University of BRISTOL

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The Effect of Image Quality on Automated Composite Defect Inspection

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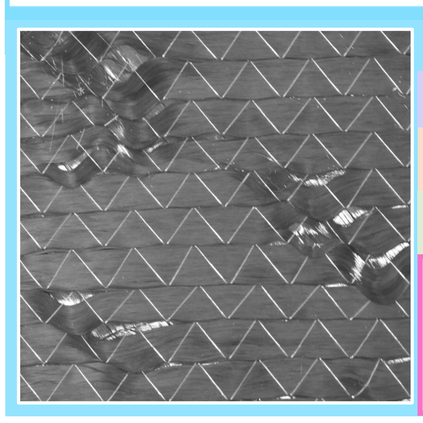
Industrial Sponsor: Turlough McMahon, Jon Wright, Airbus.

The delivery of high-performance aircraft has driven the increase in rate targets. A promising rate-enabler is preforming of Non-Crimp Fabrics. Preforming over complex shapes can lead to defects, like wrinkles, reducing part quality. Using photographs to quantitatively analyse defects shows promise in reducing the cost of inspection. However, current implementations have yet to address the analysis bottleneck of photograph variability.

Global Challenge: Are these wrinkles acceptable?



Goal: Quantify preform wrinkles

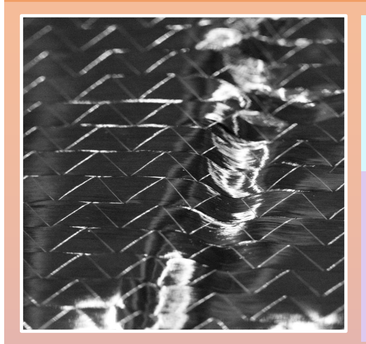
Using: DSLR factory photographs

Output: Geometrical **metrics** (A, λ, θ)

Impact: Inform lay-up **decisions**

Current Limit: Numerical analysis has only been applied to **idealised and controlled photograph qualities**

The Reality of Factory Photographs



Highly variable from **image artefacts** (low wrinkle visibility)

≫ **Quantifying** goal becomes increasingly **difficult to achieve**

Motivation: Assess photo-quality to **de-risk** wrinkle analyses

Aim: To quantify photograph quality

Key Objectives

Assess quality by analysis of image artefacts **(glare)**

Use artefact data to score net image processability

Figure: Preforming Non-Crimp Fabrics from [1]

Factory Floor Processes

Feed to Design & Stress Analysis

Inspection (Part Quality)

Preforming

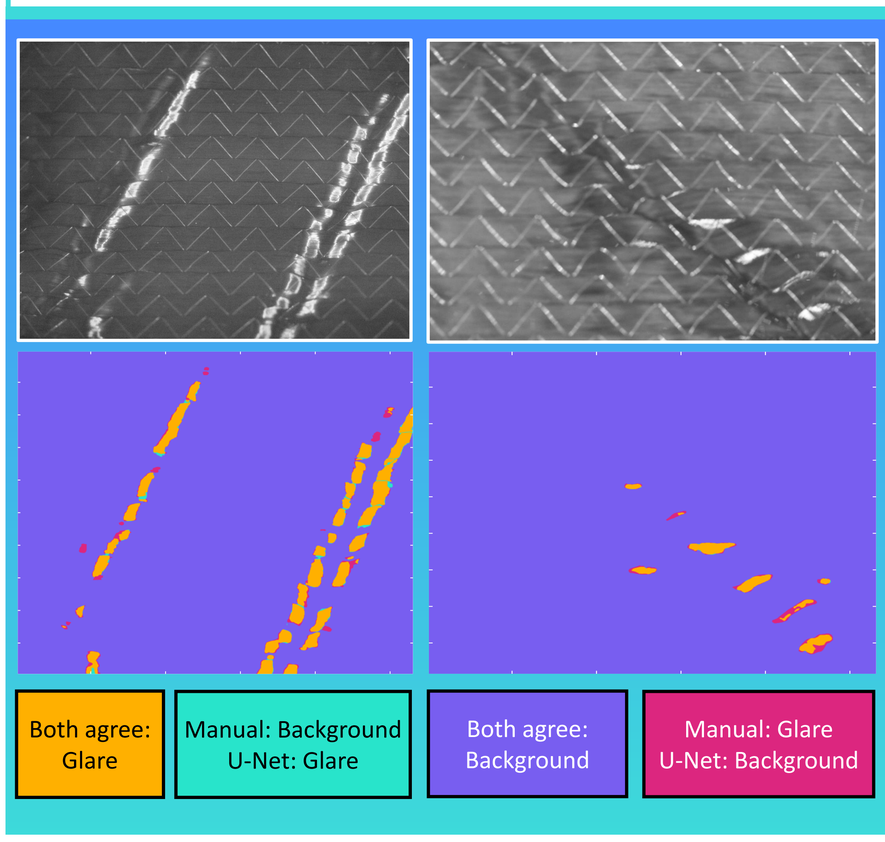
Approach: Deep Learning

Glare regions are annotated then trained with U-Net

Initial 3 state problem: Glare in: *Tows*, *Gaps*; Not Glare

Reporting positional data **(Area & Centroid)** of artefacts is used to **meaningfully describe** photo-quality

Artefact Mapping – Results



Findings

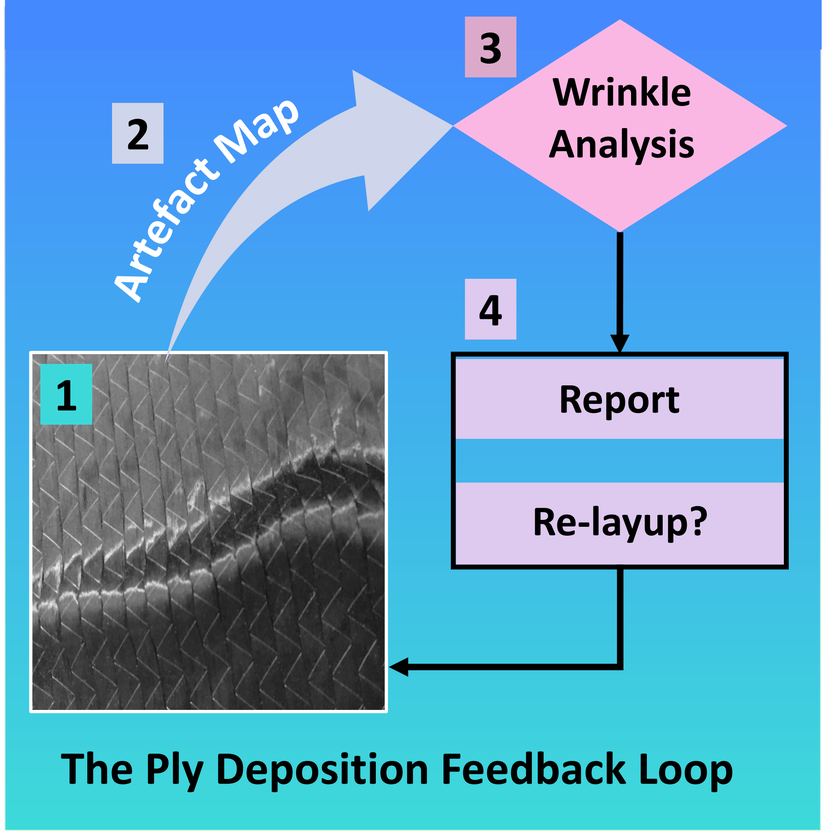
1. Able to capture glare with regional specificity (indicate challenge zones prior to tow analysis)

2. Directing intermediate processing (making overall wrinkle analysis insensitive to artefacts by tailoring processing steps)

Examples of glare segmentation (Deep Learning) vs. manual annotation; whilst predicted areas tend to underestimate, centroids closely agree.

As Deep Learning can distinguish region specificity (Tow or Gap) – there lies potential in applying to other defect types.

Where Next? Integration Roadmap



The Ply Deposition Feedback Loop

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bristol.ac.uk/composites

Supported by AIRBUS

[1] - https://www.compositesworld.com/articles/one-piece-one-shot-17-meter-wing-spar-for-high-rate-aircraft-manufacture