DATA SCIENCE DIVISION

Data Scientists at the Center for Naval Analyses develop innovative predictive and prescriptive analytics to tackle the most important challenges in the Department of Defense. These efforts rely on a collaborative partnership between Department of the Navy personnel and data scientists here at the department's federally funded research and development center (FFRDC). Close collaboration ensures that insights can be developed iteratively and acted upon quickly. CNA's Data Science Division, led by Vice President of Data Science Tim Kao, consists of approximately 30 data scientists with graduate degrees in data science, operations research, computer science, statistics, economics, and other sciences. They develop solutions for Department of the Navy leadership at forums such as Performance to Plan (P2P), which is co-chaired by the Vice Chief of Naval Operations and the Assistant Secretary of the Navy for Research, Development and Acquisition. CNA presents senior Navy leadership at the P2P forum with forward-looking performance forecasts, a foundation to progress toward readiness and capability goals.

The P2P forum accelerates the Navy's data-driven decision-making

FORECAST PERFORMANCE, THEN IDENTIFY ROOT CAUSES

Our approach has three fundamental steps:

- **Predictive analytics.** CNA data scientists use modeling and simulation tools to construct a set of models that accurately forecast future performance.

- **Drivers.** We build models that identify internal and external factors that significantly influence performance.

- **Prescriptive analytics.** We determine the optimal combination of driver levels to achieve target performance.

Our iterative analytic methodology delivers quick insights to senior leaders so they can take action to achieve objectives to ensure a competitive advantage over adversaries while ensuring effective stewardship of resources.

CASE STUDY: AVIATION PERFORMANCE

F/A-18 Super Hornet readiness began decreasing steadily in 2008, and fewer than half were mission-capable in 2018, when CNA became the data science partner of the aviation P2P forum. CNA's Data Science Division built a forecasting model that could anticipate the percentage of aircraft that would be mission capable with 97% accuracy. The model became an essential tool when then-Secretary of Defense James Mattis ordered the services to fix the problem by the end of fiscal 2019, setting an ambitious target of 80% readiness.

Figure 1
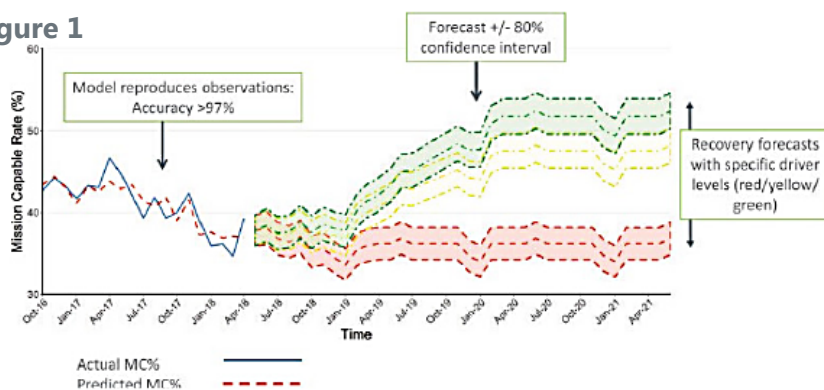
The model uses data on a large and varied mix of drivers—such as staff vacancies at different maintenance levels. Using the drivers identified by the model as the highest impact levers, CNA next forecasted future mission capable rates under different driver levels. These forecasts were the starting point for a multi-pronged effort that would see the Navy meet the 80% target, with results continuously tracked by CNA.

CASE STUDY: SURFACE MAINTENANCE PERFORMANCE

The surface warfare enterprise P2P forum aims to support the Optimized Fleet Response Plan by improving the execution of maintenance availabilities for guided missile destroyers (DDGs). In recent years, the majority of long, scheduled DDG maintenance events took longer to complete than anticipated. This hinders fleet scheduling and increases operational risks for the fleet. CNA's Data Science Division built an availability prediction model using machine learning techniques like random forests and artificial neural networks. The model reduced the average forecast duration error from 128 days to 31 days.

OUR APPROACH

Modeling and machine learning are at the core of our analytic efforts, but none of our work would be possible without the right overarching framework.

- The right data — unbiased, reproducible, longitudinal data

- The right culture — a relationship of trust between the analytic team and operators, as well as a culture that values the power of its data

- The right approach — a swarming and iterative methodology to deliver actionable insights quickly

OUR TEAM

Members of the CNA Data Science Division have high-level programming and predictive analytics skills, as well as operational experience from working directly with commanders and operating forces. Our core capabilities include:

- **Leveraging high performance computing** to obtain operational, readiness, and budgetary **insights from big data**

- **Facilitating human-centered design workshops** to ensure data-driven solutions meet stakeholder requirements

- **Applying** supervised and unsupervised **machine learning techniques**, such as artificial neural networks, random forests, and clustering, to predict outcomes and assist decision-makers

- **Developing custom analytical simulations** using continuous time, discrete event, Monte Carlo, and other techniques to approximate existing systems and **quantify the effects of changes** to improve those systems

- **Identifying optimal solutions** using mathematical programming techniques such as mixed integer programming, network analysis, and linear/non-linear programming.

ABOUT CNA

CNA is a not-for-profit research and analysis organization with almost 80 years of experience providing government agencies with data-driven insights and real-world, actionable solutions grounded in our direct experience with the operational environments where these solutions are applied. CNA developed the foundational techniques for operational analysis to address complex challenges facing government programs. We have applied these techniques successfully in areas ranging from defense to aviation, education, justice, and homeland security.

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