Refurbish or Replace?

The life cycle carbon footprint and life cycle cost of refurbished and new buildings

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In Optimisation studies, Parametric Design, Simulation and Optimisation tools are often used. In Optimisation studies, Parametric Design, Simulation and Optimisation tools are often used.

Using these tools, design parameters can be iteratively modified and their impact on the building performance can be evaluated.



For example, to examine the impact that different design parameters might have on the overall performance of a building

















etc...

Many optimisation studies examine the impact of non-geometric design parameters, such as construction build-up (U-Value), orientation, building systems etc.

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Others focus on simple geometric design parameters, such as Window-to-Wall ratio or overhang depth



A limited number of studies examine the impact of more complex geometric parameters, but these tend to be relatively simplistic (basic geometric shapes, focus on floorplan contour only).



TuhusDubrow & Krarti (2010)



Geletka & Sedláková(2011)

The proposed method

The proposed method suggests to use different building geometries (different spatial arrangements) as a parameter, when examining building performance





Parameters	Values			Model
Build-up				
Window-to- Wall Ratio	25%	50%	75%	
Orientation		\bigcirc		
Geometry				

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To generate new building layouts automatically, PLUTO was created

PLUTO - Parametric LayoUT generatOr

PLUTO is an early design stage layout generator that covers a wide range of design solutions. It can both save time for early designs, and offer new, 'never thought of' designs.



PLUTO was used for the generation of new building layouts, based on a "typical" terrace house.





We stopped it at 32 layouts



Genetic Algorithms were then used to find the optimal building, which could have any of:

32 Layouts

8 rooms in each layout

9 External wall build-ups

- 9 Ground floor build-ups
- 9 Roof build-ups
- 3 Party-wall build-ups
- 3 Window types

2 Potential Window-to-Wall ratio (25%, 75%)

1 Window per room



This method found a series of the most efficient building forms – buildings with minimal life cycle carbon footprint and life cycle cost







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How did a computer generate buildings with minimal heating and cooling loads?

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- 1. Used geometry as a design parameter in building performance optimisation
- 2. PLUTO for layout generation
- 3. Running Genetic Algorithms to find the most efficient building designs