Call For Research

Understanding Adhesion Forecasting

11 June 2018
As technology expands we are faced with ever increasing volumes of data to help us. This data is valuable for identifying when and where low adhesion may be a problem, and for deciding what measures to apply to combat the problem.

Proposals funded through this call should develop novel ideas and innovative solutions that can help the rail industry understand adhesion forecasting in order to support decision-making.

Submissions are welcome from non-rail experts who may have experience in other fields, which could be transferred or applied to this specific research call.

**The competition opens on 11 June 2018. The deadline to submit proposals is at 17:00 on 21 September 2018.**

This document contains some background information about the challenge and serves as guidance for the submission of proposals.

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The ADHEsion Research challenge (ADHERE) sets out to deliver research to achieve ‘adhesion conditions that are agnostic to and independent of the weather and climate’ and address industry’s gaps in knowledge where greater clarity could help alleviate the adhesion challenge. ADHERE was developed with the Adhesion Research Group (ARG) and Adhesion Working Group (AWG) and focuses on five workstreams:

- **Changes to Train Design**
  - Exploitation of existing trainborne technology

- **Forecasting Adhesion**
  - Improved decision making in low adhesion conditions

- **Rail Cleaning and Re-Contamination**
  - Improved effectiveness and flexibility of rail cleaning

- **Driver Behaviours**
  - Improved driver confidence and performance in low adhesion conditions

- **Fundamental Research**
  - Improved ability to model low adhesion contaminants and braking

This research call is part of the ADHERE Forecasting Adhesion workstream
1. Background

Adhesion is a year-round challenge for the rail industry. Poor traction and braking from leaf fall in the autumn can cause severe problems to the system; whilst low levels of moisture from dew and light rain, as well as the presence of other contaminants, can affect the small contact point between the wheel and the rail and cause poor adhesion.

Rail head adhesion is a complex problem because of the number of factors involved, some of which can be monitored and controlled and some of which cannot. Due to the complexities involved there are large variations in performance, as adhesion conditions can change rapidly with both time and distance.

The range of possible adhesion conditions reduces the reliability and predictability of braking, which results in significant train disruptions and cancellations and an increased number of safety related incidents including signals passed at danger (SPAD), and station over-runs.

The cost implication of the adhesion problem is also significant. The estimated direct costs (such as rail head treatment trains, manual rail cleaning, etc.) and indirect costs (such as driver reaction and morale; service disruptions and delays; other damages and maintenance etc.) make low adhesion an expensive challenge for the rail industry to tackle.

Improvements in rail adhesion and braking are also an enabler to greater automation and increased capacity leading to significant future benefits.

This call for research aims to address aspects of the vison for the future outlined in the Rail Technical Strategy (RTS 2012) and the Capability Delivery Plan (RTS CDP 2017). The RTS outlines a vision for the future where trains are able to run closer together and service disruption is minimised. The strategy describes the need to develop industry tools that take data and information, based on common architectures and open source technology, making information available in useable formats when and where needed\(^1\).

\(^{1}\) Rail Technical Strategy, 2012
The delivery plan provides further insight and identifies the key capabilities needed to deliver the vision. Particularly relevant to this call for research are Key Capability 1 – Running trains closer together and Key Capability 2 – Minimal disruption to train services. Key Capability 4 – More value from data is an important enabler in this area.

Predicting how conditions will vary from year to year, season to season, even hour to hour is an important part of managing adhesion. As the rail industry moves towards an increasingly digital railway of the future, which seeks to run trains closer together, gain more value from data, and have more minimal disruption to services; there is an opportunity to look at ways to exploit existing datasets and improve the precision, accuracy, latency, resolution and reliability of adhesion forecasts and observations that will make them truly valuable.
2. The industry’s use of adhesion forecasts

In an effort to reduce delays and minimise disruption, the industry invests in a range of mitigation programmes that require varying degrees of foresight and accuracy. Mitigations include activities with long lead times such as vegetation management and implementing timetable changes to shorter term activities such as briefing drivers on daily risk and sending out rail head treatment teams. The industry has many measures in place to help duty holders predict adhesion conditions to deliver a safe, reliable service in low adhesion conditions, with different measures being used at different time intervals.

<table>
<thead>
<tr>
<th>Long-term</th>
<th>Medium-term</th>
<th>Short-term</th>
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<tbody>
<tr>
<td><strong>Infrastructure Seasonal Management</strong></td>
<td>Looking at long-term forecasts and historical information to develop actions plans for the deployment of rail head conditioning programmes and the management of track conditions to prevent the contamination of the rail head. Have processes in place to identify locations where low adhesion may occur. Key roles include Seasonal Delivery Specialist, Vegetation Managers and Route Services. <strong>To inform:</strong> Vegetation management, railhead treatment, staff and plan allocation etc.</td>
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<tr>
<td><strong>Timetablers/planners</strong></td>
<td>Looking at medium and short-term forecasts/information to put actions in place to plan for low adhesion conditions. <strong>To inform:</strong> Planning for longer trains, implementation of the autumn timetable, implementation of operational restrictions.</td>
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<tr>
<td><strong>Fleets engineers</strong></td>
<td>Ensuring that the fleet is suitably equipped to deal with low adhesion conditions and there are sufficient materials and enough staff to carry out proposed plan. <strong>To inform:</strong> Management of trainborne sanding equipment and optimisation of wheel slide prevention equipment.</td>
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<tr>
<td><strong>Driver managers and Signallers</strong></td>
<td>Provide information to train crews to ensure they are suitably equipped to deal with low adhesion conditions. Real-time and predictive reports can help identify areas of low adhesion and support decision making. <strong>To inform:</strong> Driver briefings, berth warnings.</td>
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<tr>
<td><strong>Route Controller</strong></td>
<td>Coordinates the operational within the route on a day-to-day basis. <strong>To inform:</strong> Skip-Stop operation, deployment of operational teams.</td>
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Network Rail and train operators work closely with organisations such as the Met Office and Met Desk who provide data, reports, graphical output and text forecast summaries that are used to inform decision making for tackling low adhesion conditions.

Examples of industry approaches in this area can be found in the latest Adhesion Working Group Manal, Managing Low Adhesion, 6th Edition.
3. Datasets relevant to understanding adhesion forecasting

- Weather observation data: this is collected and quality controlled by the Met Office. It captures standard weather parameters such as temperature; wind speed/direction; humidity; precipitation; dew point and other general weather information.
- Met Office adhesion forecasting data: this is generated to predict adhesion levels on the tracks. It is presented as a colour-coded map, with different colours indicating different levels of expected adhesion.
- Leaf-fall data: this Met Office data provides information regarding the amount of leaves that have fallen from trees. Daily leaf-fall data measures quantities day-by-day, whilst cumulative leaf-fall data adds days together to measure how total leaf-fall has progressed over the season.
- Train event recorder data (On-Train Monitoring Recorder – OTMR or On-Train Data Recorder – OTDR): this is comparable to a train ‘black box’; the data records all train control operations and performance.
- Train Movement data: this is a record of the time at which trains move passed timetabled calling and passing points. A train movement message is sent whenever a train arrives, passes or departs a location monitored by a system called TRUST.
- Train Describer (TD) feed: this provides details about the position of trains and their train reporting number through a network of berths (usually a berth is associated with a signal). A step between berths represents movement of the train from one berth to another. It shows raw data in more detail than the Train Movements feed.
- Darwin: provides real-time arrival and departure predictions, platform numbers, delay estimates, as well as real-time schedule changes and cancellations. It powers all National Rail Enquiry and train operator customer-facing real-time information tools, including websites, mobile apps and train station departure board screens.
- Knowledgebase: contains a wealth of static and real-time information, such as information about station facilities, service disruption, and engineering work.
- WSP data: this records the activation and operation of wheel-slide protection (WSP) brakes on trains.
- Track Circuit Remote Condition Monitoring (RCM) data: this records data from RCM units deployed across the rail network.
- Key performance indicator (KPI) data: this is collected by Network Rail and records:
  - Wrong-side-track-circuit-failure (WSTCF) incidents, where circuit detection loses track of a train.
  - Category A Signal-Passed-At-Danger (SPAD) incidents, where trains fail to stop at signals.
  - Station overruns, where trains overshoot the intended stopping location at a station. This data is broken down into incidents that are adhesion-related and those which are not.
• TRUST Delay data: this records whether a train has been delayed and, if so, the number of minutes it has been delayed by. The information is captured on Network Rail’s TRUST system (a nested acronym standing for Train Running System on TOPS (Total Operation Processing System)).

• iTed performance data: this newly opening database (going online summer 2018) provides information on train movements and delays.

• Bugle data: this consolidates and enables manipulation and reporting of TRUST delay data. The Rail Delivery Group (RDG) is beginning to gather large quantities of Bugle data from summer 2018.

• Average Minutes Lateness (AML) data: this gives delay information with a higher level of resolution than TRUST or Bugle, as it records all delays of one minute or over (as opposed to three minutes).

• Treatment plan data: this records Network Rail’s plans and operations related to adhesion treatments and mitigations, including the deployment of seasonal treatment trains.

• Vegetation management plan: this records Network Rail’s plans and operations related to vegetation control and management.

• Sander trials research data: this records the results of experimental trials comparing the effectiveness of different configurations of on-board sanders.

• Open data available from sources such as the Forestry Commission or Ordnance Survey could also be useful to adhesion forecasting researchers.

The online data ‘sandbox’ has sample dataset that can be accessed to build proposal.

To support the successful projects, we will be working with Network Rail, train operators, train maintainers, manufacturers and owners to gather relevant data this autumn that can be for analysis and research purposes.

If you are interested in supporting the 2018 Autumn Data gathering exercise, please contact us at ResearchCompetitions@rssb.co.uk
4. Scope

The feasibility studies funded through this research call should look at how relevant industry data can be used and analysed to improve adhesion forecast for an identified user groups, has highlighted in Table 1. These may include the datasets described in this document, samples of these datasets can be found at https://rssb.wavecast.io/forecasting-adhesion, or relevant datasets identified by the proposer.

Key challenge areas:

- Using big data techniques to understand the effectiveness of mitigations put in place to manage low adhesion and providing recommendations of how they can be improved.
- Understanding the correlation between train performance and actual conditions (e.g. WSP and wet rail, understanding sander performance) to improve adhesion predictions and post-event analysis. This can include areas where data is currently not collected in real time, but potentially could be in the future.
- Making effective use of existing and novel datasets to predict future adhesion conditions. The granularity and frequency of data collection is improving. Are there ways to use existing and novel datasets to improve decision making in low adhesion?

The call for research seeks out feasibility studies that will provide demos, toolkits, algorithms able to extract learning from structured and unstructured data and provide further insights that will be able to support better decision making in low adhesion conditions. The development of new technology to measure or estimate factors that affect adhesion conditions is outside of the remit of this call (e.g. weather stations, moisture sensors etc). Looking at ways that data collected by novel technology can be used is within the scope of this call (e.g. COF-TAR-01, COF-E14-02).

Further information on these and other relevant projects can be found in the Forecasting Adhesion web portal (https://rssb.wavecast.io/forecasting-adhesion), in the Resources section.

Proposals should consider the validation, verification and accuracy of any proposed solution.

We expect the proposals received to in response to this call:

1. Be novel and innovative, based on low technology readiness levels (from 1-3), and generating new knowledge.
2. Propose a solution or improvement that can have a measurable impact. The ideas cannot simply gather new knowledge, but are expected to be addressing the problem described in the requirements section of this document.
3. Produce an implementation map, where (if successful) the solution’s journey into everyday practice can be broadly mapped.
5. Submission Guidance

The technology content of the proposals is expected to fall within the low rail industry readiness level8 (1-3, see diagram below) and to be able to generate new knowledge while addressing a specific challenge. The solution or improvement suggested should have a measurable impact and be supported by a relevant business case.

WHOLE-LIFE MANAGEMENT (9)
Continuous incremental improvements using business as usual practices are undertaken or directed by asset owners.

EXPLOITATION (7-8)
First of class deployment sees the concept earning value with end users acting as agents for delivery. Cost price and risk are all well understood.

DEVELOPMENT (4-6)
Promising ideas and concepts are developed and qualified by development and demonstration agents. Business plans are increasingly robust and end users are engaged with the concept being prepared for deployment.

INVENTION (1-3)
New ideas, emerging technologies are usually created in/by the academic/research/innovation agent domain. Business plans are necessarily loose allowing the potential room to evolve and be understood.
5.1 A fresh approach

Multi-disciplinary teams and inter-departmental collaboration are highly recommended. Potential bidders are encouraged to think beyond traditional constraints and foster collaborations in disciplines and backgrounds different to those they would normally collaborate with. The proposals must demonstrate both a good understanding of the chosen challenge and an awareness of relevant research that has already been undertaken in the area.

5.2 Proposal format and guidance

We are expecting good quality proposals, clearly written and formatted. You must use the proposal template provided, which is available via the webinar hub.

Your proposal should be between 8-12 pages long and should include the following:

- **Description of the proposed research** including clear scope and objectives; methodology; break-down of tasks; description of expected deliverables for each task and associated delivery dates. (4-6 pages max.)

- **Workplan**: a Gantt chart or other graphic representation comprehensive of milestones, activities and deliverable dates. (1 page max.)

- **Pathway to impact**: this should be a high-level description of next steps and an explanation of all the associated potential benefits to the industry, should the proposal be successful. This section is expected to be kept live during the life of the project (1-2 pages max.)

- **Justification of resources**: Breakdown of costs using the template provided (1 page max.)

- **Track record**: a list of all consortium members and industry supporters (if any), which should detail the relevant expertise that each investigator will bring to the research. (1-2 pages max.)

- **Short summary** which we will upload on SPARK, if your feasibility study is selected and funded. (half page)

Please note that the assessment panel may request additional clarifications or ask for a proposal to be resubmitted if it does not meet the required format.
5.3 Evaluation criteria

All proposals will be assessed by a panel of industry experts. Proposals will be assessed according to the following criteria:

**Novelty of the idea**

1. Relevance to the scope of the call
2. Originality of the proposed work and innovative approach
3. Scientific contribution to knowledge

**Demonstrated delivery capability**

1. Ability of bidding team to deliver the research. This will include evidence of support from data owners and relevant industry stakeholders and clear evidence that they will support the project with access to data
2. Probability of technical success, acknowledgment of risks and relevant mitigation actions
3. Evidence of adequate plans for industry engagement during the life span of the research

**Resources and management:**

1. Clear costing and transparent breakdown of resources, which demonstrate value for money of the proposed study. Your proposal should include a clear narrative description that demonstrates:
   - All costs associated with the project have been identified
   - An explanation of why you believe the costs to be reasonable
   - The level of commitment where funding is contributed from other sources (if any)

**Potential impact:**

1. Clear identification and, when possible, quantification of potential benefits for the industry
2. Evidence of early and sound thinking on next steps and possible ‘routes to market’

Criteria will be weighted evenly and scored out of 3:

0. = Does not meet the criterion
1. = Significant concerns about ability to meet criterion
2. = Minor concerns about ability to meet criterion
3. = Confident that response fully meets criterion
5.4 Consortia guidance

A successful consortium is likely to consist of participants with a range of disciplinary perspectives and different rail expertise. This competition is open to both academic institutions and suppliers. Project teams should include industry experts. Industry representatives are encouraged to provide their in-kind support.

5.5 Funding

If a proposal is accepted, each consortium must appoint a lead partner, who will be responsible for receiving and managing the funding accordingly. RSSB will contract directly with the lead partner.

RSSB will issue a grant agreement. The lead partner is required to sign and return it with 30 days of receipt or funding may be withdrawn.

RSSB will fund as many feasibility studies as can be afforded within the available £300,000 funding. Potential bidders should note that 3 to 5 feasibility studies are expected to be funded, spread across the different challenges. RSSB will pay 50% of the contribution at the start and 50% at completion, upon acceptance of the final deliverable.

A sample agreement is available on the webinar hub for reference. Bidders are encouraged to review the grant agreement and submit any changes together with their proposal. This will enable us to accelerate the procurement process.

We expect all feasibility studies to be in contract by December 2018.
6. Future funding opportunities

Once the successful feasibility studies have been completed, and if they demonstrate the required stage of development, they could be considered for trials and demonstration or for additional funding via other mechanisms. The timescale over which this could happen will depend on the nature of the project itself.

We encourage interested bidders to establish contacts with relevant industry stakeholders early on. RSSB will facilitate contact with industry representatives, should the academics require support with this.

Dissemination and networking opportunities will be made available throughout the life of the feasibility studies.

7. Key dates

An information day will be held on 11 June 2018 at Code Node – Skills Matter, in London. The recording of the event, proceedings and background material will be available on the webinar hub, which can be accessed via the following link: www.rssb.wavecast.io/forecasting-adhesion

From the hub, you will also be able to download the feasibility study template, the master pricing sheet and the grant agreement.

All the proposals should be submitted by

Please use “Forecasting Adhesion Competition” in the email subject. The submission should include:

- Project proposal using the feasibility study template provided
- Master pricing sheet

For any questions, please contact: researchcompetitions@rssb.co.uk

Twitter: #AdhesionRiddle

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<thead>
<tr>
<th>Feasibility studies proposals due</th>
<th>21 September 2018</th>
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<tbody>
<tr>
<td>Winning bids will be announced</td>
<td>9 November 2018</td>
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<tr>
<td>Contracts to be in place by</td>
<td>Early December 2018</td>
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<tr>
<td>Feasibility studies to start</td>
<td>Early January 2019</td>
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