**Designation: F3200 – 17b**

# Standard Terminology for
# Driverless Automatic Guided Industrial Vehicles[1]

## 1. Scope

1.1 This terminology covers terms associated with unmanned (that is, driverless), ground (that is, land-based and in continuous contact with the ground), industrial vehicles. By providing a common and consistent lexicon, the purpose of this terminology is to facilitate communication between individuals who may be involved in the research, design, deployment, and use of unmanned ground vehicles, including but not limited to, for manufacturing, distribution, security, etc. The terminology covers terms used in performance test methods of automatic guided vehicles (AGVs), autonomous mobile robots, and all other driverless, ground vehicles. In addition, with increasingly intelligent vehicle systems with onboard equipment, robotics industry terms that are used in associated test methods and descriptions are also included.

1.2 For the terminology to be harmonious with the practices in the field, definitions have been drawn from the literature or other public sources when possible. When no definition is available, is similar but requires change for use within standards produced by Committee F45, or in dispute, a consensus-based approach will be used to resolve definitions and add them to the lexicon. The development of this terminology is taking place in close coordination with corresponding efforts in all Committee F45 subcommittees to ensure comprehensive and consistent coverage.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 *ANSI/ITSDF Standard:*[2]
ANSI/ITSDF B56.5 Safety Standard for Driverless, Automatic Guided Industrial Vehicles and Automated Functions of Manned Industrial Vehicles

2.2 *ISO Standard:*[3]
ISO 8373 Robots and Robotic Devices—Vocabulary

## 3. Terminology

3.1 *Definitions:*

**A-UGV operator,** *n*—person responsible for initiating and monitoring vehicle operation.

**A-UGV technician,** *n*—person(s) responsible for executing the test procedures under supervision of the test supervisor.

**A-unmanned ground vehicle, A-UGV,** *n*—automatic, automated or autonomous vehicle that operates while in contact with the ground without a human operator.

**Ackermann steer,** *n*—kinematic configuration for vehicles with pairs of wheels in which the front or rear wheels are pivoted to achieve steering.

DISCUSSION—The pivot angles of each wheel within the pivoted set are calculated such that each wheel's axle intersects a common point. This common point serves as the instantaneous center of the vehicle's turning circle.

**adaptive control,** *n*—control scheme whereby the control system parameters are adjusted from conditions detected during the process.

**aisle,** *n*—in a facility, the passageway between locations where temporary or permanent obstructions may exist.

**aisle, guide path clearance,** *n*—minimum distance between fixed structures along the vehicle guide path or objects intentionally positioned in a designated area along the vehicle guide path and the rigid parts of the vehicle, the load, and trailers if towed. **ANSI/ITSDF B56.5**

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**ambient temperature,** *n*—temperature of the atmosphere surrounding equipment.

**automatic data capture,** *n*—identification and direct collection of data into a computer system or other microprocessor-controlled device without using a keyboard (for example, technologies that support the function are: barcode, radio frequency data communication, radio frequency identification, and other emerging technologies).

> DISCUSSION—Other similar terms are *automatic data collection* or *automatic identification*.

**axis of motion,** *n*—axis along which the vehicle moves in translation or around which the vehicle moves in rotation.

**barcode,** *n*—system of printed patterns that represent alphanumeric data that are able to be optically read.

**barcode reader,** *n*—device used to read a barcode.

**benchmarking,** *v*—measurement process that can be used for comparison against established goals, operating targets, and performance expectations.

**braking,** *v*—any controlled or emergency means to slow or stop the vehicle. **ANSI/ITSDF B56.5**

**bumper, physical,** *n*—surface designed to absorb or withstand impact.

**collision prevention,** *n*—use of sensors to detect the presence of obstacles and, through the use of integrated controls, prevent a collision from occurring; *see also* **obstacle avoidance**.

**commissioning,** *v*—sequence of actions of setting up and checking the A-UGVS followed by the verification of the A-UGV functions after installation.

**configuration,** *n*—all hardware, software, and settings needed to operate the A-UGV as specified.

**controls** and **control system,** *n*—hardware and software required to operate A-UGVs and communicate with the environment (equipment and users); *see also* **integrated systems and controls**.

**cycle,** *n*—single execution of a task program.

**cycle time,** *n*—time required to perform the cycle.

**defined areas,** *n*—space constrained by test method boundaries for A-unmanned ground vehicle (A-UGV) operation.

**differential steer,** *n*—kinematic configuration for vehicles with two drive wheels in which steering is achieved solely via varying wheel speeds and the wheels are not able to pivot; *see* **skid steer**.

**distance accuracy,** *n*—difference between a command distance and the attained distance over a set of points.

**dock,** *n*—target location where the A-UGV interacts with another object.

**docking,** *v*—arrival and act of stopping at a position relative to another object.

**drift,** *n*—movement from the designated hold point because of the system's inability to maintain a fixed position.

**echo,** *n*—time elapsed between signal emission and reception that is used to determine target position in a sensor.

**emergency stop,** *n*—vehicle stop, not part of normal operation, that requires operator action to restart; also known as E-stop.

**environment map** or **environment model,** *n*—map or model that describes an environment with its distinguishable features. **ISO 8373**

> DISCUSSION—Examples are grid map, geometrical map, topological map, and so forth.

**exteroceptive sensor** or **external state sensor,** *n*—mobile platform sensor intended to measure the state of a vehicle's environment or interaction of the vehicle with its environment.

> DISCUSSION—Examples are global positioning system (GPS), vision sensor, distance sensor, force sensor, tactile sensor, and acoustic sensor.

**guidepath,** *n*—intended path for an A-UGV used with automatic or automated guidance.

**human-machine interaction,** *n*—information and action exchanges between human and A-UGV to perform a task by means of a user interface.

**integration,** *n*—act of combining an A-UGV with other software or hardware, or both.

**intended path,** *n*—heading of a vehicle at a given instant in time dictated by the control logic, recognizing that the heading is a dynamic property and can change at any instant in time depending on conditions in the operating environment (for example, the decision to allow a vehicle to pass another vehicle or to navigate around an obstacle); *see* **path deviation**. **ANSI/ITSDF B56.5**

**interlock**, *v, n*—method to limit or prevent the operation of machine functions under specified conditions.

**joystick,** *n*—manually controlled input device whose variable positions and orientations or applied forces are measured and result in commands to the vehicle control system.

**landmark,** *n*—artificial or natural object identifiable on the environment map used for localization of the A-UGV.

**layout,** *n*—graphical representation of the environment and A-UGV functional space.

**load, rated,** *n*—load stated by the manufacturer that can be applied to the A-UGV under defined operating conditions.

**load-bearing surface,** *n*—actual area of material in contact with and supporting a unit load.

**local operator,** *n*—operator within reach of the vehicle, its control, or safety devices. **ANSI/ITSDF B56.5**

**localization,** *n*—ability of the A-UGV to determine its pose within an environment map.

**main direction of travel,** *n*—forward movement of the vehicle, including turns, unless otherwise specified and agreed to by the user and system supplier.

**ANSI/ITSDF B56.5**

**manipulator,** *n*—automatically controlled, reprogrammable, multipurpose device, programmable in multiple axes that can be either fixed in place or mobile for use in industrial automation applications.

**manual mode, manual control, manual operation,** *n*—operating mode in which the complete vehicle is under control of an operator.

**manufacturer,** *n*—company or organization responsible for the vehicle system to be installed and integrated into the environment where it will be operating.

**mapping** or **map building** or **map generation,** *n*—constructing the environment map to describe the environment with its geometrical and detectable features, landmarks, and obstacles. **ISO 8373**

**master-slave control,** *n*—control method in which the motion of a primary device (master) is reproduced on secondary devices (slaves). **ISO 8373**

DISCUSSION—Master-slave control is typically used for manual control.

**maximum force** or **maximum thrust,** *n*—force (thrust), excluding any inertial effect, that can be continuously applied by or to the mobile platform without causing any permanent damage to the vehicle.

**maximum moment** or **maximum torque,** *n*—moment (torque) excluding any inertial effect that can be continuously applied by or to the mobile platform without causing any permanent damage to the vehicle.

**natural features,** *n*—features in the environment that were not specifically installed to assist in A-UGV navigation.

**navigation,** *n*—deciding on and controlling the direction of travel derived from localization and the environment map; *see* **simultaneous localization and mapping (SLAM), localization**.

DISCUSSION—Navigation can include path planning for location-to-location travel and complete area coverage.

**non-contact sensing device,** *n*—device used to sense the presence, location, or other characteristics of objects without physical contact.

**non-restricted area,** *n*—area in which the A-UGV may operate and is shared with personnel.

**normal operating conditions,** *n*—range of conditions that can influence vehicle performance (such as electrical supply instability, electromagnetic fields) within which the performance of the vehicle specified by the manufacturer is valid.

DISCUSSION—This could also include environmental conditions, for example, temperature and humidity.

**object,** *n*—anything in the environment that may or may not be an obstacle.

**object detection,** *n*—use of sensors to identify the presence of an object.

**obstacle,** *n*—static or moving object or feature (on ground, wall, or ceiling) that obstructs the intended movement.

**ISO 8373**

DISCUSSION—Ground obstacles include steps, holes, uneven terrain, and so forth.

**obstacle avoidance,** *n*—autonomously avoiding impact with obstacles (for example, stopping, driving around).

**omni-directional A-UGV,** *n*—an A-UGV that is capable of rotational and linear movement in any direction.

**operator control unit (OCU),** *n*—device linked (wireless or wired) to the control system with which a vehicle can be programmed or moved.

**operating mode** or **operational mode,** *n*—state of the A-UGV control system.

**operator,** *n*—person designated to start, monitor, and stop the intended operation of an A-UGV or A-UGVS.

**path deviation,** *n*—measurement derived from the vehicle control logic and guidance reference information that enables the vehicle to know whether it is wandering off the current intended path such that, when specified deviation tolerances are exceeded, appropriate action can be taken; *see* **intended path**.

**path velocity fluctuation,** *n*—difference between the minimum and maximum velocities along the complete path that result from traversing a given command path with a given command velocity and not from external interferences.

**ISO 8373**

**path velocity repeatability,** *n*—closeness of agreement of the velocities attained for a given command path velocity.

**ISO 8373**

**pendant,** *n*—*see* **operator control unit (OCU).**

**pose,** *n*—position and orientation.

**processor monitor,** *n*—hardware device that ensures that the software program in the computer is being executed.

**ANSI/ITSDF B56.5**

**proprioceptive sensor** or **internal state sensor,** *n*—mobile platform sensor intended to measure the vehicle's internal state(s).

DISCUSSION—Examples are encoder, potentiometer, tachometer generator, inertial sensor such as accelerometer, and gyroscope.

**qualified person,** *n*—person who, by possession of a recognized degree or certificate of professional standing or extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work. **ANSI/ITSDF B56.5**

**radio controlled,** *adj*—means by which a material-handling device or piece of equipment is controlled by receiving

commands via radio frequencies sent to an onboard receiver and allows the equipment or device to be controlled remotely.

**rated capacity,** *n*—load, its position, and the vehicle speed, as established by the manufacturer, at which design and performance can be expected. **ANSI/ITSDF B56.5**

**rated speed,** *n*—speed, as established by the manufacturer, at which design performance can be expected.

**ANSI/ITSDF B56.5**

**repetition,** *n*—performance of a task.

**reprogrammable,** *adj*—designed so that the programmed motions or auxiliary functions can be changed without physical alteration. **ISO 8373**

**robot cooperation,** *n*—information and action exchanges between multiple robots to ensure that their motions work effectively together to accomplish the task. **ISO 8373**

**second surface reflection,** *n*—problem for polarized retro-reflective sensors that is created by shiny objects wrapped in shiny material.

DISCUSSION—The wrapping material can depolarize the light as it passes through.

**sensor,** *n*—electronic device designed to detect a specific phenomenon, such as the presence or absence of a physical object, and used to affect control over a designated process.

**sensor fusion,** *n*—process to obtain improved information by merging information from multiple sensors. **ISO 8373**

**simultaneous localization and mapping, SLAM,** *n*—computational technique for constructing or updating a map of an environment while simultaneously keeping track of an A-UGV's location or pose within it.

**skid steer,** *n*—kinematic configuration for vehicles in which steering is achieved solely via independently varying speeds of more than two drive wheels or two tracks and the wheels/tracks are not able to pivot; *see* **differential steer**.

**sleep,** *n*—condition, in automatic operation, in which all vehicle power is shut off except for the ability to receive a signal that removes it from this condition and turns vehicle power back on.

**synchronous detection,** *n*—use of an exact sequence of light pulses to activate the output on a photoelectric cell.

**task,** *n*—sequence of movements and measurements that comprise one repetition within a test.

**task planning,** *v*—process of solving the task to be carried out by generating a task procedure, which includes subtasks and motions. **ISO 8373**

DISCUSSION—Task planning can include autonomous and user-generated task planning.

**test,** *n*—a collection of task repetitions.

**test load**—force or torque or both on the mobile platform that can be applied to the vehicle.

**test requestor**—person or organization selecting the test(s) and defining the conditions under which they are performed.

**test settings,** *n*—all variables for a particular test method including those of the apparatus, method, and procedure.

**test supervisor,** *n*—person responsible for setting up the apparatus, instrumentation, directing, and reporting results of the test according to the test requestor or test sponsor.

**test technician,** *n*—person(s) responsible for executing the test procedures under supervision of the test supervisor.

**tracked A-UGV,** *n*—a crawler type A-UGV that travels on its own continuous tracks rather than wheels; *see* **A-UGV, differential steer**.

**trajectory control,** *n*—continuous path control with a programmed velocity profile. **ISO 8373**

**travel surface,** *n*—terrain on which the A-UGV travels.

**ISO 8373**

**tugger, A-UGV,** *n*—A-UGV that is capable of pulling one or more non-driven carts (with or without loads) behind it in a train; *see* **unit load A-UGV**.

**unit load A-UGV,** *n*—A-UGV that carries a load on or within the vehicle.

**validation,** *n*—assurance that an A-UGV or A-UGVS meets the criteria set by the test requestor.
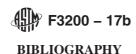
**vehicle path,** *n*—actual path of the vehicle.

**vehicle trajectory,** *n*—path in time.

**verification,** *n*—evaluation of whether or not an A-UGV or A-UGVS meets the criteria set by the test requestor using the standard test method(s) or practice(s).

**world coordinate system,** *n*—stationary coordinate system referenced to earth that is independent of the vehicle.

## 4. Keywords

4.1 A-UGV; automatic guided vehicle (AGV); driverless automatic guided industrial vehicles; industrial; mobile robot; mobility

## BIBLIOGRAPHY

**(1)** Material Handling Industry of America, *Automatic Guided Vehicle Systems*, http://www.mhi.org/glossary, 2014.