

for the



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Center for Coastal and Ocean Mapping







Non-profit organization that designs and manages public competitions intended to encourage technological development

Believes that the spirit of competition brings about breakthroughs and solutions that once seemed unimaginable. Impossible.



A \$7 million global competition challenging teams to advance deep-sea technologies for autonomous, fast and high-resolution ocean exploration.

Create solutions that advance the autonomy, scale, speed, depths and resolution of ocean exploration http://oceandiscovery.xprize.org



Requirements for the Round 2

- 1. Create an autonomous solution to collect data
- 2. Fit all components within a standard 40 ft shipping container
- Produce a high-resolution bathymetric map of an area of minimum 250 km² (5 m horizontal and 0.5 m vertical resolution)
- 4. Produce images of a specified object
- 5. Identify and image ten archeological, biological or geological features
- 6. Data collection must be completed in 24 hours with 48 hours for product generation

The Postgraduate Certificate in Ocean Bathymetry



The Center for Coastal and Ocean Mapping /Joint Hydrographic Center University of New Hampshire, USA



90 scholars from 39 coastal states over last 15 years



Meeting global challenges



Nippon Foundation - GEBCO Seabed 2030

<u>Produce</u>: Bathymetric grids where no features of the accessible parts of the World Ocean floor larger than 100 m remains to be portrayed. <u>Challenges</u>: Keeping up with technology

GEBCO-NF Alumni Team: 15 active alumni

15 different coastal states & 10 years of training program





The GEBCO-NF Alumni Team concept





- Unmanned controller by KM
 - HiPAP 502
 - EM304



Kongsberg Maritime HUGIN AUV

Round 2 – KM Rental 1 AUV (4,500 m)



OFG • Round 1 - OFG Chercheur AUV (3,000 m)

CARIS CARIS

High quality seafloor bathymetry and imagery

Combination of EM304, EM2040 MBES, HISAS wide-area and HISAS bathymetry & spotfocused HiSAS imagery







- Designed as mother vessel for AUV
- Fits in 40 ft container
- Rapid survey deployment
- Passive Acoustic Monitoring
- Acoustic positioning USBL
- Ocean Data Collection Platform
- Communications Repeater Station









SEA-KIT for Shell Ocean Discovery XPRIZE



SEA-Kit	• Length: 11.75 m			
Dimensions:	Beam: 2.2 m			
	Transport Height: 2.0 m - Operational Height: 8.5 m			
	Weight: 13,000 kg (estimated)			
Fully redundant	Propulsion: 2 X 10 kW / 1200 rpm electric directional thrust motors			
propulsion and	Communication: Wi-Fi, Radio, Satellite (Iridium and Inmarsat) and			
communication	Kongsberg Maritime Broadband Radio (<45 km offshore)			
systems	• CCTV: 2 interior and 6 fore and aft cameras, 1 night-vision camera			
Two independent	Generator 2 X 18 kW 48 V DC			
power supplies	Fuel 2,000 I			
and power charge	• 56 Gel and Absorbent Glass Mat (AGM) types of valve-regulated			
	lead-acid battery (VRLA) Marine Batteries, 12 V – 214 Ah capacity			
	• 4 dry cell Absorbed Glass Matt (AGM) VRLA 12 V 100 Ah Marine			
	Dual Purpose Batteries for the engine and propulsion			



SEA-KIT first wet tests in UK

Christened USV Maxlimer - 1 Sept 2017











SEA-KIT Communication & Navigation



Remote control antennae

Kongsberg Seapath 130 GPS antenna

Wind Sensor & AIS antenna

Kongsberg MBR

Wifi and Radio antennae for AUV (OFG) & Iridium antenna

HS70 GPS compass

Simrad 4G radar & GPS for Iridium

Loud hailer: anti-hijack!

Inmarsat SAILOR 500 FleetBroadband





SEA-KIT Gondola installation





EM 304 2°x4° system







HUGIN AUV for Round 2 Specs

General	Depth Rating: 4,500 m			
	• Length: 6.5 m			
	Weight in Air: 1,200 kg			
	Neutrally buoyant			
Sensors	SAS: Kongsberg Maritime HISAS 1030			
	MBES: EM2040 200-400 kHz (0.7° x 0.7° beam width)			
	Sub-Bottom Profiler: EdgeTech DW 106 SBP			
Navigation Sensors	IMU: MGC			
	Compass: Leica DMC			
	DVL: Nortek 500 kHz			
	Altimeter: Kongsberg Mesotech 675 kHz down looking			
	 Forward Looking Sonar: Imagenex MBES sonar 			
	CTD: SAIV CTD			
	 USBL: HiPAP Transponder 			
	Depth Sensor: DigiQuartz 8CB4000			
	GPS Receiver: Novatel			
Power	 3 batteries (24 kWh) 			
	Endurance estimates: 37 hrs @ 3 kts & 27 hrs @ 4kts			



AUV Sea-trials

Data group, OFG and KM operators acquired bathymetric and side-scan data, as well as sub-bottom profiles.

The data was collected during 19 dives in 10 weeks over 2years.

Included:

- DVL calibrations
- Patch tests separately for EM2040 and HISAS 1032
- Various operational modes: getting wide-area side scan bathymetry operational (KM input), testing standard HISAS bathymetry and HISAS imagery
- Data collection different altitudes and speeds



HISAS operating modes





AUV Sea-trials









CENT DISCOVERY P

Data Group

Focus on Automated Data Flow





Masanao Sumiyoshi worked with Teledyne CARIS to understand:

- AUV work flow in processing HISAS data & EM2040 data (Ms. Fernanda Viana Da Conceicao)
- 2. Developed automated work flow based on CARIS processing tools

Fine-tuned and further developed during sea trials at Kongsberg Maritime

CARIS output is imported into ArcGIS

- 1. Analysis of bathymetric data (contours, slope etc.)
- 2. Publishing of image services in ArcGIS online
- 3. Collection of bathymetric data available from internet sources

SCALL DISCOVER-

Data types

The second

Sonar	File type	Data	Resolution
EM2040	*.all	Bathymetry & Imagery	<1 m
HISAS (Standard)	*.all	Port and Starboard Bathymetry	1 m
HISAS (Standard)	*.xtf	Imagery	4 cm
HISAS (Standard)	*.all	Port and Starboard Spot Bathymetry	10 cm
HISAS (Standard)	raw data	Port and Starboard Spot Imagery	~2-4 cm
HISAS (Wide-area)	*.all	Port and Starboard Bathymetry	5 m
HISAS (Wide-area)	*.xtf	Imagery	5 m
EM304	*.kmall	Bathymetry	7% of depth

Simplified data work flow







EM2040 data

- Nadir fill
- Approximate total swath width = 200 m (120° swath & 400 beams at 60 m altitude)
- Data resolution ≤1 m



SCHUDISCOVERNME CONCERNMENT CONCERNMENT

HISAS Wide-Area Test

30 m AUV altitude

60 m AUV altitude





Data density: Different HISAS modes

Standard HISAS 0.5 m along track spacing

Wide-area side-scan mode ~1.5 m along track spacing





The Team plan for XPRIZE R2 is to run various AUV modes:

- 4 hours of standard HISAS mode (10 km²)
 Constant navigation aiding
- 17 hours of HISAS wide-area mode (132 km²)
 Autonomous navigation with hourly HiPAP updates
 = ~52% of required coverage
- 17 hours of EM304 survey (440 km²)



Sea floor images



Shipwreck 20 m Length; 5 m Beam in ~200 m water depths





ArcGIS Web Application









to Kongsberg Maritime in Horten, Norway for supporting us through 6 months of sea-trials





THANK YOU

























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OFG

