



COMMERCIALIZATION ASSISTANCE PROGRAM

Fully Automated Cargo Handling System

Business Opportunity:

Automated storage and retrieval systems on naval ships are being developed to reduce the number of sailors, necessary for cargo handling, and to improve the quality of work conditions for those on board. Current systems are unreliable, loud, time consuming and inefficient. BEC Industries' innovative Three Dimensional Automated Guided Vehicle (3D-AGV) revolutionizes the way goods are transported and stored by extending automation from two dimensions (horizontal movement) to three dimensions (horizontal and vertical movement). In addition to the naval development, the 3D-AGV technology has applications in a variety of settings including automated warehouses, distribution warehousing, automated parking garages and more. BEC Industries is looking for a federal agency sponsor or industrial company engagement to establish user requirements and funding for a pilot manufacturing or warehousing operation, a material handling equipment manufacturer for a licensing transaction, and/or a shipyard or military facility contractor to fund site-specific design application.

Company Background:

BEC Industries, LLC (BEC) was founded as Benedict Engineering Company in 1982 by Dr. Charles Benedict, who came to the enterprise with 11 years experience in product and machine design. The company began with four employees and over the years has grown into a full-service research and design-focused engineering company with a national reputation. Our personnel represent a broad range of disciplines, including engineers, technical specialists, graphics specialists, and research assistants, as well as business analysts and administrative staff. With over 25 years in the engineering industry, BEC has carefully charted the growth necessary to support the development and commercialization of our material handling products.

Industry Problem:

On aircraft carriers, pallets of cargo are brought on board the ship during an underway replenishment (UNREP) operation. The pallets must be moved by forklift trucks so that the goods can be broken down into the individual packages so they can be moved to the storage areas by either a package conveyor or by human chain. This requires large working parties (upwards of 400 personnel) and consumes a considerable amount of time which is a detriment to the carrier's war-fighting capabilities and the sailor's quality of life. Similar issues exist in other industries where cargo must be handled by multiple personnel and/or equipment to get from the receiving location to the storage location and vice-versa. Each hand-off takes more time and increases the chances of damaging and/or misplacing the goods.

Technology:

The BEC 3D-AGV system utilizes current gear rack technology along with ground-based automated guided vehicles to retrieve and transfer loads and can automatically move from planar horizontal travel to vertical travel up a trunk between decks of a ship or floors of a building, or travel up a storage structure to store goods. The system utilizes multiple 3D-AGVs to provide redundancy and increase cycle times.

Advantages:

The 3D-AGV offers a reduction in labor and associated expenses while increasing the speed and accuracy with which materials are moved and stored. The system operates exclusively on electrical power eliminating emissions from forklift trucks and other mechanical equipment that would no longer be required in a storage facility. The 3D-AGV system optimizes the storage footprint by reducing the number and necessary width of aisles, breaks down the inherent height restrictions imposed by forklifts and other material handling equipment, reduces the time necessary to store and retrieve goods, and reduces the equipment necessary to transport goods. The 3D-AGV is the only automated vehicle of its kind capable of travel in both horizontal and vertical directions enabling it to increase storage density, speed material delivery and storage operations, reduce labor costs, and increase operational safety through automation.

Differentiating Feature:

The 3D-AGV system has the ability to operate as a traditional AGV by adeptly maneuvering on a planar surface while adding the capability of transitioning into a vertical trunk or storage rack system and climbing to either change levels or deposit / retrieve goods. The system setup affords the operation of multiple 3D-AGVs in an area providing redundancy and increased cycle times.

Stage of Development:

The 3D-AGV system was conceived and a preliminary design was constructed. The proof-of-concept prototype was utilized to test various aspects of the technology including battery lifespan and power usage, rack and pinion tooth wear, self alignment capability, and transfer mechanism reliability. The same prototype was subsequently used to test the 3D-AGV concept in a shipboard environment. During at-sea testing, when the ship got into high Sea-State 3 and low Sea-State 4, the system was able to complete the entire series of tests required in the test plan for those sea states. Additionally, it successfully extended and retracted a container with the transfer mechanism. During the development of the 3D-AGV, BEC evaluated methods for the unit to transfer between decks and a trunk, and resized the system to accept a wider variety of goods. Additional development areas include detailed design of the cargo transfer mechanism, application refinement for industry specific needs, design of a cargo locking mechanism within the storage racks, and value engineering for cost and weight reduction.

Competing Technologies:

A variety of material handling equipment currently address conventional material handling and storage, but they only move cargo in lines or a geometric plane, not 3-dimensionally from the receiving point to the storage or usage location utilizing horizontal movements and separate vertical movements. Equipment such as elevators, conveyor belts, forklift trucks, and human chains move, organize and store cargo and require multiple hand-offs before reaching the cargo destination, unlike the 3D-AGV. Gantry cranes, aisle cranes and similar technology utilize a dedicated system to access storage areas so only one bundle of goods or cargo can be moved at a time, unlike the 3D-AGV system that can have multiple units traversing within the system at a given time.

Applications:

3D-AGV technology offers a variety of opportunities to automate storage on board ships and in land-based storage operations. Shipboard applications include the movement of dry goods, reefer goods, parts, supplies and munitions on ships such as an aircraft carrier or supply ships such as the T-AKE. Land based applications including warehouses and parking garages could be automated with adoption of this system so that product is inputted into the system at a designated entry point and the system automatically moves the goods to a storage location and tracks that location. The goods can then be retrieved whenever the product is requested and delivered to a designated delivery point. The 3D-AGV system can be scaled up or down to accommodate a variety of loads from pallet sized goods or smaller up to cars or larger items. This technology applies to any market that desires to move materials in an automated fashion with selective storage and retrieval.

Benefits:

Our technology offers advantages in storage capacity, throughput and redundancy (multiple units operating in the system and storage area at the same time) that other technologies do not offer. Due to the excessive number of personnel used for extended hours to support the existing shipboard on-load efforts to manually transport the cargo received, risk of serious injuries greatly increases. Automation of this process with the 3D-AGV minimizes the interruption of war-fighting capabilities while enhancing the quality of life on board ships by increasing operator safety and decreasing the time and manual labor considerably. In land-based applications, automation is advantageous to reduce manpower, reduce storage cycle time, and improve security and protection of goods as a result of reduced hand-offs and limited human interaction.

Intellectual Property:

The technology described herein is owned exclusively by BEC Industries LLC and covered by U.S. Patents No. 4,733,783 and 7,101,139, as well as a number of U.S. and international patents which have been applied for and are pending.