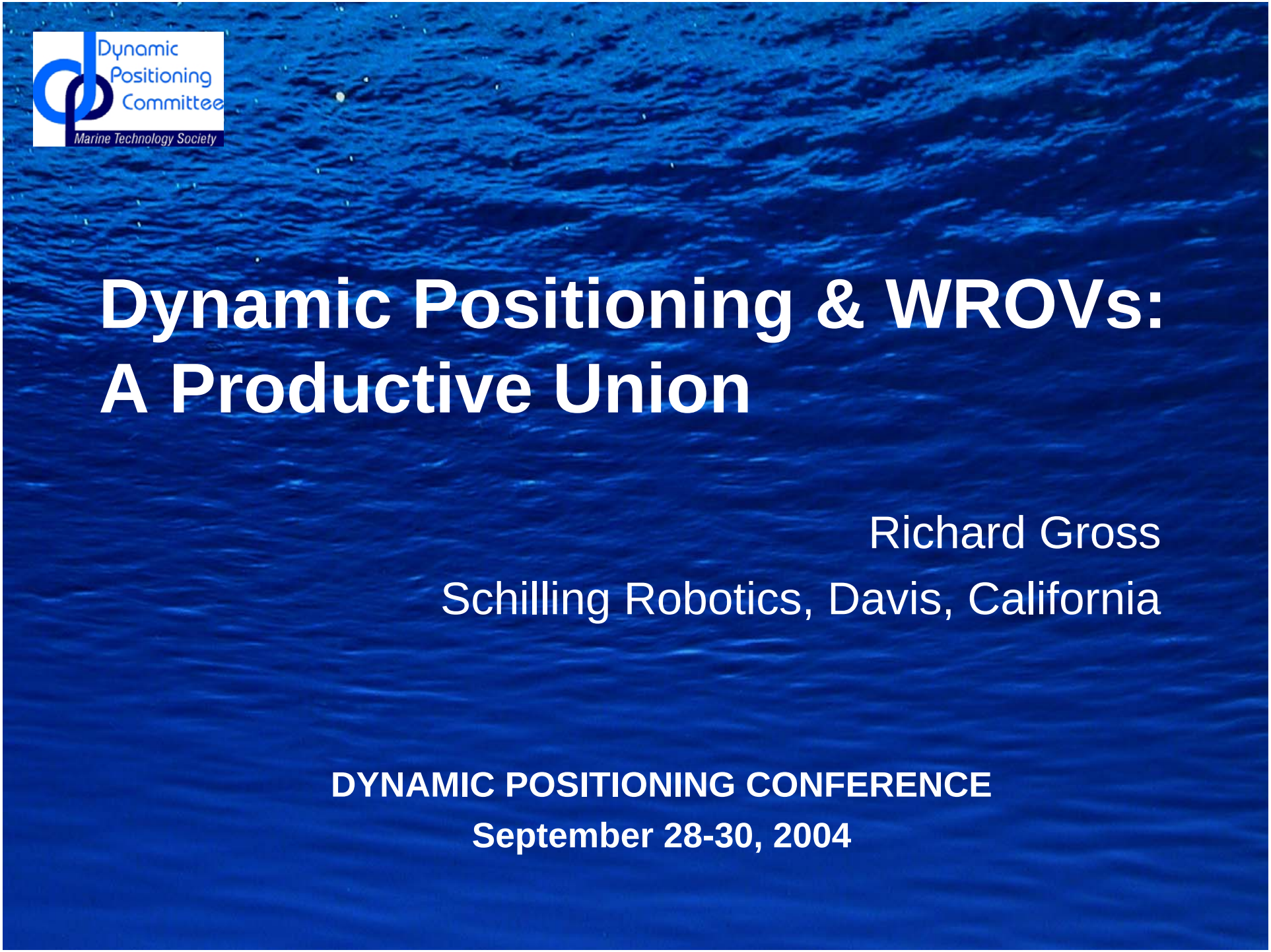


# Dynamic Positioning & WROVs: A Productive Union

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**DYNAMIC POSITIONING CONFERENCE**
**September 28-30, 2004**

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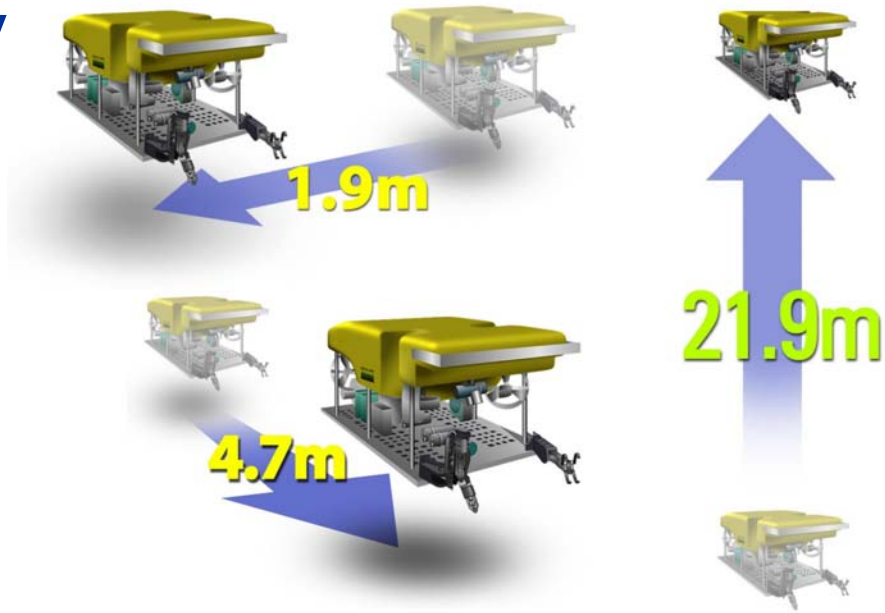
# Dynamic Positioning and WROVs

- DP used on surface vessels for 20+ years with great success.
- DP used on many AUVs.
- DP not used on commercial WROVs.
- Quest WROV provides DVL-based DP.
- Improved efficiency and equipment safety.

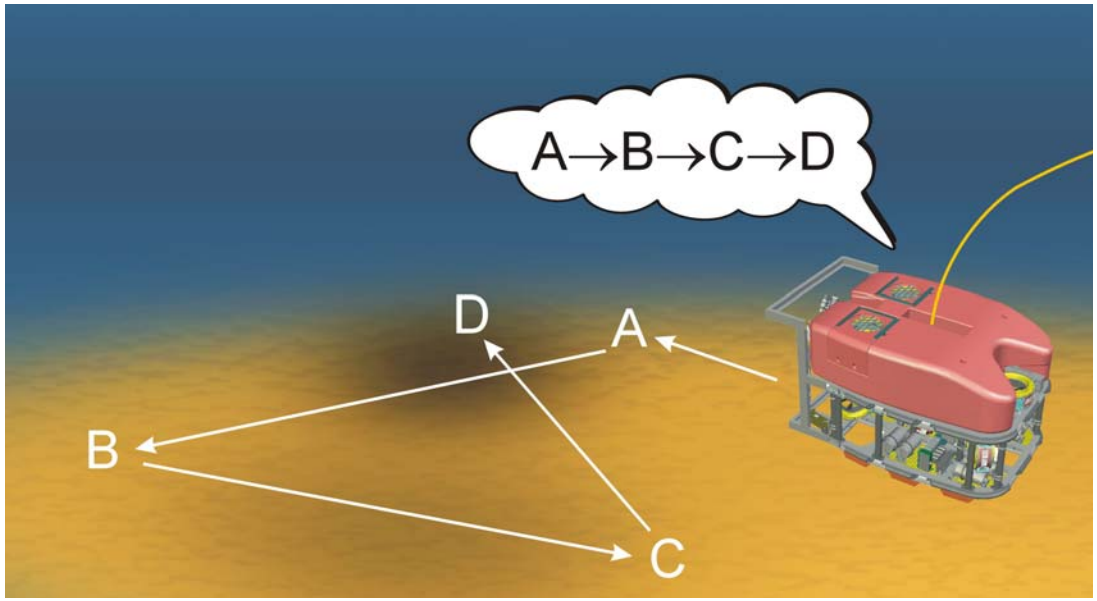
# WROV DP Characteristics

- Using its own propulsion system and sensors, vehicle can remain stationary (within a decimeter) for unlimited time.
- Vehicle can accurately displace (move to) another location in the x, y, and z axes in arbitrary pitch,roll, and yaw orientations.



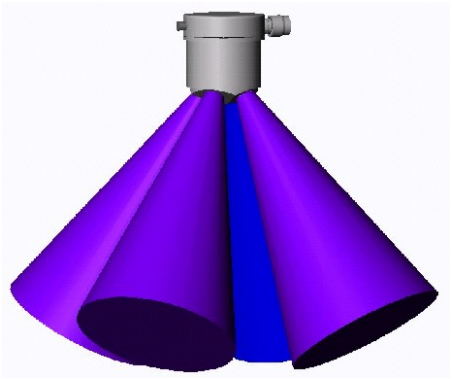
# WROV DP Characteristics

- Set point can be altered via joystick.
- Can accurately report the distance and vector between two locations.
- Can follow a set of way points or fly a pre-planned path.



# DP Sensors

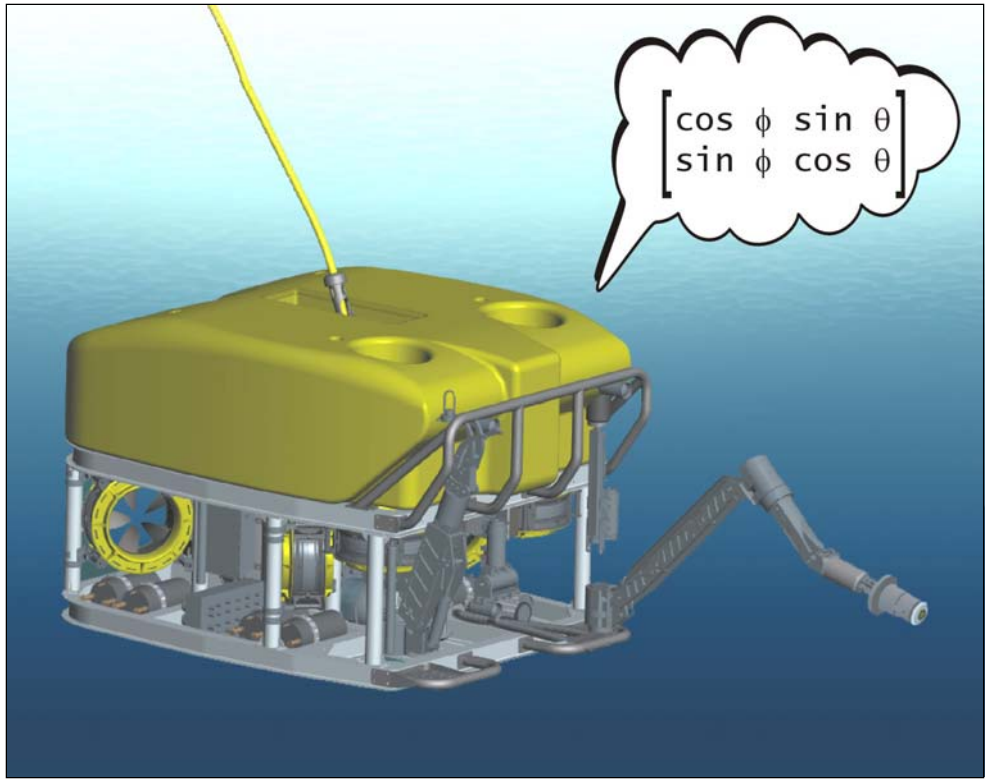
- DVL-based, using RD Instruments Workhorse 1200 with 9-Hz update rate. Off-center compensation in software.



- MRU augments DVL. Crossbow 700CA updating at 40 Hz. Supplies pitch and roll angles; pitch, roll, and yaw rates; x,y,z accelerations.

# Control Model

- PID model with additional actuation modeling. No modeling of drag, coriolis, or buoyancy.
- Body-to-inertial linear transform.



# Control Model

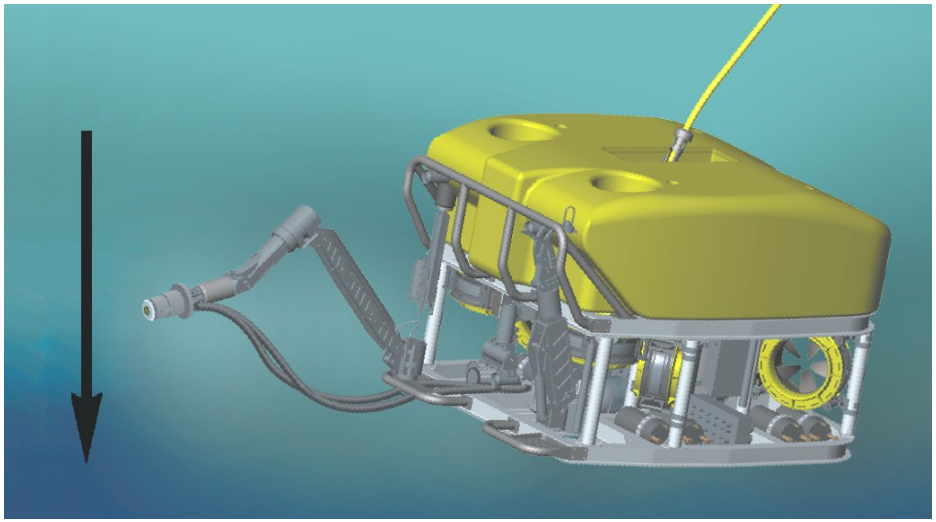
| Thrust (lbf) | RPM |
|---|---|
| 0 | 0 |
| 100 | 210 |
| 200 | 430 |
| 300 | 600 |
| 400 | 850 |
| 450 | 1000 |

- Affine transform on resultant thrust vector to thruster components.
- Thrust-to-speed map.

The control system uses a lookup table to convert thrust commands into thruster rpm.

# Control Model

- Distributed closed-loop control of both position and velocity.
- Pitch and roll compensation provides a very stable platform.
- Use of *a priori* knowledge, such as ROV pitching up when thrust is applied forward: inject counter force.



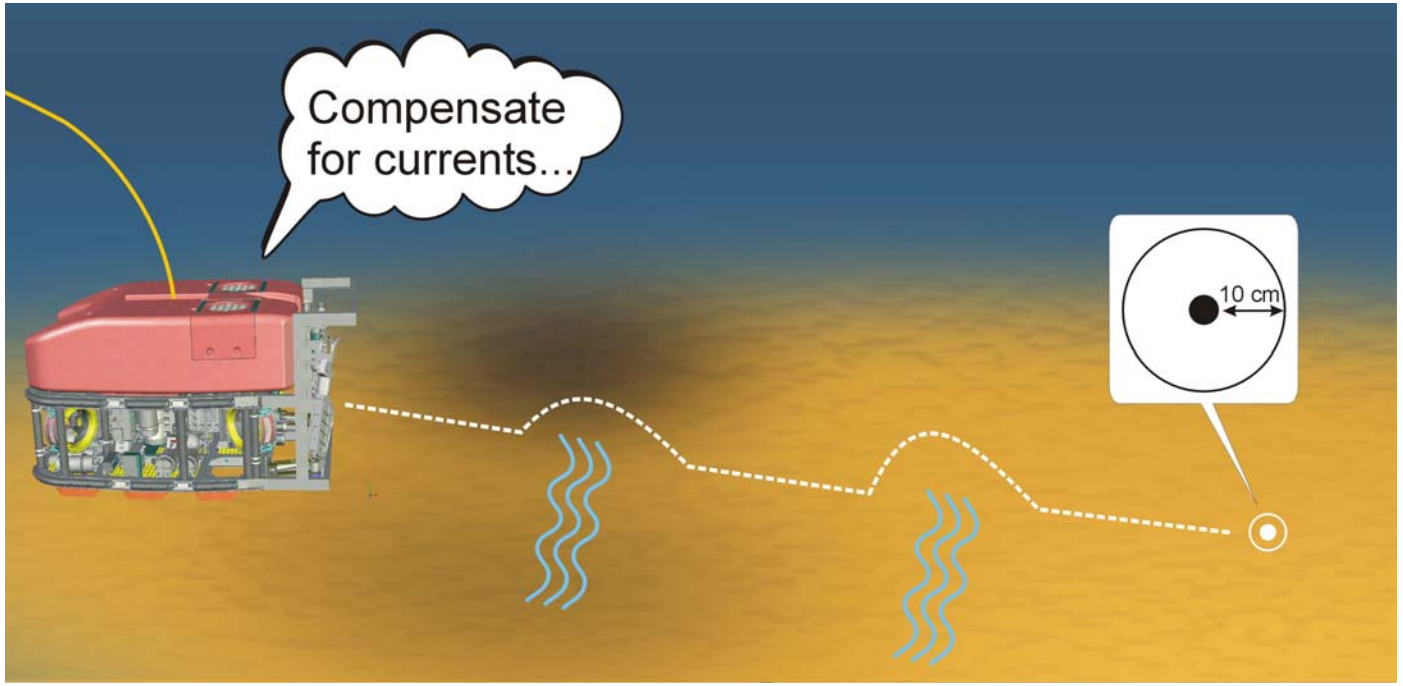
Automatic responses are calculated to counteract known tendencies

# Control Model

- Proprietary trajectory generator based on velocity tracking.
- Deviated less than ± 1 meter from path in cross currents.

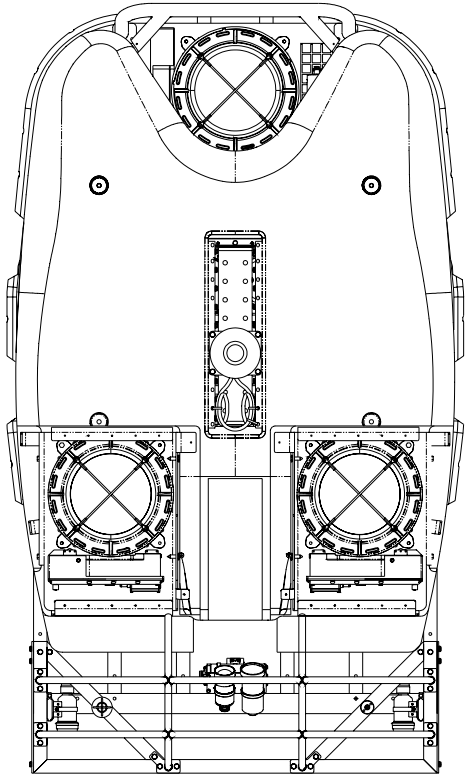
# Control Model

- Very accurate; moves greater than 60 meters and arrives within a decimeter.
- User-controllable velocity.

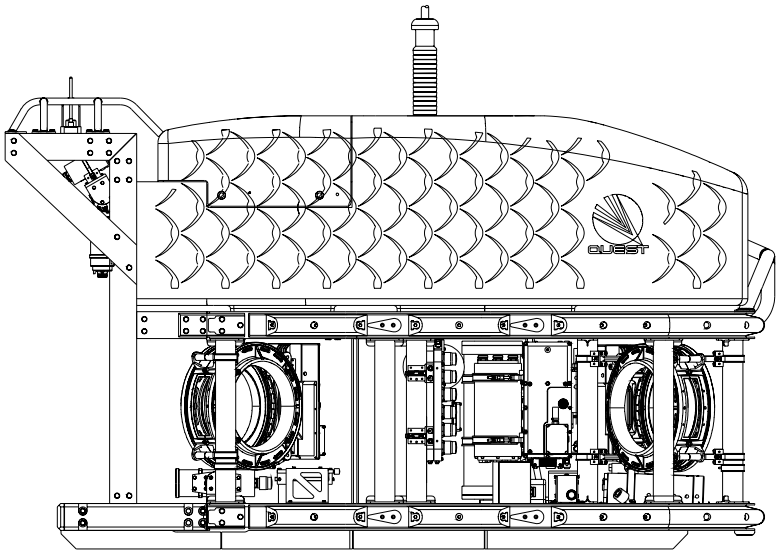


# Actuation

- Uses 7 thrusters, 4 lateral and 3 vertical.



Top View (vertical thrusters)



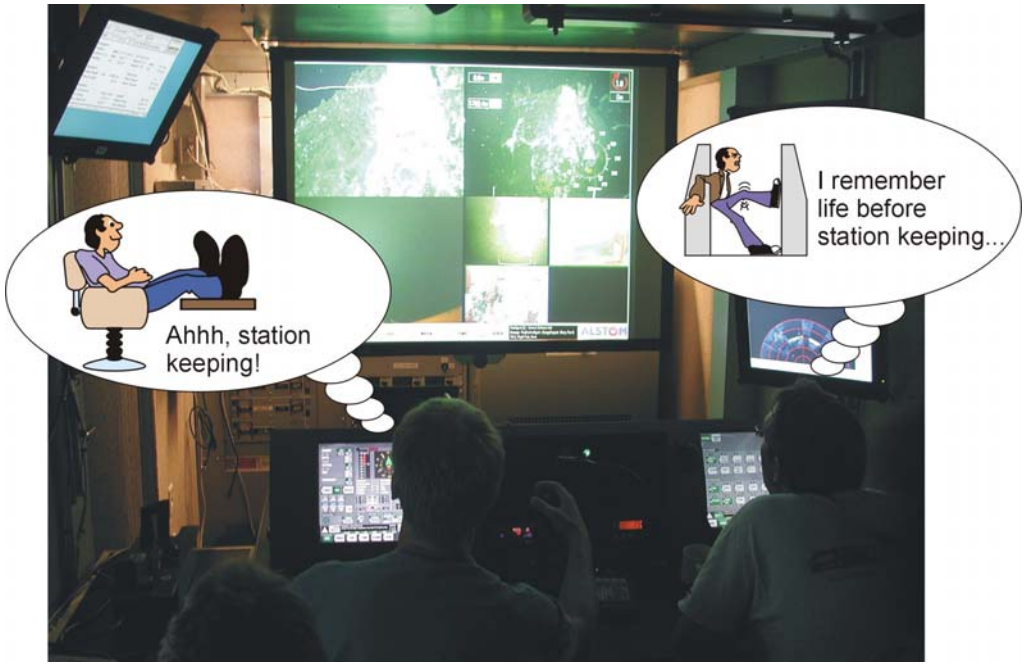
Side View (horizontal thrusters)

# Actuation

- Closed-loop speed controlled at the thrusters.
- Thruster acceleration rates greater than 2500 rpm/sec/sec.
- Uses feed-forward technique for quick, accurate response.
- Hydraulic thruster has local control of pressure and flow.

# WROV Tasks: General Operation

- Allows the operator to “take a break” from controlling the vehicle while other tasks are performed (checking sonar, manipulators, tether position, etc.).
- Crew isn’t panicked.
- Allows less experienced operators to provide quality operations.



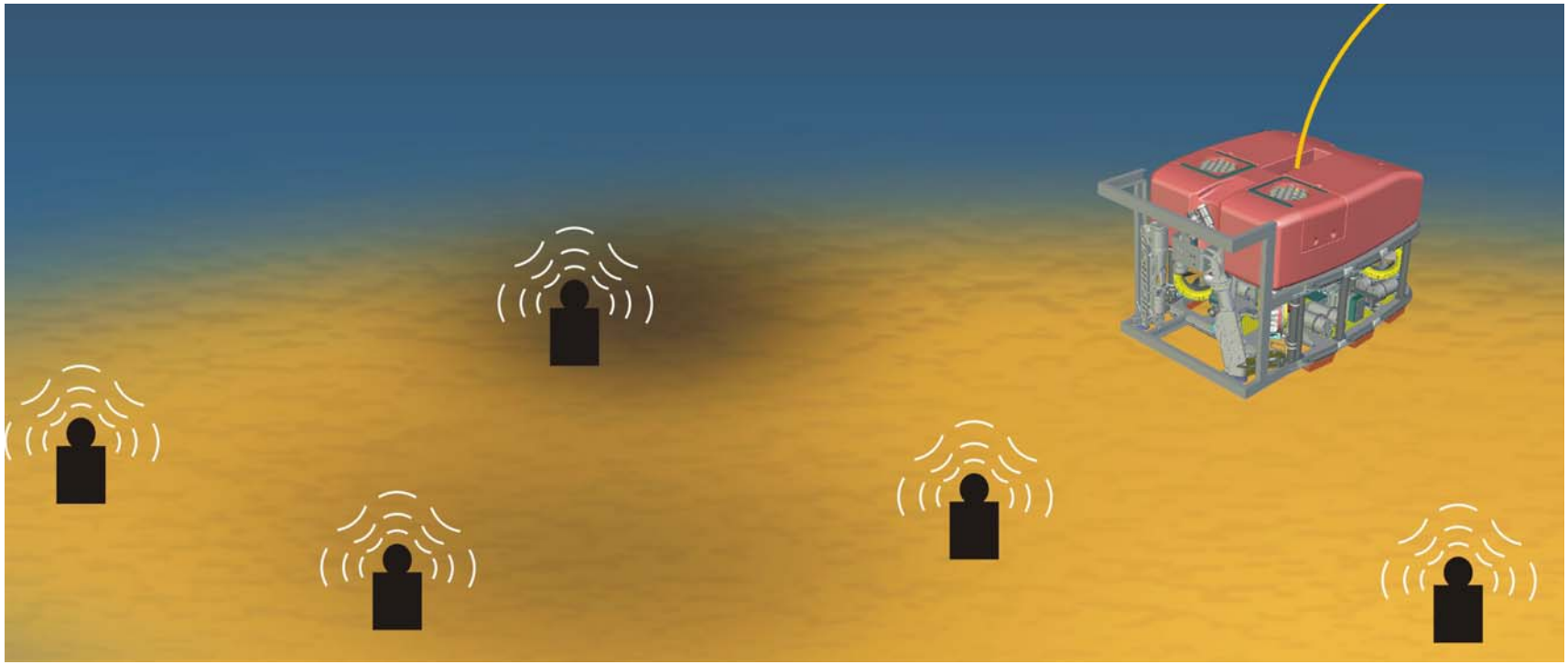
# WROV Tasks: No Grabber Needed

- Grabber does not adequately stabilize the vehicle; it acts as a pivot point and the pilot must counter any additional forces acting on the vehicle.
- Many older subsea structures don't have grab points.
- DP makes close-quarters work much easier.

Deepwater Subsea Manifold

# WROV Tasks: Deployment and Retrieval

- Find first location using surface methods.
- Find all other locations using DP.



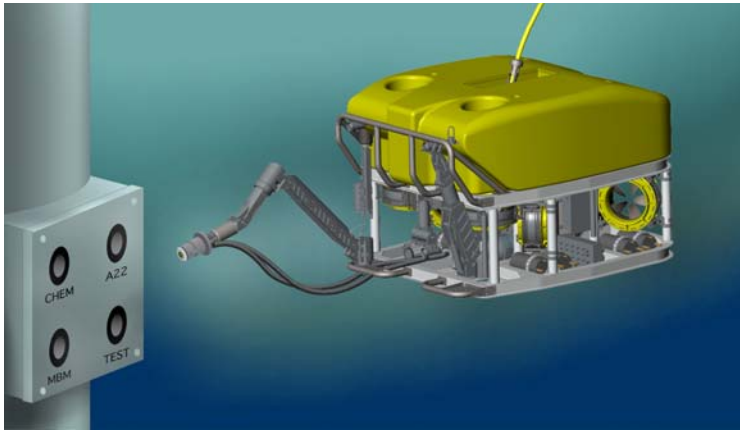
# WROV Tasks: Deployment and Retrieval

- More accurate than surface-based methods, particularly at great depths.
- No searching on retrieval; arrive exactly at location.
- Can work in low- to no-visibility conditions.

# WROV Tasks: Hot Stab Connection

- Make and break hydraulic or electrical connections.

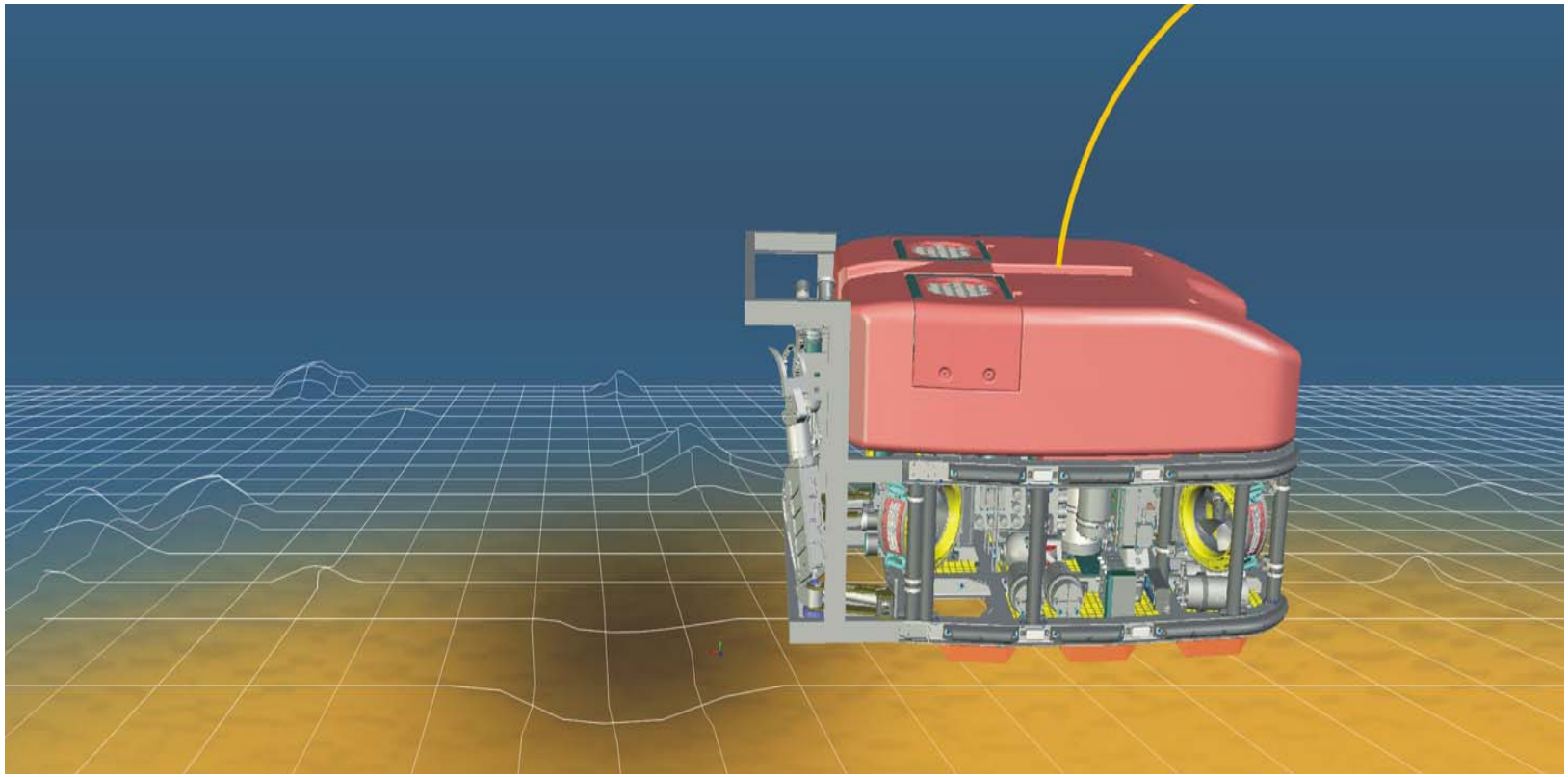
- Requires stable platform to get hot stab into slot.
- No need to freeze the manipulator and fly the hot stab into the socket.




- Vehicle is stable; operator can use a manipulator to insert hot stab.

# WROV Tasks: Grid Searches & Surveys

- WROV can make searches and surveys with accuracy measured in centimeters.

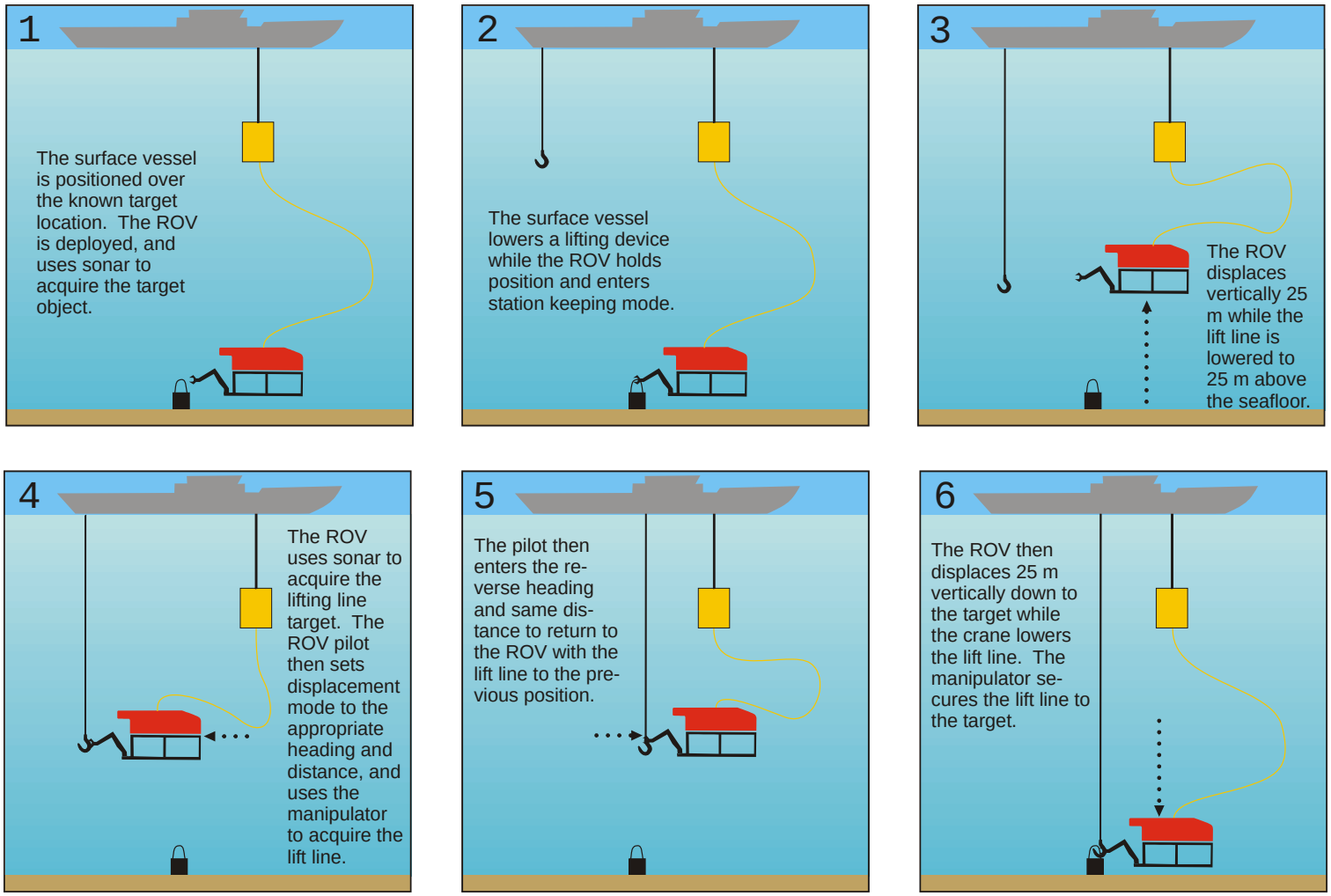


# WROV Tasks: Grid Searches & Surveys

- Telepresence allows quick changing of task parameters based on real-time view.
- Can view video live instead of in post-dive download.
- WROV has “unlimited power.”

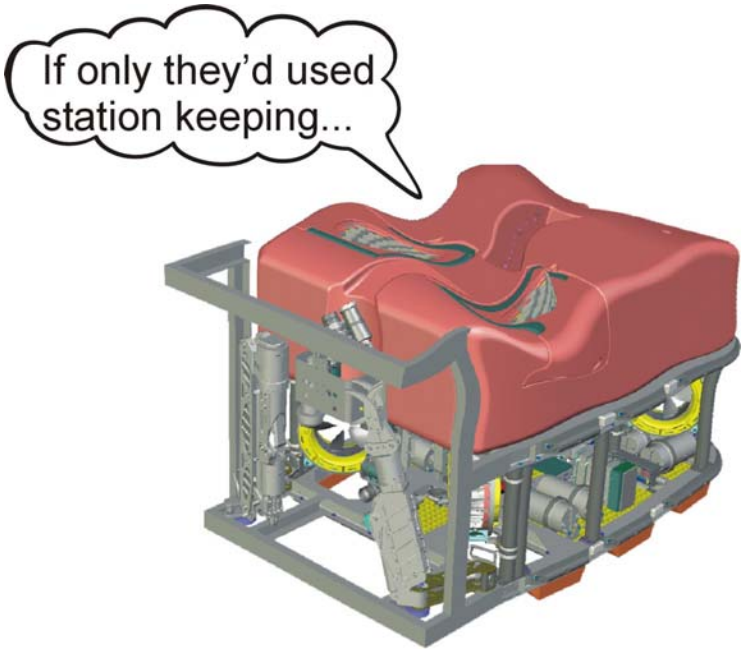
# WROV Tasks: Intercepting Down-Lines

- Locating/fixing down-lines is quick and easy.



# WROV Tasks: Deployment of Heaving Loads

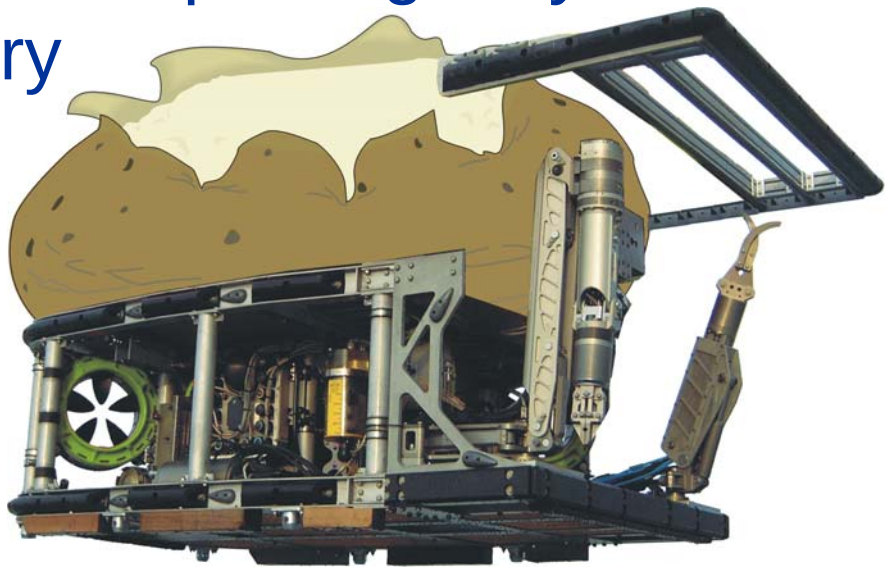
- Visibility loss as seabed is stirred up.
- Reduces crew stress when visibility is poor.
- Reduces chance of WROV/pipe collision.




- Reduces chance of trapping tether under pipe.
- Crew focuses on providing good camera and sonar views.

# WROV Tasks: Lengthy Observation

"So the ROV is on station for 1-3 days during spudding in. SK is used here to keep the ROV close to the drill bit and watch for gas. As you can see, a drill bit spinning very fast in front of you is a scary thing, a tether and ROV killer, so panic can set in if visibility is lost. But with SK, nerves are re-laxed and you don't drift anywhere you don't want to be."



"Spudding in" is simultaneously stressful and boring.

# WROV Tasks: Maintain Camera View

- Small vehicle movements produce unusable video when camera is zoomed up close.
- Can wait for hours or days for a single event to occur. Easy to miss if WROV is not stable.

- Less stress on crew than non-DP method.

# The Future of DP on WROVs

- Absolute DP
- Multi-WROV DP
- Midwater DP
- Position storage and recall
- DP for WROV tools

# DP and WROVS: A Productive Union

- Saves significant time on a large variety of tasks.
- Safer environment for equipment.
- Less stress and fatigue for crew members.
- Makes possible some tasks that are infeasible without DP.
- Will it become a standard feature of WROVs?

# QUESTIONS?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