



AFRL-RX-TY-TP-2009-4595

ROBOTIC RANGE CLEARANCE COMPETITION (R2C2) COMPETITION EVENTS AND RULES

Brian Beyer

**Applied Research Associates
P.O. Box 40128
Tyndall Air Force Base, FL 32403**

DECEMBER 2009

**DISTRIBUTION STATEMENT A: Approved for public release;
distribution unlimited.**

**AIRBASE TECHNOLOGIES DIVISION
MATERIALS AND MANUFACTURING DIRECTORATE
AIR FORCE RESEARCH LABORATORY
AIR FORCE MATERIEL COMMAND
139 BARNES DRIVE, SUITE 2
TYNDALL AIR FORCE BASE, FL 32403-5323**

REPORT DOCUMENTATION PAGE				<i>Form Approved</i> <i>OMB No. 0704-0188</i>	
The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE (DD-MM-YYYY) 10-DEC-2009		2. REPORT TYPE Presentation		3. DATES COVERED (From - To) 09-DEC-2009 -- 11-DEC-2009	
4. TITLE AND SUBTITLE Robotic Range Clearance Competition (R2C2) Competition Events and Rules				5a. CONTRACT NUMBER FA4819-07-D-0001	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER 99999F	
6. AUTHOR(S) Beyer, Brian				5d. PROJECT NUMBER GOVT	
				5e. TASK NUMBER F0	
				5f. WORK UNIT NUMBER Q240FD6G	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Applied Research Associates P.O. Box 40128 Tyndall Air Force Base, FL 32403				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Research Laboratory Materials and Manufacturing Directorate Airbase Technologies Division 139 Barnes Drive, Suite 2 Tyndall Air Force Base, FL 32403-5323				10. SPONSOR/MONITOR'S ACRONYM(S) AFRL/RXQF	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) AFRL-RX-TY-TP-2009-4595	
12. DISTRIBUTION/AVAILABILITY STATEMENT Distribution Statement A: Approved for public release; distribution unlimited.					
13. SUPPLEMENTARY NOTES Ref AFRL/RXQ Public Affairs Case # 10-004. Document contains color images.					
14. ABSTRACT This presentation provides an overview of the events to take place in the R2C2 Competition, how to participate, rules, safety concerns, and competition metrics. The competition will take place at the Joint Training and Experimentation Center, Camp Guernsey, Wyoming in two years. This briefing will be presented on 9 February 2010 at Tyndall Air Force Base, Florida.					
15. SUBJECT TERMS R2C2, Robotic Range Clearance Competition, ARTS, rules, qualification, vegetation removal					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 45	19a. NAME OF RESPONSIBLE PERSON Walter M. Waltz
a. REPORT U	b. ABSTRACT U	c. THIS PAGE U			19b. TELEPHONE NUMBER (Include area code)

Reset

Robotic Range Clearance Competition (R2C2) Events & Rules

Mr. Brian Beyer
Joint Training and Experimentation Center, Camp Guernsey
bbeyer@ara.com
10 December 2009

DISTRIBUTION A: Approved for public release; distribution unlimited.

Topics

- Current Schedule of Events
- How to participate in the competition
- Letter of Intent (LOI)
- Competitor SharePoint Site
- Competition Events
- BREAK
- R2C2 Rules Document and FAQ
- Safety
- Vegetation Removal
- Surface Debris Clearance
- Sub-Surface Removal
- Geophysical Mapping

FY10 R2C2 Schedule

- Kick Off Event – complete
- Industry Day – today
- Letters of Intent – due January 4
- Category Registration – due January 15
- Pre-Trial Competitor Testing – May to July
- Qualification Packet Due – 15 June
- Qualification Ranges Issued – 1 July
- Qualification Trial – 1 August to 15 Sep

Process for late registrations driven by EA and resources.

Adjudication process to decide late entries, final decision authority (DA) will be Joint Ground Robotics Enterprise (JGRE).

FY11 R2C2 Schedule

- Prize Competition Packets Issued – 90 days prior
- Prize Competition Packets Due – 45 days prior
- Prize Competition – Summer '11

Steps to Compete

1. Form a team

- a. Sign Letter of Intent
- b. Receive access to team SharePoint

2. Choose competition categories

3. Qualify

- a. Submit Qualification Packet
- b. Participate in Qualification Trials to include safety demonstration

4. Compete

- a. Submit Prize Competition Packet
- b. Participate in Prize Competition

With regard to qual, what are qual metrics for safety
Safety demonstration
Late entry again...

Form a Team

- Team Leader
 - Must be an individual
 - Must sign LOI
- Team Members
 - Individuals may only be on one team
- Sponsors/Vendors
 - No restrictions
 - Prior approved government furnished equipment (GFE)
- Name the team

Non-disclosure agreement (NDA) conflicts handled by teams.

Management reserves right to disapprove names, first come first served for team names

Letter of Intent

- Letters of intent are at roboticrangeclearance.com
- The team lead for each competitor team must complete and turn in an LOI no later than 4 January
- The letter of intent establishes who the competitor teams are it is not a binding agreement that compels participation
- Teams can withdraw from the competition at any time, in writing

Allows us to scope resources

Competitor SharePoint

- Once your team's LOI is received your SharePoint account will be created
- The SharePoint is the primary communication clearinghouse for the competition
- Up to two individuals may be given access per team
- The Competitor SharePoint has two parts:
 - An all competitor level that includes competition documents, the competition calendar, and discussion board
 - A team folder that can only be accessed by your team and the competition oversight

Category Registration

- Due Jan 15 via SharePoint
- Category Registration is where teams choose all or some of the 4 competition categories to participate in.
- They are Vegetation Removal, Surface Debris Clearance, Geophysical Mapping, Sub-surface removal
- This will allow us adequate time to resource, approve, and build the surrogate ranges for the qualification trial

Pre-Trial Competitor Testing

- Any team that does not have access to adequate developmental test facilities may utilize Camp Guernsey with prior approval
- Packets will be posted on the SharePoint with all required information due 45 days before your requested test period
- This will be available from 1 May to 1 July
 - This is the busy season at Camp Guernsey so a little patience will be required
 - No billeting is available in this period
 - A list of available Camp Guernsey resources will be posted on the SharePoint

Discuss freq constraints

Qualification Packet

- The packet will include, but is not limited to:
 - Technical approach
 - Radio frequencies requested
 - Composite risk management
 - Release of Liability

Radio Frequencies

- Camp Guernsey is a highly active DOD facility.
- R2C2 is not a regulatory agency and makes no such claims
- Competitor systems RF signature will be captured during operations by spectrum analyzer
- Competitors will comply with all DOD and FCC regulations
- Frequencies in amateur that are generally open at Camp:
 - 219 -220, 222-225 MHz
 - 420-450 MHz
 - 902-928 MHz
 - 1.24-1.3 GHz
 - 2.3-2.31 GHz
 - 2.39-2.45 GHz
 - 3.3 – 3.5 GHz

Frequencies prohibited due to military use:

- 2 to 50 MHz
- 138 to 144 MHz
- 148 to 149 MHz
- 163 to 168 MHz
- 227 to 293 MHz
- 328 to 419 MHz

Qualification Trials

- Participation is required
- Safety is the only disqualification possible
- A safety demonstration will be conducted as part of the trial
- Competitor systems will not be officially scored. Data will be collected such that competitors will gain an understanding of their systems' performance, especially areas that may need improvement.
- Results will be posted anonymously.

The overall performance at the qualification may affect how the prize competition is scored

Qualification Ranges

- There will be a single geophysical mapping range that all competitor teams will use for that task
- Each team will be issued a surrogate range for the qualification trial.
- Qualification trials will not exceed 5 acres however prize competition ranges may be as large as 50 acres, depending on the number of competitors

No competitors will share ranges.

Location of Ranges

- Surrogate ranges will be fabricated in Camp Guernsey's North Training Area
- The sites have no history of munitions use. They will be seeded with inert munitions, inert munitions debris, ISOs, and range related debris. SMEC items include inert 20mm TP up to inert 155mm projectiles. Munitions debris at the site consisted primarily of fragmentation, 81mm illumination mortars, and miscellaneous target debris
- Surrogate ranges will have vehicle targets placed on them as navigation hazards common to Army ranges.

Break

Rules

- The rules are intended to promote the widest variety of technical solutions
- The competition is being put together to represent active range clearance prior to new range construction on an Army facility.
- Safety is the number one priority

Rules change process not finalized, etc

Rules Changes

- Robotic technology advancement is a key objective of the R2C2. Competitors are invited to communicate directly with R2C2 regarding any rule that restricts their ability to demonstrate technical achievement and innovative solutions.
- The R2C2 has the authority to modify the rules at any time. Rules may be modified for many reasons, including accommodation of a promising technical approach that would have been prohibited by the rules.
- R2C2 will communicate any modifications to the rules through the competitor SharePoint.
- The R2C2 may revise the schedule at any time and interpret the rules in any manner to best meet R2C2's objectives. The R2C2's decisions are based on a number of factors such as fairness, safety, statutes, program goals, environmental protection, and efficient operations.

Rules Doc & FAQ

- There are two primary rules documents:
 - R2C2 Competition Rules
 - R2C2 Competition Rules FAQ
- Questions regarding rules will be published in the FAQ as they are answered
- These will be evolving documents.
- The latest versions will always be posted on the Competitor SharePoint

Personnel Safety

- No personnel shall be within 300 ft of a moving UGV nor shall any personnel be closer to a moving UGV than the operator
- Teams shall designate a safety officer for the duration of the competition. Safety shall be his/her sole responsibility while the UGV is operating
- Operators shall be limited to 8 hr shifts

E-Stop Rules

- The system shall have an Emergency Stop with a range of not less than 3000ft. The system must halt within 50 ft and cease all equipment operations when e-stop initiated.

Warning Devices

- Each vehicle shall be equipped with a warning light that is activated according to the state of the E-stop system.
- Each vehicle shall display one or more flashing amber warning lights, the combination of which results in 360-degree visibility azimuthally around the vehicle. The warning light(s) shall operate when the vehicle is in E-stop RUN mode. The vehicle may not commence movement until the warning light has been in operation for 5 seconds. The warning light(s) shall comply with SAE Class 1 standards for warning lights and shall not produce light(s) that can be confused with those of public safety vehicles such as law enforcement, fire, or ambulance.

Loss of Comms Stop

- The system shall automatically halt and cease operations if communications with the system are lost or interrupted for a maximum of 2 seconds and may travel no further than 100 ft.

No Freewheel

- The systems shall not be capable of motion when stopped or un-powered.
- For example systems that would roll downhill if shut off are considered freewheeling and are un-safe for competition

Speed Limit

- The Camp Guernsey North Training Area speed limit is 30 MPH.

Required Safety Equipment

- The competitor team shall provide all safety equipment required to operate their system such as: first aid and eyewash kits, fire extinguishers, safety glasses, Wet-Bulb Globe Temperature (WBGT) instrument, personal monitoring devices, etc., to ensure compliance with EM 385-1-1 and 385-1-95a as appropriate.

Applicable Safety Documents

- DA-PAM 385-10 Army Safety
- EM 385-1-1

Radiated Energy Safety Standards

- Teams are directed to OSHA 29 CFR 1926.54 and OSHA Technical Manual (TED 1-0.15A), Section III - Chapter 6 (1999, January 20) for relevant laser safety standards.
- Teams are directed to OSHA 29 CFR 1910.97 (Non-ionizing Radiation) and Department of Defense Instruction 6055.11 (1995, February 21) for relevant RF safety standards.
- Teams are directed to OSHA 29 CFR 1910.95 (Occupational Noise Control) and OSHA Technical Manual (TED 1-0.15A), Section III - Chapter 5 (1999, January 20) for relevant acoustic safety standards.

Personnel Proximity

- No personnel may enter the range without R2C2 authorization
- No team personnel may enter the range at any time except for deliberate recovery operations of a disabled system
- While the robots are moving on the range no team personnel may be within 3000' of the range perimeter

Based on real operations 155rnd

Leaving the range

- Systems may only leave the perimeter of the range to go to a collection point or the pit
- No system shall be more than 9 feet outside the perimeter of the range or a penalty will be assessed (based on Army Form-144 REC)

Recovery

- If at any time personnel and/or manned equipment must go onto the range in order to recover a system or systems, a penalty will be assessed
- This is intended to represent the down time caused by recovering a vehicle

Glossary

- Industry Standard Object (ISO): pipe sections commonly used in evaluating geophysical sensors
- Stimulant Munitions and Explosives of Concern (SMEC)
- Target practice (TP)
- Engineering Manual (EM)
- Stimulant Material Potentially Presenting an Explosive Hazard (SMPPEH)

Industry Standard Objects



Item	Nominal Pipe Size	Outside Diameter	Length	Part Number ¹	ASTM Specification
Small ISO	1"	1.315" (33 mm)	4" (102 mm)	44615K466	A53/A773
Medium ISO	2"	2.375" (60 mm)	8" (204 mm)	44615K529	A53/A773
Large ISO	4"	4.500" (115 mm)	12" (306 mm)	44615K137	A53/A773

¹ Part number from the McMaster-Carr catalog.

Human Interaction

- Human Interaction, for the purpose of the R2C2, is defined as:
 - Any time an operator or team member uses any human-machine interface device such as joystick, keyboard, or voice recognition software

Competition Metrics

- System task performance
- Level of human interaction
- Time represented as man-hours

Vegetation Removal

- Remove all vegetation to include trees up to 14 inches in diameter (measured at 48" height) standing above the **pre-existing** grade higher than 3 inches for stumps and 6 inches for residue.
- Residue must either be removed from the site or reduced to stand no higher than 6 inches above the pre-existing grade.
- No damage to existing roads or infrastructure.
- Leave the site with no ruts or gouges in the ground surface deeper than 6 inches or bumps greater than 4 inches high.
- Residue removed from the site must be placed in a designated area within 300 yards of the site

Surface Debris Removal

- Remove SMEC and SMPPEH (to include munitions debris and range related debris) 20mm in width, from the surface of the contest site in the areas designated, and no munitions debris or range related debris equivalent to, or greater than 20mm in diameter or width
- All SMEC and SMPPEH (to include munitions debris and range related debris) shall be removed from the clearance site and placed in a designated area
- The removed material shall contain no more than 50% by volume of non-metallic material.
- The competitors shall not utilize magnets or similar devices that will leave a remnant magnetic signature on the soil.
- The site grade shall not be changed more than 6 inches plus or minus from the initial ground elevation
- Leave the site with no ruts or gouges in the ground surface deeper than 6 inches or bumps greater than 4 inches high

Subsurface Debris Removal

- Remove SMEC and SMPPEH (to include munitions debris and range related debris) from the contest site in the areas and to the depths designated
- All SMEC and SMPPEH (to include munitions debris and range related debris) shall be removed from the clearance site and placed in a designated area.
- The removed material shall contain no more than 50% by volume of non-metallic material.
- The Contestant shall not utilize magnets or similar devices that will leave a remnant magnetic signature on the soil.
- The site grade shall not be changed more than 6 inches plus or minus from the initial ground elevation
- Leave the site with no ruts or gouges in the ground surface deeper than 6 inches or bumps greater than 4 inches high
- If the competitor team has no geophysical mapping capability, a manually geophysical map will be provided

Geophysical Mapping

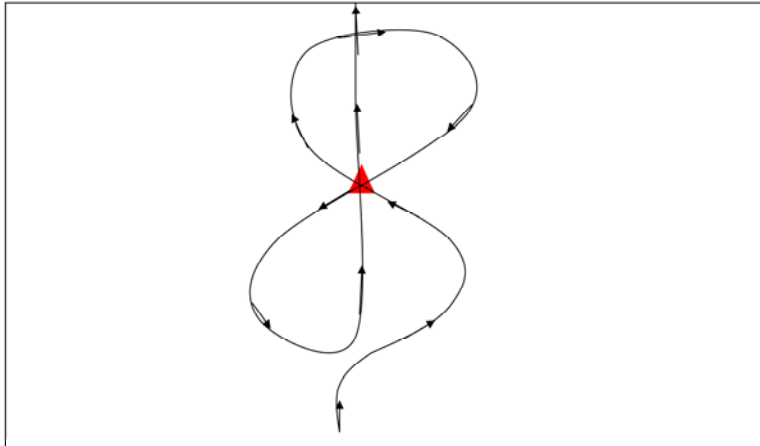
- An area having anomalies seeded throughout will be the challenge.
- Anomalies will be placed such that their response will be at least five times RMS background noise based on EM61 MK2 capabilities.
 - The millivolt values for noise and minimum signal will be published after R2C2 has mapped the area.
 - A portion of the area will be “background” and used to calculate noise in geophysical data.
- The entire area is to be mapped at a line spacing equal to one-half the individual sensor width (i.e. an array of multiple sensors that are one meter wide must still provide 100% coverage at 0.5m spacing).
 - If magnetometers are used, the line spacing shall be no more than 25cm.
- The sensor platform is to be operated in as smoothly a manner as possible
- The sensor platform is to be operated with as constant a speed as possible.
 - The R2C2 will specify one or more design speeds, which will be between 1 and 5 miles per hour.

AEC's earlier comments recommend removing line spacing requirements

Geophysical Mapping

- Site topography is left in same condition as it was before operations began with no new ruts or bumps larger than four inches
- All operations performed within delineated area
- Between 25 and 50 waypoint locations will require geophysical mapping using a specified coverage pattern over each waypoint and at a specified speed or start-stop pattern.
 - The pattern will have specific design requirements (e.g. an “X” or “+” pattern with each leg extending between 1.5 and 2m from the center, with speed of 0.2 meters per second or a start-stop pattern every 0.5m having a pause interval of 1 to 5 seconds at each stop location.)
 - The transit speed between waypoints will not be a factor for this portion of the mapping challenge.

Geophysical Mapping



Mapping Data

- All raw geophysical data is to be delivered to the R2C2 in the raw data format defined in Section 4 of Data Item Description MMRP-09-04.
 - This DID can be found at the following web site address:
http://www.hnd.usace.army.mil/oew/policy/dids/FY09_MMRP_DIDS/MMRP-09-004.pdf
- It is recommended the raw data can be delivered in a format where the navigation data has been merged with the geophysical sensor data by the competitor, though this is not a requirement.

Kalman filter documentation? Is this reasonable or should a range of error be provided?
What frequency?

Mapping Data

- If not merged by the competitor:
 - The raw data must be delivered in such a manner that the R2C2 can easily merge the navigation data with the geophysical sensor data using the suite of data processing tools available in Geosoft's Oasis Montaj UXProcess software package.
 - This means all information needed to correct the positioning data for offsets between the sensor(s) and positioning antenna(e), as well as any other information, such as platform tilt information and positioning antenna(e) heights, will be required in the metadata.
- The geophysical data shall NOT be filtered in any manner.
 - The positioning data may be filtered to produce what the competitor believes to be the best representation of where geophysical data measurements were actually recorded.
 - All such filtering must be documented in the metadata file(s) accompanying the geophysical data delivery.

Questions?