Research in Brief

Robust Automated Servicing of Passenger Train Fluids

Feasibility study led by Brunel University in partnership with Chiltern Railways
**Background**

Transport was one of the first sectors to take advantage of robotic systems for manufacturing. However, the railway industry is currently getting a small fraction of the potential benefits that robotics could deliver. With passenger numbers rising, depots are reaching full capacity and the industry must address the challenges associated with accommodating and maintaining larger fleets in the future. Robotics and autonomous systems could help reduce the time and cost of maintenance, improve the reliability of rolling stock inspections, and improve servicing to keep more trains in service.

**Aim**

This project explored the feasibility of developing an autonomous system capable of performing fluid servicing tasks such as topping up water, windscreen wash and sand, and emptying effluent. A human centred approach was taken to optimise human-machine interaction and ensure staff can focus on safer and higher value tasks.

**Findings**

A Robotic and Autonomous System (RAS) can be used to perform fluid servicing on electric and diesel passenger trains, removing most of the human errors associated with these tasks.

Two main approaches to designing a RAS for fluids servicing were identified: Cartesian and Articulated.

1. **A Cartesian design, with a hose dispensing rack**

2. **An Articulator design**

Both designs have benefits and drawbacks. However, the Cartesian approach is simpler, which has health and safety benefits, and would be less expensive.

While fluid servicing processes tend to be similar between depots, there are considerable differences between fluid port and nozzle designs. The research identified fluid coupling products that are currently on the market which could be adapted to allow for quick, simple and leak free couplings.

**Impact and benefits**

With passenger traffic expected to increase by between 52% and 90% over the next 30 years, the rail industry will face a major challenge in terms of the load on maintenance depots. The introduction of a RAS has the potential to double servicing throughput of vehicles enabling depots to focus on more skilled maintenance and repair tasks. RAS operators will have an improved quality of work, due to the reduced interaction with fluid servicing processes. Automated servicing will result in fewer trains being taken out-of-service due to missed top-ups. Increased servicing capacity will help to improve overall capacity on the network, while better-quality servicing will improve the efficiency of train operators and reduce operating costs.
Method
A Hierarchical Task Analysis (HTA) of current fluid servicing processes was undertaken. These processes were mapped using HTA process trees, with errors identified and assigned Systematic Human Error Reduction and Prediction Approach (SHERPA) error modes. The opinions of technical managers and staff were gathered and inputted into a Quality Function Deployment (QFD) matrix, which helped to establish the focus of the design requirements. RAS and port design concepts were developed using computer-aided design (CAD). An economic assessment used cost deltas to compare RAS costs with the cost of increasing maintenance capacity based on current practices.

Next steps
Brunel University is part of a consortium, led by TBG Solutions, which has been awarded funding from Innovate UK to develop prototype port interfaces, robotic end effectors and a test rig. Future phases of research are being planned to support the construction of a full-scale prototype, to be tested on a dedicated vehicle test platform.

Find out more
This project was led by Brunel University as part of an RSSB funded call for feasibility studies on “Applications of Robotics and Autonomous Systems to Rolling Stock Maintenance”.

The technical report is available at www.sparkrail.org

2. An Articulator design