A Revolutionary **Unmanned Aerial System:**
Night Unmanned Aerial Firefighting

**K-MAX**

[Image of a helicopter with a basket attached, flying over rugged terrain.]
Agenda

- K-MAX UAV Video
- Night Unmanned Firefighting
- Development & Capabilities
- Firefighting Trial Videos
- Future Commercial Service
Developing the K-max UAV
Unmanned Firefighting Need

Many challenges exist when fighting fires including manned helicopters ability to only fly in visual flight conditions. Unmanned systems can shift this paradigm by enabling 24/7 fire suppression support.

Using the K-MAX Helicopter Unmanned Aerial Systems (UAS) specifically tailored to this unique mission can provide significant benefit to firefighting efforts.

**Capabilities:**
- Autonomous Water Pickup
- Hotspot Identification
- Dynamic UAS Retasking
- Autonomous Water Delivery
- Delivery Effects Evaluation
- Cooperative UAS Operations
- Precision Resupply Operations
- Personnel Recovery & Equipment Delivery

**Night Operations:**
- Sensors Package – Allows Night Operation
- High Risk Missions
- Allows 24/7 Continuous Operations
- Increases Situational Awareness
- Autonomous Resupply
- Not degraded by smoke
Innovation to Realize the Vision

1. The Right Aircraft – Easy to Maintain in Austere Environments
   - Intermeshing main rotor = No tail rotor & 1:1 lift ratio
   - Servo-Flap = No swash-plate or hydraulic system

2. Robust Unmanned Control System
   - Redundant Mission / Flight Control Architecture
   - Dual, dissimilar data link systems (LOS/BLOS)
   - Rugged, portable ground control system

3. Practicality
   - Navigating the NAS in manned configuration
   - Spares readily available – commercial support

Operational Necessity Driving Aviation Innovation
K-MAX Air Vehicle Overview

- Engine: One 1,800 shp Honeywell T5317A -1
- Internal fuel: 228 U.S. Gallons (1550 lbs)
- Empty weight: 5,500 lb. (2500 Kg)
- Maximum gross weight: 12,000 lb. (5,443 Kg)
- Hook/Multi -Hook capacity: 6,000 lb. (2,722 kg)

Over 300,000 fleet flight hours accumulated since 1994 FAA certification.
# K-MAX Aircraft Capabilities

<table>
<thead>
<tr>
<th>Feature</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Range:</strong></td>
<td>267 nm</td>
</tr>
<tr>
<td><strong>Endurance:</strong></td>
<td></td>
</tr>
<tr>
<td>Internal Fuel:</td>
<td>2hr 41 min</td>
</tr>
<tr>
<td>Aux Tank:</td>
<td>12 + hr</td>
</tr>
<tr>
<td><strong>Multiple Delivery:</strong></td>
<td>1 to 4</td>
</tr>
<tr>
<td><strong>Payload:</strong></td>
<td>6,000 lbs</td>
</tr>
</tbody>
</table>

---

**K-MAX Maintains Performance in High/Hot Environment**
K-MAX: Purpose Built for the Mission

- K-MAX is the only helicopter designed, built, and tested for the repetitive lift industry
- K-MAX was designed and tested based on the logging mission
- Aircraft has proven itself with over 300K hrs on the K-MAX fleet
- Intermeshing rotors eliminate tail rotor and simplify maintenance
- K-MAX cost / maintenance / fuel burn < ½ manned rotary wing
  - 1.5 Maintenance Man Hours per Flight Hour (MMH/FH)
  - 85 gal / hr – Fuel Burn Rate
Cargo UAS Configuration

UAS Kit Modifications to the K-1200

- Redundant Flight Control Computers
- Redundant Embedded GPS Inertial w/ SAASM and Zeroize
- Iridium BLOS Satellite Telephone Modem
- Data Link Encryption
- Mission Management Computer
- Unmanned Post Maintenance Check Flight Capability
- Redundant Air Data Computers
- Mini TCDL LOS Data Link
- Data Link Encryption
- Redundant Flight Control Actuators
- AN/APN-194 Radar Altimeter
- IR Anti-Collision Strobe IR Payload Floodlight
- Cable Angle Sensors
- Early Demonstration Configuration
- Production Configuration

Distribution Statement A - Approved for public release; distribution is unlimited under NAVAIR Public Release Number SPR-2012-1089
Ground Control Station
Unmanned K-MAX Capabilities

Unmanned K-MAX Offers:

– Programmable waypoint navigation
– BLOS Control
– LOS and BLOS Data Link
– Dynamic re-tasking
– Control hand-off
– Auto-land/auto-takeoff
– Safety pilot for development/flights in national airspace
– 25kw of auxiliary power to energize payloads
– Precision delivery
– Low noise levels
– Low down-wash
– **Night-time operations**
Unmanned K-MAX®

Lockheed Martin and Kaman Aerospace successfully transformed Kaman’s proven K-1200 power lift helicopter into a Cargo Unmanned Aircraft System (UAS). The K-MAX® UAS can lift more than 4,300 lb at 15,000 ft density altitude with a robust autonomous control system.

Since 2011, the K-MAX UAS has been deployed in Afghanistan conducting 24/7 unmanned resupply operations for the US Marine Corps transporting >4.5M lbs in 2K sorties with mission capability rate >94% at less than 1.4 MMH/FH and $1,300/HR direct operating costs.

Achievements – World Firsts

- 4.5M lb Equivalent to 900 Cargo/Security Vehicles Taken Off Roads
- UAS Delivery of Munitions into “Hot” LZ in lieu of 2 H-53s (plus crew)
- Time Critical Deliveries within 2 Hours of Request
- Critical Deliveries by UAV Made with Armed Escort (Cobras)
- MOB to FOB and GPS Grid Delivery with <3m Accuracy
- Helicopter Support Team Hot-Hookup under Hovering UAV
- Unmanned Retrograde >30% of British FOB
- 30,000 lbs Delivered in 1 Day – 4,500 lb Water Pump Moved

K-Max K-1200

By the Numbers

300,000+

Hours flown by global K-Max fleet

1900+

Sorties flown by Unmanned K-MAX in Afghanistan

1.4

Maintenance Man Hours per Flight Hour

4,500,000+

Pounds of cargo moved for US Marine Corps in Afghanistan

46,000 ➔ 0

Exposure hours eliminated using UAS vs. convoy

900

Convoy vehicles to move equivalent cargo
Unmanned K-MAX Heavy Lifter

Technology Overview

• Optionally Piloted Vehicle (OPV)
  – FAA Experimental Certified
• Day/Night Operations
• Autonomous take-off/flight/land
• Intermeshing Rotor System
• Precision Delivery
• 1:1 lift ratio – Minimal Ops Cost

Features & Benefits

• Highly reliable logistics delivery
  – >300K hrs on fleet
• Designed/Tested for repetitive lift
• Proven in austere environments
• Operates in zero visibility
• Increased availability
• Reduced operating costs
• Reduced pilot exposure
• Simplified maintenance
• Precision delivery
• Small footprint
**Commercial Utility**

- **UAS Resupply Benefits**
  - Loads up to 4,500 lbs
  - Distances up to 100 nm
  - Technology has been proven
  - Ready for use

- **Emergency Response Benefits**
  - Fire Fighting – Wildfires, Vehicular, High Rise and Structures
  - 24/7 Operations when manned fleet is grounded due to visibility
  - Disaster Recovery without required infrastructure (delivery / extraction)

- **UAS Resupply Benefits**
  - No intermediate transshipment / handling required
  - No roads or transportation infrastructure required
  - Multiple Loads with Carrousel

On-board camera for remote precision delivery
Unmanned Firefighting - Results
K-MAX Future

- Optionally Piloted Vehicle
- Inherent Reliability for Heavy Lift Missions
- Commercial Service for Fire Fighting

**Adaptability**
- Multi-Mission UAS – 24/7 Operations
- Reliable, Heavy Lift Airframe – 1.5 MMH/FH
- Minimal Deployment Footprint

**Innovative UAS**
- Robust / Redundant Unmanned Control
- Dual Dissimilar Communication Links
- Optionally Piloted – Flexibility

**Navigating the NAS**
- Manned Configuration – Transit NAS
- Rapid Deployment – No need special airspace

**UAS Missions**

**Fire Fighting**
- Day/Night Capability
- Sensor Package Configurable
- Cargo Delivery

**Future Capability**
- Commercial Service
- Contaminated Areas

- Integrate with other UAVs
- Concurrent Mapping
Questions??

Contact:
RAVCO
POC: Njord Rota, Director of Operations
172 Red Bluff Vista, Glenwood Springs, CO  81601
Tel: (970) 366-6600
email: info@ravco.com