



Business challenge

Operations research provides essential tools for optimizing military logistics. West Point wanted to give its cadets direct experience with optimization methods used in industrial-scale applications.

Transformation

West Point cadets use IBM prescriptive analytics to solve complex real-world problems, helping them prepare for their army careers, and revealing new ways for the Academy to operate more efficiently.

Business benefits:

Builds

experience for the next generation of operations researchers

Reveals

new insight into the Academy's operations

Supports

better decision-making to help optimize efficiency

West Point Training the next generation of operations researchers with IBM Analytics

The United States Military Academy at West Point has been educating, training and inspiring leaders for more than 200 years. Its Operations Research program aims to give approximately 30 cadets per year the skills to analyze, model and solve real-world problems in military logistics and other key areas.

"IBM Analytics gives our cadets excellent preparation for exciting careers in operations research."

William R. Pulleyblank
Professor of Operations Research
West Point

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Solving complex military logistics problems

Whether it was Frederick the Great or Napoleon Bonaparte who coined the phrase, the idea that “an army marches on its stomach” is even more relevant today than it was in the 1700s. Modern armed forces face logistical challenges on a scale that few other organizations can imagine.

The need to not only move tens of thousands of people and vehicles across the world, but also keep them supplied with food, fuel and other necessities, creates enormous complexity—especially when troops need to be deployed in a matter of weeks.

Operations research is a discipline that military organizations use to manage these types of problems. Mathematical modeling and optimization techniques such as linear programming are used to describe the problem and then solve it by generating optimal or near-optimal solutions that either maximize or minimize the desired real-world objectives.

William R. Pulleyblank, Professor of Operations Research at West Point, comments: “We offer a course to our upper class cadets that helps them learn the principles of linear programming and gain experience in modeling and solving complex problems.

“When I first arrived at West Point in 2010, our cadets were working with educational-level optimization software, rather than commercial-quality products. We believed that if we could train them on the same technologies that they will be using after they graduate, we would be doing a better job of preparing the next generation of operational researchers for a successful military career.”

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Choosing the right optimization solution

Prior to West Point, Professor Pulleyblank had spent many years working at IBM, helping businesses harness analytics and optimization software to solve their own business problems.

IBM had announced that its IBM® ILOG® CPLEX® Optimization Studio software would be freely available for educational purposes for institutions that joined the IBM Academic Initiative. The Professor jumped at the chance for West Point to take advantage of this.

“Optimization software is a competitive market, but there were three reasons—besides my own personal experience—that made the IBM solution a particularly good fit for the Operations Research faculty at West Point,” says Professor Pulleyblank.

“First, the solution is globally available and supported by IBM worldwide. Our cadets end up working all over the world, both with the Army and with other organizations, so it’s good to have experience with a widely used solution from a major vendor, rather than a niche product.

“Second, the IBM Optimization Programming Language [OPL] is very well designed for linear programming. Unlike a procedural programming language, where you are giving the computer a set of step-by-step instructions to follow, OPL is designed to help you specify what kind of solution you are looking for, and define the constraints that it must fall within. It’s a highly expressive language for modeling real-world situations, which is crucial when dealing with very complex problems.

“Finally, the CPLEX engine is a very comprehensive, well-engineered solver; over the years, I have seen CPLEX solve problems that other packages couldn’t. It has a powerful set of default techniques that it applies intelligently to each problem, and will switch between them automatically to try to find the most efficient method. It also allows the user to specify which algorithms it should try, which is helpful for more difficult problems.”

With the product in place, Professor Pulleyblank and his colleagues began teaching cadets how to model problems in OPL. Although the initial learning curve was relatively steep, the course soon inspired some exciting, award-winning projects that not only prove the ability of the cadets, but could also make a real difference to the efficiency of West Point’s own operations.

Supporting award-winning operations research

Professor Pulleyblank comments: “Last year, one of our cadets completed an honors thesis on the security of West Point’s food supply. Providing more than 4,000 cadets with three meals a day requires a complex supply chain, which is vulnerable to disruption by extreme weather conditions, disease epidemics, terrorism, or many other potential threats.”

The project used OPL to create a mixed integer model that assessed the likelihood of various threats, the severity of their impact on different parts of the supply chain, and the cost and efficacy of various mitigations for each threat. It then used CPLEX to solve the problem by finding optimal combinations of mitigations that West Point could apply while staying within a given budget.

In layman’s terms, the solution would potentially allow West Point to answer questions such as whether it should assign a guard to prevent any tampering with its water supply, install an extra generator in case of power outages, or build a new store-room to keep more days’ worth of rations on hand – and which combinations of these mitigations would protect it most effectively against disruption, while keeping costs at an acceptable level.

“The project won the Hollis Award, which is given annually by the departments of mathematical sciences and systems engineering to recognize excellence in military focused operations research projects,” says Professor Pulleyblank.

“And the methods used are not just relevant in the immediate context of West Point’s food supply – they could be expanded to apply to any army base around the world, even in an active theater.”

Similarly, this year, a member of the faculty was inspired to research the energy efficiency of West Point’s housing facilities, with the ultimate aim of developing methods that the Army could use to optimize energy utilization at all of its bases.

“Architecturally, the West Point campus is an interesting mix, with some modern buildings and some that are over 100 years old,” says Professor Pulleyblank.

“As a result, if you want to improve energy efficiency, you can’t take a one-size-fits-all approach. It might be more effective to install a new water heater in one house, to put double-glazed windows in a second, and to upgrade the air conditioning of a third. With dozens of buildings, finding the best overall course of action within particular budget constraints is an interesting optimization problem.”

Again, the project used OPL to define the problem as a mixed integer model, and CPLEX to solve it – providing a set of solutions that would help West Point decide on the best course of action to minimize its electricity costs while keeping its construction budget within specified limits.

“West Point is taking these findings seriously, and within a year we expect to see some real results from the recommendations made by this project,” comments Professor Pulleyblank.

“It’s also an exciting prospect to generalize this model so that the Army could use it to optimize energy efficiency at bases around the world, where the climate may be very different to the hot summers and cold winters that we have here in New York State.”

He concludes: “The work that our cadets are doing with IBM ILOG CPLEX Optimization Studio is excellent preparation for their future careers, where they will be helping the Army make the best possible decisions in response to some of the toughest problems in the field of operations research. And West Point itself can only benefit from the insights that these exciting projects uncover, revealing new ways to optimize operations and drive efficiency.”

Solution components

- IBM® ILOG® CPLEX® Optimization Studio
- IBM Optimization Programming Language

Take the next step

IBM Analytics offers one of the world's deepest and broadest analytics platform, domain and industry solutions that deliver new value to businesses, governments and individuals. For more information about how IBM Analytics helps to transform industries and professions with data, visit ibm.com/analytics. Follow us on Twitter at @IBMAalytics, on our blog at ibmbigdatahub.com and join the conversation #IBMAalytics.

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