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Engineering Spotlight: Mel Terry, Wheelift

Mel Terry, the designer, developer and patent holder of the Wheelift heavy transporter system, has been quietly revolutionizing the way manufacturers get their work done. Terry is anticipating a future in which his creation is being used — and abused — in transporting the heaviest creations of our various industries, such as submarine propellers that weigh tons or large pieces of the F-35 fighter jet.

Sep 17th, 2012

The men and women who strive to innovate, who seek out new technological developments and turn them into patent-able visions, are a critical backbone of our economy.
The Engineering Spotlight *aims to pay some tribute, now and then, to the relatively unknown inventions that are having big impacts on the way we work or live.*

This time, we feature Mel Terry, who has developed an automated transporter system that has changed the way the U.S.'s biggest defense contractors get their work done. It's a stunning example of sticking to an idea that one truly believes is viable and innovative.

Mel Terry, the designer, developer and patent holder of the Wheelift heavy transporter system, has been quietly revolutionizing the way manufacturers get their work done. And from where he sits right now, Terry is anticipating a future in which his creation is being used — and abused — in transporting the heaviest creations of our various industries, such as submarine propellers that weigh 70 to 80 tons or large pieces of the F-35 fighter jet.

In the early 1990s, Terry was working for NASA, which needed a heavy-duty transporter to shuffle around massive pieces of an in-development rocket motor. When it comes to moving extremely heavy loads, there aren't a lot of options — for NASA and typical manufacturers alike — with the most reliable choices being cranes or rails in the floor. Air bearings have always been a possibility, but they require extremely smooth floors — something that's not all too common in the U.S.

NASA killed the project that Terry was working on, but that didn't kill his desire to make a better heavy load transporter. He had been in contact with heavy car builders, and one asked if he could design the wheel assemblies for an automated roll changer. In 1992, the first production was brought on-line, and the company was pleased. Terry's patent was issued a few years later.

For the next few years, Terry worked on other projects, but never could give up on his heavy-load transporter. In 1998, he returned to the plant where his first machine had been brought on-line years ago, not sure what to expect. He says, "The first thing I did was check the wheels. They were urethane wheels, and they had never been used to move those kinds of loads before. So, I figured they had damaged the wheel seriously. But the original wheels, other than being greasy and nasty—there was no damage. That was the first that I knew this on-center idea would work."

From there, Terry needed a company to work with to bring the Wheelift into the big show. Terry says that "Doerfer took this on and decided it was a technology they wanted to do. It would allow them to build larger AGVs, so they licensed the technology and we began to pursue it vigorously."

Bring On The Heavy Loads

Despite the capacity to deal with massive loads, the Wheelift system is rather elegant in design. The system uses an open center axle, with a vertical lift column that allows the assembly to turn on center. This is important, because the wheels needed to be omnidirectional, and they needed to move in coordination with the all the others in a modular fashion. All of the movements are done with a series of complex mathematical functions, so that the system always knows the location of all the axles and the center point. Without these important requirements, the Wheelift system would have never been viable in the first place.

The second critical component of the wheel assemblies is a fluid suspension system that shares the load equally, no matter how many wheels have been tethered together to make the transporter. Pressure actuators are used in conjunction with a centralized pressure monitoring system so that unbalanced loads are compensated for properly, and that no single wheel will be forced to carry more than its individual limit. This is also what allows the transporter to tackle less-than-perfect flooring, which is commonplace on many plant floors, and often the status quo in Navy dry docks and other extremely harsh environments.

This connectivity is what helps the transporters move incredible loads. Terry says that the Wheelift has an unlimited capacity range due to its modular construction and the emphasis on omnidirectional, fluid suspended axles that can turn precisely on center. He says, "They can

carry 10,000 pounds or 200 tons. It's just a matter of how many axle assemblies are beneath it, and what size they are."

That's why the transporters have been popular in the aerospace and naval industries, where production lines have changed considerably in the last few decades. When building a plane, manufacturers used to construct them in place, ferrying over components as needed. Now, they can use a transporter like the Wheelift to move them down a massively-scaled production line. And for a lot of industries, that's a game-changer.

While manufacturers of smaller goods have been automating large portions of their process — if not its entirety — for decades, the makers of extremely large objects have always required a greater human interaction for even simple actions, such as bolting together components. According to Terry, the Wheelift could help change that status quo. Because the motions are based on sophisticated calculations from a single point of origin, his transporters are, essentially, automatic guided vehicles (AGVs).

And an incredible degree of automated precision is exactly what defense contractors, among other industries, have been begging for. Terry says, "The advantage of the Wheelift system is that its sophistication allows a whole new range of how manufacturers can build products."

Engineering Spotlight: The Wheelift In Action

The Naval Sea Systems Command (NAVSEA) has selected the Wheelift transporters for dry docks and machine shops in order to conduct necessary maintenance on massive crafts that monitor the seas worldwide. The plan was to provide eight 150-ton transporters, each of which is capable of being operated independently or as a group of any size. As a single unit, the transporters can carry 200 tons.

Sep 18th, 2012

This is the second part of a two-part series on engineer Mel Terry and his invention, the Wheelift transporter. Read the first part here.

The Wheelift in Action

The aerospace industry was one of Terry's first targets when it came to finding customers for the Wheelift transporter. Manufacturers of airliners and fighter jets alike regularly need to lift loads between 35 and 75 tons, and with an incredible degree of precision. The capability to be partially or fully automated is also a major plus when it comes to the small tolerances in assembly that can make the difference between a plane that flies and once that doesn't.

Unfortunately, most current AGVs aren't capable of carrying such heavy loads — they're often limited to 10 tons, which puts them below the thresholds for the massive parts, such as wing sections or engines that need to be transported to the plane for assembly. The list of locations where Terry's creation has made an enormous impact is already long and impressive, but it's still growing.

F-35

The Wheelift's ability to overcome these restrictions is one of the reasons it was chosen to be part of the current F-35 Lightning II Program, also known as the Joint Strike Fighter, as part of an automated guided vehicle (AGV) system designed by KUKA Robotics. By utilizing Wheelift transporters, the systems were able to be designed so that aircraft could be built in machine cells — a typical configuration in a manufacturing plant producing much smaller items.

Doerfer provided a five-vehicle "free range" system, which included three 38,000-pound AGVs with two additional 75,000-pound AGVs and a central Control & Indication server (C&I) that serves as the heart of the automated system. The C&I communicates with an AGV server, which manages all tooling/work-in-progress moves. Both servers allow the system to be completely flexible based on the current needs, in addition to priority routing, safety and fault tracking.

Terry says that the low-profile Wheelift chassis with an integrated lift eliminates the need for other material handling mechanisms, such as cranes, to provide tooling access to the part. The F-35 program also appreciates the incredible accuracy of the transporters. Terry says, "The Wheelift uses an AC control system. That means we're using servomotor drives — that's like the precision drive used in a milling machine. We can dial in to move a few thousandths of an inch, and it will move a few thousandths of an inch."

In The Navy

The Naval Sea Systems Command (NAVSEA) has also selected the Wheelift transporters for dry docks and machine shops in order to conduct necessary maintenance on massive crafts that monitor the seas worldwide. The plan was to provide eight 150-ton transporters, each of which is capable of being operated independently or as a group of any size. As a single unit, the transporters can carry 200 tons, and two or more units can work in tandem for larger loads. All are controlled via wireless controllers. These massive capacities come in handy when NAVSEA needs to lift a new propeller or rudder into one of its ships.

NAVSEA also required that the transporters they specified be capable of delivering positioning better than 0.005" — an incredibly difficult proposal considering that one of the propellers can weigh nearly 80 tons, and that the facility is often bombarded by strong winds and sea spray. Terry was confident

that the Wheelift would be able to meet these specifications. He says, "They're able to join components together within thousandths of an inch. It's incredible. They're doing it every day."

Neutrinos?

Doerfer's Wheelift transporters were chosen to handle the underground movement of large components at the Daya Bay nuclear plant in China, where the US Department of Energy (DOE) and the Chinese Institute of High Energy Physics (IHEP) are jointly trying to study neutrinos, which are invisible, mysterious particles emitted by the sun and nuclear fission here on earth.

The company provided an eight-axle transporter rated for 130 metric tons, which they called the "Ox" in honor of the Chinese calendar. While the Wheelift transporter is not tied to the actual process of discovering neutrinos, Terry is proud to explain how it helps move eight massive underground detectors around two miles of tunnels running through solid granite mountains. By using the nimble Wheelift transporters, the tunnels were able to be one third smaller than necessary for any other type of underground system.

Those detectors, known as "liquid onions," are made in three layers. Central-most is 20 tons of organic liquid scintillator containing gadolinium—a heavy rare-earth metal—followed by another layer of liquid scintillator without gadolinium. The outermost layer uses mineral oil, and it adds together to 100 metric tons of precise machinery that must be kept level and at absolutely minimal g-forces during movement. Operators are then able to control the movement of the Wheelift transporters and their payloads via a wireless joystick controller, while the on-board guidance system steers clear of the granite walls. And this process of moving around the "liquid onions" is almost continuous, as scientists need to verify their data. Sound precise enough?

Where next?

Perhaps the greatest testament to any innovation's real value is how it lasts in a rapidly changing marketplace. Terry is confident that his system will continue to be relevant to manufacturers of heavy equipment for decades to come, as automation becomes more integral into operations and we always strive to make things better and more quickly.

Terry says that he wants to get Wheelift transporters into mining facilities, where companies need to move vast amounts of heavy material or large machines in notoriously difficult underground environments. Same goes for the nuclear industry, which deals in large quantities of raw materials and wastes. In the automotive industry, his transporters could find a good deal of use moving around dies or transporting molds in plastics manufacturing plants. He says, "It just totally changes how companies can build their products. And that's what the story is all about."

More than anything, Terry's story is a perfect example of how years of hard work toward an idea — along with a little perseverance — can lead to fantastic places. That, in essence, is the mission of product development and of engineering: the creation of a lasting technology that has the potential to change the way others do business. Clearly, the Wheelift is well on its way to disrupting the status quo of heavy-duty manufacturing.

Self-Propelled Trailer operates in confined areas.

WheeLift Systems Div., ~~Ederer Inc.~~ Jan 17, 2011 Doerfer Companies

Offering 100 ton capacity, Self-Propelled Trailer features SynchroSteer® computerized independent steering, Uniload® on-center rotating front axles, remote control operation, and on-board power generation. Unit measures 21 x 8 ft with 27 in. deck height and 15 x 7.5 in. solid urethane wheels that operate on any floor surface. With recommended speeds from 0-100 fpm empty and 0-70 ft loaded, trailer is suited for in-plant operation in congested, confined areas and narrow intersecting aisles.

Self-Propelled Trailer Saves Space, Increases Productivity

Waverly, IA. - Wheelift Systems announces its space-saving, ultra-maneuverable, self-propelled trailers (SPT) in capacities to 100 tons and greater for in-plant use. These newly developed self-propelled trailers are ideal for in-plant operation in congested, confined areas, and narrow intersecting aisles. Highly maneuverable, the Wheelift self-propelled trailers feature computerized independent steering, on-center rotating front axles, remote control operation, low-profile design and on-board power generation. These qualities serve to increase the areas in which these heavy duty in-plant platforms can operate - opening up new possibilities in manufacturing when dealing with the logistics of moving very large and awkward assemblies through manufacturing and assembly processes. The combination of high maneuverability, on board self-propulsion, and remote-control operation opens a new realm of capabilities in heavy manufacturing operations These easy-to-operate self-propelled trailers benefit from Wheelift's proprietary Uniload® on-center rotation axle assemblies combined with their SynchroSteer® computerized steering technology. Each self-propelled trailer has two on-center rotation, electronically steered and driven independent axle assemblies on the front end. At the rear are two fixed direction rocker beam mounted axle assemblies that each has lateral articulation capability to assure fully equalized load sharing. This configuration allows for new levels of maneuverability by being able to rotate around the center point of the rear axles. Fully loaded, this featured Wheelift 100-ton SPT travels effortlessly via precise wireless controlled travel speed, direction and rotation. Wheelift's Engineering Manager, Craig Schmeiser offers: "Our customers are achieving significant gains in overall productively and a short return on investment. This new technology dramatically changes how manufacturers utilize their facilities

by easily transporting and maneuvering huge assemblies, anywhere in-plant on any floor surface. The ability to effortlessly maneuver in narrow and confined spaces, as well as transporting loads weighing 50 tons and greater between assembly areas and outside storage, completely changes how plant space can be utilized." These self-propelled trailers are powered by a 480v, 3 phase AC, LP gas engine driven generator. A shore power back-up option is offered as a back-up power source and where virtually silent operation is desirable. While Wheelift SPTs can be built to a wide range of capacities and dimensions, this featured 100 ton unit has an overall length of 21 feet (6401mm), width of 8 feet (2438), deck height of 27 inches (686mm), and feature mill-duty-design axle and trailer frame construction. The 15 inch (381mm) by 7.5 inch (191mm) solid urethane wheels operate on virtually any floor surface. Operation on grades of less than 2% is recommended when fully loaded. The flat load deck measures 18.5 feet by 8 feet - Wheelift offers fixturing and custom fabrication services to accommodate specific requirements for locating and orienting the loads. Wheelift SPTs will operate in ambient temperatures of 110° F / 43° C maximum and minimum temperatures of 20° F / -7° C. Recommended speeds range from 0 - 100 fpm (30.5 mpm) empty and 0 - 70 fpm (21.4 mpm) loaded. This featured SPT's empty weight is 20,000 lb (9,072 kg), with a rated capacity of 200,000 lb (90,718 kg). These new self-propelled trailers are derived from Wheelift's omni-directional steer, self-loading transporters. Substituting the transporter's sophisticated all fluid suspension and lift capability for a three point suspension configuration utilizing a mechanical rocker beam mounting of two fixed direction laterally articulated axle assemblies on the rear the self-propelled trailer design greatly reduces the cost and opens up new alternatives in operations in which a lift or tilt capability is not necessary. The Wheelift heavy transporter and trailer capability group is part of the Doerfer Companies' TDS Automation division, headquartered in Waverly, IA. Doerfer's proprietary Wheelift technology offers customers an entirely new wheeled technology that provides flexibility never before available for moving very heavy payloads in large assembly operations. Doerfer was founded in 1961 to provide assembly automation and engineering services to the agricultural and metalworking industries. It has since grown to become the leading entity providing turnkey factory automation, press technology, tooling and automated guided vehicle technologies. These core competencies apply to a diverse industry cross section, incorporate numerous advanced technological capabilities, including specialized expertise in the nuclear, specialty fibers and chemical industries. Doerfer manufactures large format hydraulic presses, ranging in size from 500 to 13,000 tons, for the aerospace, automotive, building products, and transportation industries. Operating one of the largest tool and die facilities in the Southeast and Midwest United States, Doerfer serves the forming needs of customers in the aerospace, appliance, automotive and HVAC industries. Doerfer specializes in custom heavy capacity Automatic Guided Vehicle Systems with traditional wire or laser-guidance systems as well as inertial guidance technology. For additional information:
Self-Propelled Trailers, http://www.selfpropelledtrailers.com/
Wheelift Omni-Directional self-loading Transporters, http://www.wheelift.com/
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