What makes big dumb bells a mega shopping mall?

Polly Fong
University College London,UK

Abstract
This paper will present a morphological analysis of a late 20th century building type: mega-scale shopping centres. Given that 'buildings are fundamentally about movement, how it is generated and controlled,' (Hillier, 1993; 1996) the "shopping mall" is a very interesting case in itself, in that it attempts to recreate the scene of natural movement using apparently opposing dynamics. The question explored here is to what extent do shopping malls obey natural laws of movement or is movement managed through the location of attractors? This paper will conduct a configuration analysis that will compare the relative patterns of 'spatial potential' that are constructed in different shopping mall layouts. It presents a morphological approach that gives the vocabulary and the tools to explore the differences and regularities in the spatial patterning across a British sample. It will conclude that thought of as configured space, shopping malls can be better understood in terms of their operational strategies and design intentions.

Keywords
shopping mall, morphology, design, visibility graph analysis

p.fong@ucl.ac.uk

1. Introduction

Shopping malls are built to replicate the retail offer in established city centres, providing comparison shopping in a 'continuous' selling space on goods such as clothing, footwear, furnishing, and services such as restaurants and cinemas, all under one roof. It attempts to simulate the commercial 'live centre' of cities, artificially devised to recreate the same intensity of urban buzz (if not more) removed from city streets. Comparisons made between a naturally evolved and an artificially planned shopping centre is often a contrast between semantic notions of what is authentic (equated with socially good) and what is fake (socially bad). (Gottdiener, 1995; Dovey, 1999) This simple good and bad outlook is typical of post-modern architectural critiques in their assessment of this building typology that has gained mass appeal and commercial success[i]. Social and cultural issues aside, this condemnation stemming from a critical approach within architectural discourse misses the opportunity to raise interesting questions concerning their design in terms of how natural laws of movement are seemingly opposed inside a shopping mall and to understand how they function.

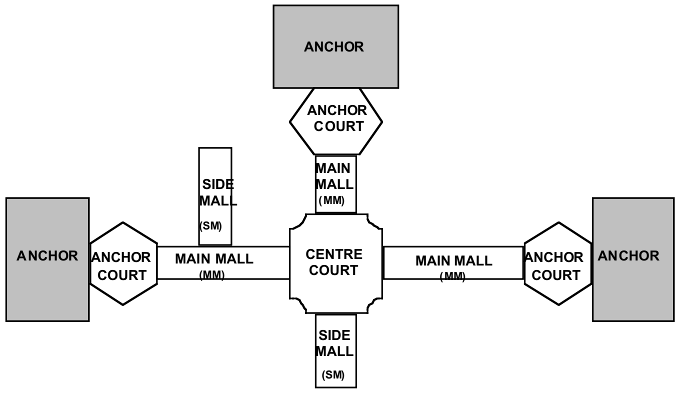
Shopping malls generally work on the premise of the classic dumb-bell concept, the large competing ‘anchor’ stores at two ends working as ‘magnets’ spaced between a two sided mall of smaller multi-cellular units. These competing anchor stores, normally full line department stores, have enough attraction power to bring movement and to induce customer circulation within the malls for themselves and a number of smaller retailers that in isolation would not have the have the same draw. The traditional ‘gravity’ model employed by shopping mall developers attempts to create an artificial ‘flow’ of pedestrian movement between two known attractors, usually multi-level department stores, and the aim of which is to reproduce the by-product effect that occurs naturally on streets. Hence the siting of major space users, location of entrances and exits, and the layout of the centre, are all important factors in mall dynamics.

10.2

Figure-1. Basic design illustrating the constituents and nomenclature of the anatomical parts within the ‘common areas’ of a super regional/regional shopping centre.

Note the distinction between Main Malls, which lead to an Anchor*, and Side Malls, which do not. Centre Courts serve as nodes that present shoppers with multiple route choices, while Anchor Courts are transitional zones between the Main Malls and the Anchor.

*Anchor is defined as a full-line Department Store of not less than 7500sq ft. (Diagram redrawn from source: Urban Land Institute, 2002 :44)



Above all, the design objective of new shopping centres is to provide a layout that will optimise rental return. The Urban Land Institute (2002) provides a basic design diagram of the spatial elements of a typical regional shopping centre, designating distinct zones within the common areas and generally accepted within the industry for sales and rental analysis. Naturally, rent yield is a major concern to shopping centre developers and this is influenced mainly by pedestrian flows, movement being an important index on which rent increases are pegged. In addition to this, there is dollar sense in the logic that a given layout should equally distribute foot-traffic throughout its spaces to benefit all its tenants, rather than the portion that can afford the prime locations. In its information brochure the Trafford Centre, one of Britain’s most recent examples, states in their letting policy that “throughout the development, the emphasis (has been) on careful consideration of layout, geometry, architecture and tenant mix. The location of retailers reflect the developer’s commitment to success and attention to detail, leading to balance and movement for the maximum benefit for all occupants.” (The Trafford Centre Ltd: 8). Maitland (1990) contends that the ‘optimal’ pattern to sustain this relationship led to the classic dumb-bell arrangement, depending on the number of anchors, the malls were calculated to minimise the access to the central flow of shoppers between the anchors. “Theoretically, in a well-laid-out shopping centre, all locations are good, and each carries equal advantage for some tenant's high volume trading."[ii] (ULI, 1999: 170)

Central to the natural movement economy theory proposed by Hillier (1993, 1996), movement density is inherent in the structure of the urban grid. "Natural movement is the proportion of movement on each line that is determined by the structure of the urban grid itself rather than by the presence of specific attractors or magnets." (Hillier, 1996: 161) Space has potentialities that through the process of partitioning it, spatial patterning allows space to be exploited. A hierarchy of space, in terms of the distribution of relative integration, is inevitable in this process. It would appear that the design objective of a shopping mall in its spatial engineering is to oppose this hierarchy because it desires to equalise movement along its malls, to achieve balanced levels of movement for the maximum benefit of each tenant for optimal rent yield. Mall management initiatives and good shopping centre design practice guidance suggest that shopping mall layouts seek to maximise locales, through strategic placement of attractors throughout the layout, an attempt to equalise "spatial potential" for maximal rental profit. In this light, shopping malls function by seeking to negate these natural forces of configuration. Hypothetically, the configuration of shopping malls should reflect this attempt through design to optimise the distribution of relative integration. The question explored here is do planned shopping malls obey natural laws of movement, such that the distribution of movement can be predicted by the pattern of relative integration in the configuration? Can configuration be overcome by the location of attractors or any other property outside of the layout? Do different mall configurations allow this to occur to a greater or lesser extent?

2. Hypotheses

Current design methodologies assume that movement rate (a proxy of shop patronage) is "generated" by the foot travel of people from going from one anchor to another. Hence the design of malls has been dictated by the placement of these anchors, and the mall bauplan[iii] divided into areas according to their placement. See Figure 1. However, it is unknown if these divisions reflect actual differences. In order to explore these questions, this study attempts to falsify the following null hypothesis:

Hypothesis 1. *That main malls (between anchors) and side malls have significantly different movement rates.*

Hillier (1993, 1996) has argued that movement is determined mainly by the configuration of space. Although this relationship has been repeatedly tested with strong evidence in natural systems, it is unclear if configuration is a good predictor of movement inside the closed, planned environments of shopping malls. This study attempts to falsify a second null hypothesis:

Hypothesis 2. *That if a shopping centre layout is successful in equalising foot traffic throughout its common areas by the location of attractors then, variables of attraction rather than variables of configuration can best predict movement distribution patterns between malls of different layout.*

3. Methodology

3.1 Sample

To carry out what is essentially a comparative study of configurational aspects of design the sample will consist of a selection of very large shopping malls[iv] for layout diversity and complexity. Maitland (1985) identified four layout types, which have been pervasive common area design options: square, linear, cruciform and L-shaped. The selected case study sample fall into these categories, although not exactly. (See Figure 2) The common area spaces in Milton Keynes comprise multiple squares while the triangular ring layout of Bluewater is an adapted square form. Lakeside represents a perfect linear layout. Merryhill and Metrocentre are cruciform such that there are multi-arms leading back to a middle point. Trafford and Meadowhall can be considered L-shaped because of the bent linear shape.

Due to the physical limitations of collecting movement data, the sample will be entirely British. Built over a span of 25 years by different developers and in varied geographic areas, the result of this study is likely to have wider design implications and not limited to the set. The average total floor space (gross leaseable area, GLA and common area) of the shopping centres used in this study is 123,963sqm with an average of 229 shop units.

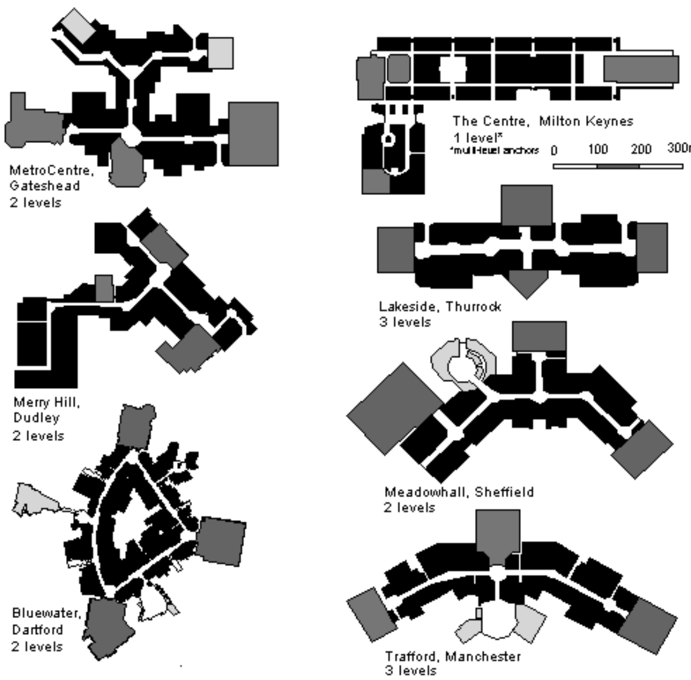


Figure-2. Ground floor maps of the seven mega scale - super regional shopping centres undertaken in this study, representative of the total population in the United Kingdom. Under this classification, each centre comprises of >800, 000 sq ft/74,320sqm of Gross Leaseable Area, GLA. (International Council of Shopping Centres, 1999) Location of anchors are highlighted in darker grey and location of food court and entertainment facilities (ie. cinema, fun-park) are in lighter grey.

3.2 Data

The Charles E. Goad shopping centre floor plans were used as the basis of the layout together with an on-site survey of each centre to include visual information missing on the floor plans.

3.3 Movement Data

The observation data was collected at each shopping centre throughout 2001. Observations were taken in a representative sample of mall segments in each shopping mall on a typical Saturday[v] during peak hours between 1pm to 4pm. Each observation point was counted for a total 6 minutes and this number was multiplied by 10 to ascertain an hourly rate. Observations of Milton Keynes were conducted over two different Saturdays for 3 minutes each on both days.

3.4 Visibility Graph Analysis

The computer technique from which relative integration can be quantitatively estimated in buildings is the "visibility graph analysis." Depthmap Turner (2001) will be employed to process the plans. This method was chosen over other space syntax methodologies because of the simplistic nature of shopping mall building plans and the ability of VGA to highlight locational differences of relative integration along the length of a straight mall space, as techniques of describing space, axially or convexly would not allow for such a finer grain of analysis.

3.5 Statistical Methods

3.5.1 Nonparametric tests.

Nonparametric tests deal with ranked data and compare the observed distribution of ranks with the expected distribution of ranks when the null hypothesis is true. They make no assumptions about the population distributions (e.g. normality), in the way that parametric tests, such as ANOVA and regression, do (Tilley, 1994). These methods area best suited to test correlations when one of the variables is qualitative. This will be used to test differentiation in the distribution of movement and relative integration between zones in common areas. The caveat is that it has less power, such that if the correlation is subtle it will be missed. Two nonparametric tests have been employed in the following study: Mann-Whitney U test and Kolmorogov-Smirnov two-sample test.[vi]

3.5.2 Simple and multiple regression.

Regression analyses[vii] were used to assess the relationship between the dependent variable (DV) and one or several independent variables (IV). Multiple regression techniques can be used even when the IVs are correlated with each other and hence it is highly useful in complex situations such as this. In sequential multiple regression, IVs were entered into the (regression) equation in the order specified by the researcher. The order is dependent on theoretical grounds (i.e. what comes logically first) as the importance of the IV's depends on the order in which they are entered.[viii] (Tabachnick & Fidell, 1996: 149)

4 Results

A morphometric analysis was conducted from the base plans of each shopping mall in the British sample. The results are summarised in the following table and diagram. (See Figure 3 &4) This aim of the exercise has been to compile metric design data for reference that can be obtained at a glance. On average the floorspace of the common area of a UK mega scale shopping centre is 19% of the GLA. The multiple square/grid layout of Milton Keynes has by far the highest ratio. The average distance between main mall nodes is 105m and 61m for side malls.

10.6 The results of the nonparametric Mann-Whitney U test and Kolmorogov-Smirnov tests show that the distribution of movement levels differ significantly between main malls and side malls.[ix] Main malls carry, on average, 40% higher foot traffic rates – it could be inferred that the design of Lakeside and Bluewater attempts to maximise this difference, due to the high ratio between main malls (MM) and and side malls (SM) at 3.1 and 2.7 respectively, compared with Metrocentre and Merryhill which are close to 1. Because of the problem of a small sample size, (limited movement count locations) it was not possible to repeat the exercise for the other parts such as anchor, centre and side courts within the common areas.

	Rank by size (total floor-space)	Common area as % of total floor-	MM area as % of comm. Area	MM area as % of comm. Area	CC area as % of comm. Area	SC area as % of comm. Area	AC area as % of comm. Area
Metrocentre	1	20.10%	26	27.5	22	16.6	7.9
Trafford	2	17.60%	27.1	19.5	11.7	37.3	4.3
Bluewater	3	20%	54.3	20.2	13	12.5	0
Meadowhall	4	17.40%	33.7	24.9	17.7	10.9	12.8
Lakeside	5	16.50%	37	11.7	26.4	10.1	14.9
Merry Hill	6	15.50%	28.8	31	9.5	1.6	29
Milton Keynes	7	28.40%	47.8	26.5	20.7	2.2	2.8

Figure-3. Summary table of morphometric data of the common areas within each shopping centre.

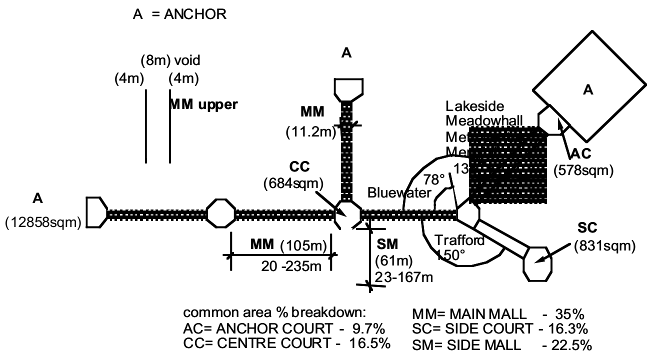


Figure-4. Basic plan summarising morphometric measurements: average main mall and side mall lengths between nodes, average mall widths, turning angles and average size of anchor, centre and side courts.

Figure 5 summarises the movement observation data. Note that the key aspect is the form of the distribution pattern of movement, and not the actual values of the mean because they may not be comparable across malls due to external factors, ie. catchment size. What these results show is that in every case, there is a positive skewness in the distribution of movement rates, and hence more counts in the lower end of the spectrum of movement rates. Metrocentre and particularly Milton Keynes exhibit more normal distributions, with more similar mean and median values. However eveness of the distribution of movement is best explained by the kurtosis, which describes the 'peakiness' of a distribution with values above zero having a pointy distribution such that the range is focused around the mode (inflection point in a distribution.) Merryhill and Meadowhall (positive kurtosis) display a higher tendency for evenness in their movement distribution patterns, while Metrocentre and Bluewater (negative kurtosis) show more differentiated distributions. Note that the observations counts represent a small sample size, hence measures of distribution are likely to have a considerable margin of error.

	Mean	Std. Dev.	Count	Skewness	Kurtosis	Median
moverate, Total	3250	1738	137	1.044	0.629	2750
moverate, BW	3113	1788	19	0.803	-0.89	2100
moverate, LK	4203	1512	13	0.913	-0.539	3675
moverate, MA	3039	1429	20	0.945	0.182	2794
moverate, MC	2428	851	28	0.539	-0.968	2325
moverate, MHI	2307	1316	17	1.269	0.260	1815
moverate, MK	4618	2430	20	0.152	-0.725	4615
moverate, TR	3560	1472	20	0.784	-0.629	2890

Figure-5. Summary table of the movement data. BW=Bluewater, LK=Lakeside, MA=Meadowhall, MC=Metrocentre, MHI=Merryhill,

Correlation between movement rates and attractor values[x] were highly signifigant at $p < .0001$. See Figure 6. These attractor measures (count of shops, length of frontage and shop area) were attributed to the convex space where the observation count was taken. Average correlation between movement rates and these attractor values was at 30%. As quantitative "antecedent" attraction variables derived from say, surveying all visitors at the entrance and asking them which stores they had come specifically to patron, are not available for this study, these measurements were used in this study to account for attraction. Although "spatial" in nature, they are in a way equivalent to 'density' measurements: density = no. units / unit of space. These measures have however, one crucial difference. Density per unit of space is purely a hard quantitative measure, which does not reflect people's perception of space or attraction. For example, a count of nine shops fronting onto a 180sqm convex space will be equivalent to a count of three shops fronting onto a 60sqm convex space, both 0.05 per square metre. The variables used are expressed as raw measures of attraction per convex space (as a visual unit) because it accurately captures the difference between the choice of nine shops and the choice of three. Furthermore, if such variables were expressed as a density measure, this would confound the objective, which is to test attractor variables against spatial variables. Average correlation between movement rates and these attractor values was 30%.

Nonparametric Mann-Whitney U test and Kolmorogov-Smirnov tests were repeated to test the distribution of integration values (in this case the Total Depth measure from the Depthmap output) and whether there were significant differences between the rental zones within the common areas; anchor, centre and side courts, main and side malls. The Average Total Depth measure was taken for each convex space and attributed to a zone accordingly. Data points of each zone were paired across a matrix and the results showed that the zones formed two highly signifcant groupings: anchor courts, centre courts and main malls while side malls and side courts formed another, while there was no significant difference within each group internally. This result is congruent with main malls and side malls, having significantly different distribution of movement.

10.8

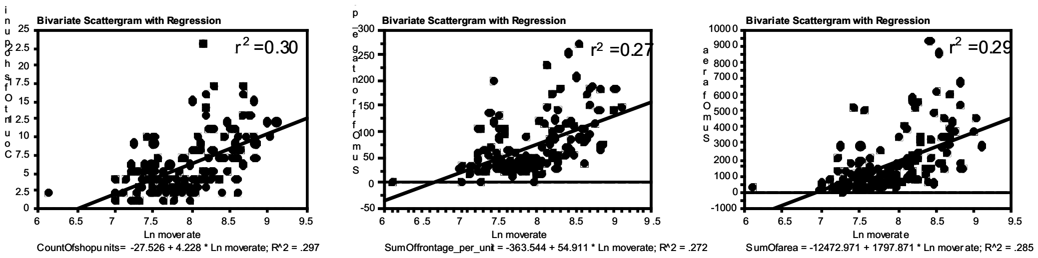


Figure-6. Scattergram showing movement rates (logged) plotted along the x-axis against three 'attractor' variables on the y-axis: count of shop units (far left), sum of the length of shop frontage (centre), and sum of shop floor space (far right). The strenght of the correlation is indicated by the line r2 value, such that a perfect relationship, where all the points along x and y axis would meet along a straight line, the r2 = 1.

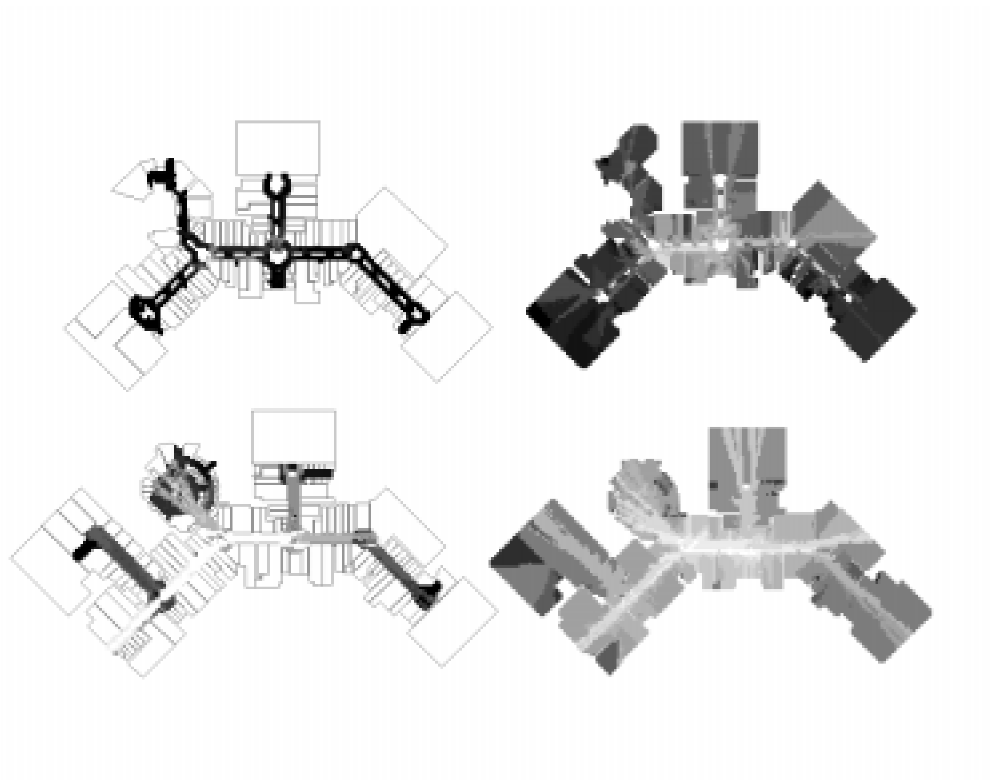


Figure-7. Visibilty Graph Analyses were generated by using Depthmap. The output maps for Meadowhall is shown above. The grey scale colouring depicts locations of the highest Total Depth (lowest integration) in black through to locations of the lowest Total Depth (highest integration) where white.The graph generated for each floor were linked via the escalator locations using the 'merge' method of connection. Two types of models were processed for each case study, one which considered only the common areas, excluding the floorspace of all shops (left) and one which included all the tenancy floorspaces (right).

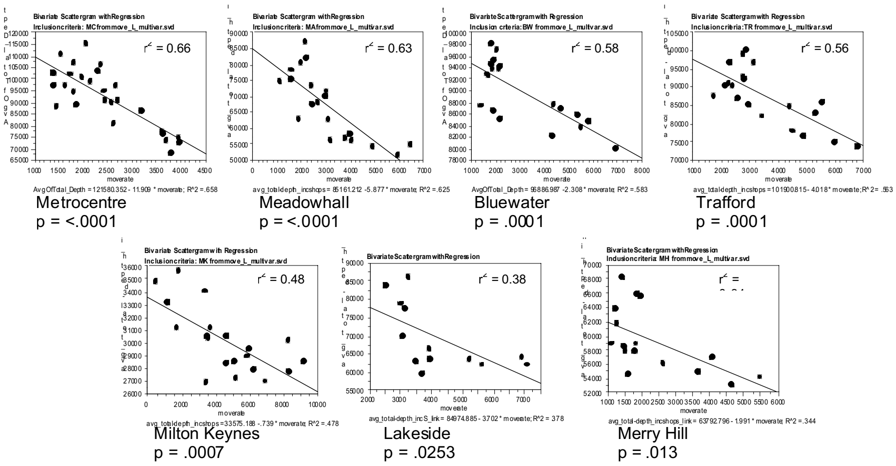


Figure-8. Scattergrams showing the relationship between movement rates (along the x-axis) and the Depthmap global measure of Total Depth* (along the y-axis).

In summary, the results of a series of correlation tests performed between movement and configurational measures (obtained from each corresponding computer model output from Depthmap, see Figure 7) found that the single best predictor of movement rate within each mall was Total Depth[xi], which exhibited high significance in every shopping centre studied and explained on average over 50% of variance. Figure 8 shows the correlation scattergrams between movement rate and average Total Depth,[xii] (derived from the computer model that included the shops in the visibility graph of each shopping centre studied,) for each shopping centre.The strength of the correlation is indicated by the r2 value, such that on a perfect relationship, where all the points along x and y axis would meet along a straight line, then r2 = 1. Note that the higher the value of Total Depth the deeper the space is within the system and therefore, less integrated.

Total Depth measures from the two types of Depthmap models (excluding and including shop floorspace) were tested against observed movement rate. These results are summarised in Figure 9. The Total Depth values from the model including the floor area of shops, has a higher correspondence with the pattern of movement levels than Total Depth values generated from the model which excluded shops. NC denotes where there is no significant correlation. Where the r2 is shown, p significance was at <0.05, while * denotes a highly significant correlation where p =/ <.0001. Two transformations of Total Depth were performed in order to make Total Depth comparable across the sample by eliminating the effect of size. Firstly, Total Depth measures were transformed using P value adjustments, Avg. RRA (adopted methodology outlined in Hillier & Hanson 1984: 114, for convex analysis) and correlated with their respective movement rates from each centre subset. On average there was little improvement. However, when correlated with the full combined data set of movement rates, there was a highly significant p=<.0001 relationship although a markedly lower corresponding r2 value. Secondly, Total Depth measures were also transformed by dividing each value by the population minimum value in each set, AvgTL, (method known as multiplicative coding, Sokal & Rohlf, 2001: 54), resulting in an improvement in the correlation, an increased r2 of 0.355 in the combined movement data set. However, the lower r2 value of the transformed Total Depth measures and movement compared with the r2 values of the individual correlations signifies that these methodologies for the normalisation of size are not optimal.

	SR (Excl. shops) Avg. Total Depth	SR (Incl. shops) Avg. Total Depth	SR (Incl. shops) Avg. RRA*	SR (Incl. shops) Avg. TL*	SMVR Avg. TL* & Count of Shops	SMVR Avg. L* & Front age Length	SMVR Avg. Avg TL* & Shop Area
Bluewater	r2 = 0.58*	r2 = 0.58*	r2 = 0.47	r2 = 0.58*	r2 = 0.68*	r2 = 0.77*	r2 = 0.64*
Lakeside	NC	r2 = 0.38	r2 = 0.31	r2 = 0.38	r2 = 0.67	r2 = 0.63	r2 = 0.69
Meadowhall	r2 = 0.51	r2 = 0.63*	r2 = 0.73*	r2 = 0.63*	r2 = 0.63*	r2 = 0.63*	r2 = 0.65*
Merryhill	NC	r2 = 0.34	r2 = 0.42	r2 = 0.34	r2 = 0.53	r2 = 0.61	r2 = 0.62
Metrocentre	r2 = 0.62*	r2 = 0.66*	r2 = 0.58*	r2 = 0.66*	r2 = 0.67*	r2 = 0.66*	r2 = 0.62*
Trafford	r2 = 0.26	r2 = 0.56*	r2 = 0.59*	r2 = 0.56*	r2 = 0.67*	r2 = 0.59*	r2 = 0.66*
Miltonkeynes	r2 = 0.33	r2 = 0.48	r2 = 0.50	r2 = 0.48	r2 = 0.51	r2 = 0.48	r2 = 0.48
COMBINED DATA	NC	NC	r2 = 0.25*	r2 = 0.36*	r2 = 0.45*	r2 = 0.45*	r2 = 0.45*

Figure-9. Table showing a summary of the individual correlations between observed movement rate and average Total Depth for each shopping centre
(NC= no correlation; SR=Simple Regression; SMVR=Sequential Multiple Regression, with Total Depth as the first IV entered).
* Transformed Total Depth measures. RRA using Pvalue adjustment method outlined in Hillier&Hanson (1984) and TL using multiplicative coding by dividing all Total Depth measure by the minimum value, Sokal & Rohlf (2001)

Since movement has correlated significantly with both total depth as well as attractor variables, the question now becomes how much each variable explains movement when in conjunction with the rest. To do so sequential multiple correlation was employed, following an a priori sequence partially guided by the results of the simple correlations (see Figure 9). In this way, the first variable added was total depth, (AvgTL) which by itself accounted for 35% of the r2 of movement on its own for the entire data set. Attractor variables were found to be essentially equivalent. Thus the addition of any one of them to total depth (AvgTL) increased r2 by ten percentage points to 45%, with further additions improving the correlation marginally (2-3%). The effect of adding measures of total depth after attractor ones was found not to change the correlational pattern held when the data was analysed individually for each shopping centre, although the average r2 values improved to 62%.

5. Discusssion

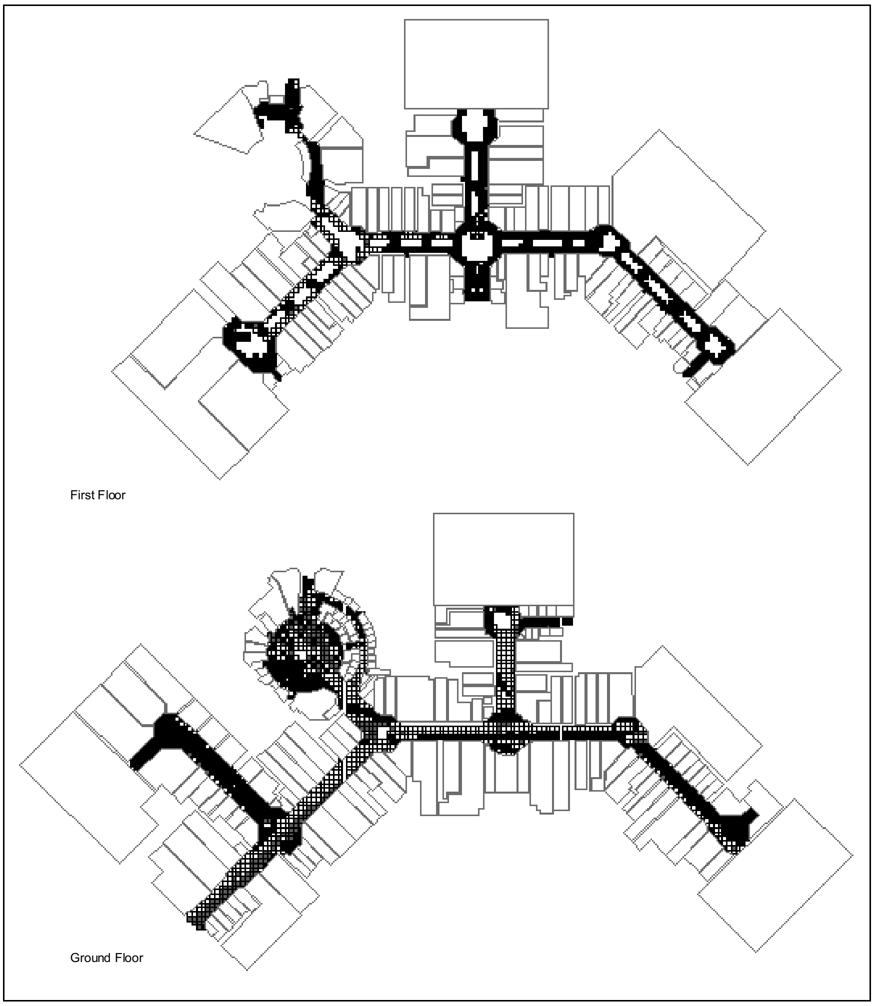
From the point of view of mall design, homogenising (= minimising) integration differences seems to be the objective of mall designers when thinking of the shopping centre as a managed 'asset.' The main concern of mall managers' and developers' is rent optimisation, which is best achieved by ensuring an evenness of foot traffic to all its tenants. It would appear that although principles of attraction do have causal effects on the distribution of movement through the arrangement, placement and allocation of space in the tenant mix process, configuration still provides a stronger predictive power. Nevertheless, what the results of this study also indicate is that configuration and the attraction variables used in this study are not exclusive. Logically, count of shop units, length of frontage and shop area are spatial properties and there is to be expected some overlap between them. This makes it difficult to distinguish the effects of any single one in isolation. Nevertheless, as has been shown, the addition of an attractor value to Total Depth increases the predictive value considerably.

Going back to the question of whether there is a layout type for common areas, (square, linear, cruciform or L-shaped configurations) that can facilitate an even distribution of movement? There is no easy answer. The interplay of multiple variables within a complex system, such as an enclosed shopping centre is a case where changing one thing is likely to affect others. Therefore, non-discursive techniques proposed by Hillier (1996) can serve as invaluable tools to capture this spatial complexity in order to evaluate the design of shopping malls. For example, if a layout type has in itself a spatial potential that can be exploited, then the tenant space allocation or the clustering of partitioned areas along a mall should be working to enhance its attributes. This differential in the relative integration pattern between the common area as one system and the common areas with the added shop areas as another, can be graphically illustrated to help understand what shops 'add' to the common area.

Figure 10 shows a map of the differential effects of the tenant mix to the upper and lower levels of the common areas in Meadowhall centre. Generally it highlights upper floors and side malls as losing depth, once the partitioned shop areas were added to the common area. This differential was calculated by taking the difference between the transformed values of Total Depth (dividing by the minimum) of the two VGA models, excluding and including shops. It was found that that in some shopping centres such as Milton Keynes and Bluewater, large areas of main malls have the effect of gaining depth when the same comparison of relative depth was made. This technique offers a visual tool for understanding the effects of 'adding' shop areas to a given skeleton layout for a common area. In this way, the massing and partitioning exercise of tenant space allocation in the design of shopping centres can be quantified and evaluated; the objective being maximising loss of depth and optimising the spatial potential of the basic design of the common area.

10.12

Figure-10. This diagram of Meadowhall shopping centre show the differential 'gain' or 'loss' of depth as a result of adding shops to a common area layout. Black areas show 'loss' in depth, white areas show negligible change and grey areas show 'gain' in depth.



The design of shopping malls is often portrayed as an exact science of the magnetic polar forces of anchors and pulls, apparently so straight forward that there is little challenge to the way its spatial structure supposedly works[xiii]. It is often wrongly assumed that shopping malls are spatially indistinguishable from one to the other, even though the criticism has been aimed at the presence of similar multiple outlets. Shopping malls are of course configured differently from one to another, they are complex buildings of huge investment that are to meet the needs of modern shoppers, requiring a sophisticated mix of general and specialist retailers. However, in the last ten years this typology has undergone a structural shift from the 1950s model. Due to changing trends in retailing, mall configurations are increasingly larger and involve more complex hybrid forms and a programme of new overlapping functions in the new breed of malls. Hence they are rarely just a 'dumb-bell.' Retail design is a complex area, requiring increasing knowledge and experience, not readily available to most architects and designers to produce commercially viable retail environments in a sector, which is growing in sophistication. The aim of this study has been to fill a small gap in that knowledge.

6. Findings

Finally, returning to the two hypotheses set out in the beginning of this paper:

That main malls (between anchors) and side malls have different movement rates. The null that they are not different has been rejected.

That if a shopping centre layout is successful in equalising foot traffic throughout its common areas by the location of attractors then, variables of attraction rather than variables of configuration can best predict movement distributions patterns between malls of different layout. From the preceding analysis, there is reasonable evidence that configuration has a direct relationship with the distribution of movement within planned, artificial shopping centre environments. From the variables examined in the study, movement is best predicted by the relative patterns of Total Depth intrinsic to properties of layout, although in combination with attraction variables this predictive power can be improved.

Notes

i Ironically, Victor Gruen's (architect of Southdale Shopping Center, the first fully enclosed shopping mall in 1956) primary motive was to offer an alternative to the suburban slum of strip development of the postwar and create a space for public life into the new communities. The enclosed shopping centre was intended as a gracious enclave where suburbanites would get out of their cars and meet each other, a place that would not only support commercial activity but social life as well. (Dovey, 1999.)

ii However, it is acknowledged (perhaps post-hoc when this desired equalisation has not been achieved) that certain types of tenants do not require prime locations in a mall or centre, and in fact, what is prime for one tenant may not be prime for another. (ULI, 1999)

iii "Bauplan" is a German word meaning "blueprint" and a term used by comparative anatomists referring to the common basic anatomy of organisms belonging to the same typological group.

iv Current definitions of shopping centre typology are mainly based on size, measured in terms of its gross leaseable area. The largest of these types is the super regional centre, which has a size criteria ranging from 800,000 sq.ft. (72,000sqm) to more than 1,500,000 sq.ft.(135,000 sqm), with the higher end of the range more popularly referred to as mega malls. The International Council of Shopping Centres stipulate that under this classification, centres of this mega scale offer extensive variety in apparel, home furnishing, services and recreational facilities and one built around three or more full-line department stores, generally not less that 75,000 sq. ft each (Urban Land Institute, 2002)

v Festivities weekends such as Easter or long bank holidays weekends were avoided.

vi Both tests compare the distributions of two populations with the assumption that they are the same (i.e. drawn from the same population type). However, the Mann-Whitney U-tests only looks at shifts in location (as measured by the number of rank interchanges in the sample) while the Kolmorogov-Smirnov test looks at changes in the entire distribution (location, skewness, etc.). This means that although both tests are looking at the similar things, they may not agree on some cases. This, however, does not affect the significance of the results.

vii Regression does not indicate causal relationship, just statistical.

viii This is different from stepwise (= statistical regression) which uses statistical criteria to determine the order of addition. For small sample sizes (like this one) stepwise regression can lead to choice of IV's which are not optimal.

ix These results were consistent regardless of transforming the data (natural logarithm to normalise it).

x Physical attractor values were employed because these could be meaningfully quantified.

[xi] Total Depth is the output configurational variable from Depthmap that measures relative integration or depth within each system. However, it is not normalised for size and cannot be compared across the sample without transformation.

[xii] The average value of Total Depth was taken with a buffer of 3-4 tiles of the 3m processed grid, pin pointed at the location where the movement count was observed.

[xiii] In the literature, design guidelines or rules of thumb are offered based on precedence with little empirical validation. For example, "(e)xperience has shown that there is a maximum distance of 200-250 metres which shoppers are prepared to travel from one major focal point to another. If distances are greater than this, they tend to loose interest and fail to complete the journey. If the pedestrian flow is to be uniform, it is desirable for the shopper to be physically capable of visiting all parts of the centre on one trip, and this is unlikely if the distances become too great." (Northern, 1977). The Urban Land Institute (2002) compiles a compendium of data from 1000 shopping centres across the United States bi-annually as a comparative tool within the industry to measure performance, however it offers little in the way of theory as to how these performance goals are reached.

References

Dovey, K., 1999, *Framing Places; Mediating Power in Built Form*. London, Routledge

Gottdiener, M., 1995, *Postmodern Semiotics; Material Culture and the Forms of Postmodern Life.* Cambridge, Blackwell, MA

Gruen, V. and Smith L., 1960, *Shopping Town USA; the Planning of Shopping Centers,* London, Reinhold

Hillier, B. and Hanson, J., 1984, *Social Logic of Space,* Cambridge, Cambridge University Press

Hillier, B., 1996, *Space is the Machine*, Cambridge, Cambridge University Press

Hillier, et al., 1993, "Natural Movement", *Environment and Planning B*, Volume 20

Trafford Centre Ltd., 2002, *Trafford Centre Info Pack*, Available on-line at URL: www.traffordcentre.com

Maitland, B., 1985, *Shopping Malls; Planning and Designs,* London, Construction Press

Maitland, B., 1990, *The Architecture of the Retail Mall,* London, Architecture Design and Technology Press

Northen, R. and Haskoll, M., 1977, *Shopping Centres; a developer's guide to planning and design,* Reading, College of Estate Management

Sokal, R. R. and Rohlf, F. J., 2001, *Biometry,* 3rd edition, New York, W. H. Freeman and Co.

Tabachnick, B. G. and Fidell, L. S., 1996, *Using Multivariate Statistics,* 3rd edition, Harper Collins College Publishers, New York

Tilley, A., 1994. *An introduction to psychological research and statistics,* 2nd edition, Brisbane, Pineap ple Press

Turner, A., 2001, "Depthmap: a Program to Perform Visibility Graph Analysis", *Proceedings of the 3rd International Symposium on Space Syntax*, Atlanta, Georgia Institute of Technology

ULI - Urban Land Institute, 1999, *Shopping Center Development Handbook*, Washington D.C., ULI

ULI - Urban Land Institute, 2002, *Dollars & Cents of Shopping Centers 2002*, Washington D. C., ULI - the Urban Land Institute