DIGITAL DOCUMENTATION OF OUR INDUSTRIAL HERITAGE

Greetings from Scotland, where we are in the process of celebrating one of the biggest and most beautiful pieces of industrial heritage in the world. This is the Forth Bridge, which will be 125 years old in 2015, and has just benefited from the completion of a major restoration programme by its owners, Network Rail.

Figure 1: The Forth Bridge after its recent restoration was complete in 2012

The Forth Bridge was built by the North British Railway between 1882 and 1890, extending the company's railway network north of Scotland's capital city, Edinburgh, to the northern half of Scotland. It was built where the 'Firth of Forth' river narrows at Queensferry, and is 2 kilomtres long. The major part of the structure consists of three double-cantilever towers each over 100 metres tall. It was constructed from mild steel, which at the time was a new material produced by the recently introduced Siemens Martin process. The Bridge attracted admiring visitors from all over the world during its construction, and has an important link with Japan. Glasgow University graduate, Kaichi Watanabe, worked on the construction of the Bridge as an engineer, and posed in a very famous picture to demonstrate the cantilever principle on which the design is based.

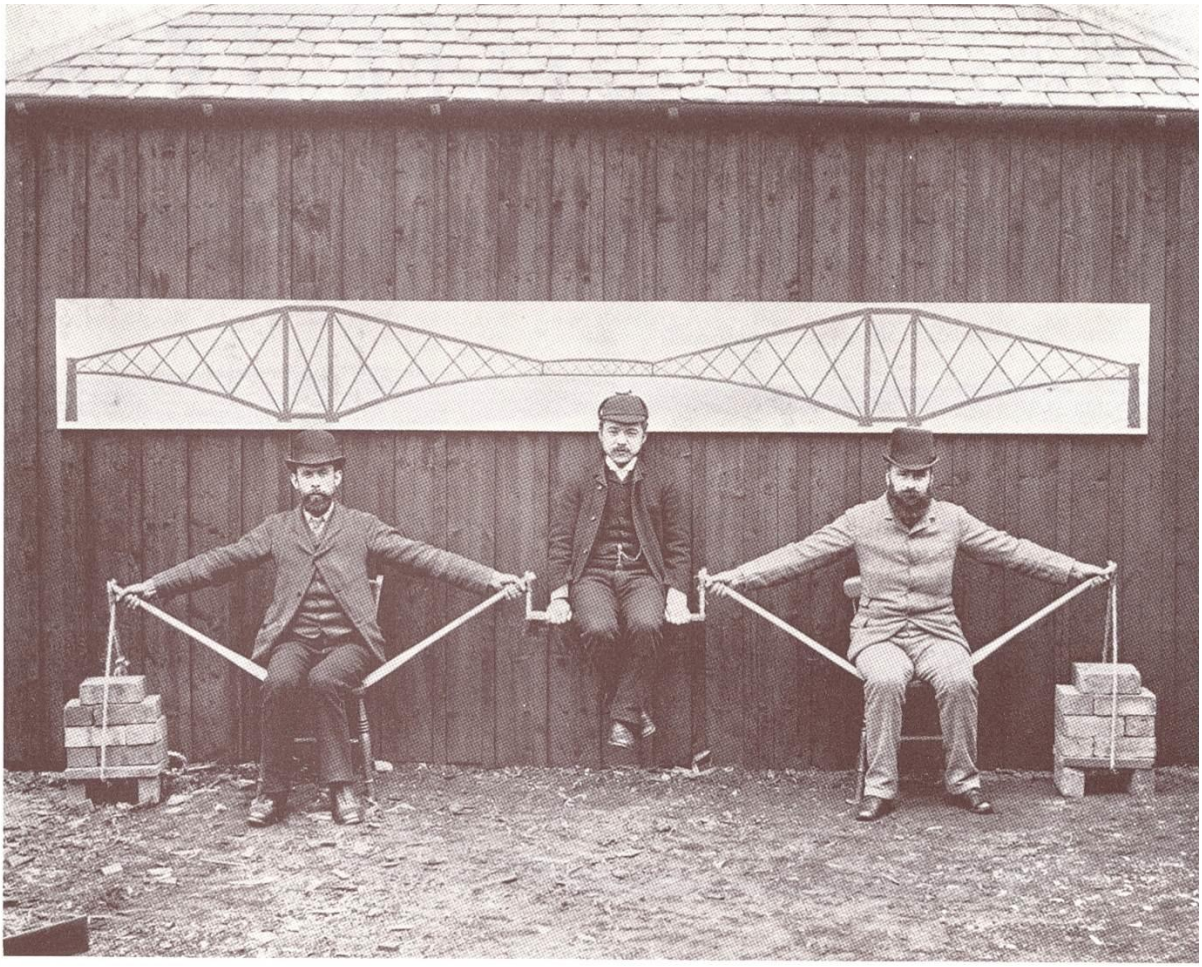

Figure 2: Japanese engineer, Kaichi Watanabe, demonstrating the cantilever principle on which the Forth Bridge's design is based

The extraordinary scale and beauty of the Bridge, combined with its unique design and use of new materials and construction technologies, makes it a very special structure. For this reason, it is being nominated for World Heritage listing. The nomination process is being led by Historic Scotland, a Scottish Government agency based in Edinburgh.

In recent years, UNESCO has required that every World Heritage nomination includes a Management Plan which demonstrates that the candidate site will be properly protected and maintained. In addition, in keeping with the founding principles of UNESCO, the Management Plans are encouraged to use their sites to promote education through access and interpretation. This can be a big challenge for some World Heritage sites because public access is either difficult or dangerous, and sometimes very remote.

In Scotland, this is one of the reasons why we are investigating using 3D laser scanning technologies to support the Management Plan of the Forth Bridge nomination. Public access to the Bridge is not possible, and the structure is very large. The 3D technology on which the scanners are based was originally developed to allow the detailed and very accurate recording of often large industrial complexes. It has since been adapted for use in the recording of a wide variety of heritage sites.

Using it for the digital documentation of the Forth Bridge and other industrial heritage sites therefore seems to be an exciting option.

Figure 3: James Hepher of Historic Scotland with a Leica laser scanner. He was one of a team working on a pilot 3D survey of the Forth Bridge in August 2013.

The laser scanners create a 3D model of their subjects by collecting data in the form of a three-dimensional cloud of millions of laser generated points. They then overlay these point clouds with rectified high-resolution digital photographs, creating an accurate photo-realistic 3D model. This can then produce still images of any part or viewpoint of the structure, but can also be used to create fly-through animations, and for the virtual visitor, allows her or him to see parts of the structure that would be impossible to see in real life.

The 3D data has many uses. Most important, it provides an extremely accurate baseline data set at a specific time from which conservation and monitoring of the condition of the structure can be managed. It also provides a unique and powerful education resource which can be put to a variety of uses ranging from virtual tourism and site interpretation to health and safety training, or the teaching of engineering.

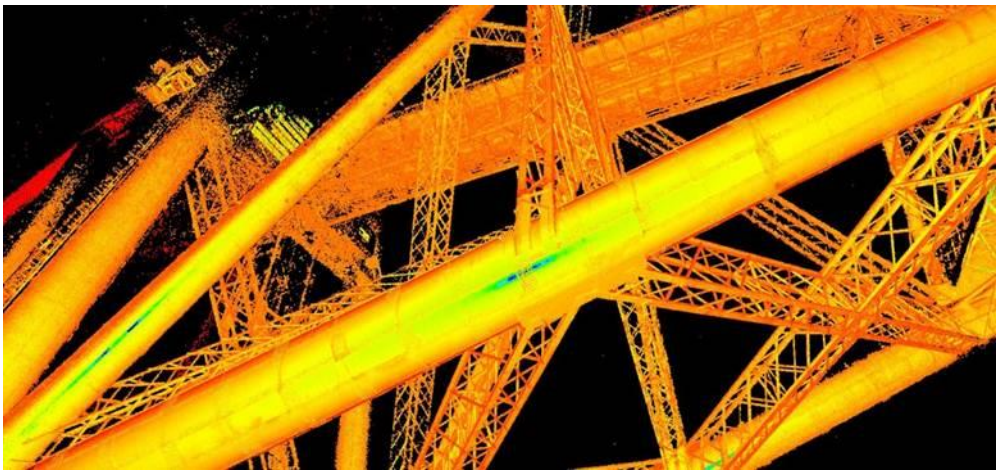

Figure 4: a sample point cloud produced as part of the pilot 3D laser scanning survey of the Forth Bridge in August 2013. This is raw data, and rectified digital photographs need to be added to create a photo-realistic 3D model.

In the case of the Forth Bridge, we have just completed a pilot survey to see if will be possible to survey the entire structure, and to assess the costs and benefits of doing so. Our hope is that we will be able to produce a complete 3D photo-realistic model of the Bridge, and bring it to life for millions of people across the world. If we are successful, we are also hoping to assist the *Emergence of Industrial Japan: Kyushu - Yamaguchi' World Heritage* nomination, which includes a number of hugely important sites that might benefit from the use of such technology. These might include the Giant Cantilever Crane in the Nagasaki Shipyard, Miike Port and the Yawata Steel Works repair factory. We very much hope to be able to take this work forward because it would be an appropriate way of honouring the strong historical links between Scotland and Japan.

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