INTERNATIONAL
INSTITUTE FOR
ANALYTICS

Analytics in Sports:
The New Science of Winning

February 2014

Authored by:

Thomas H. Davenport

Introduction

Many industries today are adopting more analytical approaches to decision-making. However, no other industry has the same types of analytical initiatives underway as the domain of professional sports. That sector has the following attributes:

1. Customers are as analytical—and sometimes more so—about the industry's product as the industry itself, endlessly debating metrics, statistical analyses, and implications for key decisions online and in fantasy leagues;
2. There are multiple analytical domains to address, including game and player performance, player selection, customer relationships, business management, injury prevention, and so forth;
3. The industry has multiple output channels for its analytics, including internal analysis by teams, direct use by fans and fantasy league players, data and analytics websites, video games, and broadcast analysis and commentary;
4. The industry's work with analytics has been celebrated in popular articles, books and movies (*Moneyball* and other works by Michael Lewis in particular);
5. The amount of data available—both big and small—is mushrooming, from game video to location sensors to online scouting reports;
6. The rapid movement of coaches and general managers from one team to another has led to a viral transmission of analytical ideas across leagues;
7. The major conference for sports analytics, sponsored by MIT, has grown from 175 attendees at the inaugural event in 2007 to over 2200 in 2013.

Despite this evidence of impressive activity and growth, the use of analytics in sports is not without its challenges. Foremost among them is the traditional culture of many teams. Relatively few owners, managers, coaches, and players pursued careers in professional sports because of their interest in analytics. Even when considerable data and analytics are available to support key decisions, they may not employ them over their intuition and experience. In short, demand from key decision-makers for sports analytics is considerably less than the supply of data, technology, new metrics, and analytics.

> *Demand from key decision-makers for sports analytics is considerably less than the supply of data, technology, new metrics, and analytics.*

Another problem for the industry that restricts the wholesale adoption of analytics is that professional sports teams are, by and large, small businesses. A 2012 analysis suggested that the average NFL (National Football League) team was worth about a billion dollars and had about $30 million in operating income; Major League Baseball (MLB) teams were worth about

half of that; National Basketball Association (NBA) teams about a third of that; National Hockey League (NHL) teams about a fourth of that.[1] The average NFL team has a lower market value than, say, Molina Healthcare, which was at the bottom of the Fortune 500 in 2012.

> *Professional sports teams are, by and large, small businesses.*

This suggests that even relatively wealthy teams cannot afford large investments in technology, data, and analytical tools. Most of their revenue goes toward player salaries. Even larger teams will maintain only about 100 personnel in the "front office," so it is unlikely that they will employ large analytical staffs.

However, it is clear that the use of analytics can contribute to success on the field or court, and at the ticket window. It's impossible to equate winning records with more analytical capability, but the recent success of highly analytical teams—the Boston Red Sox and New England Patriots, the San Francisco Giants and 49ers, the Dallas Mavericks and San Antonio Spurs—suggests an important role. Analytics are also renowned for making small market teams like the Oakland A's and Green Bay Packers relatively competitive. At the ticket window (or, more likely, the ticketing website), analytics can raise ticket revenues in good performance years, or hold them steady in poor performance years. In short, while analytics has not and will not replace strong players and good coaching as recipes for team success, they have certainly become established as important augmentation for those basic success factors.

In this report, which is based on a series of interviews with professional sports teams and vendors in the US and Europe (see sidebar, "About the Research,"), I'll describe the major areas of analytical activity. For each area, I will present both "table stakes" applications—those that are rapidly becoming common practice—and those that are at the frontier. Whenever possible, I'll present examples of particular teams that are employing that approach. I'll also highlight several analytical

About the Research

In late 2013 and early 2014, Alastair Sim of Global Performance Solutions, Ltd. and I interviewed representatives of 25 professional sports teams or leagues in American football, the English, European, and U.S. professional soccer leagues, basketball, baseball, hockey and golf. We spoke with analytics experts, general managers, IT managers, or other executives. We also interviewed several leading vendor organizations. The interview questions addressed the areas of analytics being emphasized by the team, analytical approaches and technologies employed, organizational structures, and likely future approaches to analytics. The research was sponsored by the SAS Institute, but SAS did not influence the results of the research other than to suggest a few customers to interview. Thanks to Al Sim for doing all interviews outside the US and for drafting the profile of Sam Allardyce, to Geoff Smith for connecting me to his network of sports analytics leaders, and to Al, and Geoff for providing helpful comments on the draft of this report.

leaders who have had an important impact on their team and their sport. At the end of the report, I provide a series of lessons and steps to take to succeed with sports analytics.

Analytics in Player and Game Performance

When most fans think of analytics in sports, they think of their use to enhance team performance: to select the best possible players, field the best possible teams, and make the best possible decisions on the field or court. Indeed, that was the primary focus of *Moneyball* at the Oakland A's and elsewhere in the MLB—to draft players on the basis of proven performance (particularly getting on base), and to discourage time-honored on-field tactics such as bunts and stolen bases.

These analytical approaches are still accepted, but they rarely confer any sustainable competitive advantage, unless the team is continually pursuing new approaches and insights. They are widely employed by all MLB teams, and their equivalent approaches are used by professional teams in other sports. I'll refer to this type of well-understood and broadly-applied analytical application as "table stakes" in sports performance analytics. There are certainly still advantages to effective execution of these table stakes applications, but the concepts themselves are widely disseminated.

Before discussing table stakes analytics for player and game performance, however, it's important to point out that there are still substantial obstacles to effective use of analytics in this context. More than a decade after *Moneyball*, many coaches, general managers, and owners are not yet comfortable with the use of analytics in their sport and team. As one head of analytics for an NFL team put it in an interview:

> *I am working against a culture of indifference toward analytics. Despite that, I am trying to find the one or two things the coaches will use. Every time I engage them—and that's a struggle in itself--I throw out several things. If they accept one I consider myself successful. Football is a good old boy culture that sees security in the status quo, and it has been hard for analytics to make a dent in it.*

There is little doubt that data and analytics will play more of a role in every sport in the future, but for now there are challenges in terms of acceptance. As in business, the role of aligned leadership appears to be the single most common factor in making a team successful with analytics.

One aspect of table stakes analytics that is common to all professional sports is the rise of external data sources on teams, players and their performance. One key provider of data is the leagues or associations themselves; the NBA and MLB are particularly active in this regard. The

PGA TOUR also collects extensive player performance information—every tournament shot, actually—primarily for use by broadcasters. In fact, television has become an important market for all types of team and player performance analytics. ESPN, for example, hired Dean Oliver, a well-known basketball analytics expert, as its Director of Production Analytics.

Every professional sport also has third-party providers of data and analysis, although the analytics are largely descriptive. Examples of third-party data and analytics providers—both large organizations like Bloomberg and sports analytics entrepreneurs— include:

- ShamSports—NBA salary data
- Bloomberg Sports—Player performance data and "match analysis" for all major professional sports
- BaseballProjection.com—MLB "wins above replacement player" analyses
- Sports Reference—data and analytics on major professional sports
- ProFootball Focus—NFL player analysis
- Opta and Prozone—English Premier League football (soccer)

Table stakes analytics vary somewhat by sport. In baseball, they include extensive use of various recently-developed individual hitting metrics (on-base percentage, slugging percentage, runs created, value over replacement player, etc.) and individual pitching metrics (fielding-independent pitching, true runs allowed, value over replacement pitcher, etc.). These metrics were typically created by baseball fans and analysts (the most notable being Bill James), but several such individuals (including James) have been hired by MLB teams. Fielding metrics (such as defensive runs saved, ultimate zone rating) are somewhat more cutting-edge, and tend to be position-specific to some degree. Because baseball is an individually-focused sport, optimal lineup analysis and player interaction analytics are not widely used (with the exception of batting order analysis, which has been fairly influential). Baseball has also featured for many years a variety of game tactic analytics, e.g., whether to bunt or steal.

Teams also devote considerable attention to ranking players in the draft process, although there is little evidence that their choices are better than those based on widely-available public rankings of players.[2] There are also table stakes analytics in baseball involving salary optimization, and simulation of game outcomes based on alternative lineups and strategies.

In the NBA, table stakes analytics for player and game performance generally involve some form of "plus/minus" optimal lineup analysis—evaluating individual players and combinations of

In short, while analytics has not and will not replace strong players and good coaching as recipes for team success, they have certainly become established as important augmentation for those basic success factors.

players on the basis of how the team performs with the player or players versus without them. It is widely agreed that there are strong interaction effects with different players and lineups in basketball; a player who is very effective in one context can be average or worse in another. Wayne Winston, a consultant to the Dallas Mavericks and New York Knicks (and a professor and author of the book *Mathletics*), noted one example:

> *In the 2006 playoffs for the Mavericks, for example, Jerry Stackhouse was very good in the Phoenix series, but he was horrible in the Heat series. In Game 6, when Stackhouse was on the floor the Mavs lost by 17. It's all about the context.*

Independent of context, there are also well-established analytics in the NBA ranking players in the draft and available free agents.

As in baseball, basketball teams pursue a variety of game tactic analytics. Teams are generally aware, for example, of the expected value of various types of shots. It is widely believed, for example, that three-point shots and those near the basket (layups or dunks) have the highest expected value. However, even knowing this information, some teams are much more disciplined than others in their shot choices.

In professional football, player and game performance analytics tend to be less sophisticated than in baseball or basketball. The complex interactions of a larger number of players on the field, and the difficulty in rating performance of players in each position on each play, make it more difficult to evaluate players or create optimal lineups. The culture of football coaching is relatively conservative, meaning there is relatively little demand for player and game performance analytics. Teams do almost always have rankings of players for drafting, and some predict success in the NFL. There are also some game tactic analytics that are widely used, such as whether to punt on fourth down. Bill Belichick, the coach of the New England Patriots, is renowned for having read an academic economist's article suggesting that teams punt too frequently on fourth down, and the Patriots are indeed relatively likely to "go for it" instead of punting under certain fourth down situations.

Quantitative analysts for NFL teams often have to work to make their statistics and analyses as easily digested as possible. One experienced analyst for an NFL team noted:

> *I use data visualizations—simple stuff—to try to improve group decision-making for the college draft. There are dozens of key "measurables" for players and it's difficult for the evaluators to digest all of the trade-offs between them (e.g., 'this guy is very quick, but lacks size/strength.') I provide them a color coded 1-pager that provides a "visual conjoint analysis" of sorts. I try to get these visualization tools in at the front of the decision process, and hopefully get some data-based discussions going.*

Professional soccer—in both the US and in Europe (where it is called football, of course)—is perhaps more advanced than US football in its use of player and game performance analytics, but less so than basketball or baseball. The focus in soccer is primarily on descriptive statistics, with increasing emphasis on diagnosis or prediction. That is, teams focus on what happened, rather than why it happened, or what might happen next. In the U.S., Major League Soccer, which owns all the MLS teams, largely manages business and marketing analytics centrally, but performance analytics are largely left to individual teams at the moment. Some European teams, such as Manchester City in the English Premier League, are relatively advanced in terms of performance analysis, and have even made performance data available to fans for open-source analysis. In terms of evaluating players' propensity to score, soccer is handicapped by the low frequency of scoring in most games. Tactical factors such as possession, passes completed and territory played are now being evaluated to review approach play leading to goals. The dominant focus, however, is on the physical activity and fitness of players, which I discuss later in this report.

In player and game performance, there are also "frontier" applications of analytics. These are in the early stage of adoption, and may be used aggressively by only a few teams. Across all professional sports, the frontier source of data is clearly video. In baseball, PITCHf/x video is in every MLB park, and some teams are using HITf/x and FIELDf/x to capture and analyze hitting and fielding, respectively. In the NBA, every team now captures video from six SportVU (from Stats Inc.) cameras in the rafters. All NFL teams make extensive use of video, although the league does not mandate or supply a particular approach to video. Major league soccer, hockey, and golf are also making use of video, either at the league level (as in the MLS) or at individual teams.

Across all professional sports, the frontier source of data is clearly video.

For professional leagues that do not have a league-wide approach, as in the NFL, editing, tagging, and analyzing video is a major burden on IT organizations and analysts. For leagues such as the NBA that now have the same supplier and video formats for every team (although individual teams, such as the Houston Rockets, adopted the video before other teams, and hence have an advantage in familiarity), the video data itself is tagged and managed by the vendor.

However, regardless of the data management burden of video, we are only in the earliest stages of analyzing it effectively. Video analytics in basketball, for example, keep track of descriptive analytics such as ball touches, rebounds (contested and uncontested) and so forth. This is useful analysis, but more complex analytics (how often does a particular player go to the left when driving toward the basket from the free throw line) require human analyst work. Given the massive amount of video footage available, there are probably not enough capable

humans on the planet to be able to extract all the possible findings. A common reaction to the sobering analytical possibilities is described in an article about video in baseball:

> *"We had shown them [Chicago White Sox executives] data capture on one play, a steal, and they kept asking us questions," he said. "'Do you get the initial lead? Do you get the secondary lead? Do you get the windup time, the pitch time, the pop time, the time it takes to throw down to second base?'" The answer in every case was yes. "You could see it on their faces," said [SportVision CEO Hank] Adams, "'Oh my God, what are we going to do with all this data?'"[3]*

The same article points out that the volume and quality of video data presents an opportunity for a new generation of analysts to arise. Few current analysts were trained in how to extract meaningful insights from video data. There is also an opportunity for university programs to provide such training, although few faculty are expert in such approaches either. Given their stake in the success of video for sports analytics, it is most likely that vendors will make the fastest

> *'Oh my God, what are we going to do with all this data?'*

progress toward better analytics. Those capabilities will eventually be available to all customers, but there may be early mover advantages to those who work closely with vendors and adopt their products early.

Another frontier data source for player and team performance is locational and biometric devices. These include GPS devices, radio frequency devices, accelerometers, and other types of biometric sensors. One vendor of these tools, for example, is Catapult Sports, which developed GPS and accelerometer-based devices in Australia. Zebra Technologies offers a radio frequency ID (RFID) tag for location data that is being explored by a few professional teams. Adidas offers the MiCoach system (including GPS and biometric sensors), which was adopted by all US Major League Soccer teams in 2013. Several English Premier League teams use similar devices in practices, but they are not yet allowed in game use. Some NFL (e.g., the Buffalo Bills) and NBA (e.g., San Antonio Spurs) use GPS devices in practices, which is the only time at which they are approved by their respective leagues. The locational devices are most frequently used to assess total activity (miles or kilometers run, steps taken, average speed) undertaken by players in a game or practice.

> *Full advantage from player and team performance analytics would seem to come when all the coaches and players on a team embrace analytics and use them to enhance their performance.*

As with video, the analytics of locational and biometric data are just beginning to be identified. At the moment, the primary uses are to assess the amount of physical activity a particular

player undertakes. It's also possible to use this type of data to understand interactions between players, but this will require greater sophistication in data analysis.

There is far more data than most teams can currently analyze. In the soccer leagues that have adopted GPS devices, for example, the teams will undoubtedly have far more data than they know what to do with at first. There will also be overlaps between types of data; for example, it's possible to know how many yards, feet, or meters a player has run during a game from either GPS devices or video cameras. For several years, it's likely that the analytics from such devices will be simple descriptive reports—what happened in numbers or charts, without any prediction or optimization. Over time, sophisticated teams will develop predictive and associational measures, such as these hypothetical examples:

- "This player tends to allow an average of three more points per game on defense when he runs more than 10,000 meters in a game."
- "Players who heart rates exceed 160 beats/minute for over two consecutive minutes tend to run much slower in the last quarter of games."

Another frontier approach to player and game performance analytics is to gather proprietary data on players. Most teams make use of widely-available data that is provided by their league or by commercial firms that sell player and team data. A few highly analytical teams, however, gather their own proprietary data, or adopt technologies that produce it. There are several examples across sports:

- Daryl Morey, the General Manager of the Houston Rockets (see sidebar—"Analytical Leadership Profile—Daryl Morey"), has written that "real advantage comes from unique data that no one else has," and he has used a number of analysts, interns, and volunteers to collect such data on the Rockets and their opponents. The exact nature of such data is, of course, proprietary.
- The Orlando Magic's management team also believes that competitive advantage requires proprietary data, and has collected some on both the team and player performance and business domains. The Magic was an early adopter of SportVU video data, and managers there believe the team has both more analysis tools and more people oriented to the data than other teams.
- The Boston Red Sox have gathered proprietary data on NCAA players. Joe Torre, former coach of the New York Yankees, wrote in his book *The Yankee Years* that:

> *Intellect and player development is where Boston lapped the Yankees. The Red Sox, for instance, became so insatiable about the power of information that they deployed expert number crunchers to the NCAA headquarters to input every available statistic on all college players in history into a database. They then cross-referenced those numbers*

against the performance of those college players who made it into the big leagues, and from there they devised their own tables of how college performance might help predict major league performance— information that would become critical in their draft-day decisions.

- The San Francisco Giants MLB team was the first to adopt video data from SportVision for pitching (PITCHf/x), hitting (HITf/x) and fielding (FIELDf/x), giving them proprietary data for several years before other teams adopted the same tools. The Giants also track and attempt to quantify a variety of intangible metrics that they feel help them to create a more holistic way to measure the expected value of each player.
- The New England Patriots also had proprietary measures of player personality and attitude, and for several years selected players whom other teams had dismissed as having attitude problems. Such proprietary measures offer promise, but they are not without problems. At the Patriots, for example, the drafting of Aaron Hernandez, who is currently in jail on murder charges, may lead to less reliance on this proprietary data.

A different type of frontier for player and team performance analytics is involving players themselves in the use of analytics. Most coaches, and many outside observers, seem to believe that it is either fruitless or ill-advised to expose players to extensive analytics about their own or their opponents' performance. As one NBA player said on a CBS News story about video cameras in basketball arenas:

"If you're thinking about the camera up there while you're playing, then Chris Paul might go by you for a layup or, you know, Blake Griffin might," said [Garrett] Temple [of the Washington Wizards].[4]

However, there are some notable exceptions. Daryl Morey of the Houston Rockets has commented that Shane Battier, a former Rockets player who was profiled in a Michael Lewis article, is the one player he has encountered who was able to absorb and act on analytics related to his own performance.

In baseball, there are a small number of players who have used analytics to dramatically improve their own performance. Pitchers Brandon McCarthy (see "Analytical Leadership Profile—Brandon McCarthy") and Brian Bannister are perhaps the best examples. Bannister, now retired from baseball, viewed himself as a "typical fourth starter" and notes about the role of analytics in his own career:

When this is important is trying to get a fringe guy [as opposed to a truly exceptional player] to get the most out of his talent and ability. I'm not trying to reach new horizons. I'm trying to filter out what's applicable to player development. That's what's important to me.

He analyzes relatively obscure metrics on his own performance (including BABIP, batting average for balls in play, and xFIP, expected Fielding Independent Pitching). He also closely watches PITCHf/x video for evidence about which types of curveballs are most difficult for hitters to hit. Bannister was somewhat successful in improving his own performance, but he also inspired Kansas City Royals teammate Zack Greinke to adopt similar sabermetric analyses of his own performance, and Greinke won the American League Cy Young award for best pitcher in the 2009 season.

Analytical Leadership Profile: Brandon McCarthy

Few players have adopted analytics to improve their own performance more than Brandon McCarthy, an MLB pitcher currently playing for the Arizona Diamondbacks. The 32-year old pitcher was previously at the Texas Rangers, where in 2009 he had a bit of an analytical conversion. Few would have labeled him a statistical egghead before this time; McCarthy was drafted out of high school and never went to college.

During a three-month injury rehab period from a shoulder injury, he studied his data relative to more successful pitchers. His particular focus was on the Fielding Independent Pitching (FIP) metric, and the ratio of ground balls to fly balls. He realized that his pitching style led to too many fly balls, which create more than twice the expected value of runs than ground balls. He began to work on a two-seam fastball, which induces grounders at a higher rate.[5]

His performance improved dramatically, and he was signed to a one-year contract by the sabermetrics-minded Oakland A's for the 2011 season. There he achieved a 9-9 record and had the lowest FIP in baseball's American League. He was throwing substantially fewer pitches and hitters were hitting fewer fly balls. The next season the A's signed him to a much higher contract.

McCarthy described his move toward analytics in an interview:

> *A lot of it is just … the more smart information the better. A lot of things in baseball are done by feel or gut of kind of sticking with what you've done and it just became less and less acceptable to me that I was just going to keep playing out my career with doing things the way I had always done them. I decided to change everything and fit a different model, try and kind of change everything…But a lot of that fit into trying to fit a different statistical model -- more groundballs, more strikeouts -- which kind of seems intuitive, but if you're not doing it, it feels like a different universe. So I wanted to kind of get into that. And now that I do it, it's something that you can focus on different little things, percentages here and there that you can work in your favor.*[6]

McCarthy's numbers have improved, but his luck hasn't. He was hit in the head by a fast-moving ball in September 2012, which ended his season. In 2013 he had a brain seizure as a result of the injury, and additional shoulder problems. It's unclear whether he'll ever return to his analytically-driven level of excellence again. but it was a dramatic improvement while it lasted.

In the NFL, New England Patriots quarterback Tom Brady is known to be among the more disciplined analytical players. One account called him a "student of error" for his detailed review of incomplete and intercepted passes in game videos.[7] In a 2014 press conference, he described what he thinks leads to success in professional football:

> *You have to be a technician, you have to understand, you have to be a student of the game, you have to work, you have to understand what the coaches are asking, understand what the team is looking for and just keep working harder and harder and harder and then when you get your opportunity you have to make it pay off.[8]*

Of course, full advantage from player and team performance analytics would seem to come when all the coaches and players on a team embrace analytics and use them to enhance their performance. That appears to be the approach taken by the English Premier League soccer team West Ham United, whose manager, Sam Allardyce, has been an early adopter of analytics in that sport (see sidebar, "Analytical Leadership Profile—Sam Allardyce").[9]

West Ham has a meeting after games in which Allardyce and David Woodfine, the team's head of performance analysis, spends 15 minutes going over the numbers that characterize the team's performance during the game. The primary data source is the Prozone player and team performance data of which Allardyce was an early user at a previous club. After the team overview, individual profiles of players and their specific metrics are reviewed and discussed. Evidence-based coaching points are presented to players, including analysis of GPS captured training data, wearable device data such as sleep and heart monitors, video clips and Prozone numbers.[10]

Analytical Leadership Profile—Sam Allardyce

Sam Allardyce is the Manager at West Ham United Football Club and has become a regular managerial fixture in the English Premier League (EPL). He managed the Bolton Wanderers as well as Newcastle and Blackburn before taking on the challenge at West Ham in 2011. Allardyce led the club from the second tier of the English soccer leagues to the EPL in the 2011-12 season and has kept it there since.

Allardyce played soccer for several teams in the EPL as well as for the Tampa Bay Rowdies in the North American Soccer League. There he first became aware of the potential that data and analytics had to positively affect the performance of sports teams and athletes. While in Tampa he was able to observe the NFL Tampa Bay Buccaneers, and noted the importance of tying together strategies for specific positions and groups in a unified game plan and playbook.

Allardyce observed that preparation and planning for a variety of tactical options is the key to success. Being able to call upon those options based on fact-based scenarios is something that Allardyce has taken with him on his managerial journey.

At Bolton, Allardyce built up a reputation for getting the best out of players at various stages in their careers. The team competed more than once for the UEFA Cup. Allardyce was also known at Bolton for the extensive use of data to evaluate player performance and team strategies. The team also used analytics to identify its most valuable customers and to offer them benefits that helped to build loyalty.

Allardyce's teams have generally not been the beneficiary of limitless resources from billionaire owners. Therefore he has had to succeed by smart decisions instead of deep pockets. Allardyce recognizes the value in data and the application of analytics, and works with his support staff and team of analysts as well as specialist analytics partners who can utilize statistical analysis software. His teams have also been early adopters of new technology, including CRM, GPS devices, video, and sleep monitoring.

There are three words that Allardyce cites as being key to the success of driving analytical change to positively affect the performance of the sporting business assets(players): faith, proof and determination. Faith means the trust and support of the boardroom of a sports organization. Proof means the use of data and analytics to provide fact-based evidence for managerial approaches and decisions. Determination is something which is needed during the times when results are affected by external/mitigating circumstances. To borrow (and adapt) a sporting cliché: fortune is temporary but knowledge is permanent.

At West Ham, Allardyce and his staff are deploying data and analytics in several different areas:

1. Support for individual game strategy: competitive intelligence and tactical options;
2. Insights on player performance to provide specific conditioning and strengthening;
3. Modelling patterns of injuries with the ultimate goal of prediction and prevention;
4. Sharing of performance analysis with players to reinforce messages and empower them to take ownership of their performance improvement.

Allardyce breaks the season into clearly-defined phases, sets team and player objectives for each phase based on analytically defined metrics, and then reviews in open forum the results against objectives.

He argues, "It's what we know, not what we think, that matters!"

A final frontier in player and team performance analytics involves sourcing fans to do analytics on open data. Involving fans is not new, particularly in baseball. Bill James' Project Scoresheet and David Smith's Retrosheet involved fans into capturing baseball data and making it available for analysis. But this activity was not sponsored or sanctioned by teams. Another way that fans get involved in analysis is when they are hired by teams. The Boston Red Sox have hired such "uber-fans" as Bill James and Tom Tippett; the Seattle Mariners and St. Louis Cardinals have

hired Tom Tippett, and the Orioles have hired Eddie Epstein. The PGA TOUR uses volunteers to measure player shots using handheld devices.

But perhaps the most aggressive use of open data and fan crowdsourcing comes from the Manchester City team in the English Premier League (EPL) for soccer. That organization has partnered with its primary data provider Opta to make all player performance data from all EPL clubs available for analysis by fans and researchers.

As Gavin Fleig, the team's head of performance analysis, explains:

> *The whole reason for putting this data out there is to open the doors. The data has value, previously it has been kept in-house and behind guarded doors, but there is a recognition now that clubs need to help this space develop. There are a lot of people out there blogging and doing their own research and they can do a lot more with this data. I hope it will have a big impact on those who want to do research. It might just be the armchair enthusiast. If the worst it does is show a few people that there are different ways of looking at a player's performance, then great. If it helps universities and gets the blogging world talking and coming up with fantastic ways of modelling performance, that is what we want. We want to engage with them.[11]*

Thus far over 5000 fans have downloaded the data. It may prove to help teams in analyzing the massive amount of data that is available on player and team performance.

Analytical Leadership Profile—Daryl Morey[12]

Daryl Morey, the General Manager of the Houston Rockets, is often described as the Billy Beane of the NBA, but it's not a fully apt comparison. Like Beane, he's a strong advocate of analytical decision-making, and he was the earliest aggressive user of analytics in his role in his sport. Unlike Beane, however, he has a strong analytical background himself, and has become a convener and marketer of sports analytics in general as the co-chair of the MIT Sports Analytics Conference.

Morey got an MBA at the analytically-oriented MIT Sloan School, and before that a BA in Computer Science at Northwestern. He worked part-time for sports data and analytics firm Stats Inc. while in college, and after his MBA worked for the research company MITRE as "Senior Knowledge Management Engineer," where he co-edited a book on knowledge management. Later he took a job at the consulting firm Parthenon Group. After Parthenon helped structure the deal that took the Boston Celtics private, Morey moved to the Celtics and eventually became Senior VP of Operations. In that job he worked on both basketball and business analytics, including ticket pricing. At age 33—unusually young for the NBA—he was recruited by Houston Rockets owner Leslie Alexander to become the team's General Manager.

As GM of the Rockets, Morey is most notable for four achievements from an analytical perspective:

1. Identifying the free agent players that could help the Rockets most, and then relentlessly pursuing them until they join his team. Morey was able to shuffle players, draft picks, and money around until he eventually acquired superstars James Harden and Dwight Howard. Both players' playing styles are consistent with the Rockets' game strategy.
2. Building a strong group of analysts and interns at the Rockets. Given Morey's strong leadership, there is high demand for these roles. Interns, for example, must commit to working for two years without pay. Morey says that Houston at one point spent ten times as much as any other team on analytics, but feels that other teams have caught up to some degree—though not completely.
3. Developing a disciplined strategy for team shot selection. Houston's players generally shoot only near the basket and outside the three point line, consistent with the high expected value of these shots. The Rockets almost always have the lowest percentage of shots in the league from within the "no-man's land" of 16 and 23 feet from the basket. Players like Harden and Howard were selected in part for their adherence to this approach.
4. Intensive pursuit of distinctive or proprietary data. Morey has used his army of interns and volunteers to classify player behaviors across the league. He was also the first NBA GM to strike a deal with SportVU from Stats, Inc.L to put video cameras over the court to capture all play. The NBA has now put cameras in all of its arenas, but the Rockets presumably still have an advantage in using and interpreting the data.

Morey also employed a rigorous—and somewhat analytical—approach to selecting a head coach for the Rockets in 2011, eventually selecting Kevin McHale. The former Boston Celtic is amenable to analytical strategies and is "very smart," according to Morey.

Despite his focus on the data and the details, Morey is able to understand and explain the big picture of success in the NBA. Acquiring one or two superstars is essential for any team. In an "AMA" (Ask Me Anything) online discussion on Reddit, for example—Morey is typically voluble in talking to the press and fans—he commented on this situation in an insightful fashion:

> *[There is] a near asymptotic distribution function of high end talent. One way I describe it is imagine [that] in baseball when Barry Bonds was at the height of his powers he could have kept calling himself to the plate over and over, ignoring the lineup card. This is essentially what the top players in basketball can do each time down the floor - they can "call their own number" and make sure the team gets a great possession each time.*

It's no wonder that another NBA executive has referred to Morey as "the smartest GM in the league." However, not all parties in the NBA are believers in either Morey or basketball analytics, and it may take decades to convince them that numbers are a better guide to basketball decisions than intuition and experience alone.

Table Stakes and Frontier Analytics for Player and Team Performance

Table Stakes Analytics	Frontier Analytics
Use of external data sources	Analytics on video data
Descriptive analytics on players	Analytics on locational/biometric data
Optimal lineup analytics (basketball)	Open data analysis by fans
Player scoring for draft analysis	Engaging players in analytics
Player salary optimization	Gathering and using proprietary data
Simulation of games	
Analysis of game tactics	

Business Analytics in Sports

A second major category of analytics in sports revolves around business-oriented applications. These include analytics for ticket pricing, fan loyalty analysis, promotions, social media, and fan engagement. While there is considerable interest in this type of analytics among professional teams, it is fair to say that it receives less enthusiasm and support than do player and team performance analytics. More than one business analytics manager or analyst stated that they felt somewhat like second-class citizens compared to team performance analytics staff. It's also fair to say that the great majority of teams are less sophisticated than leading businesses in terms of business analytics. This is not surprising given their size and primary emphasis on performance and winning on the field or court. To address this issue, some teams are creating a single enterprise

Some teams are creating a single enterprise organization for both player and team performance analytics and business analytics.

organization for both player and team performance analytics and business analytics. Teams such as the Orlando Magic and Phoenix Suns have adopted this approach with apparent success, and some analytical leaders, such as the Mets' Sandy Alderson, have taken an interest in both domains when their jobs warrant it (see Analytical Leadership Profile: Sandy Alderson). All three of these teams also make use of analytics software that is widely used in businesses, and which addresses both business and performance applications.

Analytical Leadership Profile—Sandy Alderson

Sandy Alderson, now General Manager of the New York Mets, is arguably the person most responsible for the Moneyball revolution in baseball. Although he wasn't featured in the book and movie by that name, as the General Manager of the Oakland A's from 1983 to 1997, he set the analytical direction that many teams have now adopted.

Alderson "put a toe in the analytics water" at an early stage—around 1984—for one primary reason. He had just taken over as GM and had little experience in the game. Therefore, he was searching for an effective decision-making approach. There were two primary schools of thought at the time: "smallball," or a series of small hits and walks, or a more aggressive approach involving as many home runs as possible. The well-known analyst Bill James was just beginning to publish at the time, and his work suggested the "big ball" approach. At about this time, Alderson heard influential baseball analyst Eric Walker on a local radio station, and hired him to study what really helped teams win games. This led to a greater focus on home runs and on-base percentage, and a decreased focus on bunts and steals. Alderson brought former player Billy Beane into the front office, and was Beane's mentor on analytical thinking. Beane eventually succeeded Alderson as GM of the A's.

After the A's, Alderson was a senior MLB executive and then became CEO of the San Diego Padres from 2001 to 2005. In that role he fostered greater use of both baseball and business analytics, such as dynamic ticket pricing. He took the GM job at the Mets in 2010. Alderson has surrounded himself with sabermetrically-minded colleagues, including Paul DePodesta, and J.P. Ricciardi. He has also hired on-field managers who are at least somewhat analytical in their orientations.

Alderson is a disciplined executive, with a strong focus on building systems and processes, and on evaluating players and strategies in terms of their long-term probabilities for success. He believes in using all the tools at his disposal for good decision-making, and not just analytics. He says he tries to be "both analytical and innovative—essentially craving information, while not being overly reliant on statistics."[13]

Alderson views video and player movement data as potential frontiers for baseball analytics. However, he feels that most teams today have similar data. Competitive advantage comes, he believes, primarily from better execution of existing analytical concepts, and taking the knowledge derived from data to develop players. He and his colleagues at the Mets are trying to engage players in the process of analytically-driven improvement—not just recognizing existing value in a player, but helping to create it through directed growth in skills.

There are, however, some "table stakes" applications in business analytics. They include ticket pricing, fan loyalty analysis, and fan satisfaction metrics. These analytical areas are not being addressed by all teams, but they are well-established among leaders, and by now most professional teams have adopted them to some degree.

Ticket pricing is a reliable way for teams to make additional revenue through analytics. One account suggests that in Major League Baseball, 26 of 30 teams use some sort of ticket pricing analytics for more flexible pricing.[14] The most common approach to analytical ticket pricing is to offer variable pricing; under that approach, some tickets cost more than others, but the variable prices remain static throughout the season. A team might charge more, for example, for games against a popular or successful opponent. Several teams in the NFL, which tends to be relatively conservative in its use of analytics, are planning to institute variable pricing in the 2014 season.

A more sophisticated ticket pricing approach is to offer dynamic pricing, in which variable prices change throughout the season based on factors such as how well the team is doing, the success of the team's opponent in the league standings, and even factors like weather. Put simply, with dynamic pricing, tickets that are in high demand sell for higher prices. The San Francisco Giants were the first team to institute variable pricing in the MLB,

> *Ticket pricing is a reliable way for teams to make additional revenue through analytics.*

employing it for about 2000 seats per game. The experiment was a success, leading to additional revenues for the team of about $500,000. Now the Giants and several other teams employ variable pricing on a broad level. The Giants' ticket pricing model incorporates 120 different variables to determine an optimal price for a ticket. Since the team has sold out 246 games in a row, variable pricing is clearly not hurting demand. Some teams have also moved to dynamic pricing of concessions, and of ticket and concession bundles. Of course, some sports have more inventory than others; NFL teams have only 10 home games, while MLB teams have 81 games of ticket inventory to sell. MLB teams have to work harder to sell so much inventory, so the benefit from analytical tools is more compelling for them.

The move to variable pricing was aided by the MLB's partnership with StubHub In 2007 to create an official online resale market. Since resale prices are inherently variable, teams felt more freedom to charge variable prices for original sales. The StubHub deal also allowed teams to learn what fans are paying for different types of tickets in the resale marketplace.

Some degree of marketing, promotion, and fan engagement are all table stakes areas for professional sports teams. Significant progress is being made in these areas in terms of analytics, but only a few teams reach the sophistication of the most advanced business analytics users. Marketing and promotion are increasingly common because sports teams have CRM systems that keep track of customer offers and purchases. However, for the most part there is little analytical targeting or customized offers across most teams.

From a fan engagement standpoint, all professional leagues are employing websites with statistics and video as a means to increase fan engagement. It is thus a table stakes activity. However, there are no widely-used metrics of fan engagement. Some websites are planning a

degree of personalization of the online content provided—for example, the "NFL Now" offering planned for the 2014 season—but it appears that analytics do not play an important role in the personalization process.

One exception is Major League Baseball Advanced Media (MLBAM), which has digital content of several types and does some personalization of ads and content based on inferred or furnished fan information. MLBAM has been employing statistical tools for over a decade to understand its fans, and has more recently adopted programmatic marketing tools using analytics to place digital ads. It is widely viewed as being the most sophisticated media organization in professional sports, and it manages video and digital assets for other sports organizations, including the NCAA College World Series and women's NCAA softball, the NCAA College Basketball Championships, and Australian football and cricket.

In the NBA, a few individual teams, such as the Orlando Magic, are attempting to personalize web content for each person who visits their website, though it is early in the process. Therefore, detailed personalization is a frontier activity for business analytics.

Other frontier approaches to professional sports marketing involve segmentation, personalization outside of the web, and optimization. The goal is to not treat all fans as if they were alike, and to develop increasingly targeted approaches to marketing based on a fan's history and past purchases. In professional leagues with a centralized marketing approach, such as the MLB and MLS in North America, there is sometimes contention between teams and the league over who owns and can act on fan information.

In season ticket sales, for example, several teams, including the San Francisco Giants in the MLB and the Orlando Magic in the NBA, pay special attention to fans identified (through a scoring model) as likely to attrit. The Magic, for example, creates:

> *…decision tree models that bucket subscribers into three categories: most likely to renew, least likely and fence sitters. The fence sitters then get the customer service department's attention come renewal time.*[15]

The New England Patriots use an approach to season ticketholder retention that is based on a variety of behavioral metrics. Their models include such variables as game attendance, purchases of team merchandise, attendance at special season ticketholder events, and attendance at concerts or soccer games at Gillette Stadium. The Patriots also explore which channels in what sequence are best to communicate with season ticketholders. "Of course, we analyze their opens and clicks," says Jessica Gelman, the VP of customer marketing and strategy for the Kraft Sports Group, which owns the Patriots. Other teams are beginning to adopt similar approaches, but the Patriots began using the behavioral model in 2009, and it led to a record 97% renewal of season tickets for the 2010 season. Gelman also notes that Jonathan Kraft, the president of the Patriots, is an enthusiastic supporter of analytics initiatives.[16]

The use of social media analytics is a frontier practice in measuring fan sentiment and engagement. The San Francisco Giants, befitting their home location in the technology-focused Bay Area, are aggressive users of social media analytics. The team mines social media content to measure the "buzz" and level of engagement around the team overall, individual players, and specific games. Bill Schlough, the Giants' Chief Information Officer, notes:

> *We are growing our staff to analyze social media and are acquiring new tools to help us do it. There are some owners and teams that want you looking at the field or court all the time, but we feel that social media is an important tool. We turned AT&T Park into a Giant wifi hotspot to promote connectivity and engagement. We have an @Cafe in the park where we display tweets and other media. We track use of promoted hashtags for different days and events, and things we promote on the scoreboard. Everyone does TV and radio, but we feel that social media is just as important. If you're not there, it's almost like not having a broadcast deal.*

A few other teams are as aggressive as the Giants in terms of social media, including the New England Patriots. That NFL team also established its own wifi network at Gillette Stadium, and social media is its most common use. The Patriots monitor mentions of the team on social media. Although social media analysis is still a frontier practice, it's likely that analytics of this data will grow substantially over time. However, neither the Giants, Patriots, nor other teams are yet using automated analytics of social media content.

Another frontier practice is to optimize marketing spending and programs for fan-oriented promotions. Marketing optimization is an increasingly popular analytical approach in business, but only a few professional sports teams have begun to use it. There is a lot of tradition in this domain for sports; baseball teams, for example, have been distributing miniature bats, helmets, and bobble-headed dolls modeled after star players for many years.

Such traditional marketing practices, however, are beginning to be examined with analytics.[17] The Cleveland Indians, for example, are doing optimization of marketing programs and budgets—sometimes called marketing mix models—based on advice from Alex King, a former Procter & Gamble marketing executive (Geoff Smith, another former P&G executive, is advising the Cincinnati Bengals on technology and analytics). One of the most difficult aspects of marketing optimization is to gather all the relevant data. The Indians, for example, gathered data on PR impressions, traditional and digital media spending, and game-day promotions, all in order to correlate the data with sales for particular games. They concluded, among other results, that there should be fewer bobbleheads distributed at fewer games for optimal ticket lift from their marketing spending.

The Orlando Magic is exploring another frontier application in business analytics for professional sports, which is the use of wifi data to understand fan engagement. The Magic is one of only a few professional teams in the US to own the wifi network in their arena, the Amway Center.

A final frontier approach to business analytics is taking place at the Phoenix Suns, which has partnered with Verizon Wireless to learn about various activities of fans before and after Suns games. Since Verizon knows the locations of its mobile phone customers, it can tell organizations like the Suns (through a business unit called Precision Market Insights) where customers are at different times. Verizon was able to tell the Suns, for example:

- Where fans attending the team's games live (and hence where people live who don't attend games) in order to target team advertising;
- How many fans at games are from out of town (about 22% in one month studied);
- The attributes of fans who attend games (most likely between 25 and 54 in age, with household incomes of more than $50,000, and parents with children at home);
- How often game attendees also attend baseball spring training games in the Phoenix area (13%);
- Increases in traffic at a fast food chain within 24 hours of a game that are linked to a Suns promotion (8.4%).

This is obviously useful information from a business analytics perspective for the Suns. Zaheer Benjamin, who heads analytics for the Suns, believes that there are many other opportunities for using this type of data.[18]

Table Stakes and Frontier Analytics for Business in Sports

Table Stakes Analytics	Frontier Analytics
Variable pricing	Dynamic ticket/product pricing
Fan loyalty analytics	Fan segmentation/personalization
Fan satisfaction analysis	Fan engagement – social media
	Fan engagement – wifi
	Marketing optimization
	Mobile location analytics

Player Health and Injury Analytics

The third and final category of sports analytics to be discussed in this report is health and injury analytics. Since a major component of every team's success involves the health of its players, prevention of injury and illness is a natural focus for the use of data and analytics.

However, the area of health analytics is a difficult one. Injuries can be caused by many factors, and are difficult to predict in advance. Physiologists disagree about the best way to approach conditioning. One might emphasize proper nutrition and sleep, while another focuses on weight training or other physical activities.

Some of the same data that support player and team performance also can be used for health analytics. Video data can be used to assess the level of physical activity, and any patterns of movement or stresses that could lead to injury. GPS data can be used to monitor movements and speed across the field. Activity monitors and accelerometers can measure steps, sleep patterns, and other biometric indicators.

A wide variety of metrics can be obtained from such devices. As one trainer from the Jacksonville Jaguars put it, these metrics can lead to interesting insights:

> *We look at total odometer, high intensity yards, accelerations, decelerations, contact load, and PlayerLoad..[it shows] the lack of any true speed in our game. It really just shows our game is truly acceleration and deceleration…*[19]

Other devices measure heart rate and blood pressure. The goal is typically to assess the level of physical activity that a player has undertaken, and its implications for training and health. It's also likely that players in sports with frequent collisions, e.g., professional U.S. football, will soon be wearing devices to measure concussive force to the head.

In health analytics, descriptive statistics of individual player activity based on video, GPS, or biometric devices is table stakes analytics for professional sports. Given the amount of data available now, the obvious frontier analytics are those involving alerts and prediction of injury.

One professional team that has already begun to employ alerts and predictive techniques is the Italian soccer team AC Milan. The team's MilanLab, an player health and conditioning research and analytics center, was initiated in 2002—very early relative to other teams. MilanLab has adopted a variety of sports conditioning technologies, including video. The team tracks 60,000 data points on each player—200 on a single jump alone. Mental, biochemical, and musculo-structural data are gathered every two weeks on eight pieces of scientific equipment; alerts are created if a player's data are out of expected range. Data and analysis gauge the fitness of each player for contract decisions, and are used to predict likelihood of serious injury. Over time

MilanLab is building a knowledge base of player data to analyze in the future, and is looking for patterns with neural network technology.

AC Milan experienced a 90% reduction in injuries in 2003—the first full use of MilanLab's establishment—compared to the five previous years, and they have remained low since then. The team is continually one of Europe's leading soccer teams, and many of its members were on the World Cup-winning team for Italy in 2006.

Teams in other sports are beginning to explore biomechanics. The San Francisco Giants baseball team, for example, uses video analysis of biomechanics to help with injured player rehabilitation. Doing so, however, requires putting a player in a video studio, which is both inconvenient and invasive. Players who do go through the analysis can be compared to their previous mechanics, or to other similar players. Such biomechanical analysis, however, does not currently allow for prediction.

Although most health and injury analytics are descriptive, some teams are beginning to apply predictive analysis based on past data. Stan Conte, the senior director of medical services at the Los Angeles Dodgers, has been particularly active in gathering past data and using it to project forward the likelihood of injury for various players.[20] Data cleanliness and reliability for injuries in professional baseball have been historically low; the "disabled list" was a primary source, but it is used in part as a tool for roster management. Only recently has a formal system been established for injury surveillance in baseball. Despite the data quality issues, Conte is regularly asked to assess the likelihood that a draft or trade prospect will have an injury.

Conte's data suggest that injuries are a major problem in professional baseball, and despite advances in medical care and conditioning, are still climbing. He estimates that 29,000 days of player time were lost in the MLB in 2012, at a cost of $600M in player salaries. Conte has begun to assess the most common correlates of injury. Position is the highest correlate; starting pitchers, for example, are 50% likely to be injured in a particular season. Other factors associated with injury include age, service in MLB, previous injuries and surgeries, and body mass index. The Dodgers are beginning to assess PITCHf/x data, which captures release points, arm angles, step length, and many other variables, to learn whether it can be predictive of injury.

Despite leading work from teams like AC Milan and the Los Angeles Dodgers, player health and injury analytics are still in their infancy. But data sources are proliferating rapidly, and will soon allow predictive analytics as well as accurate description. Given the importance of this issue and the money at stake, most teams should probably be investing more than they are in this domain.

Table Stakes and Frontier Analytics for Player Health

Table Stakes Analytics	Frontier Analytics
Descriptive analytics on player activity	Injury analysis of video data
	Analysis of location/biometrics data
	Predictive analytics on injuries
	Detailed biomechanics analysis

Lessons from Sports Analytics Research

The interviews and sources for this research cut across a variety of professional sports. They suggest a series of lessons for how teams can improve their analytical capabilities and develop competitive advantage. The lessons are as follows:

1. *Alignment among team leadership* is critical to success with analytics. Owners, general managers, and coaches need to agree that analytics will drive or at least strongly influence major decisions. They need to agree on the level of investment in analytics and on key data sources. If even one member of the leadership team isn't committed, it's unlikely that analytics will receive sustained and serious focus.

2. *League coordination and investment* can greatly assist the course of analytics within teams. While individuals can sometimes chafe when leagues play leadership roles, many teams cannot afford to build out data and analytical infrastructures on their own. The decision by the NBA to use SportVu video technology for all teams and games, and the decision by Major League Soccer to use GPS technology for all teams, are examples of the power of leagues to drive advancements in data gathering and use.

3. Related to the previous lesson, teams should *acquire some proprietary data*, or work with a league-wide technology early to analyze available data. Analytical applications are rapidly copied, and the only ways to achieve competitive advantage from data that every other team has are through innovation in application and execution. Teams that adopt data-generating technology early in the cycle can quickly develop analytical capabilities relative to it, and can maintain advantage even when it is adopted by other teams.

4. Teams need to *seek help from analytics vendors and consultants*. The great majority of professional sports teams are relatively small businesses. They can't afford to hire large staffs of quantitative analysts. Therefore, they should seek help from vendors and consultants in the analytics space. Relatively advanced teams, including the Orlando Magic and Phoenix Suns in the NBA, and the San Francisco Giants in the MLB, often have close partnerships with vendors, and some even guard the details of the vendors they work with.

5. *Enlist amateurs to help* with analytics. The great thing about sports is that it has passionate fans, and many of them can perform sophisticated analytics on available sports data. Teams and leagues should harness amateur analytical skills in some way, either by hiring them, paying close attention to their writings, or making data available to them as a form of association.

6. *Get players involved with analytics*. While it's not common yet for teams to expose or engage players in the application of analytics, they are the missing link if analytics are to transform performance. Some individuals (Brandon McCarthy) and teams (West Ham) have benefitted from engaging with analytics at the individual level. Player-level focus on analytics can also help to improve conditioning and health.

7. Act as a single enterprise, and *combine business analytics and sports performance staff*. Consistent with their small size mentioned above, few teams can afford to maintain fully separate staffs for business analytics and sports performance analytics. The analytical skills necessary to work on each side are similar, and if business analytics staff are knowledgeable about sports, they should be given a chance to work on sports performance-oriented projects. The Orlando Magic and Phoenix Suns have both adopted this model.

8. *Move toward predictive and prescriptive analytics*. Most analytical activities in professional sports continue to be descriptive analytics—some form of reporting. But such analytics offer no guide to the future, and they don't tell players or coaches at the front line what to do. Predictive and prescriptive analytics are more powerful and useful. And if firms have been gathering descriptive analytics for several years, they probably have enough data to model it, which would then allow prediction, optimization, and recommendation.

9. Foster a *close relationship between analytics staff and key technology partners* (video coordinators, IT, vendors, etc.). Analytics in all organizations depend on technology, and they do so especially in sports. Modern technologies such as video, locational devices, and biometric sensors generate data in massive amounts, and require substantial computing horsepower to analyze. An analytics staff can't work effectively without close coordination with IT and sports technology staff and leadership.

Sports analytics have inspired many businesses to make better decisions through data and analysis. However, the most advanced businesses are more active with analytics and have more capabilities than do sports teams. It's time for professional teams to view themselves as competing not only on the field or the court, but also in the use of data and analytics.

About this Report:

This independent research study was conducted by Thomas H. Davenport and was sponsored by SAS. For more information on this topic or this research, please contact Professor Davenport at thdavenport@gmail.com. To learn how SAS analytics is transforming the sports industry, visit sas.com/sports. To learn more about the International Institute for Analytics, visit iianalytics.com.

About the Author:

Tom Davenport is the co-founder of the International Institute for Analytics and guides its research efforts. He is the President's Distinguished Professor of IT and Management at Babson College, and a research fellow at the MIT Center for Digital Business. Tom's "Competing on Analytics" idea was named by Harvard Business Review as one of the twelve most important management ideas of the past decade and the related article was named one of the ten 'must read' articles in HBR's 75 year history. His latest book is *Big Data @ Work: Dispelling the Myths, Discovering the Opportunities*.

---

[1] W.R. Hambrecht & Co. Sports Finance Group, "The US Professional Sports Market and Franchise Value Report, 2012, http://www.wrhambrecht.com/wp-content/uploads/2013/09/SportsMarketReport_2012.pdf

[2] Andrew Ball, "Should Teams Use Baseball America's Rankings to Draft?" Beyond the Box Score website, Dec. 24, 2013, http://www.beyondtheboxscore.com/2013/12/24/5240610/should-teams-use-baseball-americas-rankings-to-draft

[3] Ira Boudway, "Baseball Set for Data Deluge as Player Monitoring Goes Hi-Tech," Bloomberg News, March 31, 2011.

[4] "NBA Launches New Tracking System to Capture Player Statistics," CBS News, January 27, 2014, http://www.cbsnews.com/news/nba-launches-new-tracking-system-to-capture-player-statistics/

[5] Eddie Metz, "Saviormetrics," ESPN the Magazine, April 14, 2013, http://espn.go.com/mlb/story/_/page/Mag15saviormetrics/oakland-brandon-mccarthy-writing-moneyball-next-chapter-reinventing-analytics-espn-magazine.

[6] Adrian Martinez, "Brandon McCarthy using sabermetrics to his advantage," Arizona Sports, Feb. 28, 2013, http://www.arizonasports.com/42/1614256/Brandon-McCarthy-using-Sabermetrics-to-his-advantage

[7] Jonah Lehrer, How We Decide, Houghton Mifflin, 2009, p. 55.

[8] Tom Brady press conference for New England Patriots, January 17, 2014, transcript at http://www.patriots.com/news/article-1/Tom-Brady-Press-Conference-Transcript/2d1182fc-da53-4ce4-9ae1-1132b89aa98f

[9] Information about Allardyce comes from regular in-person meetings during 2012-13 and 2013-14 season, an interview for this study by Al Sim (Feb 2014), and the following articles: Sam Allardyce – Barclays Premier League Profile http://espnfc.com/manager/_/id/29/sam-allardyce?cc=5739

[10] Matt Lawless, "Big Sam is 100 not out.. and we reveal how life at West Ham is a numbers game under Allardyce," Daily Mail, Sept. 24, 2013, http://www.dailymail.co.uk/sport/football/article-2430369/Sam-Allardyce-100th-West-Ham-match-Sportsmail-reveals-life-Hammers-numbers-game-Big-Sam.html

[11] "Manchester City to open the archive on player data and statistics," The Guardian, August 16, 2012, http://www.theguardian.com/football/blog/2012/aug/16/manchester-city-player-statistics

[12] Information about Morey comes from several meetings, an interview for this study, and the following articles: Daryl Morey, "Success Comes from Better Data, Not Better Analysis," Harvard Business Review blog post, August 8, 2011, http://blogs.hbr.org/2011/08/success-comes-from-better-data/; Chris Ballard, "Money Ballsy," Sports Illustrated, Dec. 3, 2012, http://sportsillustrated.cnn.com/vault/article/magazine/MAG1206495/1/index.htm

[13] Adam Rubin, "Mets introduce Sandy Alderson," ESPNNewYork.com, October 30, 2010, http://sports.espn.go.com/new-york/mlb/news/story?id=5741492

[14] Ameet Sachdev, "Baseball teams get dynamic with ticket pricing," Chicago Tribune, May 12, 2013, http://articles.chicagotribune.com/2013-05-12/business/ct-biz-0512-stub-hub--20130512_1_stubhub-bleacher-ticket-ticket-reselling

[15] "Scoring higher revenue with analytics," SAS customer stories, http://www.sas.com/en_us/customers/orlando-magic.html

[16] Information about the New England Patriots from an interview with Jessica Gelman and from Heather Fletcher, "Pats' Pact: Fans Are Family," Target Marketing, December 2011, http://www.targetmarketingmag.com/article/new-england-patriots-use-analytics-and-trigger-emails-retain-season-ticket-holders/

[17] Kate Kaye, "How P&G Inspired Cleveland Indians to Offer Fewer Bobbleheads," Ad Age, March 18, 2013, http://adage.com/article/datadriven-marketing/school-marketing-practice-cleveland-indians/240362/

[18] Anton Troianovski, "Phone Firms Sell Data on Customers," The Wall Street Journal, May 22, 2013, p. B1.

[19] Catapult Sports case study: Tom Myslinski, Jacksonville Jaguars, Catapult Systems website, http://catapultsports.com/wp-content/uploads/2013/06/Case-study-Tom-Myslinski.pdf

[20] Stan Conte information from Molly Knight, "The Hurt Talker," ESPN The Magazine, August 13, 2012, and Stan Conte panel presentation, "Staying on the Field: Injury Analytics," MIT Sports Analytics Conference 2013.