

# US Navy Improves Cargo Transfers with New Motion Control System from D&K Engineering

## Intro...

Transferring items from one ship to another while underway—especially in heavy weather—has always been a challenge. Wind blows the ships off heading. Waves create pitch and roll. Wire ropes whip and swing, sometimes dipping cargo into the waves. For the past 30 years, the existing cable system has been notoriously difficult to operate. To help develop a better system, the US Navy turned to D&K Engineering.



## A Significant Design Challenge

D&K Engineering was chartered by the Navy Underway Replenishment Department (Navy UNREP) to retrofit existing machinery with a motion control system to improve the operability of the deck equipment used to transfer cargo between military ships while underway at sea. The wide range of dynamic conditions under which this equipment operates posed a significant

design challenge. Differing loads, transfer speeds, ship separation distances, and sea-state conditions dramatically affect the operability and dynamic stability of the equipment. Moreover, the more extreme these conditions become, the more difficult they are to test with real-life hardware, either on land or at sea. So, how do you create a control system robust enough to support the Navy's underway replenishment process under all possible sea-state conditions?

## Development of a “Fly-by-Wire” Control System

D&K Engineering designed a military-grade PLC-based control system that utilizes sophisticated control algorithms to “fly by wire” the trolley mechanism that carries cargo between ships. Deck machinery at UNREP's Port Hueneme test site ship was fitted with speed sensors, tension sensors, and operator controls. Signals from these devices were fed into a programmable logic controller (PLC). The PLC created outputs to electro-pneumatic actuators that controlled the tension of the wire ropes connected to the trolley. This allowed computer algorithms to control the motion of the trolley, making sophisticated compensations. To the operator, the cargo transfer seemed effortless.

## Custom Software Simulates Rope Apparatus “at Sea”

D&K Engineering's challenge was to guarantee that the system would work under all operating conditions. Landbased testing is limited in the dynamic conditions it can reproduce, and at-sea tests cannot incorporate the full range of conditions under which the system must operate. To meet this challenge, D&K Engineering developed a dynamic mathematical model of the UNREP system. Since available general-purpose mechanical modeling software could not readily capture the complexities of representing long catenary ropes between ships and cargo, especially given the constantly moving endpoints due to ship motion, D&K Engineering developed customized simulation

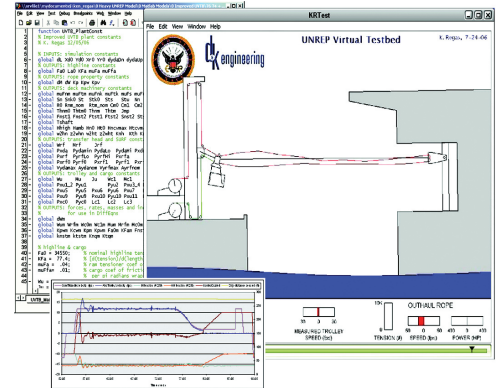
## About Us...

D&K Engineering is a global contract, R&D, engineering and manufacturing services company focused on developing and manufacturing complex electromechanical products and equipment. With a core set of best practices and industry knowledge that spans the entire product development lifecycle, D&K Engineering mobilizes the right people, processes, tools and infrastructure to create and deliver sustainable business value to organizations seeking to outsource the design, development and/or manufacturing of their equipment or products.

D&K Engineering enables organizations to decrease time-to-market, reduce cost and improve product quality.

*Simply put, D&K Engineering bridges the gap between concept and reality.*

software—the UNREP Virtual Test Bed, or UVTB—using Math Works’ MATLAB language. The UVTB provided a virtual environment to quickly test proposed control algorithms and dynamic settings, and to evaluate potential improvements to the design of the existing machinery and rigging. The virtual world of the UVTB allowed unlimited ability to rig any ship with any deck machinery one might wish to design and to place them at the ship-to-ship distance and into the sea state of one’s choosing.



The UVTB provides simulated strip-chart output of system parameter values (speeds, tensions, etc.), twodimensional animations of simulated cargo operation, and tabular numeric output of all pertinent system variables versus time. D&K Engineering used this tool to perform dozens of simulated at-sea tests, drastically reducing development time, prompting specific improvements in hardware and software, and increasing the client’s confidence in the system’s ultimate performance.

## Achieving Real-World Results for the US Navy

The motion control system developed by D&K Engineering makes transfer of cargo between ships faster, safer and easier, and extends the life of the existing UNREP machinery. D&K Engineering conceived the control algorithms, developed electromechanical sensing and actuation hardware, retrofitted existing machinery with this hardware, tested, and ultimately validated a motion control solution that significantly enhances the performance of US Navy UNREP ships. By developing an innovative simulation tool, D&K Engineering slashed development time and provided the client with greater confidence in the ruggedness of the ultimate design solution.

The D&K Engineering control system is intended to be deployed on every UNREP ship in the US Navy fleet.

*“Our experience with D&K Engineering has been 100% positive. Their ability to quickly understand our requirements and develop and implement a solution that met our cost and technical requirements has made them an integral part of our development team. From the beginning, D&K has shown a strong desire to ‘do what it takes’.”*

—UNREP Dept., US Navy

- Ship-to-ship cargo transfers made faster, safer and easier
- Development costs slashed with innovative engineering simulations that deliver with real-world results
- Test time reduced and system performance confidence increased
- Operating costs reduced by extending life of cargo transfer machinery