

# DD2410

Lecture slides  
Locomotion

# Many means of locomotion

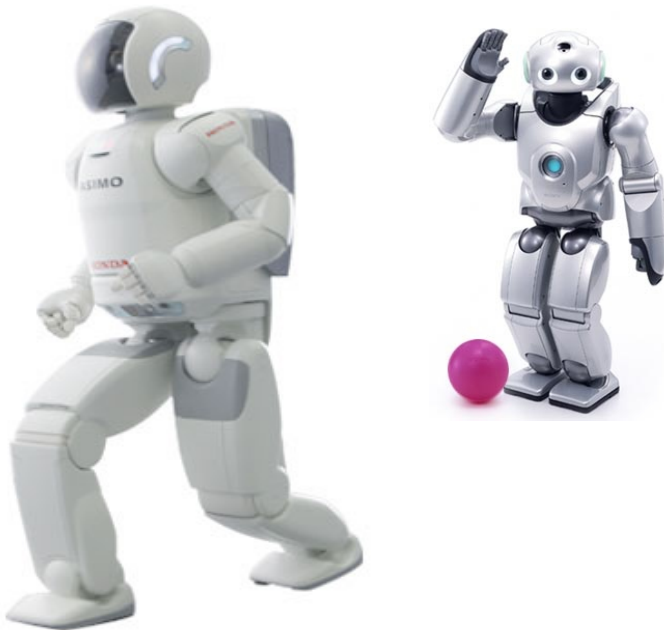
- Wheels
- Tracks
- Legs
- Flying
- ....

## Legged locomotion

- Point contacts between robot and ground
- Pros
  - Potential for handling rough terrain well
  - Only contact points need to be OK, ground in between does not matter
- Cons
  - Mechanically complex
  - Power hungry

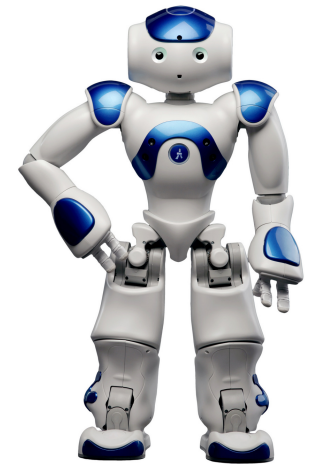
## Two legged robots (Bipeds)

- Japan/Korea almost alone on the market before



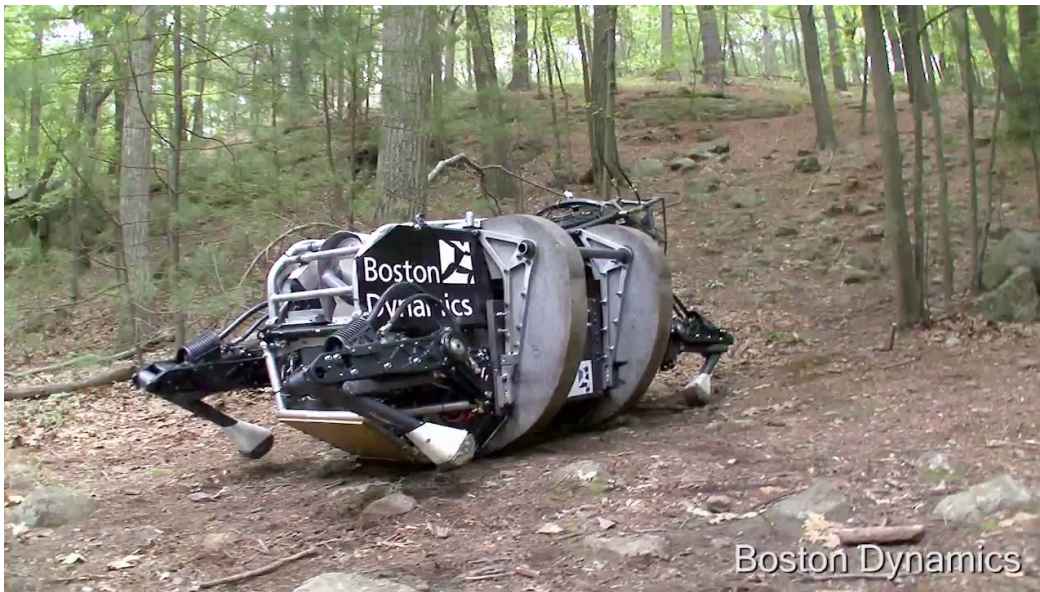
## Two legged robots (Bipeds)

- Now also in Europe and USA



# Quadrupeds

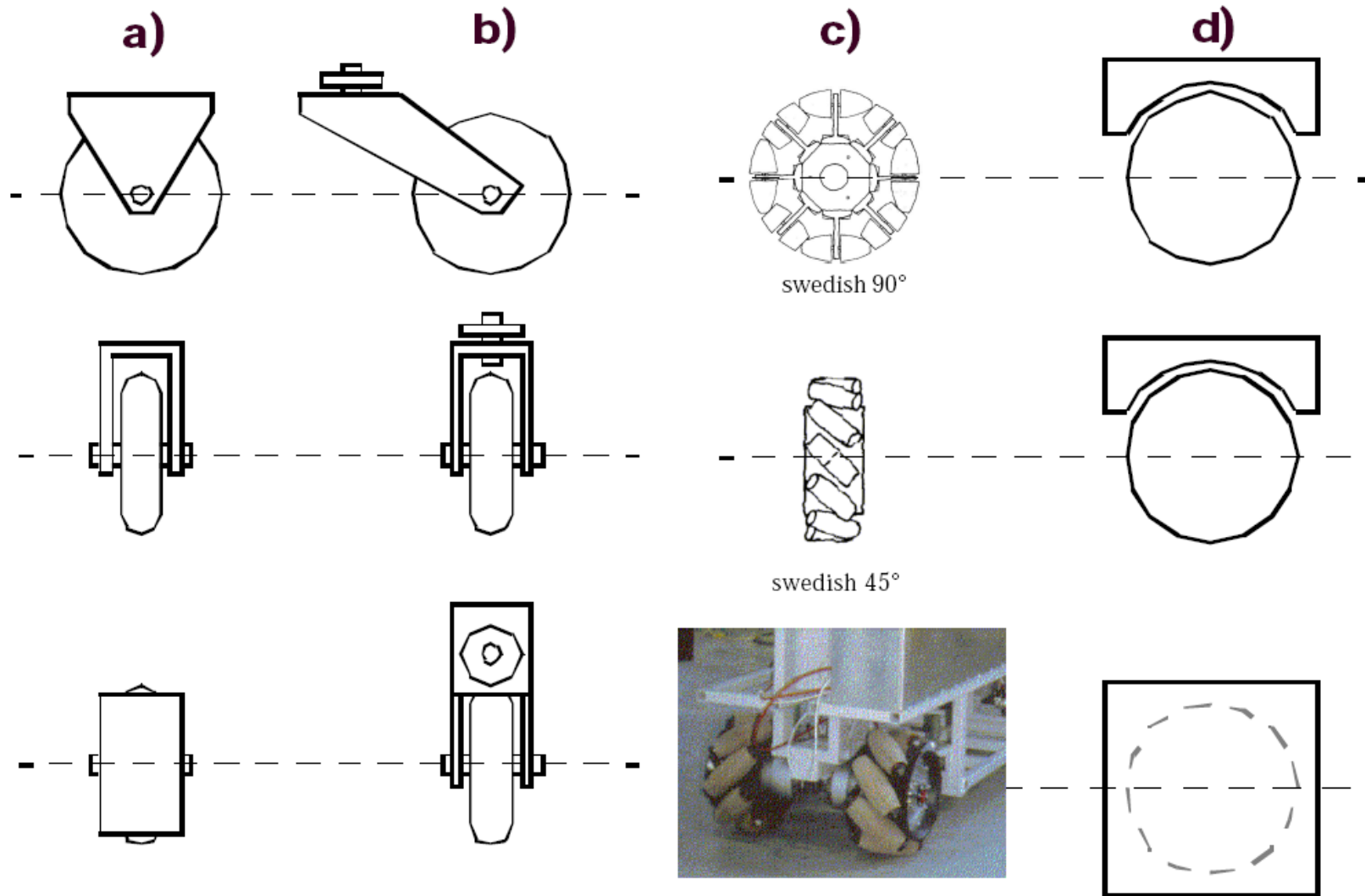
- Statically stable when still and for some gaits



## Wheeled locomotion

- Most popular means of locomotion in robotics (and other vehicles)
- Simple to implement and highly efficient
- Bigger wheels gives better handling of rough terrain
- Wheeled robots typically designed so that balance is not an issue

# Wheel design



# Study Swedish wheel

# Slip/skid steering

- Mostly for outdoor platforms
- Wheels or tracks
- Turn by applying different speed to wheels
- Skidding/slipping makes it hard to predict motion
- Extremely energy inefficient when friction is high



# Wheels and legs

## H2020 Project “Centauro”



# Flying robots

## Unmanned Aerial Vehicles (UAV)

- Increased interest
- Two main types
  - Fixed wings
  - Multirotor (rotary-wing)



# Pros and cons with fixed wings and multirotors?

- Fixed wing:
  - 
  - 
  - 
  -
- Multirotor (rotary-wing):
  - 
  - 
  - 
  -

# Pros and cons with fixed wings and multirotors?

- Fixed wing:
  - Can glide. Moves fast
  - Longer range
  - Cannot stand still
  - Need larger area for start/stop
- Multirotor (rotary-wing):
  - Can stand still (“hover”). Easy to change height.
  - Can fly close to ground
  - Start/stop on small area
  - Limited range

# Demo

# Videos: multi-rotor

The Flying Machine Arena  
Quadrocopter Ball Juggling



**ETH**

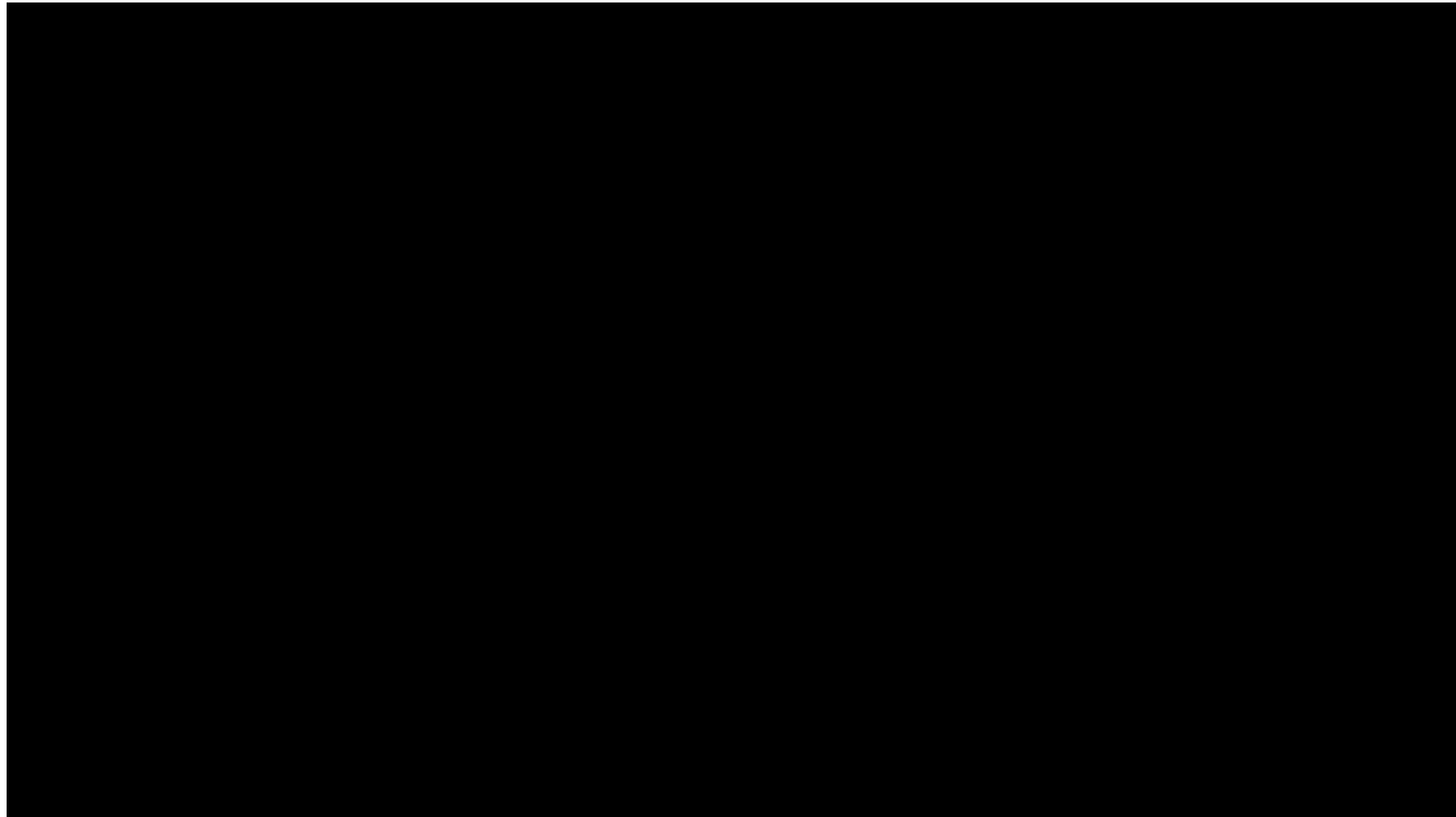
Eidgenössische Technische Hochschule Zürich  
Swiss Federal Institute of Technology Zurich



## Precise Aggressive Maneuvers for Autonomous Quadrotors

Daniel Mellinger, Nathan Michael, Vijay Kumar  
GRASP Lab, University of Pennsylvania

## Video: Zipline in Rwanda with fixed-wing



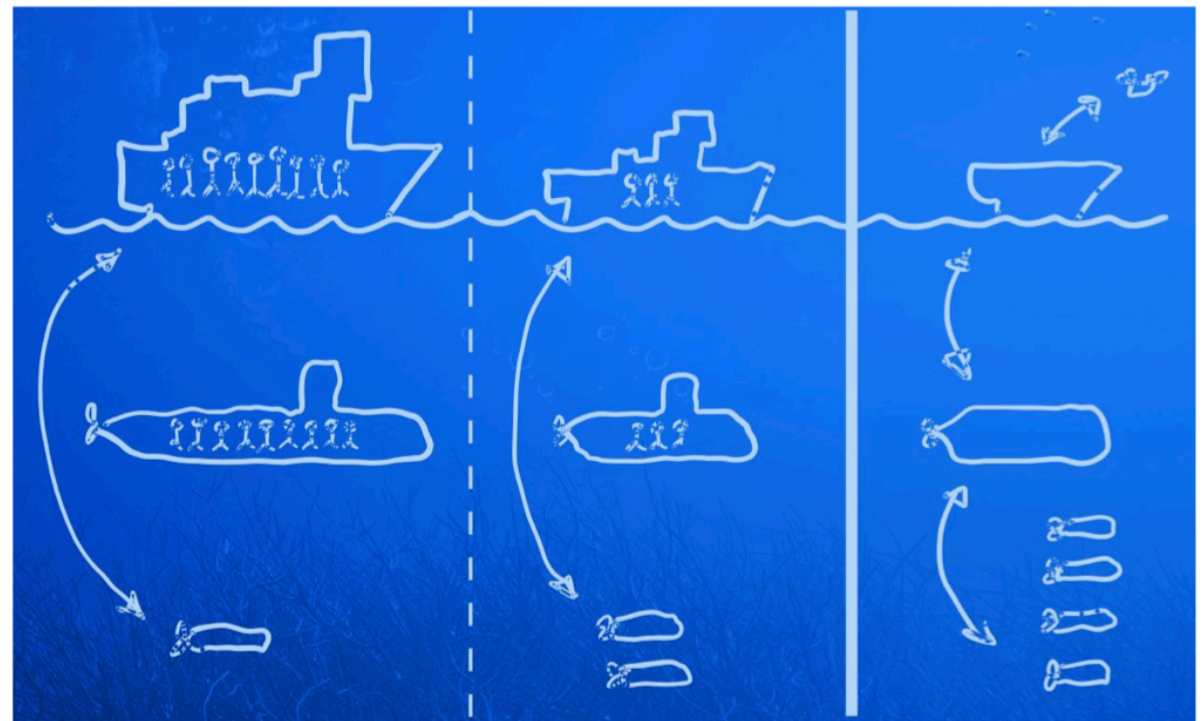
# Surface and underwater robots

- Autonomy on the sea also investigated
- Both on the water and under the water
- Why automate?

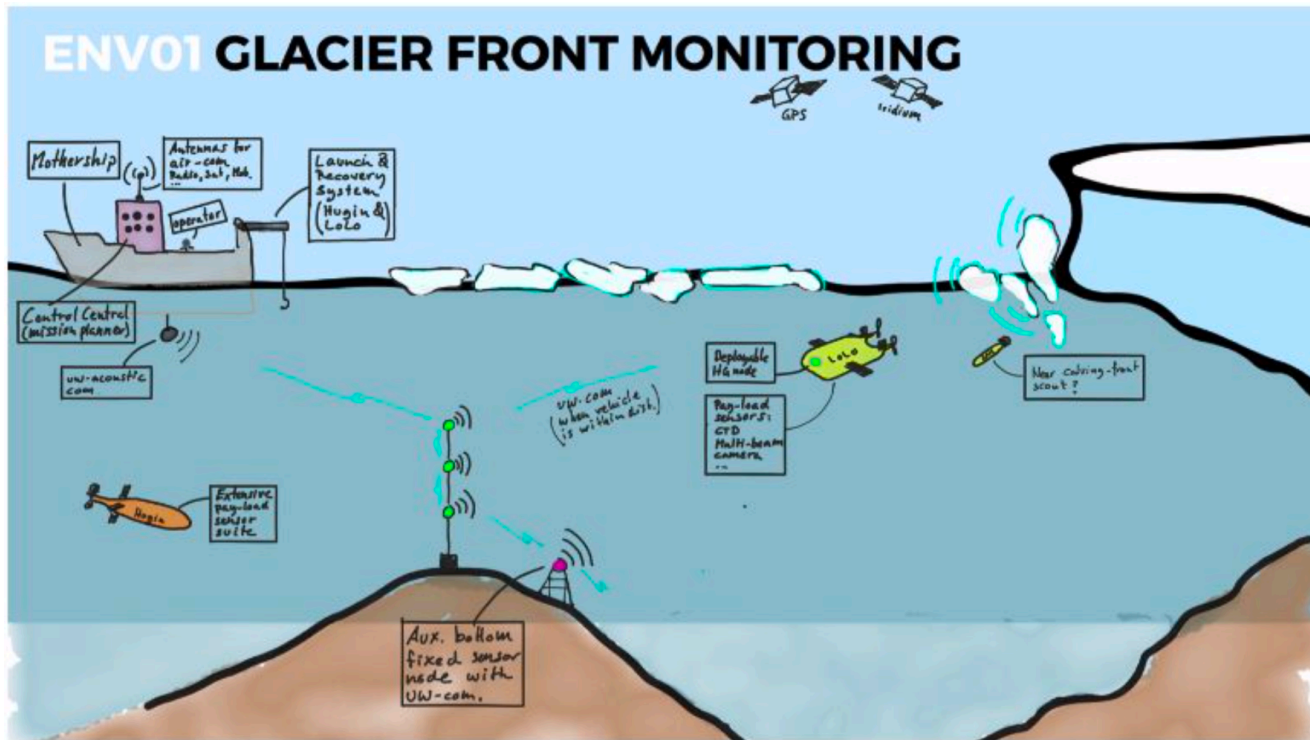
# SMaRC - <https://smarc.se>

## Swedish Maritime Robotics Centre

**Mission:** perform research on, and demonstrate, solutions that can contribute to the transition to autonomous intelligent underwater systems.

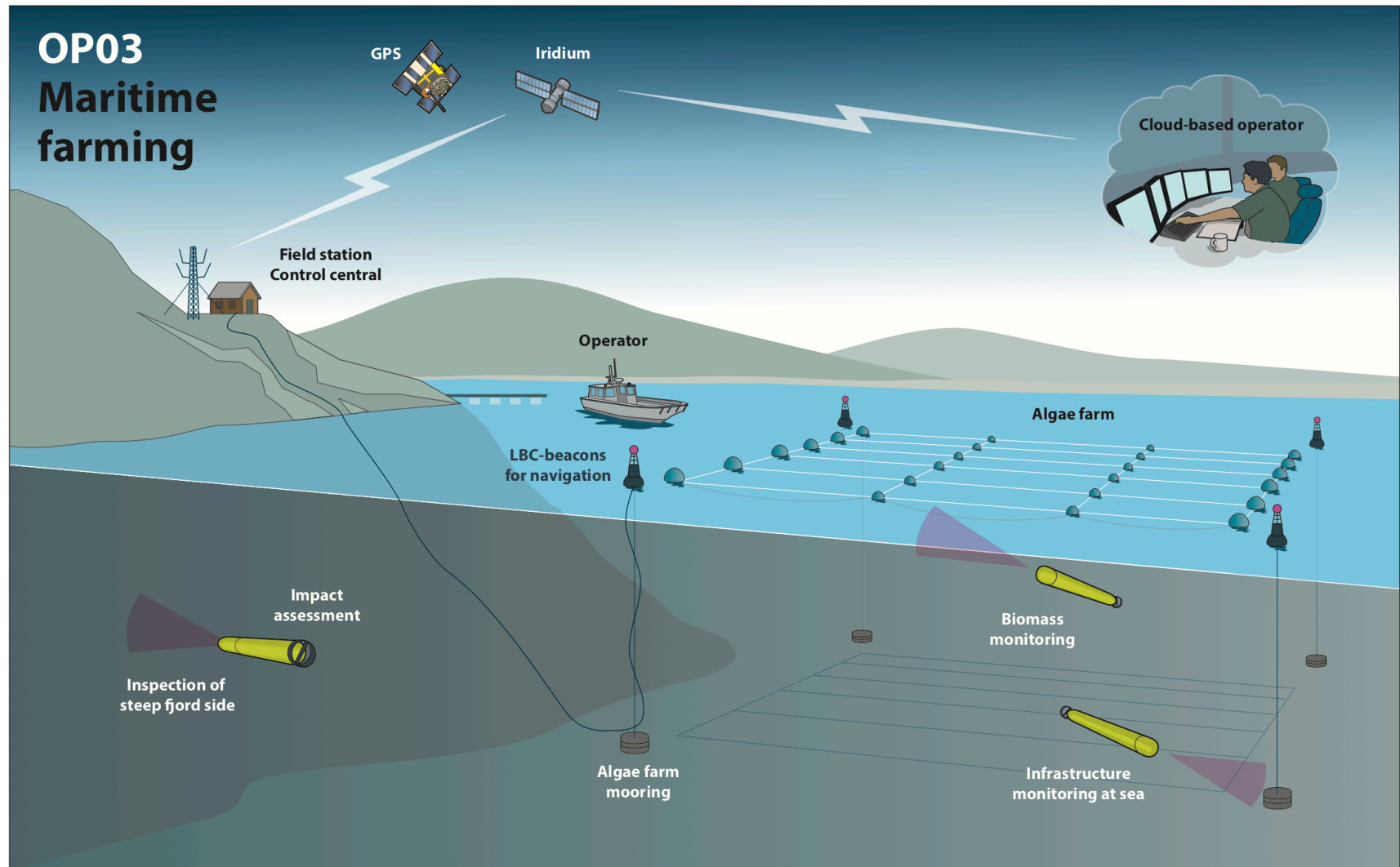


# Ex: Investigating Antarctica



The robot Ran was under the glacier for 13 hours.

# Ex: Farming

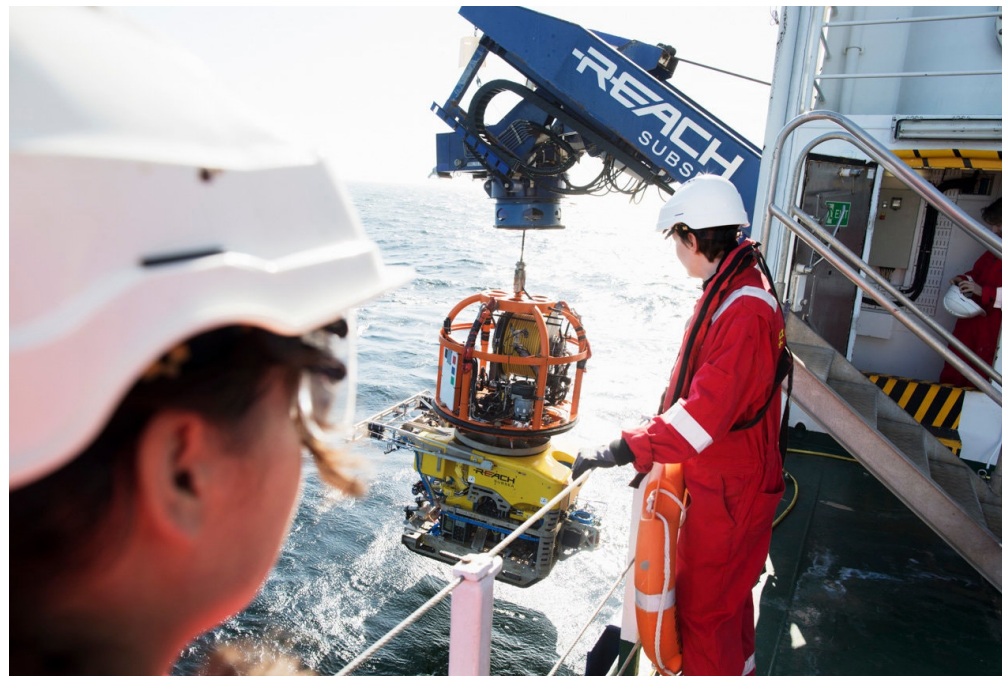
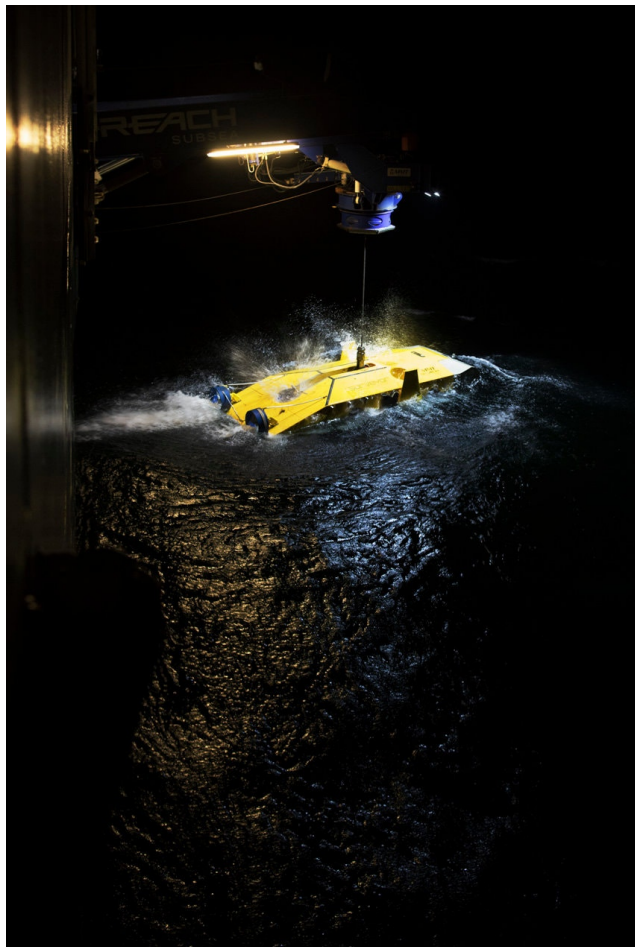


## Ex: Shipwreck



<https://www.nytimes.com/2019/07/22/science/shipwreck-archeology-shipwreck.html>

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