Problem Statement
Waste management is an important part of the circular economy and high-performing trash-processing plants are key to enabling a sustainable future. As such, Ferrovial Centre of Excellence in Asset Management wanted to trial remote condition monitoring (RCM) at a trash processing plant, Ecoparc4 (ECO4) in Barcelona. To enable data-driven improvements in availability and reliability and support decision making they asked Amey Strategic Consulting to help with:
- Identifying critical assets at the plant that would most benefit from RCM;
- Developing full technical solution;
- Analysing the data to interpret asset behaviour;
- Advising and implementing advanced analytics for early fault detection;

System Configuration
We currently monitor 2 locations at the plant: the pre-processing floor (PTR) and composting facility (CMP). Figure 2 shows the RCM architecture.

Understand Asset Behaviour
Once the data from the sensors is imported onto the platform we can visualise asset behaviour. Figure 3 shows current, temperature and vibration readings for the motor on a ballistic separator. At cold start the readings show higher vibration and current for approximately 30 minutes, after which the current consumption and vibration decrease to their normal level of operation.

Augmented Analytics
Using Mercury’s analytics engine we are able to explore relationships between the readings. Figure 5 captures time period around major parts replacement in a ballistic separator. After the maintenance, there was a significant decrease in gearbox vibration compared to the motor. This indicates that the root cause of the increased vibration was from the machine itself.

Work in Progress
We continuously look for other ways to use data to bring value. Next phase will focus on using vibration frequency analysis for fault detection, where by tracking frequency bands or shifts in key frequencies we will be able to pre-emptively identify upcoming failures. Figure 7 shows the vision for this workstream. The dominant frequency peak of 50Hz matches the RPM of the motor. The high-frequency peaks most likely represent noise from rest of the machine. Moving forward we will refine our sampling strategy to achieve better time resolution in the spectograms, eventually deploying the visualisation to Mercury UI and enabling on-site asset managers and engineers further insight into their asset behaviour.

Value Generated
To support higher asset reliability and enhance decision making through the use of data we have:
- Designed and implemented the full technical solution for condition monitoring of critical assets;
- Visualised asset data in real time and set up threshold alerts via email and text, enabling better operational oversight;
- Analysed asset data to recommended strategies for asset operation, geared towards higher availability and maintainability;
- Cultivated a relationship with an emphasis on the transfer of knowledge and culture change towards data-driven and pre-emptive maintenance.

Our Solution
We have delivered the full end-to-end service: from designing the technical specifications, to procuring and overseeing the installation of the necessary equipment, to collecting data and visualising it on our interactive analytics platform, Mercury.

Mercury is a rapidly deployable Internet of Things (IoT) platform that uses Big Data technologies, analytics and machine learning to turn data into insightful information.

Combining the power of Mercury with our team’s expertise across numerous disciplines and engineering knowledge of ECO4 staff, we continuously explore avenues to use advanced analytics to bring further value to ECO4 asset management program.

Fig 1: Diagram of ECO4. Assets with RCM are labelled

Fig 2: Mercury system architecture

To assure robust data acquisition in real-time our team identified points at the plant with best signal and power supply. At each location (PTR & CMP) the readings are sent to the local server installed at the point with best power supply. These readings are then sent to the MQTT bridge at a point with the strongest signal. As MQTT service receives the readings it posts them to a remote server topic. In the back-end, Mercury subscribes to this topic, processes the data into non-relational database optimised for Big Data applications and then displays data on Mercury’s web interface. From there users are able to visualise data in interactive displays and analyse it in real-time.

It should be noted that all software used to build the data pipeline is based on open standards, including all aspects of the security architecture, databases and messaging systems.

Fig 3: Current, temperature and vibration at the ballistic separator

It also enables users to study long-term trends and assess response to maintenance activity. Figure 4 shows vibration readings from a ballistic separator: vibration of the reducer is increasing from December and vibration of the motor is increasing from January. Monthly preventative maintenance activities (blue dotted lines) had no effect; vibration decreased only following major corrective maintenance (yellow dotted line). These factors indicate that the increasing vibration was due to mechanical failure in the machine itself.

Fig 4: Motor and reduction gearbox vibration at ballistic separator

Similarly, looking at cooling patterns of the engine in Figure 6 we can chart the expected relationship between ambient temperature and motor temperature. Moving forward, these kind of relationships can be exploited to identify data outliers and anomalies in asset behaviour.

Fig 5: Correlation between reduction gear box and motor vibration

Fig 6: Correlation between ambient and motor temperature

We will further explore the relationships between measurements to identify opportunities to apply AI predictive analytics.

Fig 7: Frequency spectrum of equispaced motor vibration measurements. Each measurement has 256 samples at 4000Hz