

Nate Silver, Billy Beane, and Alex Trebek: Making the Case for Predictive Analytics in Workplace Safety

A Predictive Solutions White Paper

How did a machine beat the greatest champions of all time on the game show Jeopardy? How did a self-described “geek” predict the outcome of the last several U.S. federal elections more accurately than seasoned political pundits? And how did the Oakland A’s effectively compete against their Major League Baseball rivals like the New York Yankees and Boston Red Sox who had payrolls three times their own?

Rather than rely on old, tired, and outdated conventional methods, they employed the latest technological advances – specifically advanced and predictive analytics. Companies have been using these analytics tools for years to make better decisions, improve their bottom lines, and save money. More recently, advanced and predictive analytics are also being used to keep people safe on the job.

It has been statistically proven, using four years of real-world safety data, that workplace injuries can be predicted with accuracy rates as high as 97%.¹ It has also been proven across numerous companies, that if injuries can be predicted, they can be prevented – some companies have reduced their injury rates by more than 90%² using advanced and predictive analytics.

The adoption and use of advanced and predictive analytics in workplace safety is growing quickly.³ Leading safety professionals are successfully making the business case for their use to previously skeptical stakeholders within their companies. How? With the facts – predictive analytics are proven and are becoming pervasive. To deny these facts is to be left behind.

Predictive Analytics are Proven and Pervasive: From Brad Pitt to Your Wallet

Both direct and indirect company stakeholders, such as boards of directors, investors, C-level executives, special interest groups, as well as regulatory agencies, are demanding better health, safety and environmental (HSE) results. In their quest for better results, many safety professionals are finding that traditional HSE practices are limited and simply cannot return the game-changing outcomes that are required. When this happens, they must make the case for change.

Making this case is much easier now that advanced and predictive analytics are proven and pervasive in many industries, business functions, and even in popular culture. If you have been to the movies, read a book, or watched TV recently, it is likely that you have been exposed to predictive analytics.

- **Movies** – One of 2011’s most popular movies, “Moneyball,” starring Brad Pitt, told the story of how predictive analytics, called sabermetrics, were used by the Oakland A’s general manager Billy Beane, to revolutionize the evaluation of Major League Baseball players.
- **Books** – In “The Signal and the Noise: Why So Many Predictions Fail – but Some Don’t,” author Nate Silver outlined how he used prediction models to accurately call the outcomes of the last several U.S. presidential and Senate elections. The book hit #4 on the The New York Times Best Seller list and was named by Amazon.com as the #1 nonfiction book of 2012.

1 <http://www.predictivesolutions.com/reduce-workplace-injuries/>

2 <http://www.predictivesolutions.com/customers/casestudies/cummins-rocky-mountain/>

3 For the purposes of this paper, predictive analytics includes predictive models that have been constructed and tested using historic safety data sets. Once the models are built and tested, they can be used to predict future injury levels using current data sets.

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- Television – In 2011, IBM unveiled “Watson,” their latest super-computer that used advanced and predictive analytics to beat Ken Jennings and the other top human champions on the game show Jeopardy.

IBM’s Watson is now transforming the medical field by using its advanced analytics to make complex medical diagnoses. According to Fast Company magazine, “a few years ago, IBM’s new computer was a game-playing curiosity. Now Watson is poised to change the way human beings make decisions about medicine, finance, and work.”⁴

If pop culture influences are not enough, there are everyday examples of predictive analytics that nearly everyone can relate to. Most people carry credit cards that were issued and are continually monitored by advanced analytics functionality. Each time you swipe your card, complex algorithms crunch various data elements such as whether or not the card has hit its credit limit; if it’s being used in a familiar geography; the nature of the purchase item; etc. Advanced analytics ultimately predict whether or not the transaction is legitimate and then decide if it should be processed.⁵

Finally, a quick Web search reveals countless examples of advanced and predictive analytics being used to improve business functions across various industries.

- Casinos – By employing analytics on hundreds of thousands of individual gaming sessions, a casino operator was able to increase the amount patrons spent by 246% and individual patron cash return by more than 35%. Through this analysis, they were able to predict which targeted marketing efforts would yield the best results and then optimize their efforts based on these predictions.⁶
- Communications – A communications service provider was able to predict and then prevent customer churn using advanced analytics achieving a 376%, five-month payback on their investment. The company estimates that they save \$4 million annually as a result of this analytics solution.⁷
- Zoos – The Cincinnati Zoo experienced a 411% ROI in just three months on their investment in advanced analytics to predict customer buying preferences for vending items such as ice cream.⁸

Progressive safety professionals are succeeding in making the case that if predictive analytics can be employed to predict gambling activity, sell more ice cream, and even make complex medical diagnoses, they can also be employed to save lives in the workplace.

4 <http://www.fastcompany.com/3001739/ibms-watson-learning-its-way-saving-lives>

5 <http://www.fico.com/en/Communities/PredictiveAnalytics/Pages/default.aspx>

6 <http://www.operasolutions.com/downloads/cases/Marketing-Casino-Case-Study.pdf>

7 http://www-01.ibm.com/software/success/cssdb.nsf/CS/CPOR-8E6HPW?OpenDocument&Site=default&cty=en_us

8 <http://nucleusresearch.com/research/roi-case-studies/roi-case-study-ibm-business-analytics-cincinnati-zoo/>

Advanced Analytics in Safety: They Work

Applying advanced analytics to predict and prevent workplace injuries works, and progressive companies that employ the practice are realizing dramatic results:

- A Fortune 150 manufacturer reduced its lost work day rate by 97% within one year
- A Fortune 150 energy company reduced its incident rate by 67% within 18 months
- A top 20 ENR⁹ contractor achieved significant safety improvements including 90% of worksites experiencing no lost-time incidents
- A top 5 public U.S. university saved over \$20 million in insurance fees across four years of building projects

These organizations met, and often exceeded, the HSE demands of their stakeholders by moving beyond traditional HSE data collection and reporting solutions, to solutions that provide more advanced and even predictive analytics of their safety data set. Their journey can be represented by the following graphic adapted from the book “Competing on Analytics” by Thomas Davenport and Jeanne Harris.



Many companies who operate near the base of this pyramid are drowning in data and have no answers beyond backward-looking, lagging-indicator reports. Progressive companies, on the other hand, are able to turn their raw data into actionable information and then optimize their preventive efforts to reduce injury rates. These leaders are driving competitive advantage for their companies by moving up the advanced analytics pyramid.

Predictive Models in Safety: How They Work

A joint team from Predictive Solutions Corporation and Carnegie Mellon University (CMU) – the same CMU department that helped build the Watson super-computer – developed injury prediction models based on four years of workplace safety inspection, audit, and observation data.

This joint team was able to overcome modeling limitations encountered by previous researchers. In 2009, an early pioneer in the field, Joel M. Haight, concluded that if a predictive model could be built with “...an absolute percent error of less than 25 and an r^2 value of greater than 0.5, it will unlock doors that will enable companies, firms and businesses to minimize incident rates and safety-related costs...”¹⁰

The CMU/Predictive Solutions team was able to exceed Haight’s requirements. The most recent model they built and put into production has an absolute percent error of less than 25 (the percent error has been measured as low as 3) and an r^2 value of greater than 0.5 (the current models’ r^2 has been measured at 0.75).

Further, rather than building and testing the model on just one company’s data set, as Haight and others had done, this team had access to real-world safety data from more than 10,000 global worksites. This diverse data set yields models that are applicable across diverse companies and industries.

Much of the power of predictive models comes from these large and diverse data sets. One of the reasons Nate Silver’s election prediction models were so accurate was because he used a “wisdom of crowds” data aggregation methodology.¹¹ Rather than relying on just one or a few polls, each of which has its own biases as measured by its “margin of error”¹², Silver aggregated ALL the public polls he had access to. This process allowed Silver, as is implied by the title of his book, to dampen the “noise” in the data in order to find the “signal”.

This methodology is similar to the one employed by the CMU and Predictive Solutions team. Rather than rely on the safety observations of one inspector, the model aggregates data from many inspectors. Further, this aggregation does not just occur within one company, but across many companies using similar, but not exact, data sets. This provides not just more accurate models, but models that are more applicable across diverse companies and industries. This aggregation is especially powerful for small companies who simply cannot collect a statistically significant data set on their own – they can rely on and benefit from similar data from other, larger companies to help them scale the advanced analytics pyramid.

¹⁰ “Predicting Incident Rates: Artificial intelligence as a forecasting tool” by Abdullah Al-Mutairi and Joel M. Haight

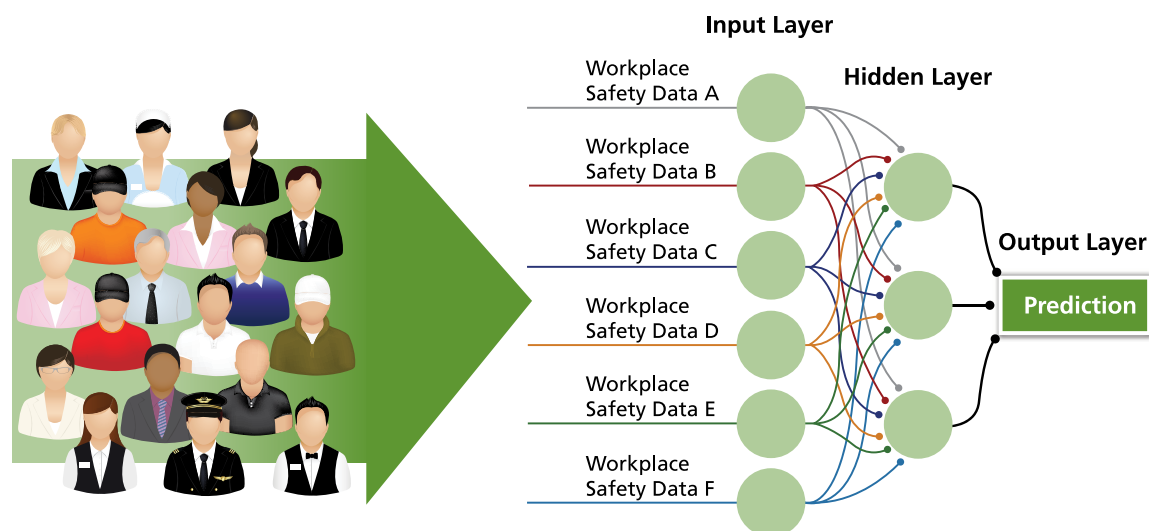
¹¹ This methodology of aggregating information from several, sometimes “non-expert” sources rather than just one, “expert” source, is also the foundation of the Intrade prediction system that had similarly impressive results in predicting the 2012 election cycle
<http://www.intrade.com/v4/home/>

¹² <http://www.robertniles.com/stats/margin.shtml>

Predictive Analytics in Safety: Hard to Build, Easier to Operate

Contrary to some who might think that advanced and predictive analytics in safety is difficult to implement, the current safety models are quite straightforward to operate – simply feed the predictive models safety data from the last 12 weeks and they will identify those sites, locations, or work teams that are at risk of having a significant increase in injuries.

But don't worry about computers taking over your job just yet. While the Watson super-computer does not replace knowledgeable medical practitioners, safety predictive models are NOT intended to replace knowledgeable safety professionals. Rather, these models are used to aggregate and extend human knowledge through the “wisdom of crowds” and then perform analysis on that data set at levels unmatched by humans. As shown in the graphic immediately below, machine learning algorithms can crunch multivariate data sets with numerous inputs and find nuanced and even hidden correlations and relationships in ways that humans simply cannot.¹³



One example of predictive analytics in safety is the “Red Flag” model. This model delivers an automated report that flags sites, operations, or teams within a company that have a high likelihood of injury. In plain terms, if your site, operation, or team is flagged, you have a nearly 70% probability of experiencing a two to three times increase in safety incidents at that site, within that operation, or across that team. Conversely, if your site is not flagged, there is, on average, a 90% probability that no increase in incident risk will occur.

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<http://www.fico.com/en/Communities/PredictiveAnalytics/Pages/default.aspx>

With the results of the Red Flag model, a safety professional can take immediate action at those flagged sites to prevent any predicted injuries from occurring. This risk management activity is directed by the findings of the model, as well as a deeper analysis of the underlying safety inspection data used to trigger the flag.

With the constraints placed on safety professionals today, having the ability to prioritize those areas within their company that need attention most is an enormous advantage in their effort to eliminate injury and death in the workplace. Again, advanced and predictive analytics do not replace safety professionals, they extend their knowledge, increase their analysis power, and help direct the use of their often scarce resources so they can optimize their efforts and reach the peak of the analytics pyramid – optimization and prevention.

Generally, organizations can utilize advanced and predictive analytics in two main ways, as a stand-alone analysis solution, or as part of a broader, software-based safety management system (SMS).

If an organization's SMS does NOT include these advanced and predictive analytics, they can generally be accessed by exporting data from the current system and then sending it electronically to an advanced and predictive analytics system for analysis. The results of the analysis can then be communicated back to the organization via automated reports, or using some other customized communication method.

Conclusion: Wrapping Up the Case

A diverse set of company stakeholders are demanding better results each and every year across all aspects of their business – including in safety. Now that advanced and predictive analytics are both proven and pervasive in other business functions, it is much easier to make the case to employ them in safety.

Companies must decide if they'd prefer to emulate Nate Silver, Brad Pitt's character in "Moneyball", and even IBM who all leveraged the power of predictive analytics to achieve game-changing success in their respective fields. Or, will they end up like Ken Jennings, Gary Kasparov¹⁴, and countless others who have been vanquished by those who embraced the power of advanced and predictive analytics.

Whether in pursuit of improved financial results, or the ability to ensure that every employee goes home safe every day, predictive analytics needs to be considered as part of a 21st century, world-class safety program.

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The world chess master who, in the 1990's, was beaten by IBM's Deep Blue super-computer – Watson's predecessor.

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About Predictive Solutions Corporation

Predictive Solutions Corporation, formerly DBO2, saves lives by predicting workplace injuries. Its software solutions help track, trend and analyze safety related data. They also employ proprietary models that predict the likelihood, frequency and location of workplace injuries using its customers' safety observation data. In addition, Predictive Solutions delivers consulting services that drive culture and process change within organizations to create sustainable safety processes that reduce injuries. With more than 140 million observations and nearly 40,000 reported incidents from more than 15,000 worksites around the world, Predictive Solutions has emerged as an industry leader in predicting injuries before they occur. Predictive Solutions, based in Pittsburgh, Pa., was founded in 2001 and became an Industrial Scientific company in 2008. Its employees, along with those of its parent company, are dedicating their careers to ending death on the job in this century. For more information, visit www.predictivesolutions.com.

Our Mission: We save lives, by predicting workplace injuries.