The Hybrid High Street Retail Store – An Optimisation Method for Retail Store Conversion to Community Use

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ABSTRACT

The research addresses the decline of UK high street retail by providing a methodology for the multi-objective optimisation of existing retail stores to generate the most efficient layout for a new hybrid community-use model. The work involves a live test case in Wigan, converted into a series of diverse hybridised community spaces. A unique Grasshopper and Rhino definition tested fitness values including cost, shelf space and efficiency of retail area in parallel with optimised conversion layouts for a diverse range of community uses in the same space, including as a cooking school baby room and art gallery. The work goes on to evaluate the success of different community use cases and demonstrates the viability of the method through the testing of a unique 1:1 multi-adaptable modular furniture system.

Keywords: optimisation, retail, high street, grasshopper, Rhino, automated, algorithm, community

1 BACKGROUND

The increasing dominance of direct-to-customer online retail companies, including Amazon, AliExpress and eBay has prompted the decline of traditional high street shopping (Carmona, 2015). There is now a concerted effort through the UK Government High Street Fund [1] to revitalise and reinvigorate the UK's high streets by subsidising innovation to suppress the demise of physical retail space. In response to the decline of the traditional high street, Graham (2017 p1) argues that "High streets should seek to be distinctive rather than differentiated: a rich mix of different offers will draw more consumers, and most, according to our evidence, are likely become shoppers". Kim (2001) suggests that physical retail stores must also recognise the importance of user experience when designing layouts. Customer experience is a defining factor for contemporary retail design, by "trying to make the place distinctive as a means of attracting customers" (Warnaby, 2009, p. 288). An innovative space can also play a role in reducing social isolation and loneliness (Rosenberg, 2015). Interactive design and layouts that can be reconfigured to change the purpose and back again on a daily basis should be considered while designing store environments given its positive effect on customer experience and impact on competitiveness (Varadarajan et al., 2010).

2 RELATED WORK

A review of research papers reveals that no existing study examines retail optimisation to community spaces using a multi-adaptable furniture system. Of the papers that explore retail layouts in the context of modular furniture layouts, most refer to the optimisation of

product positioning in relation to shelving location using mathematical formulae: Li (2010) considers a mathematics-based approach to optimising layouts, exploring the effect of entrance, aisle and counter positioning. Trauzettel (2014) investigates the impact of stock positioning in relation to seasonal supply and demand, reacting to yearly consumer patterns in shopping.

Of the wider research completed on multi-criteria optimisation of design for building layouts, Guo et al. (2017) explore a multi-agent evolutionary optimisation process to define office and housing layouts using parametric modelling. The introduction of pedestrian flow for multi-objective optimisation presented by Huang et al. (2018) provides insight into the potential of agent-based modelling on wayfinding cognition. A recent project by construction company Stamhuis (2020) [2] outlined a method in Revit Generative Design that used multi-objective methods to design a liquor retail store in the US. Yet none have investigated automated optimisation between layouts from retail to community-use then back again within the same space. In the context of this gap of knowledge, the work proposes a new methodology to bridge between theory and practical evaluation.

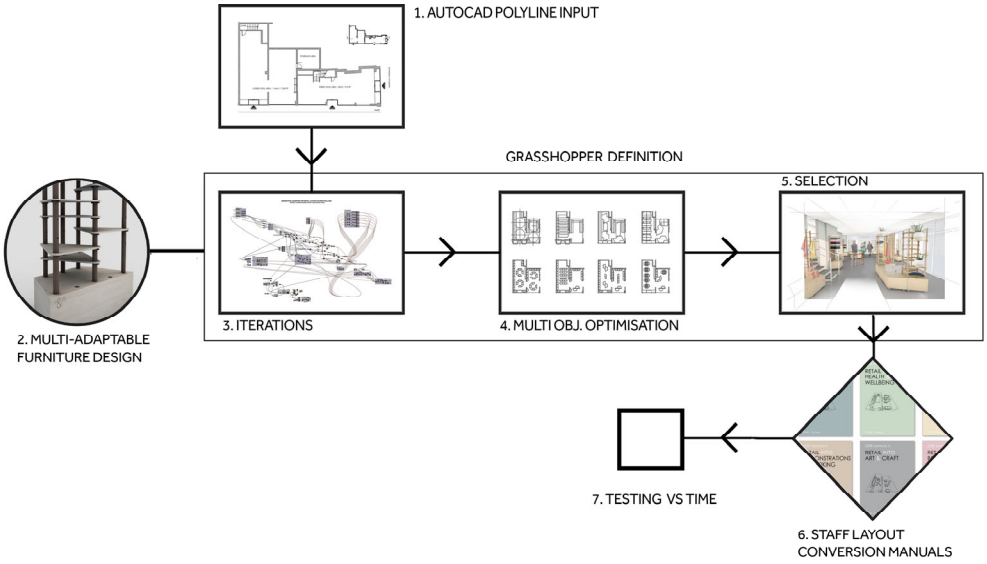

Figure 1: Optimisation framework for hybrid community and retail Rhino and Grasshopper

3 RESEARCH METHODOLOGY

Using an existing empty retail shell located in Wigan, UK, we refined the client's briefing requirements to assess the minimum operational retail area for a defined profit. We conducted an in-person (pre-pandemic) public consultation in the town centre to ascertain the type of store and community uses that might provide the most significant engagement with local community groups. A survey of 66 members of the public showed that the most important characteristics for the new hybrid retail and community store were: 1. *A caring, charitable and supportive environment (Average 4.4 out of 5);* 2. *A place where staff volunteers and customers can interact (Average 4.2 out of 5);* and 3. *A multigenerational environment (3.8 out of 5).* In relation to community use type, the top six community uses were ranked as follows: *Art and Retail (Average 3.75 out of 5); Community and Retail (3.7 out of 5); Mother*

and Baby (3.66 out of 5); Cooking and Retail (3.61 out of 5); Books and Retail (3.58 out of 5); Health, Wellbeing and Retail (3.52 out of 5). This public survey then informed both the experiential atmosphere of the store (warm, open, bright) and the six community use cases, which would form the conversion to/from retail use, as illustrated in Figure 2.

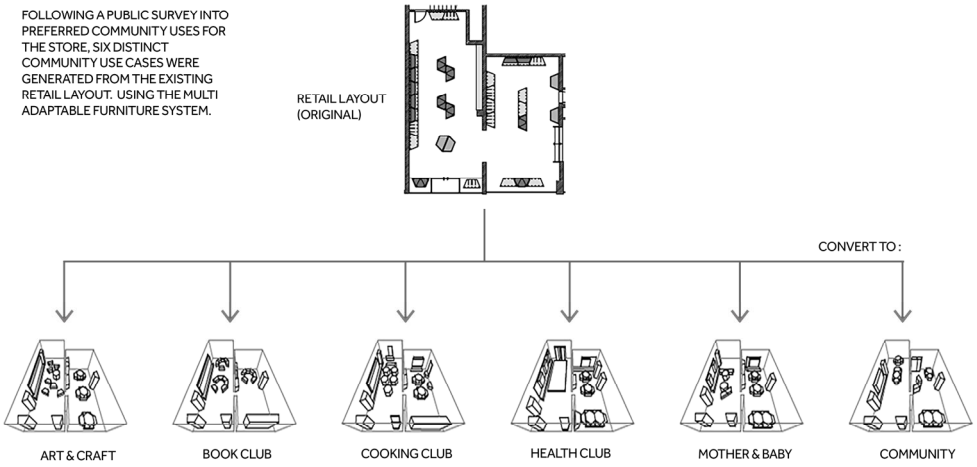

Figure 12: Diagram of community use layout conversions from retail layout

3.1 Adaptable Furniture Design

We developed an adaptable furniture system that would work in both retail and community 'modes' requiring assembly or disassembly into specific arrangements. Critical success criteria during development were: time taken to convert from one layout and function to another, mobility, safety and visual appeal (Figure 3).

Figure 3: The multi-adaptable furniture system for retail and community use

3.2 Grasshopper Generative Model Development

Using the Grasshopper programme within Rhino, we then developed a definition (Figure 4) that took as inputs: a) the established parameters of the retail area; b) the community use layouts; and c) the multi-adaptable furniture system. These would provide the parameters around which optimised layouts could be tested for the interchangeable use cases.

The Grasshopper definition worked by 1) identifying fixed areas of walls or existing retail provision; 2) generating a polyline defining the 'flexible space' within which the furniture can operate; 3) optimising layouts within this area against fitness criteria in the plug-in Wallacei: consisting of the number of furniture units, orientation and shortest path between unit positions between layouts; 4) visualising through parallel coordinate plots for client/designer selection of preferred iterations (Figure 5). In practice, this constituted careful rule definition of furniture layouts for each of the six community spaces (e.g. book club – chairs clustered around circles; cooking club – the linear grid of individual tables; arts and crafts – grouped tables and chairs).

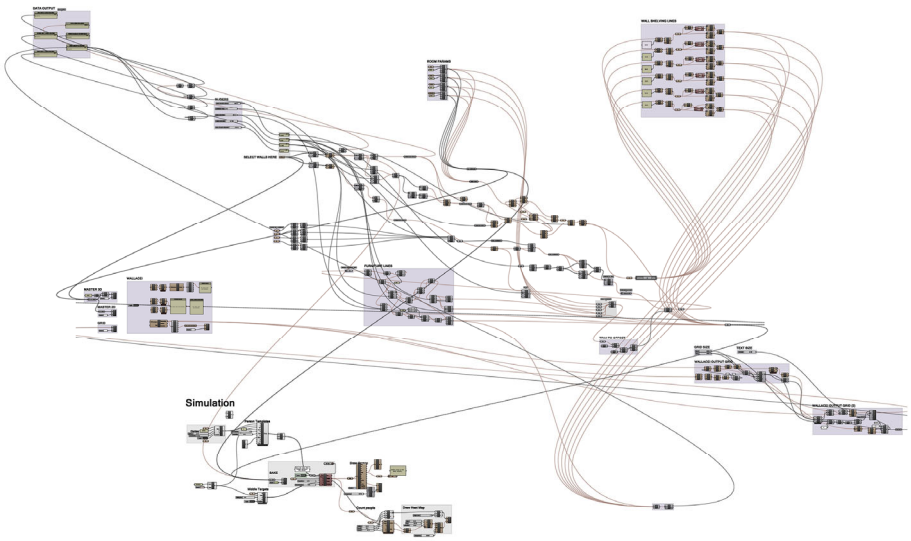

Figure 4: Grasshopper definition provided multi-objective optimisation through Wallacei

3.3 Generative Outcomes: Hybrid Store Design Drawings

The successful application of generative computing models often relies on selecting appropriate iterations by the client, designer or user. The selection was facilitated through the visual optioning of multi-criteria objectives through Wallacei. Fixed plans and elevations were then developed into layouts for construction. A branding exercise, colour and lighting schemes responded to the modular and flexible nature of the store by mimicking the natural and warm tones of the birch plywood and maple hardwood of the furniture system. Elevations and plans provided the reference for the retail shell construction fit-out and for staff for the conversion

from retail to community use. A series of layout conversion manuals were provided to staff, alongside an estimation of the total time taken to convert the layout from retail.

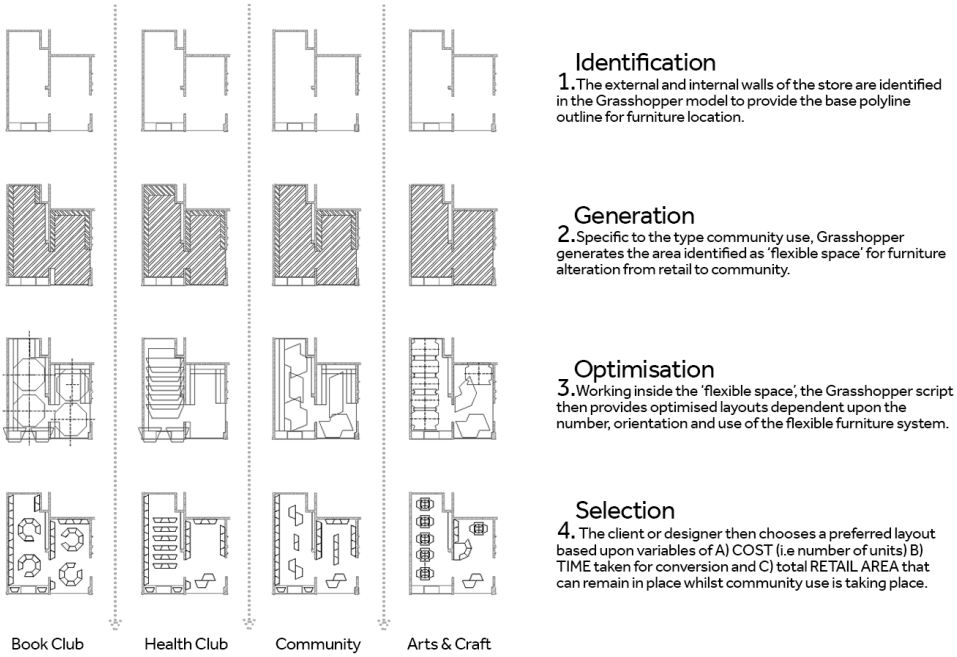

Figure 5: Method of iteration, optimisation and selection in Grasshopper

Each adaptable furniture unit was mobile, with locking wheels fixed to the underside of the base. Staff were asked to store all retail stock in the unit base when converting from retail to any of the six community uses. For health and safety reasons, two staff members were asked to reconfigure the store layout to avoid the risk of injury or fall from height.

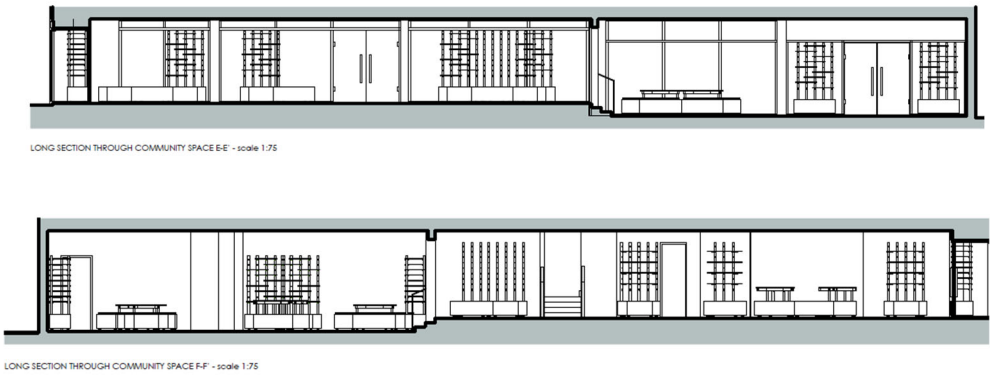

Figure 6: Interior store design elevations from plan iterations

Health and safety risk assessments considered both staff and public use. Following client feedback, the furniture system was modified to reduce the angular corners of the base unit and thereby reduce the potential of injury due to sharp edges. After testing the time taken for two-person staff conversion from one layout to another, feedback indicated that the

tolerance/clearance of the interconnecting parts was too small, leading to shelves 'sticking' on the poles. This led to an increase in intolerances (hole diameter) in each shelf unit to provide a more straightforward reconfiguration process (Figure 7).

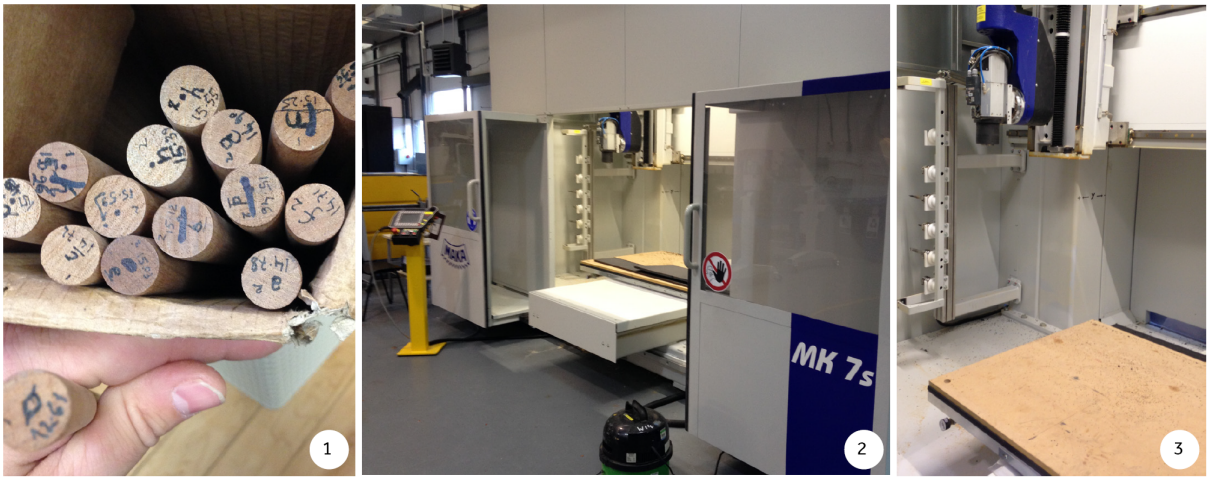

Figure 2~~7~~: Refinement of multi-adaptable furniture system through testing

4 RESULTS

Client, staff and key user feedback on the layouts and adaptable system through a series of questionnaires returned positive feedback on the project concerning aesthetic, innovation and uniqueness. Staff were, however, concerned with the time taken to convert from the retail layout into community use, as listed in Table 1.

Table 1: Time taken for staff to convert to and from retail layout to community use

Type of conversion	No. of people	Time taken to convert (minutes)	Time taken to revert (minutes)	Total minutes
Retail to Community	2	45	40	85
Retail to Health and Wellbeing	2	25	20	45
Retail to Mother and Baby	2	40	35	75
Retail to Cooking School	2	20	25	45
Retail to Art and Craft	2	45	40	85
Retail to Book Club	2	30	35	65

Although optimisation of the movement paths of furniture units resulted in reduced timescales for layout conversion, the key factor in total conversion time was in the assembly and disassembly of the furniture units, with individual units taking between 3-7 minutes to change from, for example, shelving into a table. Although feedback stated this might be acceptable once or twice during the shopping week, the process of conversion was not as immediate as hoped. Despite this, key stakeholders were positive about the potential of the project to be transformative to high street retail provision through the diversification of their retail offering.

5 CONCLUSION

The research has provided a methodology that successfully automates temporary or permanent retail layout conversion to community use using generative software in the context of the case study building. The results confirm that the method provides automated plan designs leading to improved outcomes for diversification of customer experience. Subsequent user evaluation proves the method presents a functionally innovative and aesthetically successful outcome.

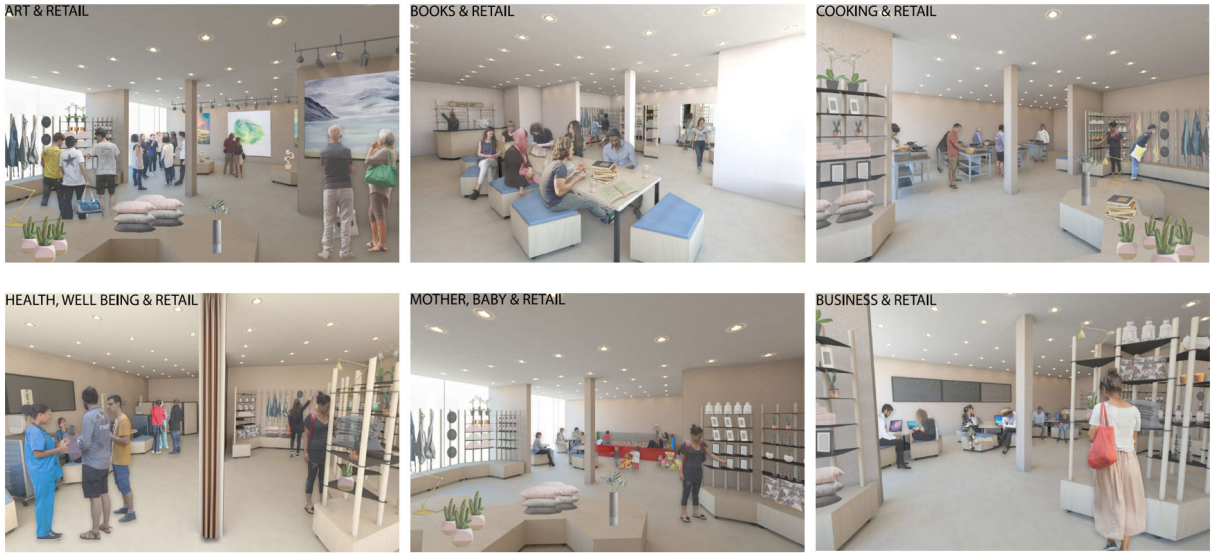

Figure 8: Visualisation of optimised alternative community use layouts generated via Wallacei and Grasshopper

6 FUTURE WORK

Future work will focus on the adaptable furniture system to minimise the time required for conversion to new layouts and thus allow for regular, even daily use changes. Based on testing and refinement, it is possible to shorten the time taken for layout conversion by reducing the total number of individual components that constitute each unit. A means to achieve this would be incorporating the furniture design into the Grasshopper model itself so that the system and the layout are fully integrated. One of the issues with the current method is that the furniture design was completed before the forms, due to the necessity of project phasing; this sequencing could be reconsidered in future research. Grasshopper has further potential to analyse health and safety parameters, e.g. to assess the risk of furniture tipping over, through structural analysis as part of a structural analysis plug-in, e.g. Karamba.

A further area of work would be to explore the application of the method to other building case studies, evaluating a variety of space uses in different retail environments and retail shell dimensions to verify and refine the approach (Figure 9). This work is currently underway in part, with the method being tested, refined and applied to layouts to explore a

more detailed economic verification of the method through empirical data gathering of broader consumer feedback, focusing on profit. We intend to demonstrate the financial viability of the model by assessing factors such as footfall, monthly takings and a wider consumer evaluation survey.

Figure 9: Retail store layout indicating the multi-adaptable furniture system in 'retail' mode

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