Meeting 1 Summary

This was the first face-to-face ASTM Committee F45 meeting with excellent attendance (35) and participation, mainly from equipment manufacturers. All committee and sub-committee officers were present and provided initial comments prior to discussion towards development of documented standard performance measurements and test methods for AGV's and mobile robots. Discussion determined no clear need to change F45 scope as this committee strives to be inclusive of automatic vehicle solutions for industrial and commercial use. However, the term 'ground' was added to mobile ground robot to exclude aerial and marine industrial vehicles. Similarly, brief (1 hr or less) discussions for each subcommittee focus area led to the following points:

F45.01 (Environmental Effects Subcommittee): Environmental 'Effects' may change the title to Environmental 'Measurements' to emphasize methods of characterizing the surrounding conditions and how they affect vehicle performance. The highest priority to consider is sunlight/high intensity light affecting vehicle functionality. Also, both indoor and outdoor vehicle environments, sensor interference, and other environmental aspects will be considered.

F45.02 (Docking and Navigation Subcommittee): A navigation working document WK48955 is being developed through a task group and a demonstration of what the task group is considering was shown. A relabeling of 'navigation' to a narrower 'navigation: defined spaces' will retitle WK48955, as well as consideration for not only vertical path barriers, but tape-line path-barriers on one side or no vertical walls and only tape or other ground-plane markers defining the path. Working document WK50379 for docking has also begun. Docking was discussed during the wrap-up session after the docking test method demonstrations where 3 DoF and 6 DoF docking and loaded and unloaded vehicle test methods referenced to a facility coordinate frame were suggested.

F45.03 (Object Detection and Protection Subcommittee): Object detection of typical industrial objects will be addressed in generic form to be determined. Static and dynamic obstacles, including overhead clearance (e.g., airplane fuselage, garage door) and exposure time of the obstacle (e.g., obstacle crossing the path or headed towards the vehicle on the path) will also be addressed.

F45.04 (Communication and Integration Subcommittee): Communication and integration will consider vehicle-to-facility and vehicle-to-off-board (e.g., management, controls, power) systems and not onboard vehicle component communication and integration. Secure communication with vehicles andintegration of vehicles into facilities while sharing facility networks will be considered.

F45.91 (Terminology Subcommittee): A very brief discussion of terminology evolved to discuss AGV vs. mobile robot, etc. A terminology working document WK48954 is near ballot as a task group has been using e-meetings to develop terms and definitions useful to this committee and based on other standards and industry group terms.

Demonstrations of F45.02 and F45.03 test methods were provided by NIST, University of Massachusetts-Lowell and Adept for the attendees to have a firsthand view of performance test methods that may be considered for these subcommittee documents.

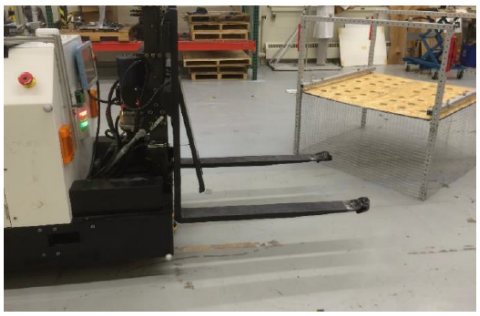
E-meetings will now commence for all subcommittees with the F45 Chairman initiating the first of these meetings and sub-committee chairmen planning follow-on meetings.

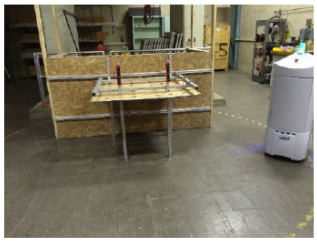
The next face-to-face meeting is planned to be in conjunction with Modex in April 2016 in Atlanta, GA.

Day 1 Demonstrations

- Obstacle Detection and Avoidance Test Method with a mobile robot – *video available at* http://nist.gov/el/isd/astm-f45.cfm

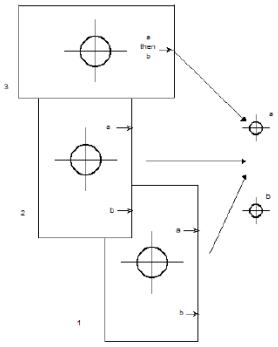
Earlier AGV ODA Test



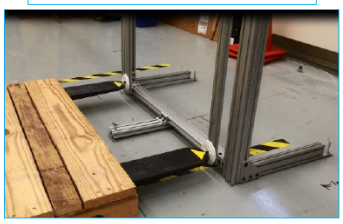


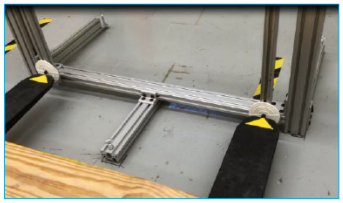
Day 2 Demonstrations

- Docking Test Method with an AGV – *video available at* http://nist.gov/el/isd/astm-f45.cfm
  - Vehicle Docking – 3 DOF
    - Shown for forks or tow-point docking and for unit-load docking

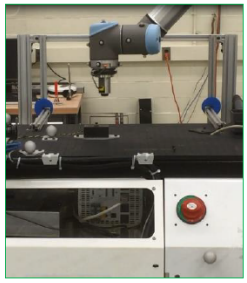


Forks or Tow-Point Docking



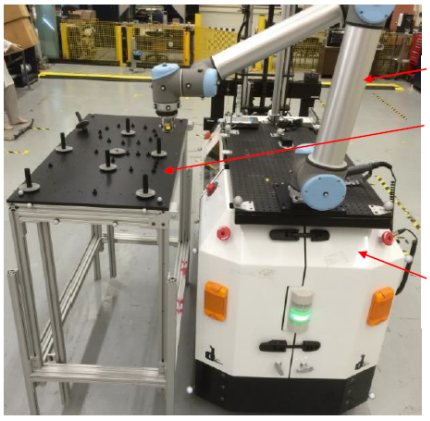


Unit-Load Docking



Day 2 Demonstrations

- Docking Test Method with an AGV – *video available at* http://nist.gov/el/isd/astm-f45.cfm
  - Vehicle with Onboard Equipment Docking – 6 DOF



1. AGV moves an onboard manipulator to an apparatus;
2. Manipulator carrying a laser retro-reflector detects circular reflectors on the apparatus;
3. Tubes are used to ensure the laser/manipulator is aligned with the reflector;
4. Alignment to reflectors with respect to x, y, z, roll, pitch, yaw;
5. The reflector size determines the AGV equipment docking uncertainty – i.e., if a certain diameter reflector is detected.

- Other:
  - NIST Collaborative and Dexterous Robotics:
    - Human/Robot, Robot/Gripper, and Robot/Robot Interaction
    - Advanced Grasping
    - More info at Robotic Systems for Smart Manufacturing Program:
    - http://www.nist.gov/el/isd/ms/rssm.cfm
  - NIST Response Robot Standard Performance Test Methods (ASTM E54.08.01)
    - http://www.nist.gov/el/isd/ms/robottestmethods.cfm