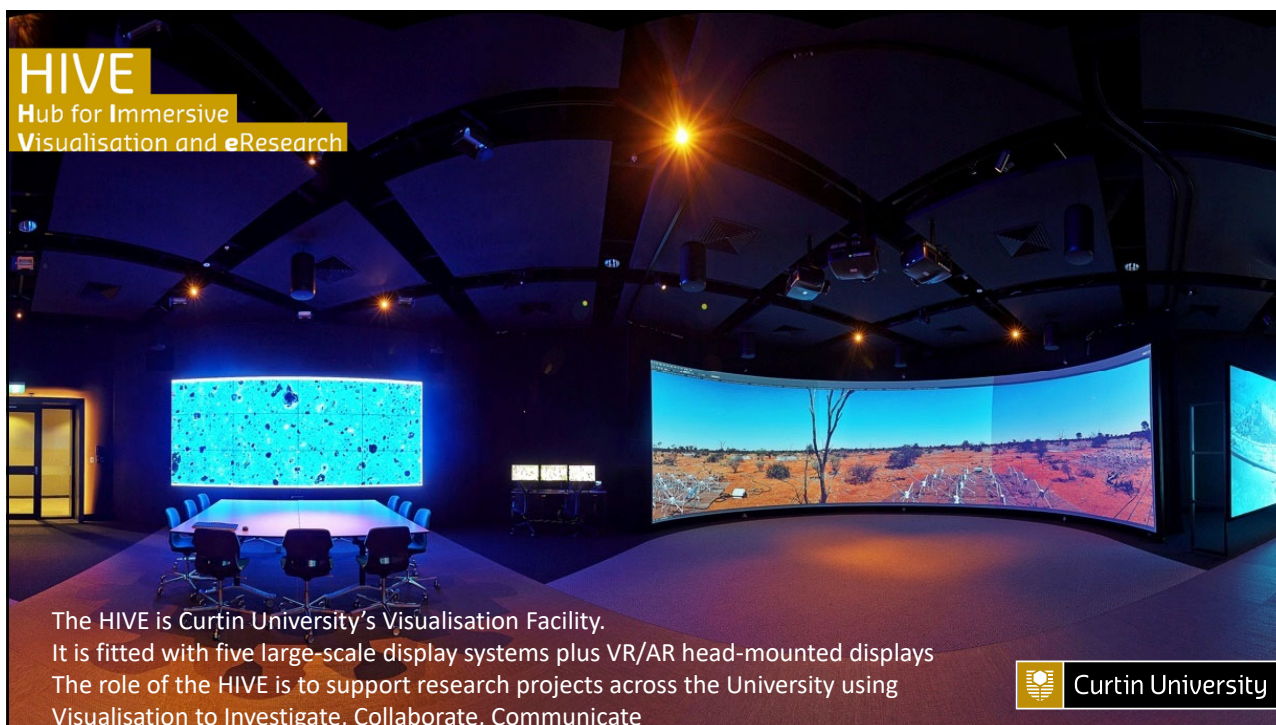


VISUALISING SHIPWRECK SITES

A/Professor Andrew Woods,
Daniel Adams, Ash Doshi,
Curtin University HIVE

Image courtesy of Curtin University and WA Museum. © WA Museum.

1



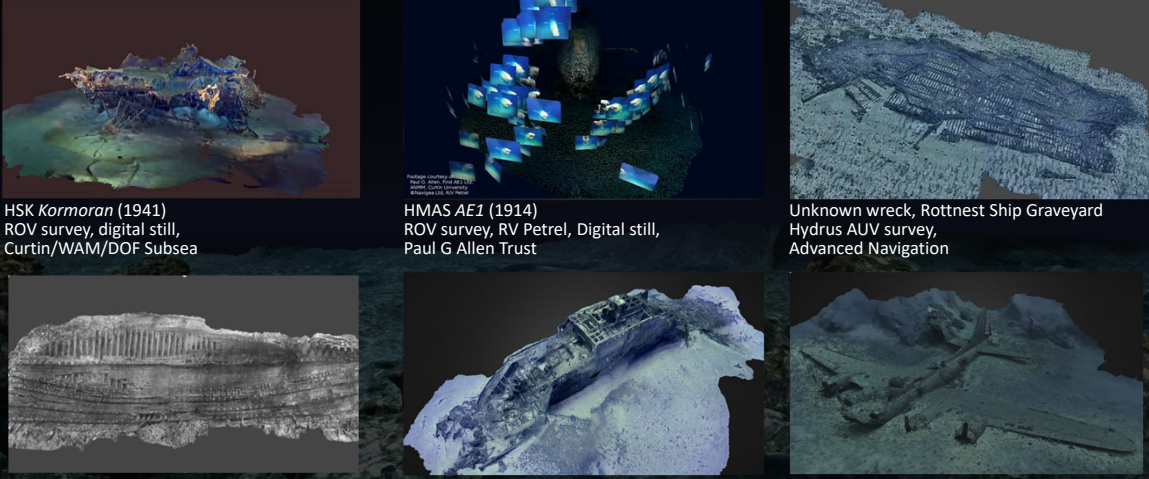
HIVE Hub for Immersive Visualisation and eResearch

The HIVE is Curtin University's Visualisation Facility. It is fitted with five large-scale display systems plus VR/AR head-mounted displays. The role of the HIVE is to support research projects across the University using Visualisation to Investigate, Collaborate, Communicate

2

A VISUAL JOURNEY

The HIVE team have worked on around 50 wreck sites to date. We have created digital 3D models from a wide range of survey, camera and data types



HSK *Kormoran* (1941)
ROV survey, digital still, Curtin/WAM/DOF Subsea

HMAS *AE1* (1914)
ROV survey, RV Petrel, Digital still, Paul G Allen Trust

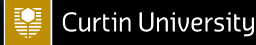
Unknown wreck, Rottneest Ship Graveyard
Hydrus AUV survey, Advanced Navigation

Santo Antonio de Tanna (1697)
Diver survey, 35mm film, Jeremy Green WA Museum

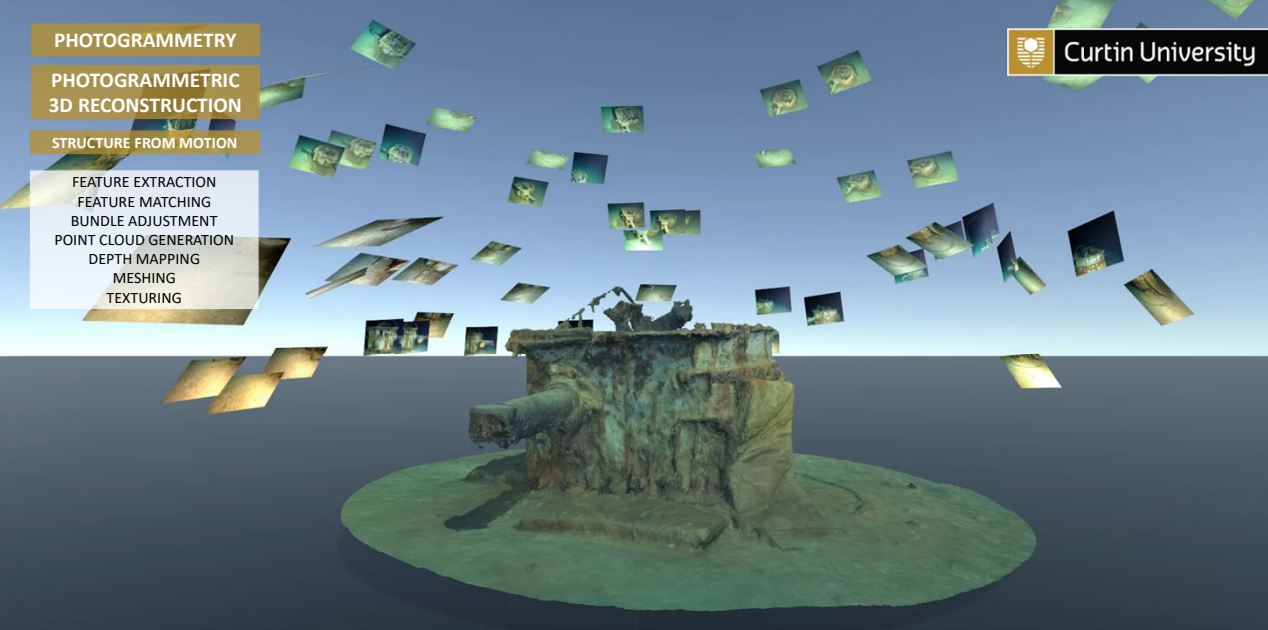
SS *Nemesis* (1904)
Drop-camera survey, video, CSIRO with Heritage NSW

B17 bomber "Black Jack" (1943)
Diver survey, DSLR, Thomas & Hamilton

See many examples of our wreck models on Sketchfab.com - search "Curtin HIVE"
<https://skfb.ly/oHZ8C>



3



PHOTOGRAMMETRY


PHOTOGRAMMETRIC 3D RECONSTRUCTION

STRUCTURE FROM MOTION

- FEATURE EXTRACTION
- FEATURE MATCHING
- BUNDLE ADJUSTMENT
- POINT CLOUD GENERATION
- DEPTH MAPPING
- MESHING
- TEXTURING

HMAS *Sydney* (II) High Angle Director Tower


Video courtesy of Curtin University and WA Museum
© WA Museum




4

OPTIMISING PHOTOGRAMMETRY WORKFLOW

CAPTURE




6000m rated digital still camera with real-time upload via ethernet. Titanium housing and Sapphire lens. Able to operate in an array.




Platform: Divers, ROVs, AUVs
Digital Still Cameras
Maximising the quality of capture

PROCESSING






SS Bonnie Dundee (1877-1879) Shipwreck (Stern) - default settings




SS Bonnie Dundee (1877-1879) Shipwreck (Stern) - optimised settings

Image Pre-processing
Optimised Processing Settings
Image Post-processing

VISUALISATION




Large-Screen Immersive 3D Displays
Head-Mounted Displays
3D Printing


 Curtin University

5

CAPTURE



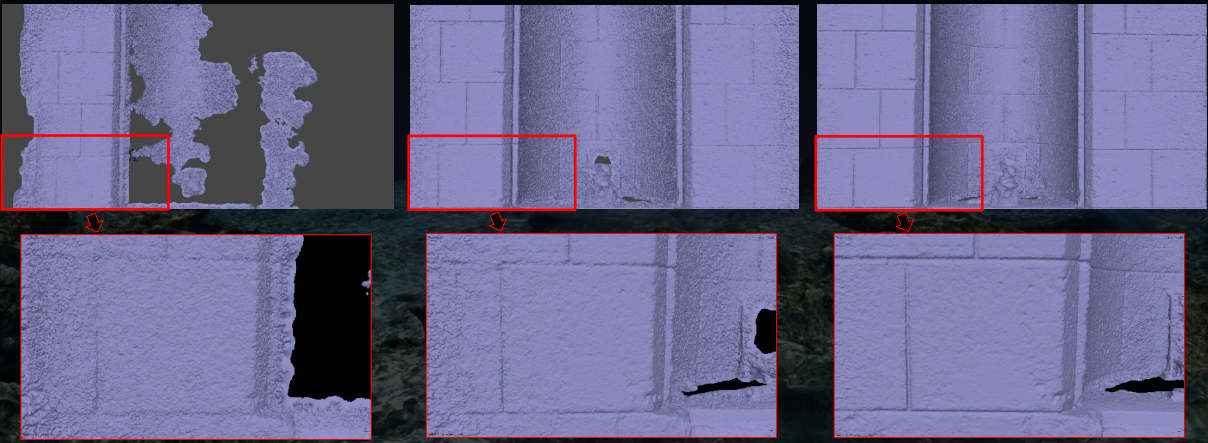
6000m rated digital still camera with real-time upload via ethernet. Titanium housing and Sapphire lens. Able to operate in an array. Developed at the Curtin HIVE.

 Curtin University


6

CAPTURE Improved Capture → Improved 3D Model Quality

ISO 3200 ISO 800 ISO 100






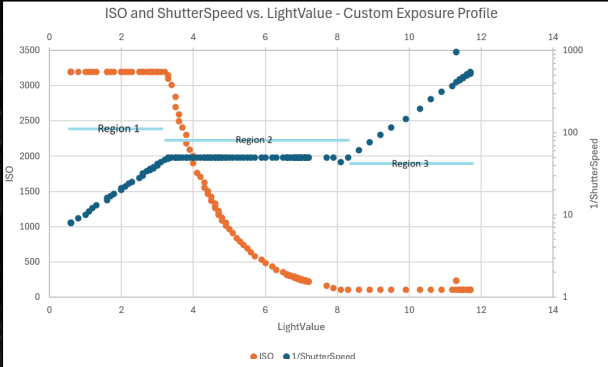
Optimising the camera capture settings improves the quality of the digital 3D model able to be produced. Capturing images with lower ISO results in less image noise and hence higher quality digital 3D models with less voids and higher quality mesh surfaces.



7

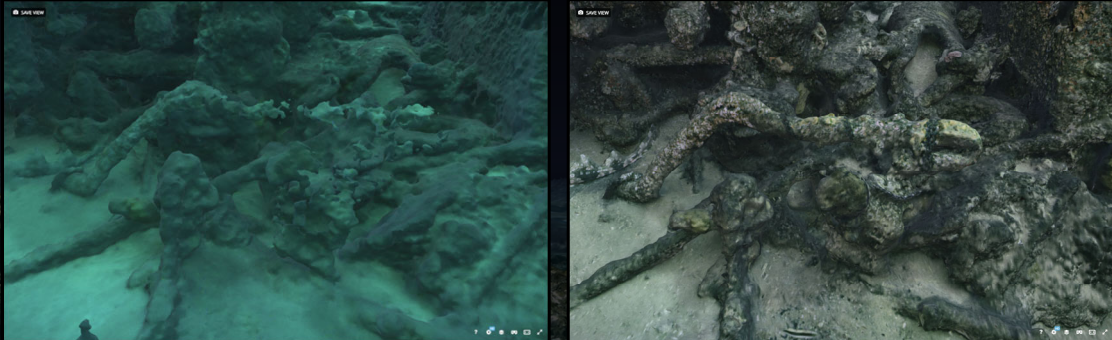
CAPTURE Optimising GoPro Cameras for Underwater Photogrammetry

GoPro cameras are optimised for action photography. We have implemented a custom exposure profile that is set using a set of special QR codes. More information here: <https://hive.curtin.edu.au/Research/GoProUP/>



8


PROCESSING



SS Bonnie Dundee (1877-1879) Shipwreck (Stern) – default settings

SS Bonnie Dundee (1877-1879) Shipwreck (Stern) - optimised settings

The quality of the final digital 3D model can be significantly improved by using improved processing at three separate stages of the photogrammetry processing:
Image Pre-processing, Optimised Processing Settings, and Image Post-processing


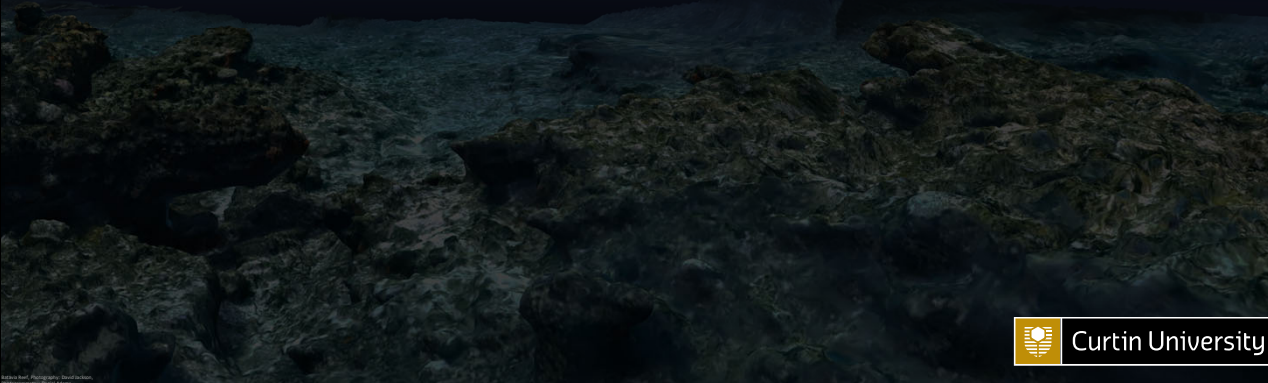


9

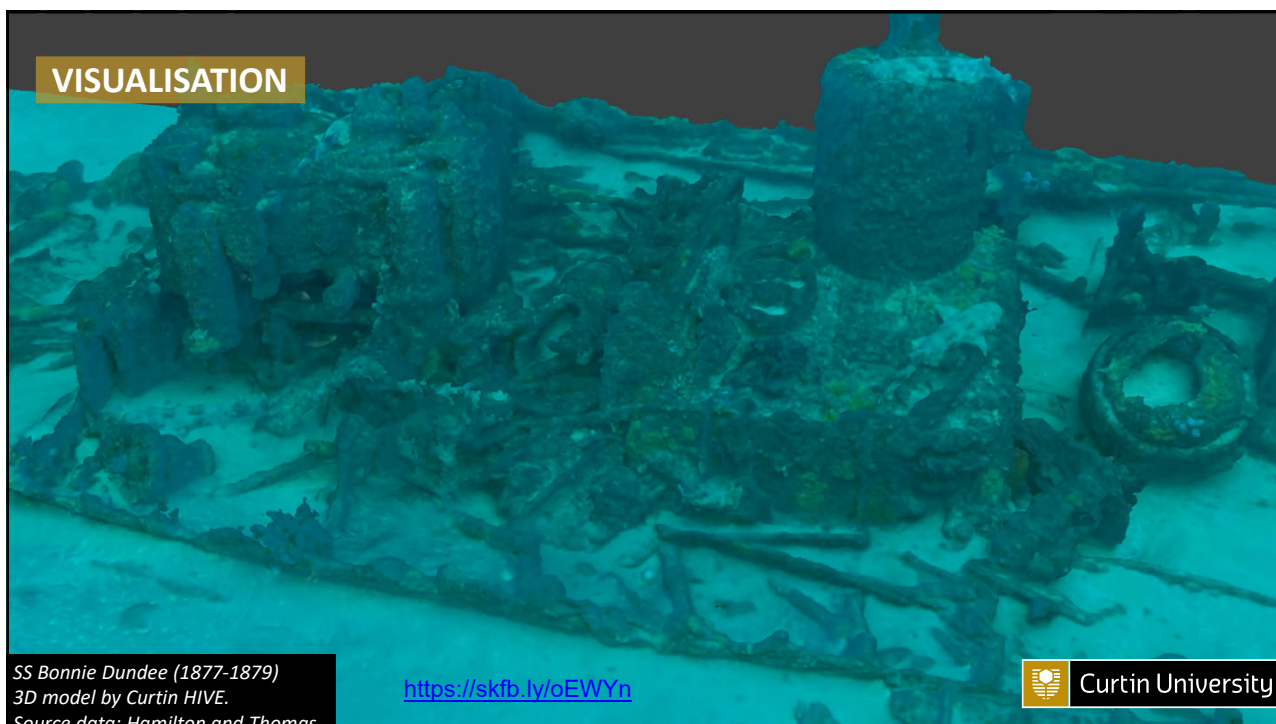
VISUALISATION

Live Demonstration

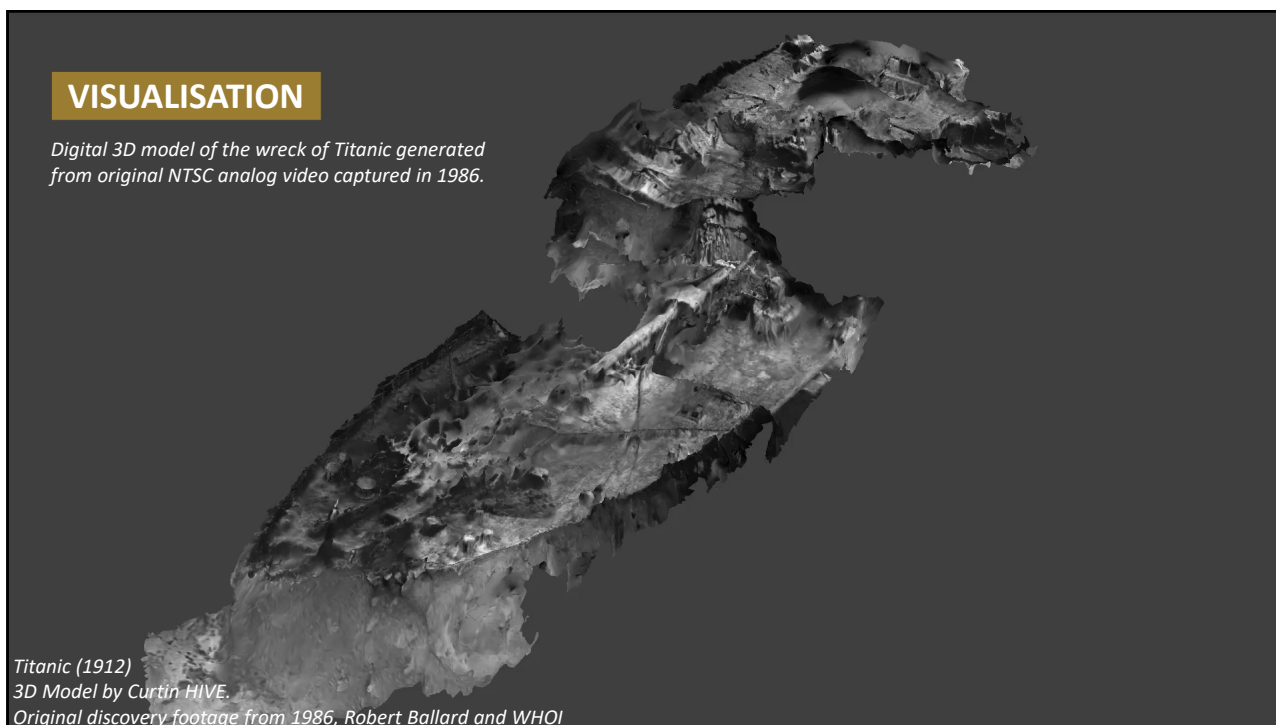
- Bonnie Dundee (1877-1879)
- Titanic (1912)
- Santo Antonio de Tanna (1697)



10



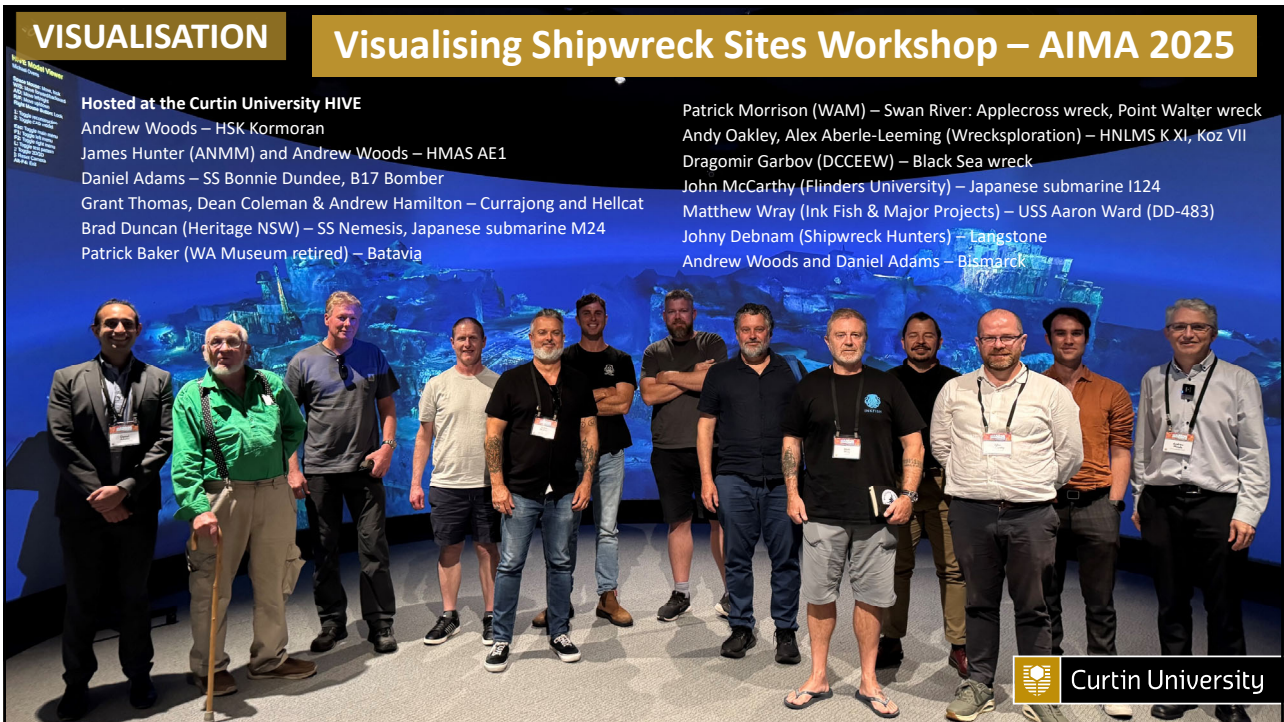
11



12



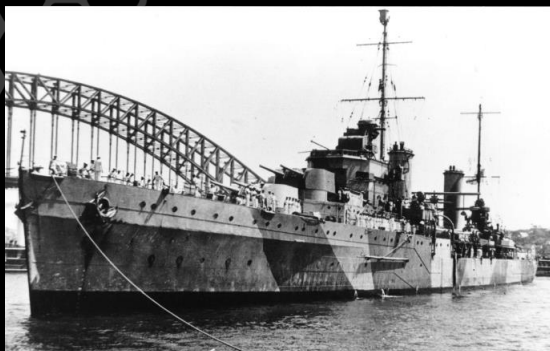
13



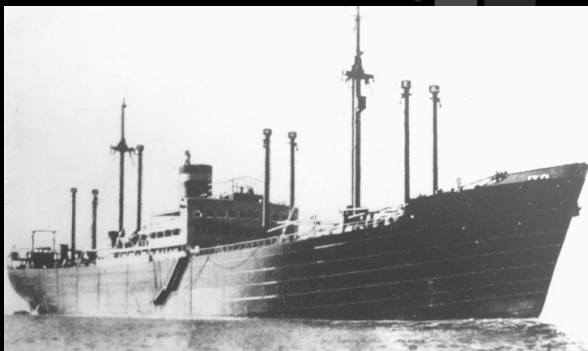
14

SYDNEY-KORMORAN PROJECT

An example of a high-end high-quality underwater photogrammetry project.



- HMAS *Sydney* (II)
- modified Leander-class light cruiser



- HSK *Kormoran*
- Merchant vessel converted to an armed raider

- Lost 19 November 1941 – in the midst of World War II – off the coast of Western Australia, 200km due west of Shark Bay
- The two vessels encounter each other and a short battle results in the sinking of both vessels
- All 645 crew of the Sydney perished. Of the 380 men on-board Kormoran, 318 survived. Wrecks at 2500m water depth.



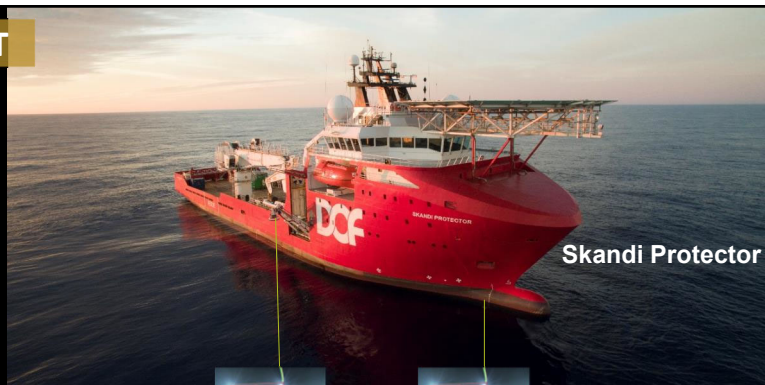
Curtin University

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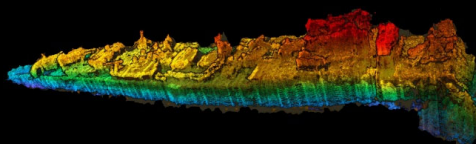
SYDNEY-KORMORAN PROJECT

Survey Expedition:

- Aim: Survey the two wrecks in exquisite detail
- Survey conducted from DOF Subsea Vessel "Skandi Protector" using two XLX150 work-class ROVs (Remotely Operated Vehicles)
- Custom lighting and camera system
- 4 days on site, 24 hour ops



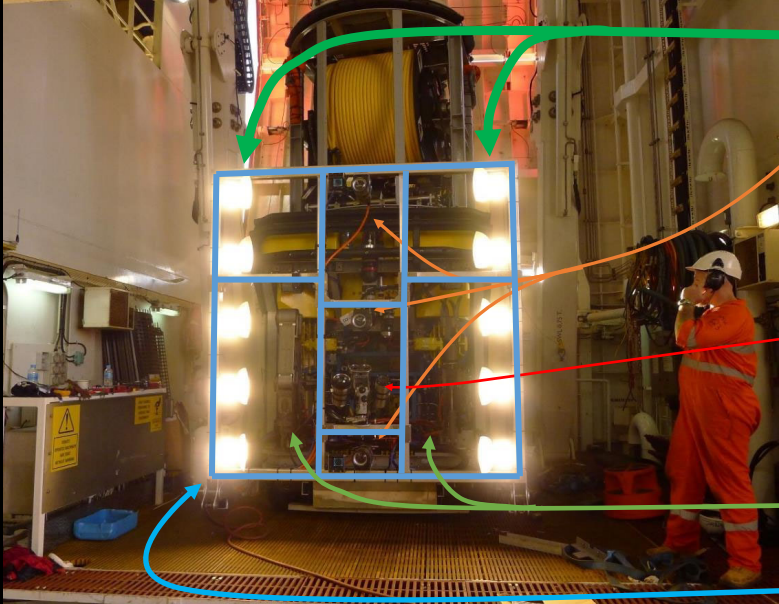
Skandi Protector



16

SYDNEY-KORMORAN PROJECT

Each of the two ROVs were equipped with a custom 3D imaging system:

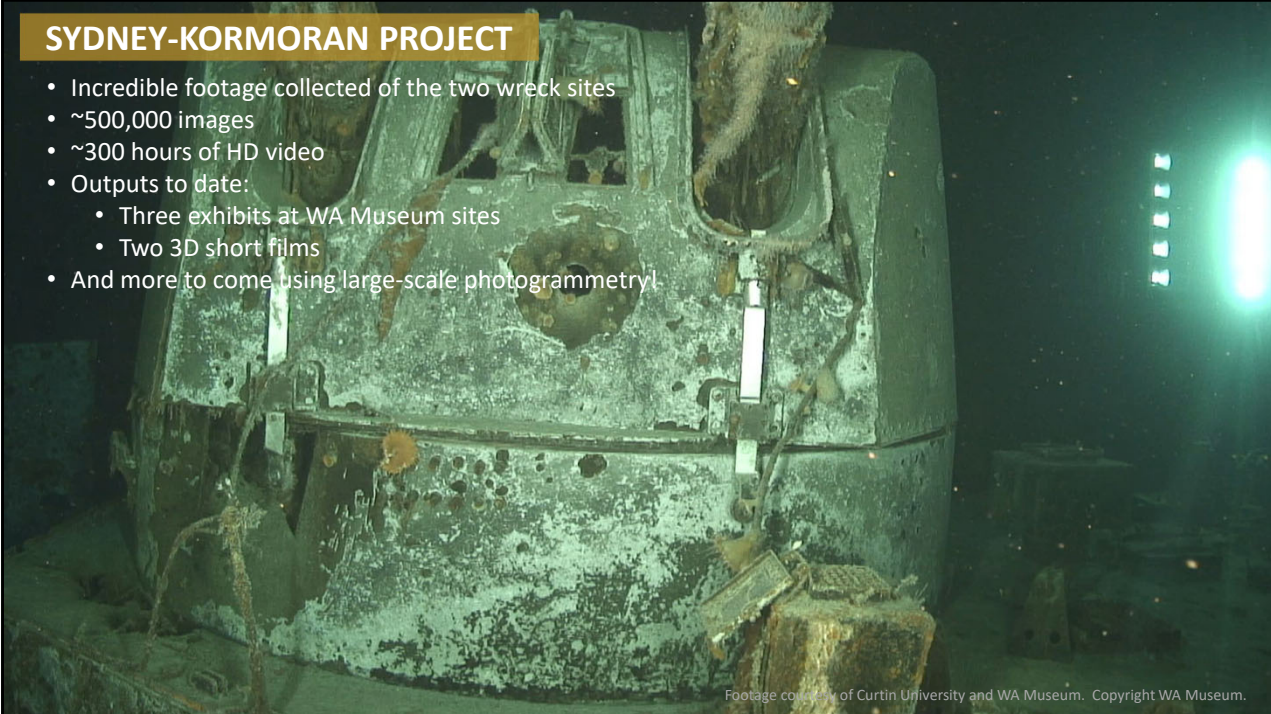


- x10 Underwater LED lights
- + tonnes of underwater cables
- And a special mounting frame **x2**

17

SYDNEY-KORMORAN PROJECT

- Incredible footage collected of the two wreck sites
- ~500,000 images
- ~300 hours of HD video
- Outputs to date:
 - Three exhibits at WA Museum sites
 - Two 3D short films
- And more to come using large-scale photogrammetry!




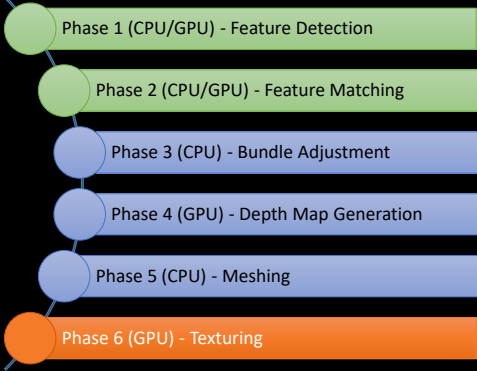
Footage courtesy of Curtin University and WA Museum. Copyright WA Museum.

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SYDNEY-KORMORAN PROJECT

Large-scale Photogrammetric 3D Reconstruction (P3DR)

- 3D Reconstruction processing is computationally intensive.
- Fortunately, it can be run highly parallel.
- Photogrammetric processing of 500,000 images
 - Single Core Workstation → 685 years
 - Quad Core Workstation → 171 years
 - Magnus → 7 days
 - Setonix → <1 day
- 30M service units on Pawsey to date



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SYDNEY-KORMORAN PROJECT



This 3D model also serves to illustrate that high-quality capture allows the production of high-quality digital 3D models.

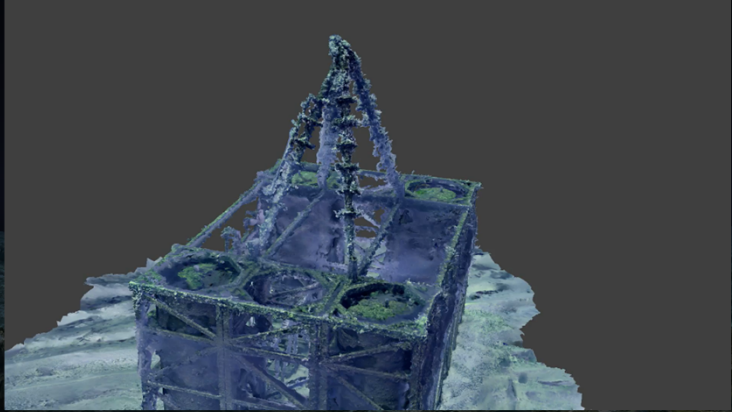
HSK *Kormoran* Engine Room Hull(1941)
3D Model by Curtin University HIVE from footage
courtesy of Curtin University and WA Museum.



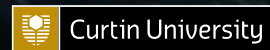
20

Infrastructure Surveys

- The same techniques that we have been using to model shipwreck sites can also be used to model subsea infrastructure.
- Example at right is a 3D model of a fish aggregation device installed offshore from Rottneest and was generated from video footage captured by an ROV.
- Discussion of coverage, and image quality: resolution, compression/noise, lighting
- We have demonstrated that advanced photogrammetry processing can be used to create digital 3D models from archival footage. It might not create a perfect 3D model, but it can save costs of a resurvey
- The 3D model allows:
 - Improved 'Global' understanding of the site
 - Physical scale & dimensions of equipment
 - More easily identify scale and location of defects & changes
 - Assist in planning of subsequent inspection, testing of ideas, and development of equipment for repair and decommissioning
 - A large team can be quickly familiarised with the location



This digital 3D model has been created using advanced photogrammetric 3D reconstruction processing techniques by Daniel Adams, Curtin University HIVE from video captured with a Sony RX0 deployed on an SRV8 ROV piloted by Kevin Holden.
Survey led by: Euan Harvey, Ben Saunders and Iain Parnum.
Survey funded by Chevron Energy Technology, Pty. Ltd. through a research grant to Curtin University via the Western Australian Energy Research Alliance (AES 17-P2TD-151-A1).

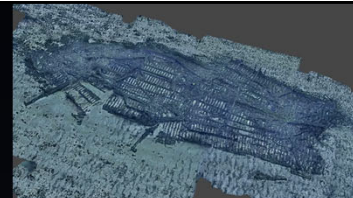


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Conclusion

Underwater Photogrammetry:

- Offers many advantages in the field of maritime archaeology to both specialists, and also the general public.
- Offers many advantages in offshore engineering
 - Subsea pipelines
 - Well heads
 - Offshore energy cables
 - Concrete mattresses
 - Other offshore infrastructure



Unknown wreck, Rottneest Shipwreck Graveyard.

American B-17 Bomber "Black Jack" wreck (lost 1943)

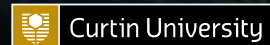
3D Model by Daniel Adams, Curtin University HIVE,
from photos captured by Grant Thomas
and Andrew Hamilton in June 2023.
© Curtin University HIVE.

B17 Bomber (1943)

SS Nemesi wreck (1880 - 1904)

3D Model by Daniel Adams, Curtin University HIVE
hive.curtin.edu.au
Commissioned by Heritage NSW
from footage by CSIRO Marine National Facility
(https://ror.org/01mae9253)

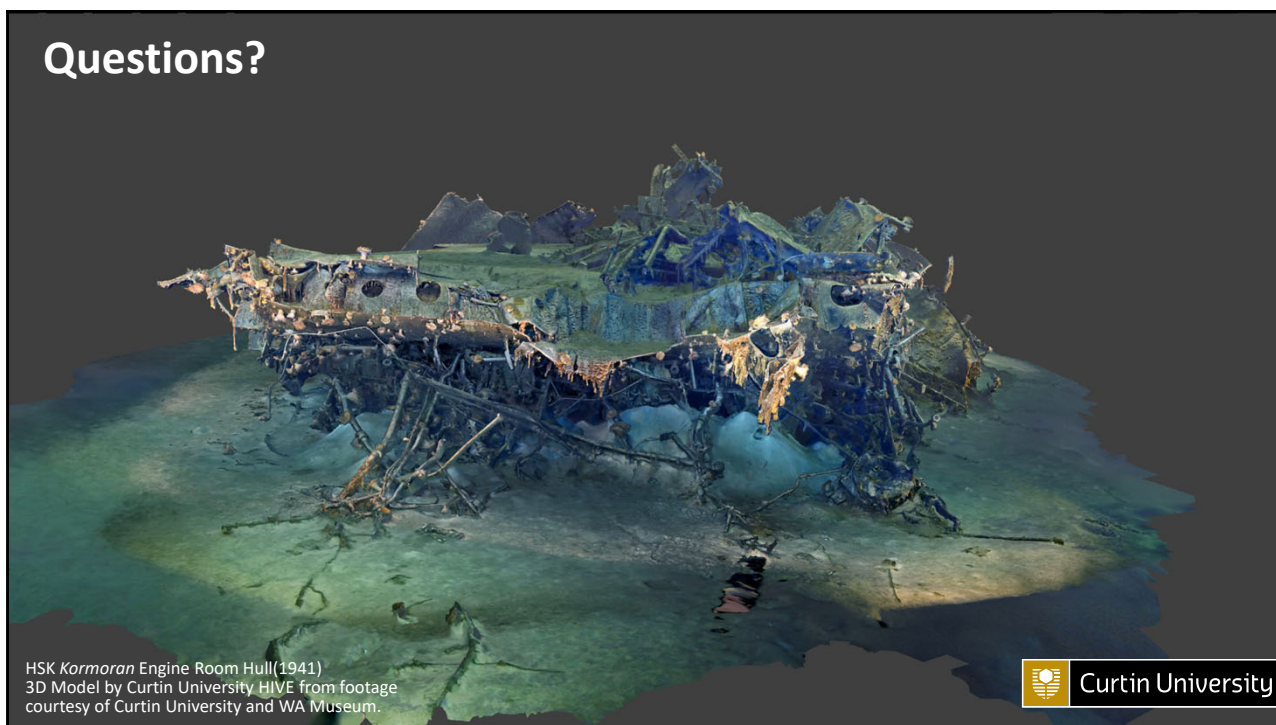
SS Nemesi (1904)



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