United Kingdom Hydrographic Office

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Challenges of Developing 3D Models of the Littoral Zone

3D Mapping and Visualization of the Naval Operation in the Littoral Zone

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Background

Helyx are a leading provider of end-to-end Geographic Information System (GIS) solutions for the management and exploitation of information based in Tewkesbury in the UK. Defence, security and public safety are our core markets.

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UKHO provide nautical charts and navigational services of the world's oceans and ports to support world shipping, including the Royal Navy.

Background

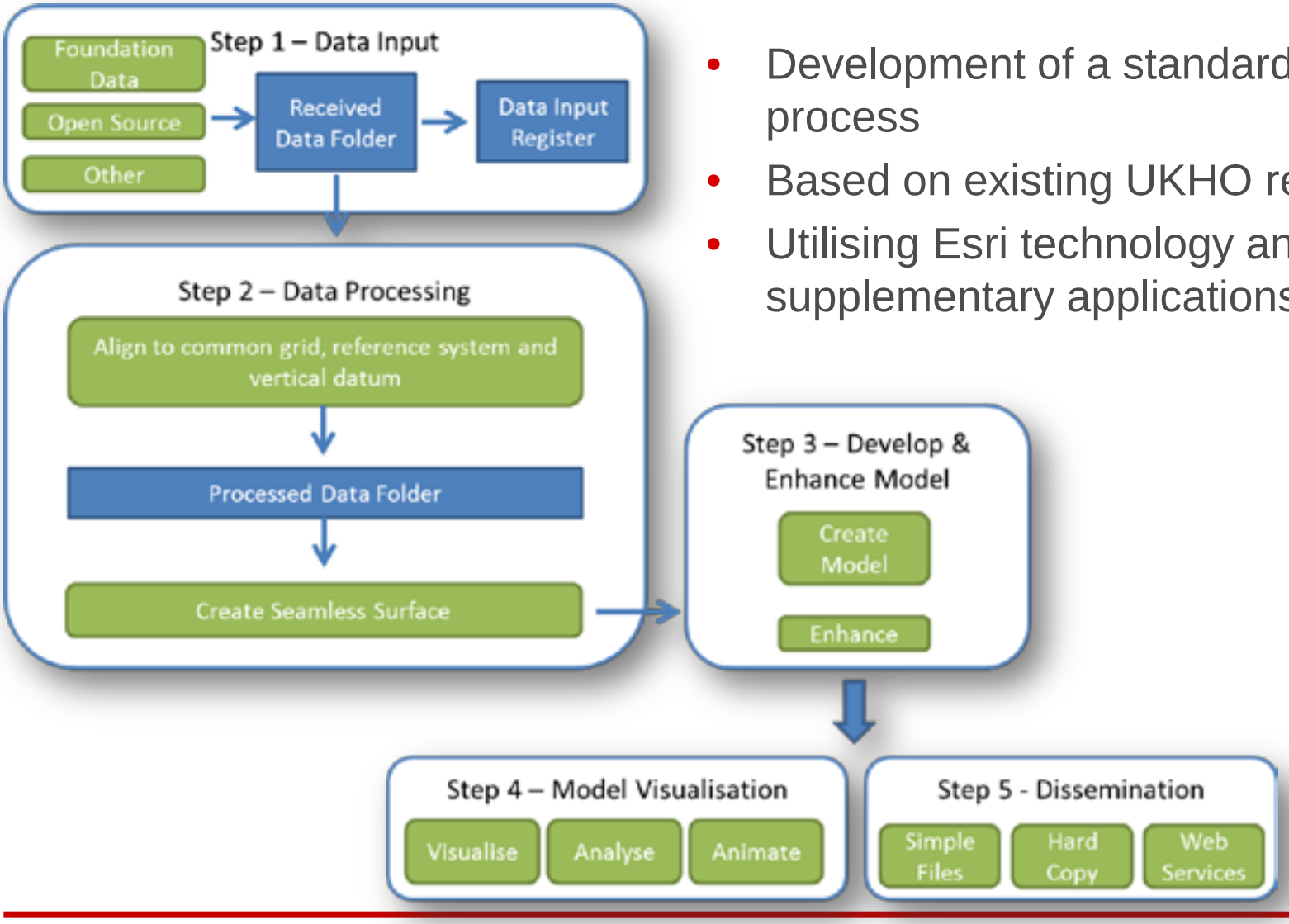
- Advanced Geospatial Information and Intelligence Services (AGIS) Task 4 – Creating Urban 3D Environments
  - Methodology based on a consistent approach between UK Specialist Geospatial Centres
  - Interoperability testing between domains (GIS, BIM, M&S)
- R&D by Helyx under contract to UKHO Defence Maritime Geospatial Intelligence Centre
  - UKHO Phase 1 – Apr 13 to Jun 13
    - Provided a methodology for 3D situational awareness of the littoral zone, based in Plymouth, using a port entry scenario.
  - UKHO Phase 2 – Dec 13 to Nov 14
    - Extends Phase 1 to include additional data and use cases

Requirement

- Future Character of Conflict
- Operational Challenges
  - e.g. mobility, transitioning through differing environments

- 3D models can be used to support maritime operations to meet these challenges
- Helyx were tasked to create a littoral model of Plymouth and provide a repeatable methodology within the UKHO Esri focussed workflow

Methodology



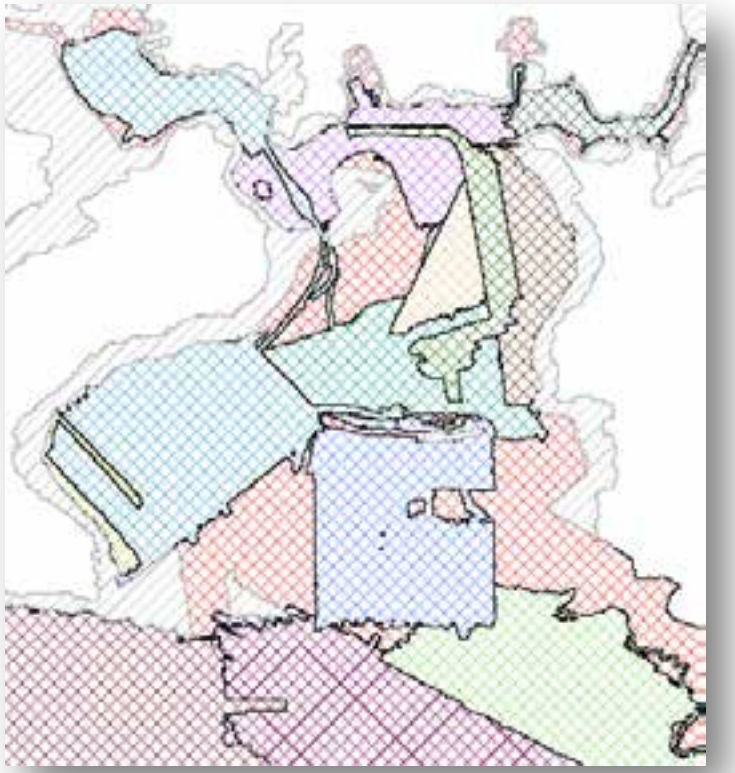
- Development of a standardised process
- Based on existing UKHO resources
- Utilising Esri technology and supplementary applications

Data Input

- Data availability and coverage was a key challenge
  - Differing spatial and temporal extents and varying methods of capture
  - Varying sources of data (e.g. mapping agencies)
- Sources: Bathymetry, Imagery, LiDAR, AML, MFDB, AIS, weather, water column, 3D models

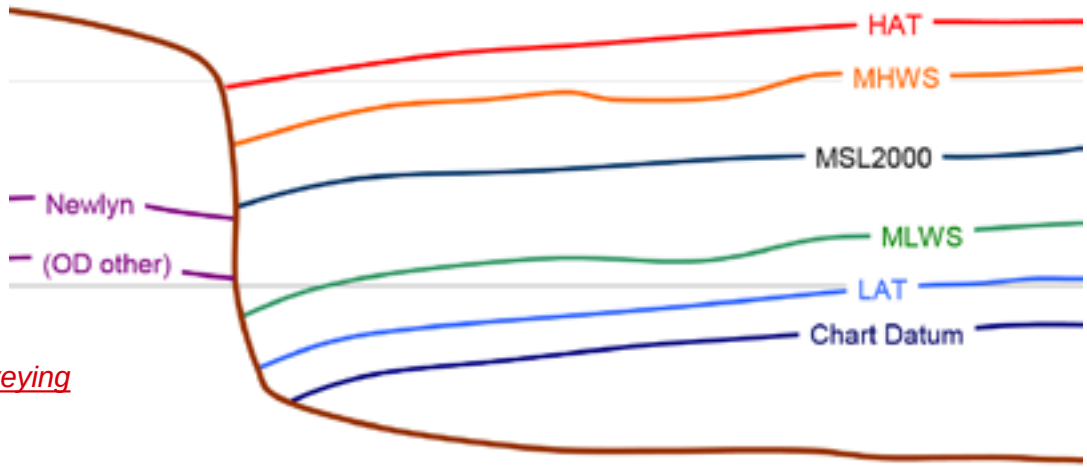
Data Processing Challenges

- Integrating terrestrial and hydrographic data
- Varying coverage, resolution and age of bathymetric data
- Maintenance of transparency and trust in underlying data
- Data volume and complexity



Data Processing Solutions

- Creation of a single surface model
  - Prioritisation of bathymetric data based on resolution and age
  - Alignment of vertical datums using the Vertical Offshore Reference Frame (VORF)
  - Maintenance of a metadata log



Source: A model for surveying to the ellipsoid, UKHO

Development and Enhancement

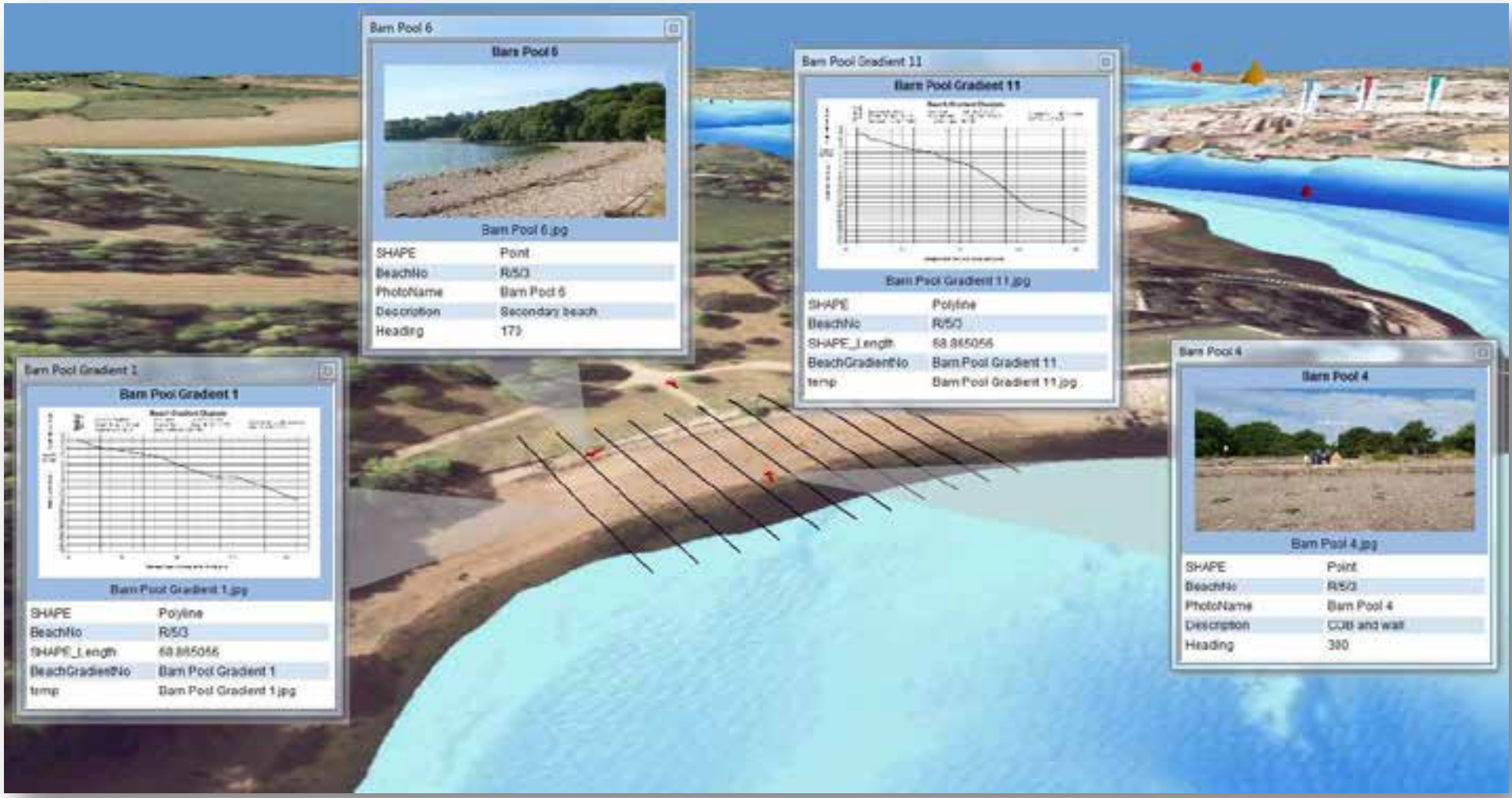
- Evolving the basic model into a more detailed model
- Conversion of 3D models between varying software applications
- Construction of bespoke 3D models in SketchUp
- Generation of representative buildings in CityEngine
- Management of the large volume of 3D models and data

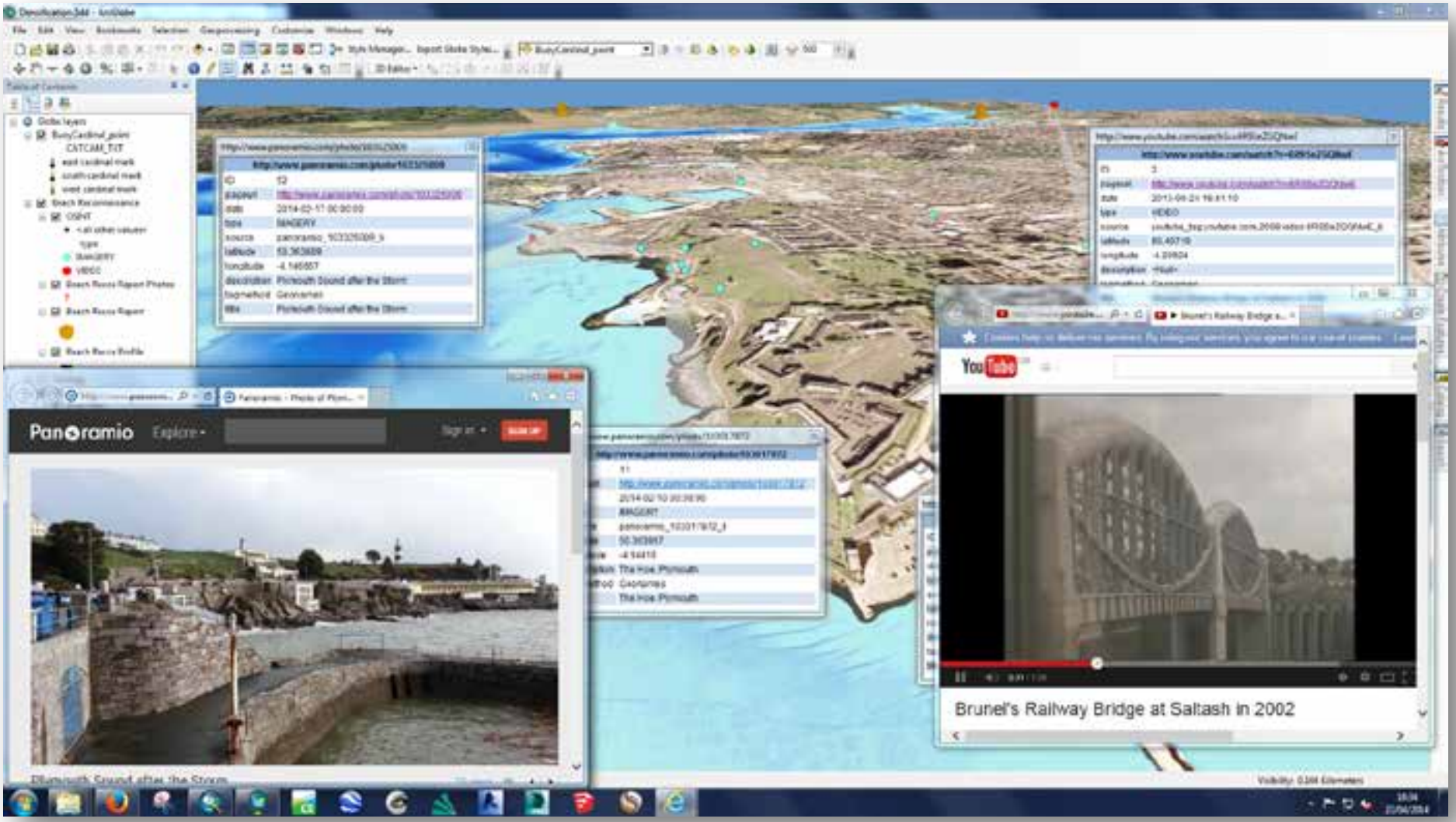
Development and Enhancement

- Model densification methodology
- Creation, conversion and representation of buildings and feature models within ArcGlobe
  - Rule based 3D building generation using CityEngine
  - 3D feature models creation in SketchUp
  - Conversion of 3D models from the modelling and simulation and open source communities using defined methodology
  - Creation of a 3D model repository

Development and Enhancement

- The complexity of 4D information poses a challenge, particularly where parameters are highly temporally variable, or streamed live
- Integration of additional data sources:
  - OSINT
  - Beach reconnaissance reports
  - Automatic Identification System
  - Weather and water column

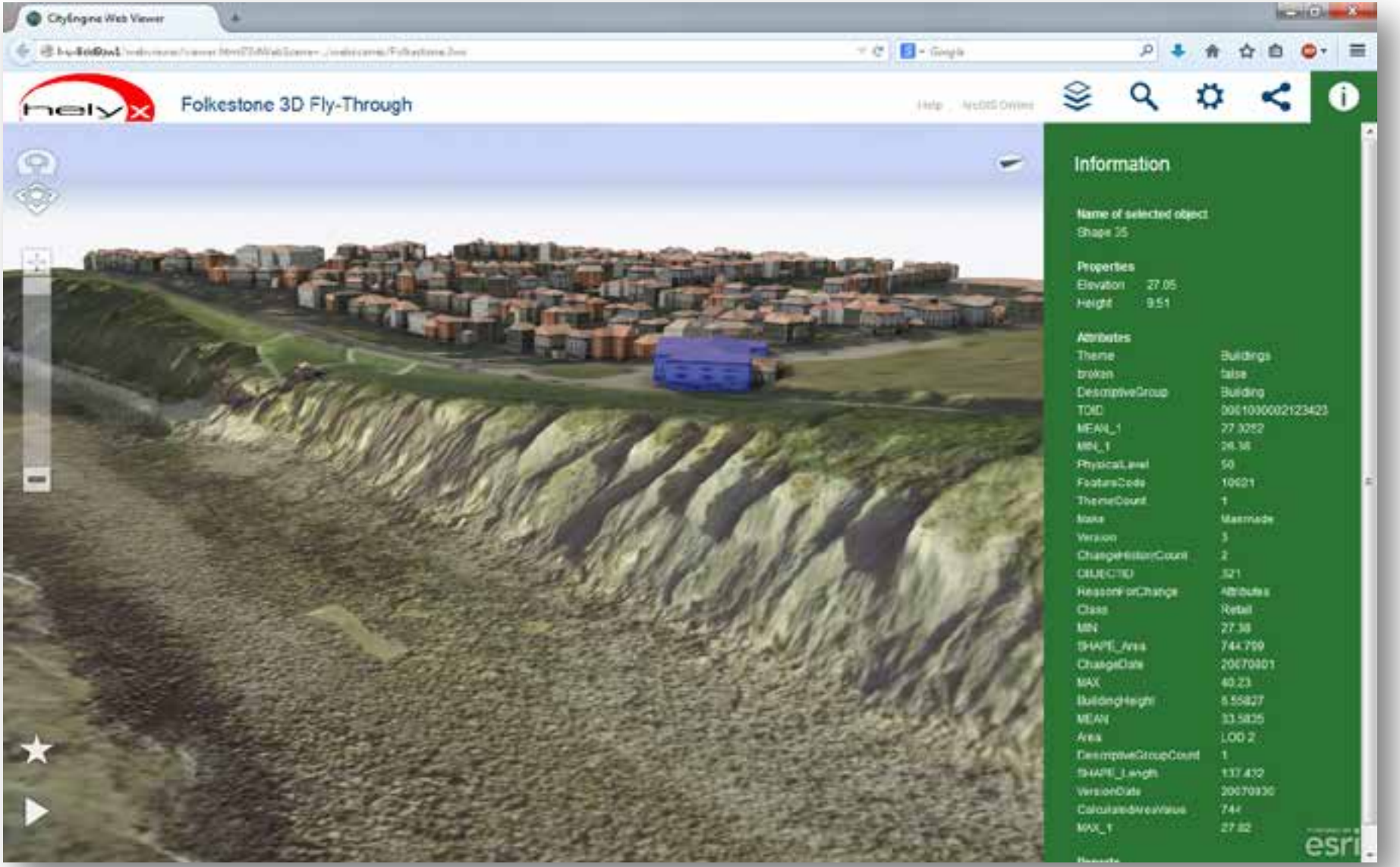

Barn Pool 6
Barn Pool 6
Barn Pool 6.jpg
SHAPE Point
BeachNo R/5/3
PhotoName Barn Pool 6
Description Secondary beach
Heading 173
Barn Pool Gradient 11
Barn Pool Gradient 11
Barn Pool Gradient 11.jpg
SHAPE Polyline
BeachNo R/5/3
SHAPE_Length 68.865056
BeachGradientNo Barn Pool Gradient 11
temp Barn Pool Gradient 11.jpg
Barn Pool Gradient 1
Barn Pool Gradient 1
Barn Pool Gradient 1.jpg
SHAPE Polyline
BeachNo R/5/3
SHAPE_Length 68.865056
BeachGradientNo Barn Pool Gradient 1
temp Barn Pool Gradient 1.jpg
Barn Pool 4
Barn Pool 4
Barn Pool 4.jpg
SHAPE Point
BeachNo R/5/3
PhotoName Barn Pool 4
Description COB and wall
Heading 360



Source: http://www.panoramio.com/photo/103325009, https://www.youtube.com/watch?v=6R9SeZGQNwE

Dissemination

- Challenges include data volume, level of detail, connectivity/bandwidth and end user expertise
- Helyx have researched a number of 3D dissemination techniques
  - 3D web services are in their infancy and are not mature enough for live system implementation
  - Current options include:
    - CityEngine WebScene, recorded animation, VRML, 3DPDF, 3D Print.


CityEngine Web Viewer
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Folkestone 3D Fly-Through
Information
Name of selected object
Shape 35
Properties
Elevation 27.05
Height 9.51
Attributes
Theme Buildings
broken false
DescriptiveGroup Building
TOID 0061000002123423
MEAN_1 27.3252
MIN_1 26.36
PhysicalLevel 50
FeatureCode 10021
ThemeCount 1
Make Manmade
Version 3
ChangeHistoryCount 2
OBJECTID 321
ReasonForChange Attributes
Class Retail
MIN 27.38
SHAPE_Area 744.759
ChangeDate 20070801
MAX 40.23
BuildingHeight 6.55827
MEAN 33.5835
Area LOD 2
DescriptiveGroupCount 1
SHAPE_Length 137.402
VersionDate 20070930
CalculatedAreaValue 744
MAX_1 27.82
esri

Conclusions

- A number of operational and technical challenges are associated with the development of 3D models of the littoral zone
- Research has demonstrated the feasibility of littoral zone 3D model creation using existing data sources and software.
- Understanding and visualising the littoral zone within a 3D model helps improve maritime situation awareness.
- Availability of data with sufficient coverage and resolution remains a key challenge. However remote collection techniques may provide access to crucial information within constrained environments.

Conclusions

- Continuing work will utilise emerging technologies as they become more stable:
  - Bathymetric LiDAR, stereo imagery and UAV LiDAR data collection can help towards data collection in ‘data sparse’ areas
  - Standards and software improvements: agreement between 3D domains on standardised exchange formats and methodologies will improve collaboration whilst software improvements will improve speed and stability

Thank you

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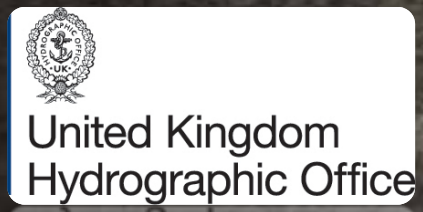

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