

# Air Force Civil Engineer Center

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## Airfield Damage Repair (ADR) Robotic Applications



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AFCEC/CXAE  
22 MAR 2017

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*Battle Ready ... Built Right!*



# Outline

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- **AFCEC/CXAE**
- **Robotics for Civil Engineering**
- **Airfield Damage Repair**
- **Assessment**
- **Mitigation**
- **Repair**

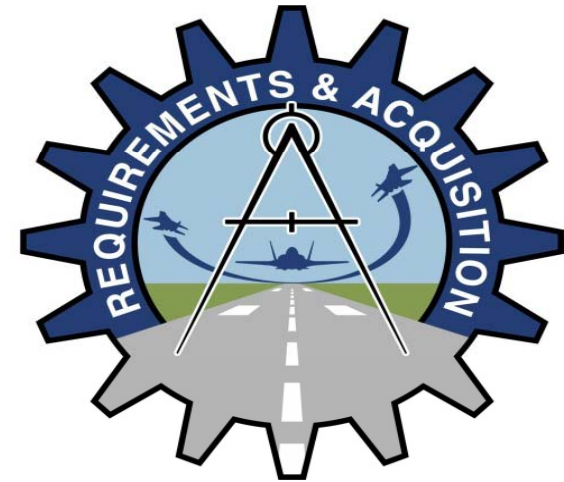


# Airbase Acquisition Branch - Mission



## ➤ RDT&E and Acquisition

- Develop, evaluate, and field technology to support the full range of USAF installation base & protect missions
- Develop (RDT&E) and field new technology (including prototypes)
- Provide CE unique test & evaluation facilities/ranges
- Evaluate commercially (COTS) available technology/equipment
- Modify existing equipment
- Procure and sustain material solutions
- Provide expert technical advice and reach back support
- And do the 'HELP ME NOW' items

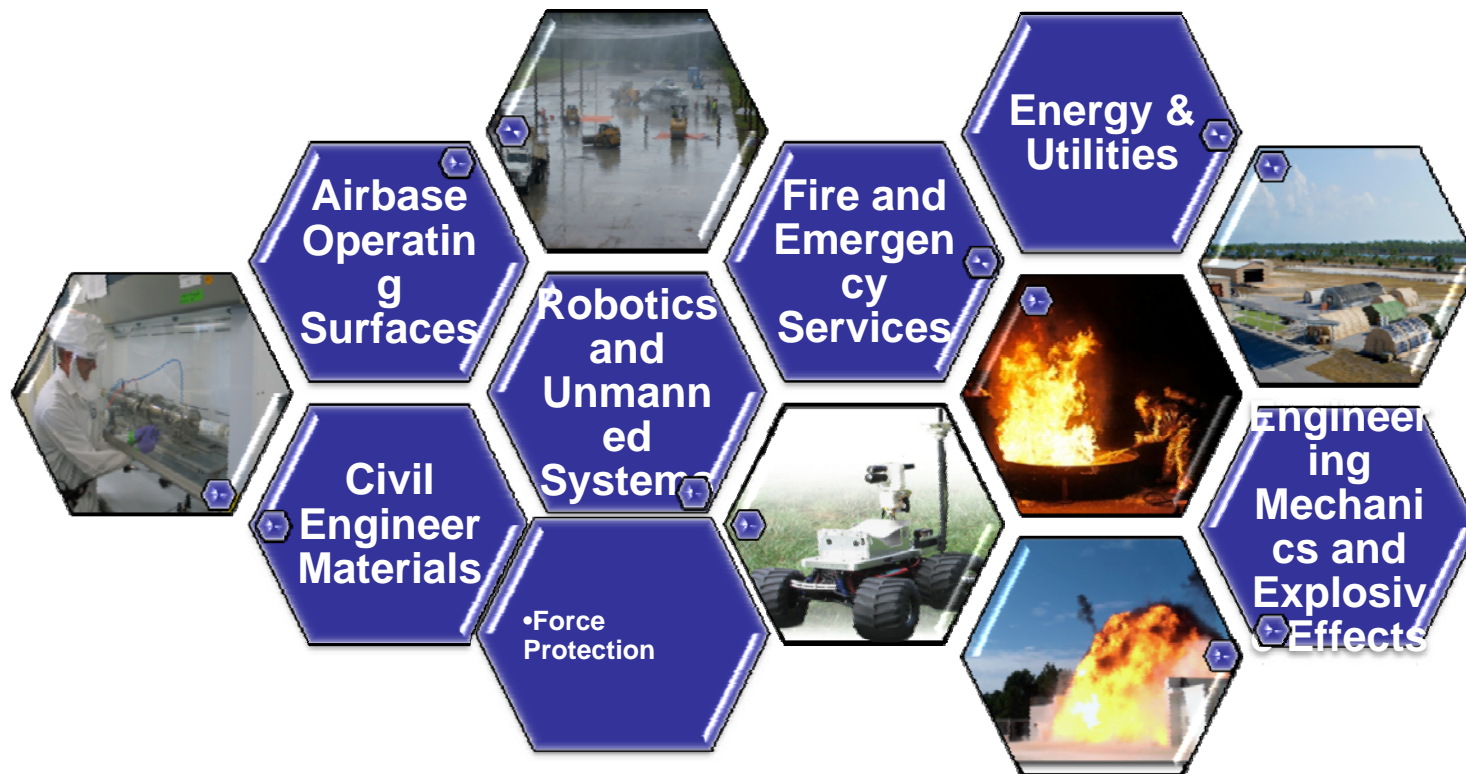


***“Air bases are a determining factor in the success of air operations.***

***The two-legged stool of men and planes would topple over without this equally important third leg.” General of the Air Force Henry H. “Hap” Arnold***



# AFCEC/CXAE Capability Areas





# Unmanned Civil Engineering Operations



- **Automated ground systems to perform AF Civil Engineer Operations**
  - Aviation firefighting, hazardous incident response, aircraft decontamination, EOD, airfield repair
- **Integrate and control appliques or retrofit systems to existing AF platforms**
- **Demonstrate unmanned systems that minimize exposure to risks associated with hazardous operations**



# Airfield Damage Repair (ADR)



- Extremely time-constrained
- Recovery actions support sustained operations for all aircraft types
- 24/7, all weather capability

- Provide capabilities to open, expand, maintain, and recover airfields





# The ADR Processes



## • Damage Assessment

- Locate, classify, and measure damage
- Utilize remote sensing and GIS technologies
- Goal is a fully automated system

## • UXO Mitigation

- Bombs, missiles, sub-munitions, artillery....
- Locate & neutralize
- Minimize time and runway damage
- Eliminate Explosive hazard



## • Damage Repair

- Pavement Damage
- Expeditionary Airfield Lighting System (EALS)
- Mobile Aircraft Arresting System (MAAS)
- Marking and Striping

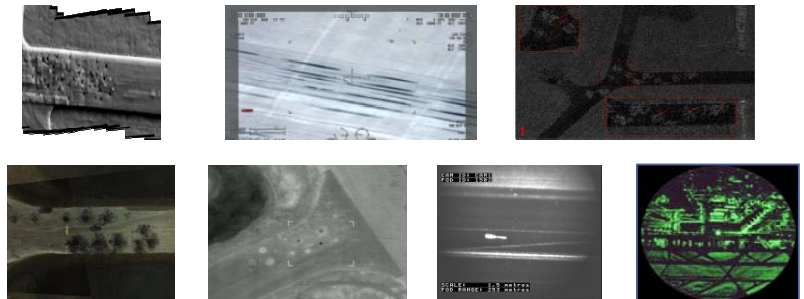


# Rapid Airfield Damage Assessment System - RADAS



## • Platforms – (Has impact on sensors)

- **Ground based**
  - Towers, UGVs, Aerostats, building mounted, vehicle mounted, ground emplaced, hand held .....
- **Air based**
  - RPAs, Manned aircraft, rotary wing, fixed wing, lighter than air



## • Sensors – (Drives Processing)

- Still photos & streaming video
- Electro-optical
- Infrared (cooled/non cooled)
  - LW, MWIR, NIR, SWIR,
- LIDAR
- RADAR - MMW, Ku, X-Band, SAR
- Acoustic & Seismic
- Multi/Hyper spectral
- Must be machine readable - automated processing





# Craters & Camouflets



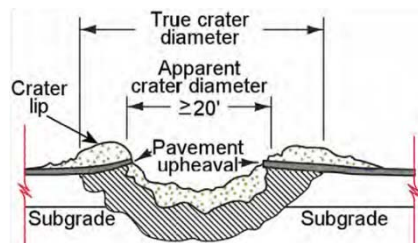
•20' Diameter  
•(16" Concrete)

- Damage will vary with munition size and type
- Most likely very few undamaged areas
- Very difficult environment to navigate if too cautious – LIDAR based OD/OA should be OK
- Damage assessment data transferred from RADAS

## •Craters



•20' Diameter  
•(8" Concrete)



•9' Diameter  
•(3" Asphalt)



## •Camouflets





# Unexploded Ordnance (UXO)

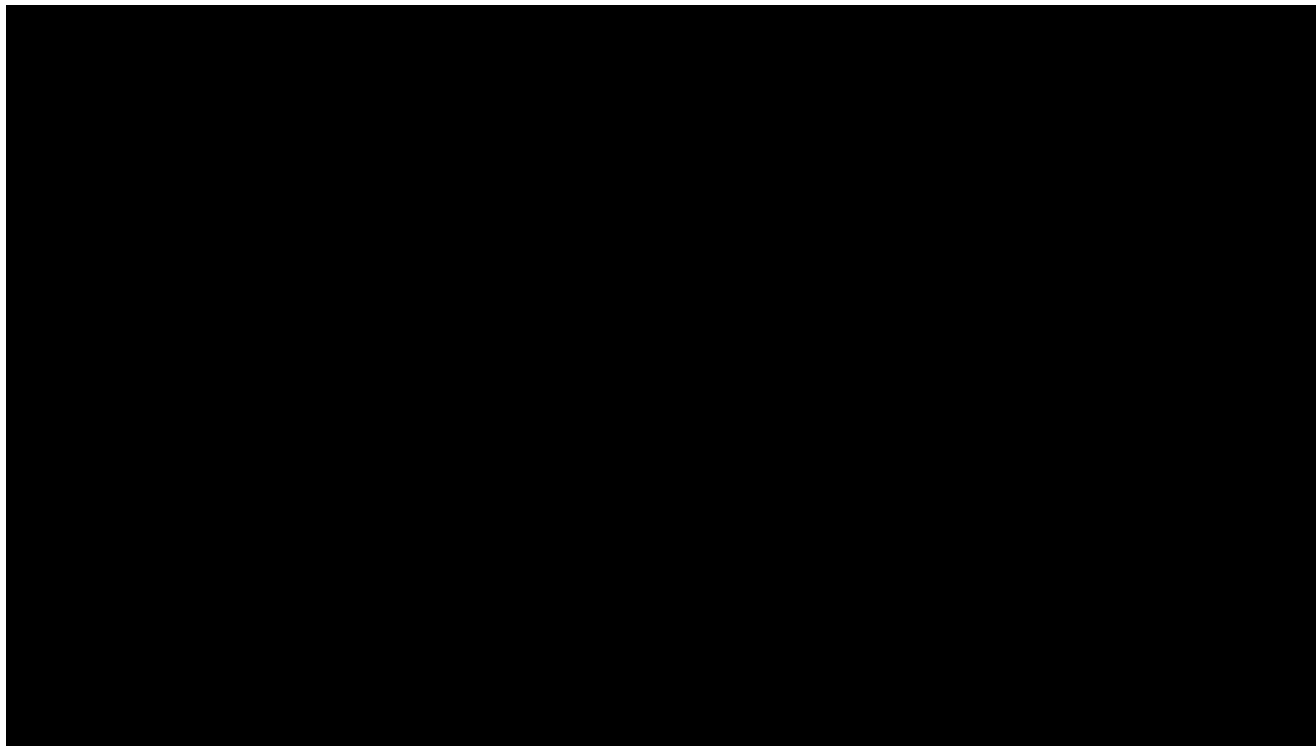


- Classify A-F (bomb, missile, sub munition)
- Colorings
- Fuze type and condition





# RADAS Demo





# Multiple UXO Removal System- MURS



- **MURS Requirement:**
  - Rapidly and safely identify, assess, render safe, and dispose of ~1000 UXOs (per event)
  - Sufficient space to start repair operations ~1hr
- **Proposed Solution to MURS requirement:**
  - **Family of systems (FoS);**
    - SUAS
    - Applique kit – UXO clearance blades
    - MRAP based neutralization system
- **Plans/Accomplishments:**
  - **FY15: Completed Operational Utility Evaluation (OUE) using RADBO\* prototype**
  - **Development ongoing for SUAS and clearance blade prototypes.**





# Background - Dec 2015 UXO Mitigation Workshop Summary



- **EOD Stakeholders (HAF, AFCEC, PACAF, USAFE, AFCENT, training & operational units)**
- **Received buy-in on pursuit of....**
  - **Direct energy platform(s) “active point defeat”**
  - **Mass mechanical clearance capability “big sweep”**
  - **Improved equipment, techniques, tactics, and procedures (TTPs) for explosive ordnance disposal (EOD) teams -- especially reconnaissance and subsurface hazard mitigation**



# Rapid Explosive Hazard Mitigation (RHEM)



- **Rapid Airfield Damage Repair (RADR)**
  - **RDA: Rapid Damage Assessment**
  - **REHM: Rapid Explosive Hazard Mitigation**
  - **RDR: Rapid Damage Repair**
- **REHM objectives**
  - **Rapidly mitigate a high density of UXO from material/equipment dispersal areas, access routes, and minimum airfield operating surface (MAOS)**
  - **Allow access to repair damaged areas ASAP**
  - **Mitigation continues as required (trade space)**



# Direct Energy



- **Recovery of Airbase Denied by Ordnance (RADBO)**
  - **Direct energy via laser**
  - **Operated by an EOD Team**
  - **Integrate with GeoExPT**
  - **Rapid target acquisition**
  - **Precision engagement**
  - **Armor protection w/stand-off**
  - **UXO manipulation with arm**





# Remote Mass Mechanical Clearance



- **Airfield Munitions Mitigation Ops (AMMO)**
- **Prime movers selected from RADR inventory**
  - **Caterpillar 279D Compact Tract Loader (CTL)**
  - **Genie 1256 GTH Telehandler**
  - **4 yard Wheel Loader**
- **Tele-op/semi-autonomous appliques**
- **Blade/electromagnet attachments with armor**



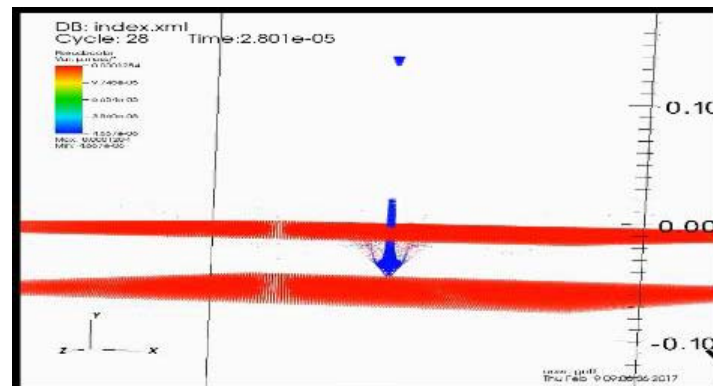
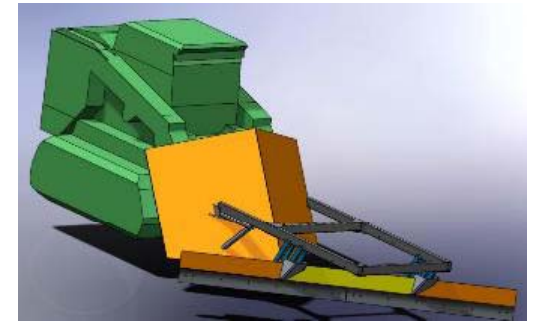




# Armor Materials Testing



- Explosive modeling software used in material selection and attachment/armor design
- Multiple phases of materials tested against types of threat ordnance





# Enhanced Equipment and TTPs



- **General reconnaissance (location/type of ordnance) gained from Assessment phase**
- **More specific EOD information likely needed**
  - **Small unmanned aerial systems (SUASs)**
  - **Small unmanned ground vehicles (SUGVs)**
- **Ordnance hole of entry interrogation tools**
  - **Is it a camouflet?**
  - **Is it a UXO?...exactly where/how big/how deep?**
- **Remote access to subsurface UXO**
- **Remote extraction/blow in place capability**



# Automated Airfield Construction and Repair



- Unmanned ground vehicles automatically performing airfield construction and repair
  - Operation at 50-75% manned tempo
- Integrate robotic appliques for airfield construction equipment
- Implement multi-robot and convoy ops
  - Leader/follower
  - Coordinated material handling
  - Operations sequencing
- Develop network of robots that can navigate and repair damaged runways

**•ADR Program Goal:** *Provide field-ready and timely base recovery supporting all the phases of the Force Module Construct and mitigating A2/AD threats!*



# In-Seat Applique System



- DoD has many of the same type of vehicle from different manufacturers
- Highly flexible, multi-vehicle system
  - steering wheel to joystick control
  - Must be able to “push some buttons”
- Does not have to “of human form” but should use human controls
- Provide basic vehicle control functions
  - teleoperation only now
  - future may include some automation – cruise control, task repetition, gps waypoint
- Ship hardened cases on pallet(s) instead of 100s of tons of robotic vehicles
  - Use vehicles of opportunity
  - Right system at the right time and place



•Photo courtesy of Juliana Reyes & Drexel University



## •Questions?

