Pressure vessel and pipework systems operating at high temperatures and pressures are vulnerable to creep degradation especially in the region of weldments. Lifetime assessment for high integrity systems, for example those installed in nuclear power stations, requires knowledge of time-dependent creep deformation in and around the welded joints at the operating temperatures. The Materials Engineering Group at the Open University has been using Digital Image Correlation (DIC) since 2004 to obtain full field strain maps of test samples. Based on DIC, significant experience and expertise have been created for successfully measuring spatially resolved mechanical properties in welded joints during tensile testing at room and elevated temperatures, as well as the full field creep strain at long term tests. These tests are now routinely carried out at the OU's laboratories, which house a suite of 10 testing stations with DIC creep measurement capability (the largest facility of its kind). Recent additions include two testing stations with a capability for 3D measurements and a unique test station with a vacuum furnace for materials prone to oxidation.

The use of 2D DIC full field strain measurement technique is limited on non-flat samples, or if there is a significant out of place deformation during loading, such as in the vicinity of crack tip in fracture samples. The use of cylindrical samples is a standard practice in creep testing, including cross-weld samples. The constraint effect observed in flat samples are different than those in cylindrical samples. There is a need to establish the effect of specimen shape on creep behaviour assessment and hence the first phase of the PhD project will utilise the 3D DIC techniques to carry out a systematic study to provide data for numerical and analytical models. The effect of elastic and strength mismatch will be studied on simplified joints manufactured by diffusion bonding and then extended to more complicated welded components.

The emphasis of the project will be to develop techniques to fully utilise the vast amount of data on creep deformation obtained by DIC tests for optimising empirical creep models and improving physics based creep behaviour and damage models. For this purpose, novel specimen designs, e.g. samples with tapered or waisted cross sections, will be developed and modelled using inverse methods, including virtual fields method, to extract elasto-plastic constitutive parameters.