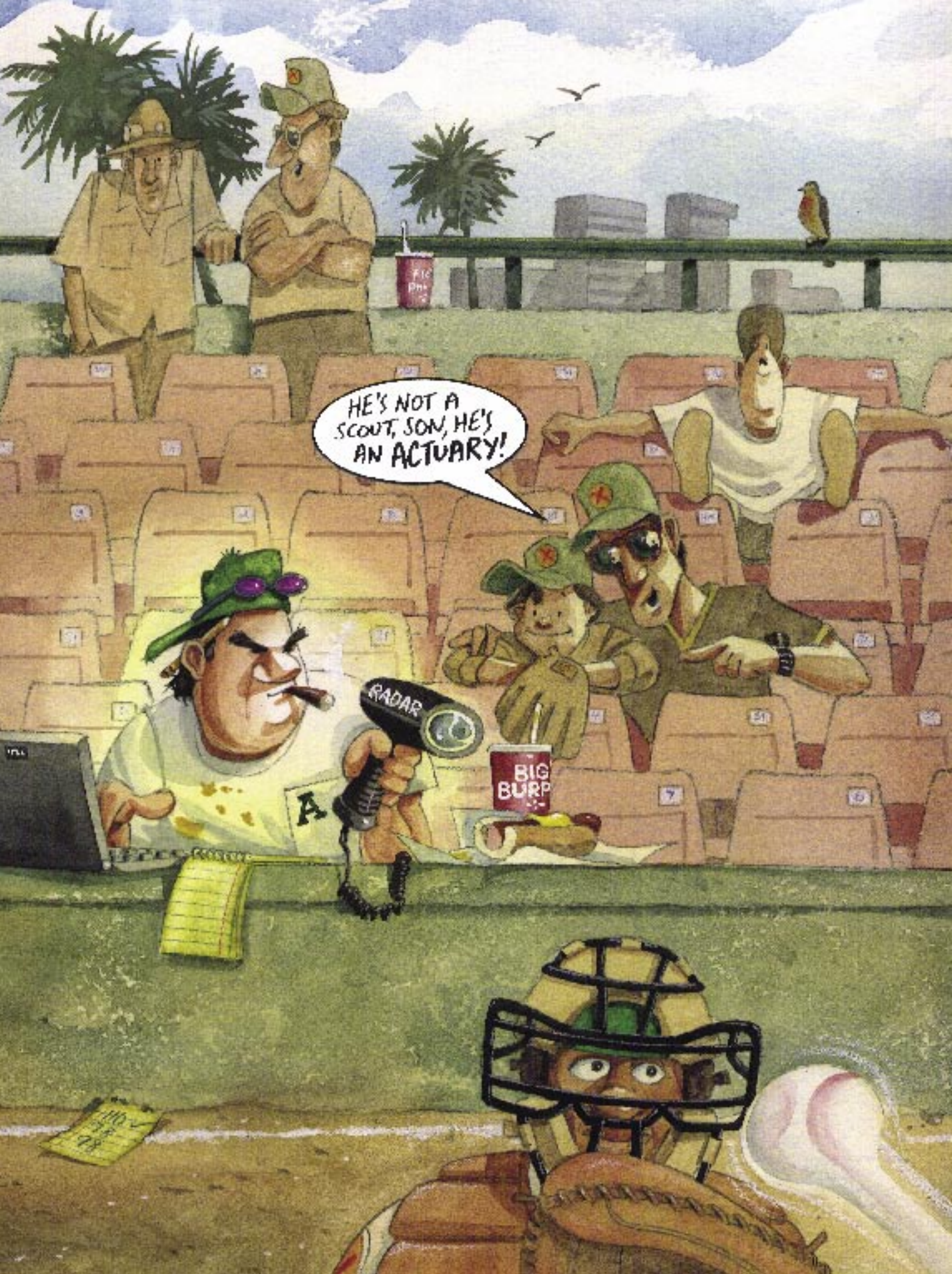
gave his philosophy a name: *sabermetrics*, based on the acronym for the Society of American Baseball Research in Cooperstown, N.Y. The word is defined as the "search for objective knowledge about baseball."

Of course, nobody inside baseball wanted to hear about it. Everybody knew you couldn't reduce the mystique of baseball to a bunch of numbers. After all, to win at baseball, you gotta have heart. You don't turn the game over to the nerds and geeks.

But a growing cadre of people outside baseball were fascinated by what James had to say. Among them were novelist Norman Mailer, screenwriter William Goldman, sportswriter Dan Ockrent … and an actuary named John Dewan.

What interested Dewan about Bill James was that he used numbers in a way not unlike the way actuaries use numbers.

"The normal population of baseball—general managers, managers—use numbers the same way most fans use them," says Dewan. What Bill James discovered is that you can go beyond the normal statistics—batting average, ERA, HRs, RBIs, etc.—to get a better understanding of each player's efficiency, his contribution to winning.

"That's what actuaries do every day, of course," says Dewan.

"They use numbers to help them get a better understanding of what it takes to win—to establish premiums properly, to set aside money for the future, to make a profit, etc."

Dewan first started reading the musings of Bill James while Dewan was working for AON Consulting in Chicago. It didn't take him long to see the similarities between what he was doing with numbers and what James was doing with baseball statistics. (See *Contingencies*, January/February 2000, pp. 43-44.) But professional baseball remained stubbornly deaf to what James had to say.

According to Michael Lewis, writing in his bestseller *Moneyball: The Art of Winning an Unfair Game*, two things happened to put Bill James on the major-league map. First, computers got a lot better at being able to manipulate and analyze the stats James generated, and do it quickly. Second, major-league salaries started going through the roof. Intense competition for free agents changed the economics of baseball forever.

This enlightenment, in part, is what enabled John Dewan to make his big move. After hooking up with James on a part-time basis for a while, Dewan finally walked away from his traditional actuarial career the way Billy Beane walked away from traditional baseball. In 1985 he, his wife, and a colleague

Does Winning Fill the Seats?

Despite a streak of winning seasons, the Oakland A's still have trouble selling out Network Associates Coliseum. Why? If Billy Beane can build a winning team out of talented nonentities, why can't he put as many people in the seats as a star-studded loser like, say, last year's Baltimore Orioles? We put the question to Bill James. Here's his answer:

"If you ever try to construct a model that explains attendance, you realize that it's bewilderingly complicated. There are hundreds of factors that influence attendance—the size of the city, the competition within that market, the economy, the size and the cleverness of the team's marketing effort, etc.

Many of these factors have wrinkles that are hard to articulate. When a team moves into a new city, for example, there's always an attendance boost. Colorado had very good attendance its first few years. Nonetheless, attendance is influenced by things that happened many years earlier—even generations earlier. We draw well in Boston, in part, because the team has a hundred-year history in the town. We've been building our fan base for a hundred years. The expansion teams of 1969 and 1977—Montreal, San Diego, Toronto, Kansas City, etc.—still don't draw at the level of the old established teams, simply because 35 years isn't really long enough to establish a fully mature fan base. So you have a parabola there—a short-term attendance effect and a long-term attendance effect, pulling in opposite directions.

Attendance is full of these confusing effects. In Boston many people believe that we sell extra tickets because the park is small. It sounds backward, but it's nonetheless reasonable: the scarcity of seats, over the course of the season, causes people to fear not being able to get into a game they want to see, which pushes them to buy tickets early. If we doubled our seating, people would figure that they could wait and see, buy tickets closer to game time, and we'd wind up

started STATS Inc. in the basement of his house. The firm used Bill James' ideas and techniques to write software that provided clients with the information they could use to win baseball games and to build winning baseball teams.

In 1999, Dewan sold STATS to the Fox News Corp. for $45 million. With the proceeds, he set up several charitable foundations and launched another firm called Baseball Info Solutions in 2002.

"I guess you can take the man out of STATS," Dewan observes, "but you can't take the stats out of the man."

TRADITIONAL BASEBALL STRATEGISTS approach winning games the way World War I military commanders approached battle. Outs are like casualties; a certain number are the inevitable price of victory. Sabermetrics offers a more efficient way to minimize the casualties while increasing the likelihood of winning.

For Billy Beane, baseball is a game of calculated risks, with the emphasis on "calculated." Taking risks based on gut instinct and experience, the way most veterans play and manage the game, is inefficient at best, a crap shoot at worst. But a risk based on careful analysis of the numbers is something else altogether.

Take the sacrifice bunt, for example. Common wisdom says that in a close game, if a batter gets on base, the next batter should bunt to move the first runner to second base. He sacrifices an out, but the runner is now in scoring position, and that supposedly makes it worth the sacrifice.

But does it? According to baseball statistics, fewer runs are scored with a runner on second and one out than with a man on first and no outs. So if it's not such a well-calculated risk after all, why take it? The answer, of course, is that's the way it's done. In such a situation, you can expect the batter to lay down a bunt, no matter what kind of hitter he is.

Same with base stealing. A speed demon who can drive a pitcher nuts with the threat of a steal is a highly valued commodity on most baseball teams—never mind that, statistically speaking, most attempted steals end in outs. But stealing is fun to watch and, in some circles, worth the risk.

Another example is the act of intentionally walking a potential long-ball hitter. Richard Thaler, a University of Chicago economics professor, sees the intentional walk as a prime illustration of his theory of inefficiency and irrationality in behavioral economics.

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selling fewer tickets because we had more available.

Nonetheless it is not generally true that fewer seats mean more ticket sales; it's merely true in this specific situation.

So you can't really "model" and predict attendance, because it's influenced by all of these quirky factors that bounce around like pool shots.

What I'm saying is, if you think about it, there are a million ways to explain the A's somewhat disappointing attendance, many of which are more reasonable than the idea that you have to have stars to draw fans.

Oakland, as a city, lacks cachet. San Jose is larger than either Oakland or San Francisco, I believe. (Somebody told me it was, anyway.) But people who live in San Jose don't like to think of themselves as living in the Oakland area; they like to think of themselves as living in the San Francisco area. Yes, the Raiders overcame this, but the Raiders built an exciting and unique team at a time when the San Francisco football team was having a dull decade, and the Raiders constructed a fan base.

The A's have been good for several years, but so have the Giants, who have been winning 90 or 95 games a year for the past seven or eight years. The Giants have a new park; the A's have an old park that isn't particularly nice and doesn't have modern parking. Oakland's population is 38 percent black [according to Family Digest's "Best Places to Live for African-Americans, 2003], certainly higher than many or most other major-league cities. Baseball is not especially popular in the black community.

Another odd wrinkle to attendance is that attendance is driven as much by the expectation of winning as by the actual fact. If two teams both have "surprise" seasons and go 95-67, but team A goes 55-26 the first half of the season, 40-41 the second half, while team A goes 40-41 the first half, then 55-26 the second half, the attendance boost for Team A will be much greater than the attendance boost for Team B. The hot start will generate excitement, lead to an expectation of winning, and sell tickets.

The A's, throughout all of this run of good seasons they've had, have played better the second half than they did the first half, several times dramatically better. That hasn't helped them get the attendance going. What has happened to them several

times is that they've had a winter like this one where they lose a superstar or two star players or three regulars, so that the news coming out over the winter is down, and expectations for them in spring training are not high. Then they start out so-so, play .500 ball the first three months, and people think that the loss of Tejada or Giambi or whoever has really hurt them. Then they shoot the lights out the last 80 games and win the division, but it's really too late to establish an expectation of winning, and they're not able to capitalize on it because then the winter comes, and they lose another two or three free agents.

What I'm saying, I guess, is that really understanding attendance is very complicated, like a lot of the world is. There just isn't any evidence that the A's relatively poor attendance is related in any meaningful way to their lack of big-name or big-salaried players. It's inference from a sample of one. Any actuary would know intuitively not to pay any attention to it.**"**

Bill James
Senior Baseball Operations Advisor
Boston Red Sox

Traditional economists assume people act rationally and in their own interests. Thaler, however, maintains they often do irrational, self-defeating things, in the same way that baseball managers often make decisions from their gut rather than from the data.

For instance, he says, if you walk San Francisco slugger Barry Bonds every time he comes to the plate, he certainly won't be able to hit a home run. But he does get on base. He gets on base every single time he comes to the plate.

"Even Barry Bonds isn't that good," Thaler says. "But you don't get fired for walking Barry Bonds, and you may get fired for pitching to Barry Bonds."

Likewise, the idea of the Closer. The Closer is usually a team's best reliever, who gets big bucks for pitching the last inning of the game when the team's ahead and getting the "save." But statistically (and common-sensically, for that matter) getting outs in the last inning is no more important than getting outs in any other inning.

"Every out is important," says Thaler. "And it's no harder to get the last three outs than the previous three outs, and in fact, it can often be the other way." So why pay more to the guy who gets the last outs of the game than you pay the guy right before him?

I**T'S ONE THING TO PHILOSOPHIZE** about the importance of statistics, and even invent new ones. But what good are they? What do the new ones do that the old ones can't? And what do they mean?

What they mean to people like Billy Beane's assistant, Paul DePodesta, is that he can plug a player's stats into his laptop and arrive at an objective assessment of the player's worth, based on everything he's ever done on a baseball field. A manager no longer has to rely on the subjective hunches of scouts who simply watch a few examples of a player's performance.

"Think about it," wrote James in one of his *Abstracts*. "One absolutely cannot tell, by watching, the difference between a .275 hitter and a .300 hitter. The difference between a good hitter and an average hitter is simply not visible—it's a matter of record."

On-base average, for instance—a stat created by Bill James—is a better predictor of a hitter's success than the traditional batting average. On-base average factors in any way the batter can get on base, including not just hits but walks and even getting nailed by pitches.

Traditional baseball wisdom tends to regard walks as somehow inferior, a kind of consolation prize in the absence of a legitimate hit. Batters may strike out going after junk pitches, but at least they go down swinging, and there's a certain nobility in that.

Nonsense, say sabermetricians. A batter with lots of walks in his on-base average is discerning. He has a good eye and swings only at pitches he figures he can do something with. He generates runs, not outs. So while the free-swinging slugger shuffles back to the dugout, the patient hitter trots down to first base. At least some of the time.

What this means, then, is that the general manager now has new tools for valuing the events on the baseball field, based on what happened in the past. And no matter how good you get at using the past to manage risk, you still can't predict the future.

"I can't predict reliably who is going to be successful in the major leagues in 2004," Bill James told James Surowiecki in an interview in *Slate*, "even if we stick with the field of players who have been in the major leagues since 2000. I can't do that, because there are limits to my knowledge, and there are flaws in my implementation of what I know."

As Michael Lewis puts it in *Moneyball*: "No matter how accurately you valued past performance, it was still an uncertain guide to future performance."

Actuaries may be comfortable with uncertainty. Not necessarily Bill James.

"In a sense," he says, "it would be equally accurate to say that my work is driven by a futile passion to eliminate uncertainty."

A**T THE END OF 2001,** Billy Beane found himself facing the next season without three of his major stars: pitcher Jason Isringhausen, outfielder Johnny Damon, and first baseman Jason Giambi. He had lost them to richer teams because he could no longer afford their free agency status. With only $40 million to spend on 25 players, Beane's budget was roughly 20 percent that of many of the teams he was competing against.

If he couldn't afford to keep these players, he couldn't afford to replace them with players just like them, either. What he had to do instead was find a combination of less expensive players who could do the same things the stars had done, so that their leaving would not leave a discernible hole. And to do that, he first had to put a value on what each of those star players had brought to the team.

In other words, says Lewis, "How fungible were baseball players?"

To find out, Beane had DePodesta run some stats. He worked through on-base percentages and slugging percentages, and refined Bill James' runs-created formula, which looks like this:

$$\frac{(\text{Hits} + \text{Walks}) \times \text{Total Bases}}{(\text{At Bats} + \text{Walks})} = \text{Runs Created}$$

I**N THE END**, he came up with a heretical theory: One extra point of on-base percentage is worth three times an extra point of slugging percentage. In other words, someone who could get on base, no matter how he did it, was worth considerably more than a flashy, crowd-pleasing power hitter—and came considerably cheaper, too.

This led to Beane's making some highly unusual choices:

A Lesson from Billy

"As the chief data analysts for health plans and employer groups, we have a duty to conduct an in-depth statistical review similar to what Billy Beane has done for the Oakland A's. In this capacity, we need to guard against practices within our organizations that use misguided qualitative judgment to make important business decisions. Instead, we need to ensure that our business decisions are based on a well-reasoned examination of all available information using sophisticated data analysis. We should also attempt to instill a mind-set within our organizations that puts greater reliance on data and statistical analysis and less on gut feel and long-held opinions of financial risk."

Kurt Wrobel, director,
Pacificare Health Systems, Cypress, Calif.
SOA Health Section Newsletter

players who fit the profile he wanted but who sometimes didn't look the part. Oakland scouts' jaws would drop as Beane drafted a player whose pear-shaped physique was nobody's ideal, even if he was a bargain.

So what? Billy told them repeatedly. "We're not selling jeans, here."

But the stars he was replacing left holes not only in the lineup and on the pitcher's mound but in the field as well. And even sabermetricians have had a hard time valuing fielding ability. The traditional way to do it was to count up the errors and pick the player with the fewest. But errors, Bill James complained, are subjective; there had to be a more objective way to value fielding ability.

Then a couple of Chicago securities traders (Bill James aficionados, both) came up with a way to transfer the concept of derivatives to the baseball diamond. In the same way derivatives carve up securities into precisely quantifiable fragments, their system carves up the baseball field into a grid, a mathematical matrix of location points that can quantify every event that happens anywhere on the field.

"We keep track of the exact location—pixel by pixel on a computer screen—of every ball that's hit into play in every major-league baseball game," says John Dewan of Baseball Info Solutions. "Utilizing this information, we've developed a plus/minus system that measures how often players at each position turn batted balls into outs compared to other players at their position."

For example, the best major-league second baseman last year was Atlanta's Marcus Giles with a +25. That means he turned 25 more outs on balls hit at or near second base than the average second baseman. Atlanta also had the best center fielder in Andruw Jones, with a +20.

"This plus/minus system has an actuarial approach to it," says Dewan. "We calculate a league average for every location —i.e., every pixel—to which a ball is hit. We then measure each fielder relative to this average for every ball that's hit in his vicinity, then do a summation of the differences to come up with the plus/minus figure."

Beane and Podesta used a similar system to create derivatives of Jason Giambi—other players who could duplicate or at least approximate the gestalt that was the A's star first baseman. These turned out to be three players nobody else wanted, outfielder David Justice, catcher Scott Hatteberg, and Jason's little brother, Jeremy.

"Some teams [pay] a lot of money for unique packages of skills," says Bill James in *Slate*, "when they could easily replace each of the individual skills by looking for different packages, different combinations of skills."

It wasn't perfect. The A's eventually traded Jeremy. And they had to teach Scott Hatteberg to play first base, which didn't prove to be all that difficult; he turned out to be almost as good at first base as he was at generating runs. And he generated runs the Billy Beane way—with care and patience at the plate.

By the end of the 2002 season, the Oakland Athletics led the American League West with 103 wins and 59 losses and the lowest payroll in the division ($41,942,665). Texas finished at the bottom of the division with a 72-90 record and the highest payroll ($106,915,180.)

Michael Lewis, writing in *Moneyball*, relates another telling statistic that any derivatives analyst should be able to understand: "If Scott Hatteberg had taken every single at bat for the Oakland A's in 2002," Lewis writes, "how many runs would he have generated? Nine Scott Hattebergs generate between 940 and 950 runs ... The offensively explosive 2002 New York Yankees, by comparison, scored 897 runs. Nine Scott Hattebergs are, by some measure, the best offense in baseball."

MIKE MCMURRAY is a retired actuary and the managing owner of the Yakima Bears, a Class A minor-league affiliate of the Arizona Diamondbacks, winners of the 2001 World Series.

Mostly what McMurray does is keep score and maintain the

stats for the team. It's a job that requires some delicacy because stats are becoming more important and therefore more subject to dispute. And baseball players aren't exactly renowned for rational disputation. Ask any umpire.

"The level of analysis done at this level is crude at best," McMurray says. "Basically what they're looking at are batting average, slugging, on-base percentage, ERA, wins, losses, strike-outs. They're starting to look at things like how a batter does against a lefty or a righty. The analysis is ad hoc and very informal at this level so far.

"We try to interject some things for our managers and coaches, but they're pretty old school. If you haven't played the game for 35 years, you don't have much credibility. Their level of comfort and familiarity with either computers or math is very little."

And familiarity with actuaries? Forget it. "Unless the intent is to bring a conversation to a screeching halt," says McMurray, "one generally will not highlight one's actuarial background within professional baseball circles."

But, he says, the Oakland A's have a team at the Class A level, too. And it's amazing how differently it's run. All the decisions on the field come from the home office—pitching changes, starting lineups, substitutions—leaving coaches and managers mostly out of the picture, and with their noses often out of joint. It's an exact mirror of the picture Michael Lewis paints of

the A's major-league operation, where most of the field decisions are made by guys with laptops and the manager's job is basically just to look crusty and wise in the dugout. Actual major-league playing experience is not required.

In 2002, the Boston Red Sox hired Bill James as senior baseball operations advisor, a position that hadn't existed before. Aside from his interest in baseball statistics, James had no baseball experience other than coaching his son's Little League team in Lawrenceville.

At the same time, the Red Sox hired a new general manager. Theo Epstein is 28 years old, the youngest general manager in baseball history. He has a degree in American studies from Yale, a law degree from the University of San Diego, and a doctorate from the School of Bill James. He played baseball in high school but never made varsity at Yale. Though most of his professional career has been in major-league baseball, it hasn't been on the field.

Last year, the Boston Red Sox came within a Yankee's pinstripe of the World Series, something they haven't done since 1986. (They haven't won one since 1918.) It's probably too early to tell whether sabermetrics had anything to do with it, but the Oakland Athletics' success has been well documented, along with the Toronto Blue Jays'.

And in February this year, the Los Angeles Dodgers announced they were hiring a new general manager—Billy Beane's former assistant, Paul DePodesta.

Does this mean that more and more major-league teams will be putting geeks with computers on the payroll? Guys (and women) who understand how to unleash the predictive power of numbers? Who understand how to quantify and manage risk at a number of different levels? Who can see the concrete in the abstract? In other words, actuaries?

Who knows? But it probably wouldn't hurt to suit up.●

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