Speed for Uncle Sam’s Cargo

A spreader bar designed to transfer military cargo directly from railcars to ships also benefits civilian freight handling.

By Michael Valenti, Senior Editor

As was demonstrated once again in October, the logistical agility of the United States armed forces enables the nation to project its power into countries as remote as Afghanistan. The aircraft, artillery, and vehicles deployed on the battlefield are effective as long as the flow of ammunition, fuel, and spare parts reaches them in good order.

For that reason, Uncle Sam is a major sponsor of innovative technologies that rely on mechanical innovation, automation, and vision systems to improve the transport of vital equipment. These breakthroughs are often commercialized to benefit private sector transport as well, as was the case with the Direct Acquisition Rail-to-Ship spreader bar system, or DARTS, designed to transfer military cargo directly from railcars to vessels, and now used in commercial shipping.

Development of DARTS was led by August Design Inc. of Ardmore, Pa., a company that performs contract research and development in computer science, electronics, and robotics for intermodal transport applications for the government and private-sector clients.

Spreader bars are the open-frame steel structures deployed from the end of a gantry crane to grip and raise the 20-, 40-, and 45-foot-long cargo containers used in intermodal transport.

Crane operators activate the spreader bar’s electrically driven hydraulic system to extend or retract its corner arms to fit the container length, then lower the spreader bar over the container. The twist lock in each corner of the spreader...
The center housings of the DARTS spreader bar separate up to 63 inches, enabling it to pick up cargo containers sitting that far apart from each other.

will snap into its corresponding corner castings so that the container can be lifted. All of the containers share the same width.

Common practice is for rail or truck cargo containers to be unloaded onto the ground, loaded onto chassis, transported to a gantry crane, and loaded onto vessels.

Some shippers would like to shorten this procedure by positioning freight trains directly beneath the gantry crane. To do that, crane operators use a combination of radios and hand signals to tell the locomotive’s engineer to inch the railcars into position.

“This would be a time-consuming process, requiring the locomotive driver to attempt to jockey his railcars back and forth into precise position, because the slack between cars causes them to bunch up or spread out, making this impractical,” explained George Simmons, an electrical engineer and vice president of August Design.

The DARTS project grew out of a separate military cargo handling project that August Design undertook in the early 1990s for the Naval Surface Warfare Center, based in Bethesda, Md. This was an intelligent spreader bar, or ISB, equipped with sensors and electronic controls, that could transfer intermodal cargo containers from ship to ship in heavy seas.

In November 1996, the ISB project caught the attention of the Logistics Management Institute in McLean, Va., a nonprofit consulting organization that works with local, state, and federal governments to improve the public sector’s management. The ISB also attracted the notice of a client of the institute, the U.S. Army’s Deputy Chief of Staff for Logistics.

“The Army determined that it was handling cargo containers too many times, transferring from railcars to the ground, then to trailers, and lastly to vessels. It believed a cargo handling system that could transfer containers directly from railcars to vessels would save time and resources at its ports,” said Chuck Fortenberry, a retired U.S. naval aviator who is a research fellow at LMI.

When LMI commissioned August Design to create the system, it set forth two demanding specifications. First, the new spreader bar had to be capable of raising two 20-foot-long containers simultaneously, even if they were separated from one another by a few feet on a railcar, effectively doubling throughput. Second, the spreader bar would need to be positioned accurately over the cargo containers to eliminate the painstaking positioning of the railcars.

**Doubling Throughput**

In February 1997, August Design joined forces with engineers from Bromma Inc. of Roxboro, N.C., whose Swedish parent company, Bromma Conquip AB of Stockholm, is the world’s leading manufacturer of spreader bars, to build a Direct Acquisition Rail-to-Ship System for LMI.

The designers based the DARTS on Bromma’s standard AST-6 telescoping spreader bar, which uses a single electric motor to drive the hydraulic pump that extends or retracts the bar’s reach.

“The most important modification we made for the DARTS spreader bar was designing its center housings to separate up to 63 inches, more than sufficient to lift two cargo containers sitting up to five feet away from each
other on railcars, then draw them together to fit into the hold of a vessel,” Simmons said.

Another modification devised by the August Design/Bromma team for the DARTS was in the upper structure of the spreader. This is connected directly to the gantry crane, lifting cables by means of a head block and allowing the lower portion of the spreader to shift 18 inches from side to side. The crane operator uses this feature to align the spreader bar over the cargo container, and eliminates painstaking positioning of containers.

“Because the DARTS spreader bar has to be able to lift two containers that may be unevenly, improperly stacked or deformed, we equipped the spreader bar with floating center housings to accommodate these deviations,” Simmons explained.

In addition, the project engineers mounted a camera on the DARTS crane to transmit live images to a video screen in the locomotive’s cabin. The driver would look at the screen to align the edge of the container with a bright marking stripe painted on the dock itself.

Some standard Bromma equipment also served the DARTS spreader bar well. These were the HS-14 rotary actuators at each of the spreader bar’s corner extenders.

“Because its added features make the DARTS spreader bar heavier than conventional spreader bars, the HS-14 actuators, which are stronger than most, can move the spreader over the container faster,” explained Simmons.

The full-scale prototype DARTS was installed at the Military Ocean Terminal Sunny Point, an Army ammunition port in North Carolina, about four years ago. Sunny Point supplies ammunition to all branches of the military.

The project engineers designed the DARTS system to be integrated with the Paccceo cranes already at Sunny Point, in part by the use of a robust electrical cable that serves both the old and new cranes' controls. Design engineers also trained two experienced crane operators to handle the new spreader bar.

The DARTS prototype was tested in difficult cargo-handling scenarios devised by military and civilian logistics. “For example, we loaded two cargo containers between truck drivers and the operators of intermodal logistics platforms like his. To that end, TAB is participating in the Idioma research project of the Educational Institute for Transport and Logistics, or IPTL, based in Monchy-Saint-Eloi, France.

“We want to avoid a train being held up indefinitely waiting for its last containers,” said Bernard Borie, head of research at IPTL. Borie explained that the Idioma project installs GPS receivers on trucks carrying containers. Then, using global position sensing, computer visualization of regional road traffic, and mobile communications, the managers of freight-handling operations can estimate possible delays, and direct drivers to change routes or proceed to another transfer facility.

According to Borie, a simulation conducted in February 2001 demonstrated that a fleet of 50 trucks could save between 380 and 520 hours in a month by using the Idioma process.
Before using the DARTS spreader bar, the Sunny Point terminal often transferred rail-borne cargo containers to trucks before loading them onto ships.

with dummy loads of very different weights—10,000 and 25,000 pounds, for instance—placed up to five feet apart, and had the crane operators pick them up,” Fortenberry recalled. “We also placed 4-by-4-inch boards under the corner of cargo containers to simulate off-kilter stacking.”

The spreader bar system works extremely well, according to Fortenberry. Once paperwork was completed and the Army certified the DARTS prototype, it was put to work full-time on loading containers at Sunny Point. A second spreader bar is now operational at Sunny Point.

“The locomotive drivers and crane operators love it,” said Fortenberry. “By watching the video screen, locomotive drivers can line up the leading edge of the cargo container within six inches of the marked stripe, inside an hour, and the crane operators can pick up cargo even if the containers are two or three feet out of alignment with the crane.”

Based on the DARTS success, Bromma developed a spreader bar with a separating center housing called the AST-6SCH for civilian use. “We removed the end shift bar, because in commercial ports the cargo containers are brought to the crane by truck or trailer, and we relocated the hydraulic cylinders to accommodate this,” said Peter Brill, a professional civil engineer and technical director at Bromma who worked on both the DARTS and AST-6SCH projects.

The AST-6SCH also can pick up a single 20-, 40-, or 45-foot-long container, or two 20-foot containers simultaneously. In dual lift mode, the operator can adjust the spreader to pick up or position two containers with a gap between them of as much as 63 inches.

Shipping lines, stevedoring companies, and port authorities using the AST-6SCH report improved cargo handling productivity of 5 percent, according to Brill.

At about the same time that Brill and his colleagues were developing the DARTS prototype, Bromma Conquip in Sweden was developing its EH-195 separating center spreader. It has similar capabilities to the AST-6SCH, and is adapted for European service, for example, by using metric measurements.

Both separating center housing systems together account for about 30 percent of Bromma’s worldwide sales, according to Brill.

**A THINKING SPREADER BAR**

The ISB project that inspired DARTS, although it played no part in the cargo handling system, is still being developed by the Navy’s Carderock Division in Bethesda, Md. “The intelligent spreader bar was one part of the mobile offshore basing project proposed in the early 1990s,” said Kelly Cooper, a naval architect at the Carderock Division who is responsible for the ISB project. “This envisioned using five 300-meter-long ocean-going units to create a mile-long aircraft landing platform. The ISB would have been used to replenish the MOB at sea.”

In addition to August Design and the Navy, Brown & Root, and McDermott Shipbuilding of New Orleans worked on the full-scale ISB prototype, built in Decem-
Engineers installed an experimental camera system on the boom crane of the Flickertail State cargo ship to assist the crane operator.

ber 1999 and installed at the government's Packer Marine Terminal in the Port of Philadelphia.

The prototype is designed to transport a single 20-foot container, and is equipped with an upper spreader that replaces the headblock on the gantry crane, and a lower spreader that grips the cargo.

"The upper spreader contains the ISB's actuators and control systems," Cooper said. "The lower spreader is connected to the upper spreader by a Stewart platform that gives it the six degrees of freedom needed to take up the cargo without imparting the swaying cables would cause in heavy seas."

The Navy is considering automation of the ISB so that the crane operator need only position it close to the cargo container before activating it.

A key component to automating the ISB is a vision system based on fuzzy logic to track the cargo container. The vision system would likely consist of two video cameras, each mounted at one end of the spreader bar, bracketing three central laser projectors mounted in a geometric pattern, according to Cooper.

The lasers would emit visible lines of light atop the container whose pattern is captured by the two cameras and transmitted to the ISB's computer. The computer's image processing system uses the changing pattern of laser stripes to determine the changing position of the container relative to the spreader bar, and to develop commands to direct the spreader bar to grip and raise the container from the vessel.

Cooper's division is also working with the Military SeaLift Command to develop vision systems for the boom crane operators transferring cargo between container ships and lighters for transport to and from shore. Ship-to-ship operation is hampered because the boom crane itself obscures the operator's forward vision. The cargo, whether it is lying in the hold of a container ship or on the deck of a lighter, is usually below the operator's line of sight.

In order to move cargo from one ship to another, a sailor on the lighter uses hand signals and a radio to communicate the position of the container to another sailor on the container ship, who relays these instructions to the crane operator. This task is made more cumbersome by the swaying cables caused by heavy seas.

Cooper said the dual-camera system will transmit stereographic images that provide the needed depth perception for the safe transfer of containers.

The Carderock engineers installed an experimental stereographic camera system created by August Design on the boom crane of the Flickertail State, a military cargo ship used by the U.S. Maritime Administration for research purposes, and docked at Cheatham Annex, Va. "These are dual camera systems whose stereographic images will provide the needed depth perception for the safe transport of containers," explained Cooper.

The experimental vision system includes dual cameras on the crane boom and crane tip, and two other mobile cameras that can be mounted on the lighter, or on shore, to communicate with the crane's cameras using fuzzy logic and provide stereographic images to the crane operator.