Bremen Cog, when Science meets the Public

Amandine Colson, German Maritime Museum, Bremerhaven, Germany
Levente Tamás, University of Cluj-Napoca, Romania
Stefanie Wefers, i3mainz, Germany
Deutsches Schifffahrtsmuseum

- Museum & Research Institute from the Leibniz Association
- 46.5 Employees
- Collection: Archaeological Objects, Shipping History, Shipbuilding
The Bremen Cog

- Discovery: 1962
- Dendrochronological dating: 1378
- Conservation: Polyethylene Glycol
- On display since 2000
- Dimensions: 24 m long, 7 m wide, 4 m high
1. Which cultural heritage (research) question(s) is addressed?

- 3D spatial monitoring and visualization of degradation and deformations processes
  
  How can we monitor deformation processes on a large scale object?
  
  Can we fuse data sets coming from different instrument?
  
  Can data sets be reuse for different purposes?
  
  For examples dissemination or museum education?
2. Which recording technique(s)/method(s) were used and why?

- Photogrammetry SfM: used broadly in Archaeology for documentation
- Total Station: used at the Vasa Museum in Stockholm for deformation monitoring
- 3D Laser scanning: high accuracy, used in the industry for deformation monitoring
3. How has technology been used?

Common coordinate system to insure comparison between all

- Network of 36 reference points
- Additionally 19 points (in the back) for resection Total station
### 3. How has technology been used?

**Photogrammetry**

#### 1. Acquisition

<table>
<thead>
<tr>
<th>Date</th>
<th>Operator</th>
<th>Duration acquisition (hours)</th>
<th>Duration post-processing (hours)</th>
<th>Number of pictures</th>
<th>Pictures ground floor</th>
<th>Pictures first floor</th>
<th>Pictures second floor</th>
<th>Daylight (yes/no)</th>
<th>Camera</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>October 2014</td>
<td>Julien Guery</td>
<td>2</td>
<td>3*</td>
<td>197</td>
<td>72</td>
<td>74</td>
<td>51</td>
<td>yes</td>
<td>Nikon D300</td>
<td>Agisoft PhotoScan</td>
</tr>
<tr>
<td>October 2014</td>
<td>Julien Guery</td>
<td>2</td>
<td>2*</td>
<td>115</td>
<td>39</td>
<td>33</td>
<td>43</td>
<td>yes</td>
<td>Canon IXUS - NIR</td>
<td>Agisoft PhotoScan</td>
</tr>
<tr>
<td>March 2015</td>
<td>Julien Guery</td>
<td>1,5</td>
<td>4*</td>
<td>235</td>
<td>80</td>
<td>75</td>
<td>80</td>
<td>no</td>
<td>Nikon D300</td>
<td>Agisoft PhotoScan</td>
</tr>
<tr>
<td>April 2016</td>
<td>Massimiliano Ditta</td>
<td>1,5</td>
<td>12</td>
<td>675</td>
<td>252</td>
<td>207</td>
<td>216</td>
<td>yes</td>
<td>Nikon D300</td>
<td>Agisoft PhotoScan</td>
</tr>
</tbody>
</table>

*this post-processing includes aero-triangulation and 3D point cloud generation but no Digital Surface Model (DSM) or ortho-photos generation

©Colson for DSM
3. How has technology been used?

Photogrammetry

1. Acquisition

©Guerry for DSM
3. How has technology been used?

Photogrammetry

3. Constraints (for measurements, processing, realisation of work)

- Light issues
- Metal structures
- Including reference points
3. How has technology been used?

Total station Leica TS06

1. Acquisition

- Live with Rhinoceros + Termite Plugin
- Use of older target points on the ship
- Reference points
- Resection points
- Use of “feature points” for the inside
- Accuracy: ±2mm

Duration: 2 days

©Ditta for DSM
3. How has technology been used?

Total station

2. Processing

none : data recorded in Rhino, no further processing necessary
3. How has technology been used?

Total station

3. Constraints (for measurements, processing, realisation of work)
- No reference points inside the ship: use of feature points
- Reproducibility of the protocol?
- Visualization of deformation

©Ditta for DSM
3. How has technology been used?

3D Laser scanning

- Deformation analysis of Bremen Cog
- Set-up of a local reference system
- 3D-recording with TLS
- Visualisation of 3D-model
3. How has technology been used?

- complex shape of the cog
  - inner & outer part with occluding areas
- object size & limited space around the cog
  - short distance between object and scanner
- conservation condition
  - Scanner position outside the cog and
  - on three levels
3. How has technology been used?

3D recording and data processing

- Tachymetric surveying used to generate a local reference system
  - Fixed-points:
    permanently applied reference points for future measurements
    accuracy: ca. 3 mm (adjusted)
  - Tie points:
    used to reference the point clouds generated by the TLS
- Laserscanning (Leica ScanStation P20)
  - 29 scanning positions, on 3 floors
  - ca. 40 million points for each full scan (360° vertical, 270° horizontal)
  - resolution of each point cloud: 6.3 mm @ 10 m
  - accuracy: 3 mm @ 50 m (manufacturer information)
- Alignment of 29 point clouds based on the local reference system
  - uninteresting areas (such as floor, roof) deleted > ca. 30 million points
  - Reduction of point cloud to point distance of ca. 5 mm
3. How has technology been used?

Coloured point cloud

> This point cloud could be used for a deformation analysis as soon as a second point cloud linked to the same local reference system is available.

> Geometric deformations of more than 5 mm can be detected.
Involvement at technical side

Levente TAMAS

Technical University of Cluj

2013-2016
Personal involvement

- 2013 - Laser data parsing/case study review
- 2014 - 1 day visit @ DSM
- 2015 - 1 week STSM in September @ DSM
- 2016 - COSCH Presentation/discussions
Worked on topics

- Heterogeneous scan data preprocessing
  - See Zoltan Kato & Levente Tamas @ CCIW2015

- Scan registration

- Evaluation/comparison
Interdisciplinary output

- Inter-disciplinary work, talks, presentations, meetings, etc:

Check out the original presentations at:

1. Large scale object monitoring
2. 3D Cloud compassion
3. Processing chain for cloud comparison
What is next from my side?

- Heterogeneous data registration
  - How to store apple&pear?

- Heterogeneous data comparison
  - How to distinguish apple&pear?

- Heterogeneous object composite
  - How to mix apple&pear?
4. How did the data of the recording technique(s)/method(s) support the cultural heritage tasks?

1. Relevant (characteristics of) content, which is inevitable to answer CH question
   - Object size
   - Accuracy needed
   - Type of acquisition: once or several

2. Identified factors having impact on the content
   - Expertise available (end-user/expert)
   - Software/hardware available
4. How did the data of the recording technique(s)/method(s) support the cultural heritage tasks?

3. Measures to be taken helping to assure required content
   - Planning better the project
   - Look for permanent cooperation partners in the geodesy field.
5. What are the limitations and sources of error?

At that stage of the project:

- Coordinate system (after renovation?)
- Data processing
- Data analyses
6. What are the benefits of the recording technique(s)/method(s)/data in comparison to traditional methods?

- Accuracy
- Overview on the data
- Comparison over time
- Using for dissemination
7. Which COSCH Primary Tasks (PT) and sub-tasks (st) are addressed (see COSCH MoU)?

- WG 2 st2.2 Analysis and comparison of the different 3D scanning techniques
- WG 3 st3.2 Integration of multi-sensor data
- WG 4 st4.1 Identification, structuring and implementation of typical use cases
- WG 4 task s4.2 Development of guidelines
- WG 5 st5.1 Identification, planning, implementation and testing of typical applications of visualisation within CH domains
- WG 5 st5.2 Further development of visualisation techniques
Output

Conference talks outside the COSCH Community
Condition 2015, Gdansk, May 2015
Journées des Restaurateurs en Archéologie, Toulouse, Octobre 2016

Publication

PhD Project
Amandine Colson, German Maritime Museum

EU-Network (in progress)
Working Group on deformation monitoring of conserved ships (1st Meeting Spring 2017)
Thank to the support of all contributors from the case study and beyond ...
Thank you for your kind attention!