Digital Lifecycle Management (DLM)

# Remote Laser Welding Laser Parameter Selection & Optimisation

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**The research aims to develop a methodology for response surface generation by integrating the physical and computational experiments for application in Laser Parameter Selection & Optimisation.**

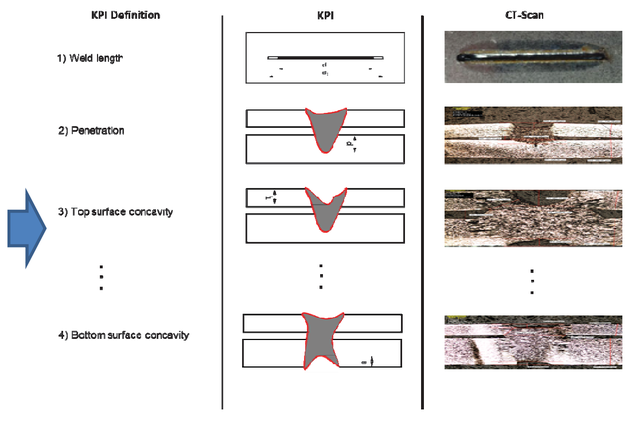
## Introduction

Rising product complexity has led to an increase in the number of product Key Performance Indicators (KPI's) used for quality evaluation. The conflicting behaviour of the KPI's results in non-linearity in process behaviour. Thus, for optimal process control the relationship between process parameter and KPI's needs to be established.

The current research focuses on developing a systematic methodology for developing response surfaces with the required accuracy by integrating physical experiments with computational analysis. The proposed approach is validated using Remote Laser Welding (RLW) process on automotive door assembly.

### Remote Laser Welding process and associated KPI's

Remote Laser Welding process



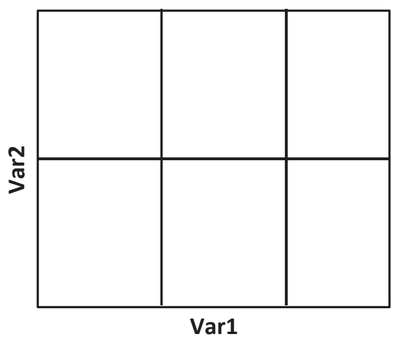

Example of KPIs used in RLW

## Proposed Methodology

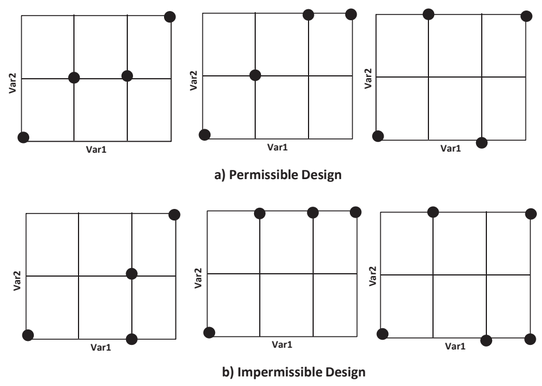
The proposed methodology utilises the following steps to generate the response surface.

### Step 1: Initial physical experiment using Latin hypercube

The Design of Experiment is conducted based on randomly sampled permissible design based on the Latin hypercube (LH) method.



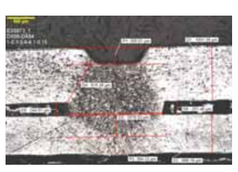

Discretise space




Permissible vs. Non-permissible design

### Step 2: Generate response surface using Kriging model

Based on the initial physical experiment, a Kriging based mathematical model is developed to perform computational experiment



Experiment

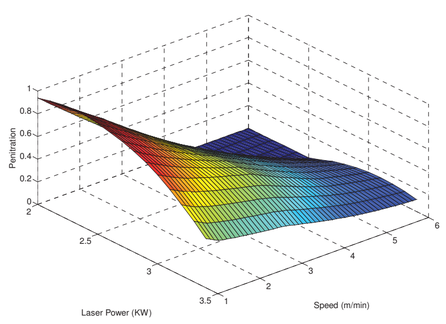
$$g^*(\mathbf{x}) - \mu = \sum_{\alpha=1}^{n(\mathbf{x})} W_\alpha [g(\mathbf{x}_\alpha) - \mu]$$

$\mathbf{x}_\alpha$ : Location of physical experiment

$\mu$ : Expected value of $g^*(\mathbf{x})$ and $g(\mathbf{x}_\alpha)$

$g^*(\mathbf{x})$ : Computer function representing the physical relationship

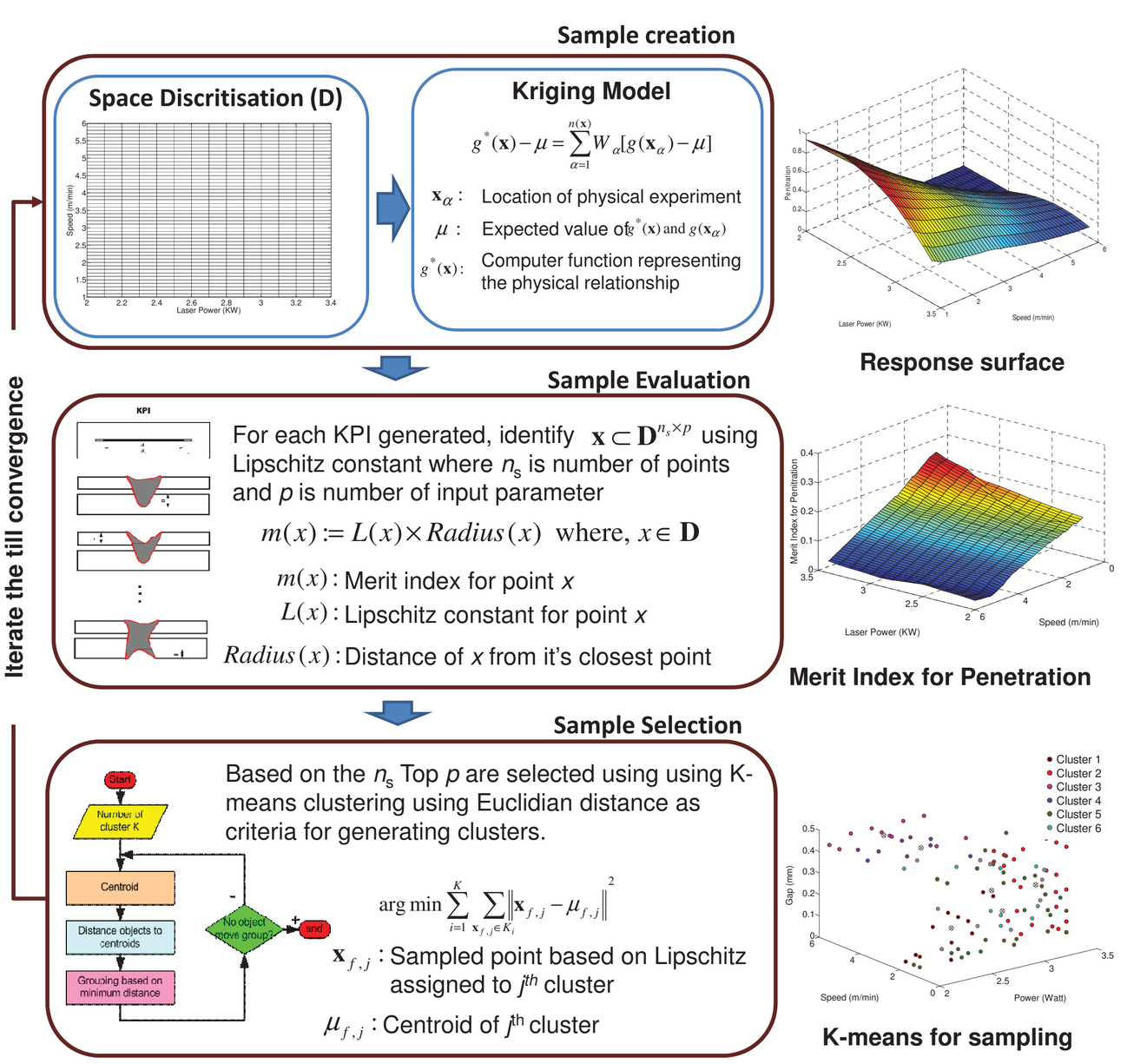
Kriging Model




Response surface

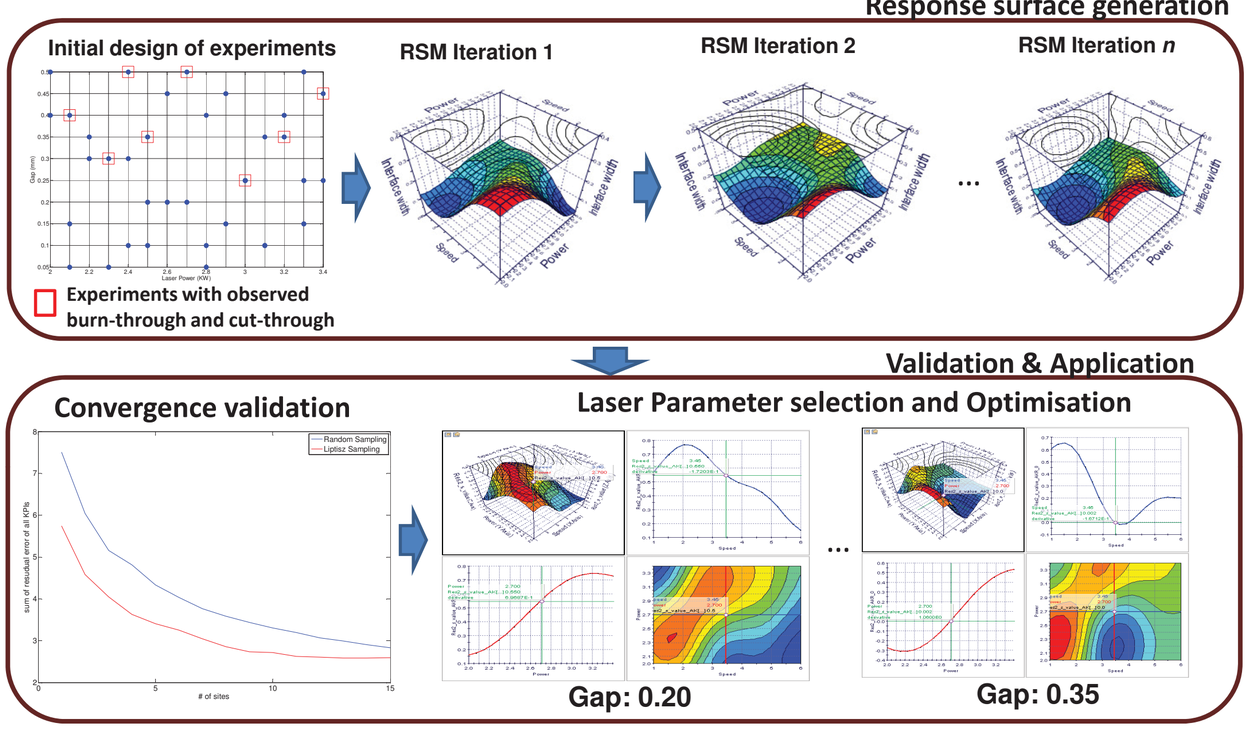
### Step 3: Adaptive sampling for multi-KPI

The section presents an adaptive sampling methodology based on Lipschitz sampling and K-means clustering for improving the response surface in a multi-KPI environment.




## Industrial Case Study

The current methodology is validated using the remote laser welding process for car front door assembly.




## Impact

The developed methodology will have an impact on:

- Optimizing response surfaces by integrating the physical and computational analysis.
- Adaptive sampling methodology in a multi-KPI domain.
- Minimising the number of physical experiments.

**For more information please contact** Prof. Darek Ceglarek (d.j.ceglarek@warwick.ac.uk). Also visit http://www.rlwnavigator.eu/