Results of Competition: SBRI: Innovation in Automated Tunnel Examination

Competition Code: 1909_SBRI_NR_TUNNEL

Total available funding is £1.5m plus VAT (£1.8m)

Note: These proposals have succeeded in the assessment stage of this competition. All are subject to grant offer and conditions being met.

Participant organisation names	Project title	Proposed project costs	Proposed project grant
COWI UK Limited	Disruptive Innovation Towards Automated Tunnel Examination	£594,000	£594,000

Note: you can see all Innovate UK-funded projects here: https://www.gov.uk/government/publications/innovate-uk-funded-projects
Use the Competition Code given above to search for this competition's results

Project description - provided by applicants

The purpose of this project is to develop techniques to reduce the amount of time personnel need to spend on the ground examining tunnel structures and hence reducing exposure to health & safety risks and reducing costs while enhancing asset knowledge of rail staff. This will lead to less disruption to rail passengers by reducing disruptive possessions required for examinations.
The project will develop a mobile mapping solution using a combination of technologies. It will build on the road-rail tunnel inspection vehicle developed by Railview as a subcontractor within the IN2TRACK2 project of SHIFT2RAIL and co-financed by Network Rail. This test vehicle builds on the previous Innovate UK INFRAMONIT project. The INFRAMONIT-TUNNEL test vehicle developed incorporates the next generation of Infrastructure Inspection Radar that will scan the tunnel lining and invert to build a 3D visualisation of the asset condition and this will be dedicated to this new project. This technology will be combined with mobile mapping laser scanners and associated positioning equipment to acquire accurate and precise geo-located spatial data as a point cloud representing the surface of the tunnel. The mobile mapping sensor platform will not only capture point cloud data but also 3600 imaging data. This multi-platform approach builds in redundancy in the data and improves survey reliability.

The data collected will be processed to build an accurate three-dimensional model which can be viewed and manipulated by engineers. This is a development of current state of the art tools which have been used by COWI for virtual inspections of bridges.

A key part of this proposal is to develop the use of machine learning algorithms to process the survey data to automatically detect anomalies and then further, to categories the defects in accordance with the Tunnel Condition Monitoring Index (TCMI). By adding intelligence to defects and using state of the art survey equipment, data from future surveys can be compared with the baseline, quickly identifying changes since the previous survey.

A combination of semi-automated defect detection and manual virtual inspections will be used to allocate the TCMI codes to defects and generate a report in the required format. The scanning and modelling process will result in much richer background data than that contained in the standard inspection report, which can then be used as part of the ongoing asset management process, including specification of remedial measures.

The final stage of the project will be to undertake an Operational Environment Demonstration and evaluate the results in conjunction with Network Rail's asset managers.

The key innovations of this proposal are to develop a new work flow for tunnel examination including: application of subsurface inspection radar technologies to the tunnel environment; improvements in positional accuracy; machine learning to automate the identification of certain defects; and production of a data-rich three-dimensional model of the tunnel to facilitate ongoing asset management and maintenance activities.

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NPL Management Limited	DIFCAM Evolution	£598,434	£598,434

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Project description - provided by applicants
DIFCAM Evolution is a development of the previous InnovateUK DIFCAM project that established the practicality of combining high resolution imagery with shape measurement to enable change in tunnel condition to be measured for the purpose of tunnel examination, evaluation and management. DIFCAM Evolution presents an opportunity to build on the solid foundations of knowledge and experience already gained from the original DIFCAM project, further developing the technologies used, enhancing and expanding capabilities in key areas such as subsurface defect detection and automatic defect recognition, and positional reproducibility using RailLoc. It will also provide a road-map for the integration of the successful technologies to deliver Network Rail's aspiration for fully automated tunnel examinations that can replace manual inspection techniques. DIFCAM Evolution will demonstrate feasibility and be a test bed for several data gathering technologies that would be needed for automated tunnel examination. These fit broadly into the categories of positional measurement and control, visual examination of the tunnel intrados, measurement of tunnel shape, determination of sub-surface defects and other important 'features of interest' such as lining thickness and quality, ground contact with the extrados and the presence of shaft eyes, for example. The development phase will combine trials of a range of non-destructive evaluation techniques alongside the cutting-edge systems provided by our technology partners, with varying technology readiness levels. The new types of data generated by the DIFCAM Evolution system will provide new opportunities for creating value and supporting the management of tunnel assets. As part of the project, processes will be developed for data fusion and analysis, including the automated identification and classification of defects in accordance with Network Rail's TCMI specification, which will be reviewed with a view to extending and enhancing it to make the most of the system's capabilities. The project will deliver a report which includes a critical review of the work carried out and its results, identifying key activities for further development and associated challenges and opportunities, with a road-map for future deployment and commercialisation to achieve Network Rail's objective of fully automated tunnel examination that considers not only technological development but also the challenges and opportunities presented by regulatory requirements, safety and technical/operational standards. This will directly support Network Rail in aligning the management of tunnel assets with their corporate objectives, delivering outputs in a safe and sustainable way while balancing life cycle costing with initial affordability.The exposure of rail workers to hazards and improvement of their wellbeing by reducing requirements to do monotonous work at anti-social times and in dirty and unpleasant environments will also be minimised through significant reduction in the requirement for 'boots on the ballast' examinations.

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Participant organisation names	Project title	Proposed project costs	Proposed project grant
Amey OW Limited	New Automated Tunnel Examination System (NATES)	£495,560	£495,560

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Project description - provided by applicants

New Automated Tunnel Examination System (NATES)

The approach to inspecting and assessing railway tunnel condition in the UK has not materially changed in decades. Whilst the collection of condition data is now largely completed in the field and immediately uploaded to central databases, the examination itself remains a physical process, undertaken by qualified engineers in all weathers, requiring considerable periods of track access, and working at height, and exposure to the often hazardous rail infrastructure environment.

This methodology is inefficient, unrewarding, and exposes people to increasingly unacceptable and unnecessary hazards. In particular it results in scarce specialist resources spending the majority of their time accessing and examining infrastructure that presents no defects - an unavoidable result of having to physically examine all tunnel elements in order to identify those that are defective. Our objective is to automate the majority of this activity such that our specialist engineers can focus their unique skills on addressing those parts of the infrastructure which are known to be defective.

Amey, working with Collins Aerospace and The Manufacturing Technology Centre (MTC) has designed NATES - a development programme designed to harness a unique set of capabilities and experiences to transform the assessment of UK railway tunnels.

ATICA aims to deliver an automated system to examine railway tunnels, process the data captured, and present the findings in line with existing report formats.

This serves to: remove many people from hazardous environments; accelerate the examination and reporting process; improve the consistency, repeatability, and accuracy of examinations; and provide greater potential for data analysis to optimise asset management strategies and improve predictive maintenance approaches.

Amey has examined and assessed Network Rail structures throughout CP4 and CP5 and has deep knowledge of this sector. Collins Aerospace brings unique surface recognition and massive data processing capability from the secure military sector. The MTC brings unique sub-surface assessment technologies developed with Amey specifically to address this challenge.

Building on previous work already done at risk by Amey and consortium member The Manufacturing Technology Centre, the project will take an already Lab based proven technology for subsurface inspection and continue its testing and development into a deployable solution for linear inspections. Adding to this consortium member Collins aerospace will support the delivery of a AI based surface inspection element, utilising experience from the military domain and proven technologies in other surface based inspections. Amey and Collins aerospace are already working on multiple inspection and survey projects for other infrastructure condition monitoring projects and are confident previous solutions can be adapted for the extreme environments seen in rail tunnels. Development work will be mainly based on the adaptation of the technology for the demanding environment to ensure the linear environments defects are captured in an efficient and effective manner.