Your secret weapon

***Some aerospace and defense companies are applying big data analytics to sharpen their business decisions, improve designs and add autonomy to complicated aerospace hardware. Wise companies will join the revolution, says analytics expert* Sam Adhikari.**

VIEWPOINT

BY SAM ADHIKARI

The amount of business and technical data available to aerospace and defense companies is exploding. For any major aerospace product, the identities and attributes of thousands of suppliers in a chain spanning from materials to components can now be tracked. The fine details of manufacturing logistics, including tallies of which vendors have how much of a given product and their projected availabilities, can be recorded. The challenge of harnessing all this information — called big data — for operational decision making and strategic insight can at times seem overwhelming. The very point of looking at big data is to analyze and spot patterns that answer questions you did not know to ask: Is a vendor deep in the supply chain going out of business? Is there a developing pattern of critical component failures?

Big data can do that and more. What if you could evaluate, analyze and interpret every transaction? What if you could capture insights from unstructured data? Or detect changing patterns in best value supply channels? What if you did not have to wait hours or days for information?

Wise aerospace and defense companies are fast adopting in-memory high-performance computing, a relatively new technology that allows the processing of massive quantities of real-time data in the main memory of a company's system to provide immediate results from analyses and transactions.

Big data analytics also enables optimal decision making in complex systems that are dynamic and dependent on real-time data. Engineers can use big data in their design work as valuable guidance. Spotting patterns of success and failure from the past data in a dynamic real-time environment brings a new dimension in design optimization. A computer in a rocket using big data can autonomously decide its next course of action by matching patterns from the past that worked. Cybersecurity applications in aviation can use big data predictive analytics to initiate preventive actions to protect an aircraft. Using predictive patterns from the past, an autonomous system can make intelligent decisions in a challenging dynamic environment. Big data analytics can crunch massive quantities of real-time data and reliably balance safety, security and efficiency. Airlines are adopting big data analytics to maximize operational efficiency, minimize cost and enhance security. Computational fluid dynamics systems continue to manage the vast amounts of data generated by current and future large-scale simulations. Aerospace industry, research, and development are impacted profoundly by the big data revolution.

Unfortunately, the potential of big data analytics has not been fully realized. Some executives and managers do not understand how to apply statistical, predictive analytical tools and machine-learning algorithms. In addition, the process of collecting multidimensional data from many sources impacts the quality of massive data sets. The real potential of big data analytics comes from harnessing data sets from diverse sources with unpredictable quality

of data. The technique of preprocessing the data to achieve high quality is critical for the success of big data implementation. We are seeing some early pioneers trying to implement predictive analytics by using big data to improve technical and business processes. I'm confident big data usage will eventually reach its full potential.

Aircraft engine diagnostics

Pratt & Whitney, for example, is collaborating with IBM to use its big data predictive analytics to analyze data from thousands of commercial aircraft engines, according to CIO Review. The data is used for predicting and interpreting problems before they occur. Huge amounts of data generated from aircraft engines are analyzed and interpreted with the help of big data analytics, resulting in foreseeing discrepancies and early signs of malfunctions.

Shrewd insights like these can help companies alert customers with maintenance intelligence information and provide intuitive flight operational data at the right time. Reducing customers' costs, a major strategic goal of any company, is accomplished by this proactive real-time monitoring of the state and robustness of customers' engines. In addition, it provides sustained visibility to plan ahead for optimized fleet operations. Applying real-time predictive analytics to huge amounts of structured and unstructured data streams generated by aircraft engines empowers companies to utilize proactive communication between services networks and customers, resulting in critical guidance at the right time. Pratt & Whitney anticipates an increase in its product's engine life by up to six years with the help of big data predictive analytics, according to Progressive Digital Media Technology News. The company also forecasts a reduction in its maintenance costs by 20 percent.

Airline operations

Generally, an airline depends on the pilots for providing estimated times of arrival. If a plane lands later than expected, the cost of operating the airline goes up enormously because the staff sits idle and adds to the cost of associated overhead. On the other hand, if a plane lands ahead of the estimated arrival time before the ground staff is ready for it, the passengers and crew are effectively trapped in a taxiing state on the runway, resulting in customer dissatisfaction and operational chaos. Andrew McAfee and Erik Brynjolfsson, writing in the Harvard Business Review in October 2012, described how a major U.S. airline decided to use big data predictive analytics after determining that approximately 10 percent of flights into its major hub were arriving 10 minutes before or after the estimated time of arrival. Today airlines are using decision-support technologies and predictive analytics to determine more accurate estimated arrival times. Using big data analytic tools and collecting a wide range of information about every plane every few seconds, the airlines and airport authorities are virtually eliminating gaps between estimated and actual arrival times. This requires handling a huge and constant flow of data gathered from diverse sources interfacing various networks. A company can keep all the data it has gathered over a long period of time, so it has a colossal amount of multidimensional information. This allows sophisticated predictive analytics and deployment of pattern matching algorithms with the help of data mining tools, machine learning technologies and neural networks. The pattern predicting and supervised and unsupervised learning algorithms answer the question: "What was the actual arrival time of an aircraft that approached this airport under similar conditions? Given the current condition is slightly different, based on learning algorithms when will this aircraft really land?"

Computational fluid dynamics

According to NASA's "CFD Vision 2030 Study: A Path to Revolutionary Computational Aerosciences," effective use of very large amounts of data generated by computational fluid dynamics will be critical to advancing aerospace technologies. Big data predictive analytic tools have already started analyzing large CFD-generated data sets to immensely improve the overall aerodynamic design and analysis process. With the advent of more powerful computing systems, big data predictive analytics will enable a single CFD simulation to solve for the flow about complete aerospace systems, including simulations of space vehicle launch sequences, aircraft with full engines and aircraft in flight maneuvering environments.

Corporate business intelligence

Today's businesses require fast and accurate analytical data in a real-time dynamic environment. Traditional database technologies cannot cope with these demands for increased complexity and speed. The new computing trend supporting big data analytics in corporate environments is to process massive quantities of real-time data in the main memory of a server to provide immediate results from analyses and transactions. This new technology is in-memory computing. It provides the ability to open up predictive and analytical bottlenecks and enables companies to access existing as well as newly generated or acquired, granular and accurate trend-predicting large data sets. Real-time enterprise computing infrastructure with in-memory business applications modules enables business processes to analyze large quantities of data from virtually any source in real time with fast response time. Big data predictive analytics combined with in-memory computing has had a massive impact on program management, manufacturing, procurement, supply chain management and planning, operations, and aftermarket services. The biggest corporate headaches today are reduced customer intuitiveness and familiarity, missed revenue opportunities, blind spots in the supply chain, and increased exposure to regulatory risk resulting from distributed processes, disparate information and unmanageable amounts of data from diverse sources. Companies are gaining sustainable competitive advantages by effectively managing their big data and associated analytics. Excellence in big data management and analytics enables an organization to improve its ability to sense changes in the business environment and react quickly in real time to changes in trends and data.

Data mining strategies

Big data has all the characteristics of small data. Data becomes information when it becomes effectively usable. Big data like any other data needs to be clean and consistent.

Pratt & Whitney

Pratt & Whitney and IBM are reportedly partnering on aircraft engine performance monitoring using big data predictive analytics.

If the data is unstructured, it can be processed into structured data sets with the help of natural language processing and text mining tools. The biggest challenge in big data analytics is dealing with missing or corrupted elements, rows, columns and dimensions. Modern applied statistical data mining tools are employed to remove these anomalies, readying the data for predictive analytics.

Assuming the right choices are made, the next few decades will see enormous big data applications in medicine, business, engineering and science. Aerospace will become intelligent, cost effective, self-sustaining and productive with big data applications.

Sam Adhikari
sadhikari@sysoft.com

Sam Adhikari teaches big data analytics at various universities, performs graduate studies at Stanford University and leads the Intelligent Systems and Informatics Division of Sysoft Corp. of Whitehouse Station, N.J. He chairs AIAA's Software Technical Committee and Aerospace Cybersecurity Working Group and is a member of the Intelligent Systems Technical Committee.