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# FIG WORKING WEEK 2023

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## Development of survey control and problem based learning in Heritage Tunnels North Derbyshire, UK

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## Background

- Postgraduate field course in the Peak District
- Aim is to scan former railway tunnels along the Monsal Trail
- Trip allows students to have practical experience surveying real infrastructure
- Student cohorts lack experience using LiDAR



## Aims and Objectives

- To create a robust survey control system within a challenging environment
- To allow for different rates of progress in the field
- To develop problem-based learning practice

## Past Practice

- Tunnel scans allow students to monitor and assess the asset (ISO 55001)
- Steady pace of work due to tunnel alignment and length of working day
- Recent increase in international students with limited practical experience
- Slower progress and more issues compared to previous cohorts



## Problems with surveying the tunnels

- Poor lighting leading to issues with locating and sighting targets
- Refraction of LASER in curved tunnels
- Shorter target shots required to minimise atmospheric corrections (longer tunnels)
- Restrictions on creating stations and leaving equipment overnight
- Condensation on Lens and water



## Developing a solution

- Creation of fixed reference points within the tunnel
- Attempts to use flat targets fixed to the tunnel walls were partially successful
- Angle of incidence impacted the target measurements
- Clustered control led to poor degree of accuracy



## Developing a solution

- Working together with the Peak Parks Authority (PPA) to find a solution
- Use of small tiltable prisms
- Metal resumption points allow the temporary installation of prisms
- Located in the middle of the tunnel
- Prisms formed strong 3D control (vertical and horizontal)





## Developing a solution



## Practical teaching impacts

- Problem based learning (PBL)
- Students asked to plan solutions to control issues
- Students are shown the working solution and asked to identify benefits and limitations
- Assessment of the working range errors by running raw data reports

Chee Tor Tunnel Original Field Data

	Working range error in mm		
Target	X plane	Y plane	Z plane
23	12.5	23.1	17.9
24	9.7	12.6	15.3
25	24.7	19.0	11.6

Litton Tunnel Test with Tilting Prisms

	Working range error in mm		
Target	X plane	Y plane	Z plane
Test 3	1.5	0.8	2.2
Test 4	0.3	1.2	0.6
Test 5	1.9	0.0	2.1
Test 6	3.4	1.1	0.7

## Conclusions

- The working solution has improved problem solving skills and can be actively introduced into teaching sessions to enhance PBL
- Students can work at their own rate and continue data collection over multiple days
- PPA now have access to control measures with limited intrusion
- GNSS tagging and linking control to GNSS network could be evaluated with further research

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## Thank you for listening



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