BRIDGE OWNERS FORUM

16th January 2018

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Grand Challenges

- From Wikipedia:

- *Grand Challenges are lists of important problems developed to energise and encourage the community (research, commercial organisations, professional bodies) to understand the issues and accelerate solutions. They are beyond ordinary research questions, may be global in scale, difficult but possible to solve, but involving numerous projects. They must capture the popular imagination to gain support.*

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Grand Challenges

- Six grand challenges have been identified as follows:

  What

  - Preventing bridge failures
  - Extending the life of existing structures
  - Building bridges that will perform better

  How

  - Embracing innovation and embedding technology
  - Securing a competent, diverse workforce
  - Sharing knowledge and best practice

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BRIDGE OWNERS FORUM GRAND CHALLENGES

❶ EXTENDING THE LIFE OF EXISTING ASSETS

A paragraph of approximately one hundred words outlining the challenge.

- A clear explanation of the challenge.
- Why is this issue considered a Grand Challenge? (A Grand Challenge is a significant issue which will need pooling of expertise and resources to solve)
- Why is this issue important – what will happen if it is not solved, or what are the benefits of solving it?
- Capture the imagination

Some links for inspiration:

UK Government Industrial Strategy – Grand Challenges
Network Rail Challenge Statements

KEY FACTS

UK Bridges have a value around £100billion. Less than 0.4% of this amount is spent annually on maintenance. The maintenance backlog is increasing at 10% per year.

60% of the nation's highway bridges are of reinforced concrete and average 50 years old. Maintenance costs are predicted to escalate over the next 20 years.

The average age of rail bridges is 105 years. Over 40% are considered in urgent need of repair or replacement.

Traffic volume, road and rail, has doubled over the last 20 years and continues to increase putting ever greater burden on existing assets.

Our best designers specialise in new structures. How do we interest them in maintaining and improving existing assets?

PRIORITY AREAS FOR DEVELOPMENT

Up to 10 likely areas where solutions could develop. These are the priority research areas.

Alternatively, the key questions that need to be addressed

Consider the findings of the themes that were developed to date.

For example, the ageing infrastructure challenge might include the following.

How do we use Structural Health Monitoring to better understand structural performance and condition of existing structures?

New materials for repair and protection.

Improved NDT and forensic engineering techniques

Can a structure be continually maintained or does replacement with modern equivalent offer better value?

Too simple?

Automating Inspection and Maintenance Activities to Remove Workforce from High-Risk Areas and Improved Data Capture

What is the situation?

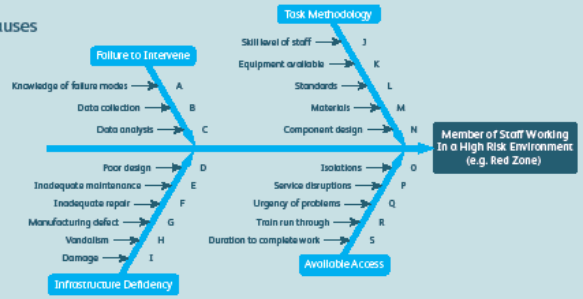
Robotics, Automation and Artificial Intelligence (RAAI) offers a potential step change in the way we manage asset data, undertake infrastructure inspection and maintenance activities on the UK railway network. This innovation will help us to deliver key business objectives of safety, performance, customer experience, capacity, cost efficiency and sustainability.

The introduction of the Digital Railway and the deployment of ERTMS will lead to an increase in capacity of the network. As we increase capacity and run more train services, the opportunity to undertake maintenance operations will reduce and degradation rates will increase.

We also need to accurately understand the condition of the assets so we can plan and perform timely maintenance activities. Autonomous systems will monitor the network, providing Artificial Intelligent Systems the data to analyse and develop trends of asset-risk. This will enable decision support tools to schedule the most effective inspection and maintenance programs with minimal disruption.

More trains will equate to more wear on the infrastructure. This will lead to an increase in inspection and repair requirements. We need to be more productive with possession time. It is expected Robotics and Automation could be one answer in enabling more productivity.

Analysis of causes



Priority problems

Specific priority problems

- Carrying out inspections in hazardous environments puts staff at risk. Therein a need to investigate means of doing this autonomously or remotely to reduce the risk.
- Demonstrating improved quality of inspection data capture (reproducibility and repeatability).
- Create an economical solution, where all devices are modular and use common communication protocols.
- Providing proof-of-concept within a system engineering environment.
- Logically planning the progression along the degree of automation.

Related goals

- Creating an overarching systems architecture to operate all remotely controlled (unmanned) systems.
- Concept demonstrator for:
  - railhead repairs and
  - brick-lined tunnel inspections.
- Identifying and replacing, through technological development, further high-risk activities currently performed by some front-line staff to go through the same process.

Scope

There are significant challenges facing the railway, including a need to reduce disruption to services.

The requirements are to:

- Improve workforce safety: be more productive using automation and increase the reliability of the infrastructure, thus increasing the capacity of the infrastructure.
- Improve workforce safety: reduce the need to access the infrastructure, develop technologies to enable activities to be remotely controlled from safe areas and mechanise and automate processes to remove manual tasks.
- Increase infrastructure reliability: automating inspection activities would improve the precision and accuracy of the data collection, introducing data analytics, removing human bias from these activities, improving repeatability and reproducibility. This will improve information about asset condition, inform inspection and repair schedules based on asset risk.

Both the Rail Technical Strategy (RTS) and Network RTS identified that autonomous robotic systems could be a potential step towards a resolution.

Demonstrator Statistics: Quality issues (e.g. Level of Rework); Number of staff working red zone; Level of injury due to manual handling/HAV.

Expected impact & benefits

We see this technology being used in two main scenarios:

- Development of a distributed sensor network enabling data to be provided to modelling, analytical and decision tools to support systems. With the aim of reduced cost and maximised network availability for routine inspection and maintenance interventions.
- Development of modular robotics to automate maintenance and inspection activities. This will reduce the requirement for infrastructure access improving worker safety, reducing cost and maximising network availability for routine inspection and maintenance interventions.

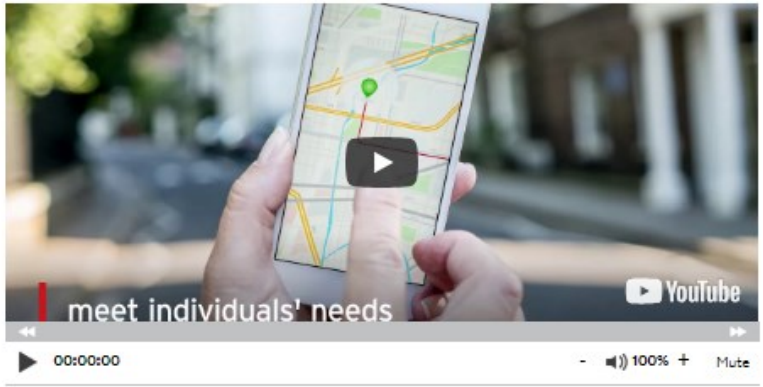
More graphics?

Artificial intelligence

We will put the UK at the forefront of the AI and data revolution.

Artificial intelligence and machine learning are general purpose technologies already starting to transform the global economy. They can be seen as new industries in their own right, but they are also transforming business models across many sectors as they deploy vast datasets to identify better ways of doing complex tasks – from helping doctors diagnose medical conditions more effectively to allowing people to communicate across the globe using instantaneous speech recognition and translation software.

Embedding AI across the UK will create thousands of good quality jobs and drive economic growth.



Grand Challenges – Way Forward

• Preventing bridge failures	Cam Middleton
• Extending the life of existing structures	Jim Hall
• Building bridges that will perform better	Jason Hibbert
• Embracing innovation and embedding technology	Nicola Head
• Securing a competent, diverse workforce	Neil Loudon
• Sharing knowledge and best practice	Rob Dean

• Finalise template	May
• First draft text	June
• Final text	early-August
• BOF sign-off	end of August

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