

# Shape optimization for ease of non-destructive testing

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The ability to accurately and precisely detect and characterise defects forming within a material is fundamental for the safe operation of components in a wide range of industries. Previously, the ease of non-destructive testing (NDT) has not been considered at the component design stage and as a result, NDT operators are often faced with the challenge of inspecting components with complex geometries which are difficult to reliably test. Here we consider the optimization of a component's shape at the manufacturing stage to maximise the coverage of the interrogating ultrasonic waves, thus enhancing our ability to resolve defects. Using analytical expressions for the sensitivity of laser induced ultrasound, we generate coverage maps of ultrasonic waves for a given component and transducer array. These coverage maps drive the shape optimization via the level set method allowing smooth variations in the shape of the component. Additional constraints can be applied to the optimization including a target volume fraction for the final shape, a design envelope which limits the possible final shapes, as well as a measure of the performance of the primary purpose of the component. The resulting shape is one that maximises the coverage of ultrasonic waves in the component, where values at lowest coverage area in the component increase by approximately 20%, and therefore provides improved defect detection.