Configuration and Design in Caring Environments: syntax and quality of life in a sample of residential care homes for older people

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Abstract

Space syntax techniques for the analysis of spatial layouts were the first to demonstrate, in a numerical way, clear and systematic relations between spatial design and observed functioning across a range of building and urban types. In this project, the techniques have been applied for the first time to the problem of layout design in care homes for older people as part of a wider study of care home performance, Design in Caring Environments (DICE), carried out by Sheffield University. We were able to do this because the DICE data included both building plans and quantitative measures of the quality of life of residents and staff. The aim of the work that is reported here was to add the syntactic dimension and to test to see if this related to the DICE quality of life variables.

Complex, multi-level regression methods (Gorard, 2003) had been used by the DICE team to plot relationships between the main physical features of each building and quality of life data for residents and staff. An identical approach was used to explore the relationship between a range of syntactic variables and the residents' quality of life scores for each building. In the final event, only two syntactic variables showed significant associations with quality of life outcomes, but these turned out to be the two most important configurational measures - axial global and local integration of the building. These measures are known to work well in predicting space occupancy, use and interaction in buildings that embed a weak organisational programme, where unplanned movement and activity are likely to make a positive contribution to community formation, but prior to this study we were unsure of the extent to which building layout would be able to overcome the effects of a strong organisational programme of the kind that exists in the care home sector and which is usually backed up by rules restricting access to different parts of the building.

The results from multi-level modelling revealed clear and positive correlations between spatial design variables and three critical performance variables: the proportion of the residents' active time, frequency of the residents' enjoyable activity and the extent of the residents' choice and control over environment. The research thus shows unambiguously that, as many designers and care home managers suspect, design is indeed a critical variable in care home management and performance.

1. The primacy of the plan

As Dunster (1985) has observed, the plan has occupied a privileged place in contemporary design discourse because, "architecture looked at plans for descriptions of ways of life". By this, he meant that if we consider a building such as a residential care home or nursing home, it is made up of a number of rooms or spaces that are connected together in such a way as to enable it to support its intended function. More precisely, the way the individual rooms or spaces are connected together into an overall building layout enables the various

users of the building, be they residents, staff or visitors, to carry out their activities within the building and to engage in interactions with one another. In this sense, a building is not just a physical entity but an embodiment of activities and social relationships, and it is these activities and relationships that are captured and crystallised in the plan of a building.

It is against this backdrop that this paper presents the findings of a one-year study that linked together two earlier research projects, Profiling the Housing Stock for Older People, hosted by University College London and carried out between April 1998 and December 2000, and Design in Caring Environments (DICE), hosted by the University of Sheffield and carried out between January 2000 and May 2003. The aim of the link project, which was carried out between September 2002 and August 2003, was to produce a building configuration analysis of the thirty-eight residential care and nursing homes that constituted the building database for Sheffield's research into the relationship between architectural design variables and quality of life, using the space syntax research methodology. Space syntax has been shown in numerous studies to provide useful and objective representations, descriptions and measurements of the layout of complex buildings that shed light on their functional performance and experience by building users.

The link project had two principal objectives. The first was to test whether the overall spatial characteristics of the care home layouts in the DICE sample, such as their degree of integration / segregation and the spatial intelligibility of the layout, factors that cannot easily be captured in a checklist of design variables or detected when walking around the interior of a building, were important to the perceived quality of life of staff and residents and to the well-functioning of the building. The second was to test whether these spatial, configurational variables related systematically to the typologies, checklists and indicators that the DICE team had developed into an assessment tool, the Sheffield Care Assessment Matrix (SCEAM), for use in evaluating the design of residential care homes and nursing homes for older people. In short, the research aim was to identify those variables of building layout that impacted (positively or negatively) on the functional efficiency of the building and the perceived quality of life of its staff and residents. These two groups might not value the same properties in the building and so it was envisaged that the impact of any design variables would need to be assessed separately for each group.

2. The SCEAM matrix for assessing care home quality

Prior to the DICE project, the efficacy of many of the recommendations enshrined in the architectural literature on residential care home design had not been adequately tested through evidence-based research. Indeed, one of the key goals of DICE was to systematically investigate the relationship between building design and the quality of life of residents, together with the job satisfaction and morale of care staff, precisely in order to develop the evidence-base for design standards in residential care homes. The SCEAM matrix (Barnes et. al, 2002, Parker et. al., 2004) was therefore devised by the DICE team specifically to explore the relationship between physical environment and quality of life variables in such a way as to facilitate building appraisal at the design stage and to support building audit and facilities management. It comprises a matrix of 318 user requirements, grouped into eleven user-centred domains and seven architectural elements, see table 11.

On the vertical, user-requirements axis the residents' domains form three clusters, relating to universal, physical and cognitive needs. There is one staff domain. On the

Table 11: The structure of SCEAM

DOMAIN	ARCHITECTURAL ELEMENT						
	Location	Outside spaces	Building form & circu-lation spaces	Day spaces	Bath-rooms & toilets	Private rooms	Staff spaces
Residents: universal							
Privacy							
Personalisation							
Choice and control							
Community							
Residents: physical							
Safety and heath							
Support for physical frailty							
Comfort of environment							
Residents: cognitive							
Support for cognitive frailty							
Awareness of outside world							
Normalness and authenticity							
Staff							
Provision for staff							

horizontal axis, the architectural elements relate to the main physical features of the building. Each domain comprises a number of individual items, most of which are scored as either being present (1) or absent (0) in the building by direct observation on-site, using a walk-through checklist. A small number of items are more easily assessed from building plans. A score is then calculated for each domain that represents the proportion of the features scored positive, taken as a percentage of the total for that domain. For example, the first domain relating to privacy contains 40 items, so a building meeting 30 of these would score 75%. Scores can be calculated in the same way for each architectural element. Each domain or architectural element can achieve two scores relating to how the building was originally designed and how the building actually functions in use, with the exception of the domain of environmental comfort which is only assessed in the building as it is actually experienced.

Sheffield's SCEAM matrix was tested and validated by applying it to the thirty-eight buildings that made up the DICE building sample. These were randomly selected from residential care and nursing homes in the Sheffield / Rotherham area of northern England. Quality of life data were also gathered in each of the sample homes from twelve randomly selected residents, with a view to collecting full information from seven. This allowed for the possible failure of some frail or confused research subjects to complete the quality of life assessments. Observations were used to assess the residents' level of activity and apparent well-being during a typical day, and proxy information on the research subjects' health and quality of life was also obtained from care workers in a questionnaire that

included standard medical research measures of dependency, frequency and enjoyment of pleasant events, outward signs of emotion and ability to choose and control the immediate environment. Where the resident was able to participate actively in the research, one-to-one structured interviews supported by large-scale cue cards were conducted in private. Managers also provided information on all the long-stay residents in each home. Information was sought from all the nursing and care staff in each home on their employment, job-related morale, work-related stress and satisfaction with the physical environment.

Multi-level regression methods were used by the DICE team to estimate the relationships between building domain scores and quality of life scores for residents and staff. After adjustment for potential confounding variables, several domain scores were found to reflect in a meaningful way the distinctions between the main building types in the sample. For example, nursing homes tended to score higher than residential care homes for the domain of safety and health, but tended to have lower scores for the domain relating to awareness of the outside world. So far as the relation to quality of life variables is concerned, well-being was positively related to the domain of choice and control. Residents living in buildings that scored high for the domain of community also tended to have higher levels of activity. Positive emotion was directly related to the domain of cognitive support.

On the negative side, residents living in buildings with a high score for safety and health tended to show lower scores for enjoyment of activity, and they also tended to have less control over their environment. This was attributed to the risk-averse culture of care that was observed in these homes. In some cases, the relation between environmental quality and quality of life was mediated by the level of dependency of the resident. For example, for more active, independent older residents the proportion of time spent active was associated with the domain of community, but for the group of residents with high physical dependency scores, the proportion of time active was associated with physical support.

Staff quality of life did not directly relate to their provision within the building, but had positive associations with the residents' domains of normalness and authenticity and personalisation. Staff therefore seemed to derive job satisfaction from working in an environment that was not experienced as institutional by the older residents they were caring for. The domains of privacy, comfort and awareness did not show any significant associations in the analysis carried out by the DICE team. However, the researchers cautioned against assuming that this meant that these properties are unimportant in the design of care homes, but rather that the overall quality of life measures that were used in the study may not have been particularly sensitive in detecting the impact of these particular domains.

Finally, the DICE team examined a number of other building variables for their impact on quality of life, including the age of the building, its location, whether or not the home was purpose-built and the amount of private and communal space per resident. None of these had a significant impact on quality of life. The size of the building made an independent contribution to one quality of life measure, in that an increase in the numbers of beds was associated with a reduction in the residents' sense of control over their environment.

3. Initial hypotheses regarding configurational variables

The architectural element in SCEAM matrix that came closest to capturing building configuration was that of building form and circulation space. This was also the most substantial architectural element, with ninety-four separate attributes. Of these, only a small number of items addressed issues in common with space syntax. These recorded the arrangements for access between the residents' private rooms and the shared bathrooms, day rooms and lounges; whether circulation routes within and outside the building took the form of a ring that afforded route choice or a series of dead end corridors; and whether the journey from the furthest bedroom to the day room was a simple one that involved only one or two changes of direction, or a more complex journey involving three or more changes in direction.

The quality of life domains identified in Sheffield's study that seemed intuitively to be associated with syntactic variables were those relating to privacy, choice and control, community and cognitive support. Syntactic variables might be expected to impact on quality of life variables, but the relationship was unlikely to be straightforward. For example, integration, a spatial property that renders the parts of a building easily accessible to one another and is associated with lively, busy places, might be valued by staff and by active residents, but disliked by frail or confused residents, who might prefer a quieter building with greater segregation between the functions and a smaller amount of co-presence, mutual awareness and casual encounter.

Previous research by Robinson et. al. (1984) and Thompson et. al. (1996) that utilised space syntax to study homeliness and institutionalisation in a sample of residential settings for people with mental health problems, suggested that homes in mainstream society incorporate three distinctive spatial patterns; a linear sequence in circulation areas, fan shaped connections in rooms accessed from a common hall and habitable spaces connected together in a triangle. These patterns reflect the transition from outside to inside and individual, intimate and group social spaces respectively. Robinson has proposed that, in ordinary domestic settings, the three patterns combine to define a distinctive 'privacy gradient' from social to intimate space that is absent in communal care homes. This finding is rather similar to Hollingberry's (1993) concept of 'progressive privacy', which is widely believed to support residents in care homes, particularly older people with dementia.

Recent research by Peatross (1997) in Alzheimer's units and juvenile detention centres has linked syntactic spatial variables with observed levels of probabilistic movement about the building and, through this, to levels of social interaction. Visual fields proved to be crucial in helping the building to appear normal to staff and inmates, rather than an environment that was dominated by control and surveillance. Elsewhere, research by De Syllas (1999) has suggested that size need not be a negative factor in the design of residential institutions, provided that the spatial integration of the layout is sensitively handled, so that residents have choice and control over how they make use of the spatial potential offered by the building to reflect their individual preferences in their domestic living arrangements.

The SCEAM matrix did not include any variables that related to the overall layout of the building, but many practising architects believe that whole building layout should affect the experiences of the people who live and work there. Characteristics of the whole building layout that we might expect to exert an influence on the atmosphere and quality of life within the care home, as experienced by residents and staff, include: the extent to which the overall layout of the home is integrated or segregated, measured by the mean

Table 12: Taxonomy of the Overall Form of the Buildings

	Small	**Medium**	**Large**	**Totals**
Simple Linear	0	3	1	**4**
L-shape	3	1	4	**8**
T-shape	0	2	1	**3**
Cruciform	0	1	0	**1**
U-shape	0	1	1	**2**
Atrium/courtyard	1	2	1	**4**
Hybrid	0	3	4	**7**
Converted building	5	1	1	**7**
Totals	**9**	**14**	**13**	**36**

global and local axial integration of each home; and the simplicity or complexity of the internal circulation system, measured by the mean intelligibility of the public realm of the building. Base difference factor may also be useful to capture the relative strength of the spatial hierarchy between the residents' bedrooms, circulation and social spaces in different care home layouts.

4. Configurational analysis

Space syntax was developed at UCL during the 1970s and 1980s as a tool to represent, describe and quantify key properties of the layout of buildings (and places) in ways that retrieve these embodied social functions by analysing built form, layout and space configuration. It is important to note that the substrate for building analysis - the plan - is the same as the basis for architectural design. Design intuitions therefore translate naturally into analytic insights, and vice versa. The method requires an accurate plan of the building, drawn to scale and with the position of doors and openings between rooms clearly identified. However, the plans of two of the thirty-eight homes in the original DICE study were so sketchy that a full building survey would have been required to reconstruct the building layout. As this would have entailed obtaining the consent of every resident, these care homes were omitted from the analysis. The UCL sample therefore comprised thirty-six buildings.

Most of the previous studies that have tried to analyse building form and function have concentrated on the overall shape and footprint of the building and did not distinguish the different parts of the plan. Robson et.al. (1997) has offered one such taxonomy of built forms for older people's housing. He proposed nine basic form-types; simple linear, offset linear, L-shape, T-shape, cruciform, U-shape, courtyard / atrium, cluster and point block. In spite of its rather obvious limitations, this classification was initially adopted by the UCL team as a general typology of built form for the buildings in the sample. As some of these buildings were not purpose-built specifically for their current function, these were allocated to a separate category, converted building. The most numerous form for purpose-built care home buildings was an L-shape, but almost as many buildings were hybrids comprising more than one built form, see table 12. There were no point or cluster blocks in Sheffield's sample of care homes.

Only one building in the sample applied a recursive design principle that operated at both the local and the global level of the building form. This example, Home 01, was

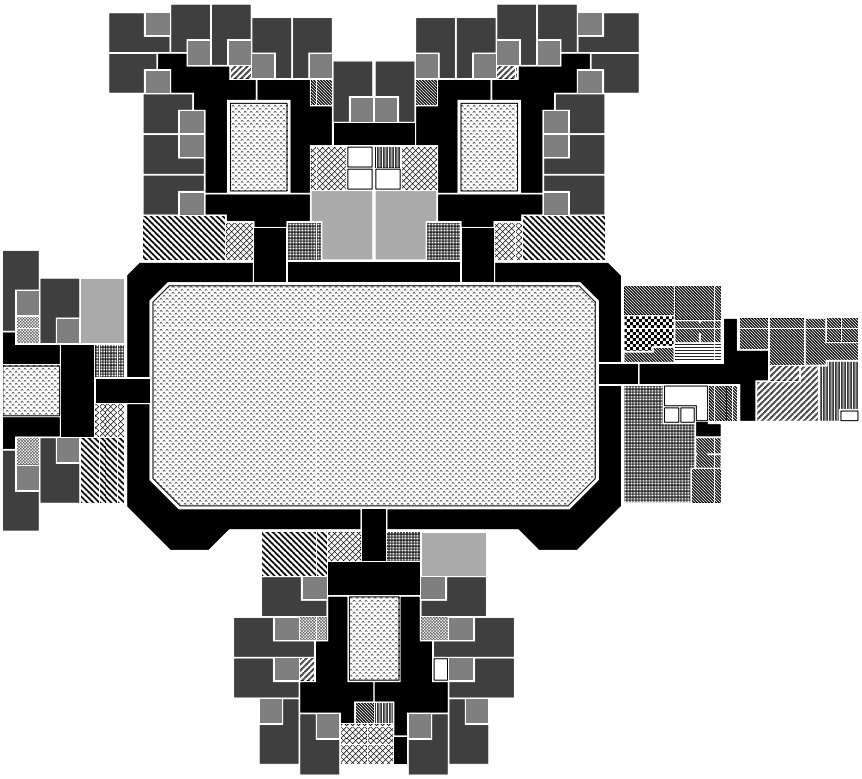

Figure 49: Functional layout of Home (01)

organised around the idea of a courtyard in both its localised parts and in its entirety. For illustrative purposes, Figure 49 shows the plan of Home 01, the starting point for syntactic analysis. Home 01 is a single storey building in which five blocks have been grouped around a large, central courtyard. The plan has been broken up into its constituent two-dimensional (convex) spaces and coded in a standard way to show the full range of functions and activities accommodated, as shown in the accompanying key. The subdivision of the building into four almost identical, localised group living units of ten residents' rooms, each with its own small courtyard and an integral dayroom and dining room, plus a fifth entrance and administration block can be easily inferred from the plan. Fire doors to corridors, which divided the continuous rings of circulation into different compartments, have been shown in this diagram by a white line crossing the corridor. This basic functional layout provided the foundation for all the other representations and quantitative measures generated for each building.

Three broad classes of space syntax representation were produced for each building in the DICE sample by the UCL team as a foundation for quantitative analysis. First, overlays were made on the convex layout to show key aspects of building function, such as the restrictions placed on the residents with respect to their access to different areas of the building. In twenty-one cases, the building contained localised group living units,

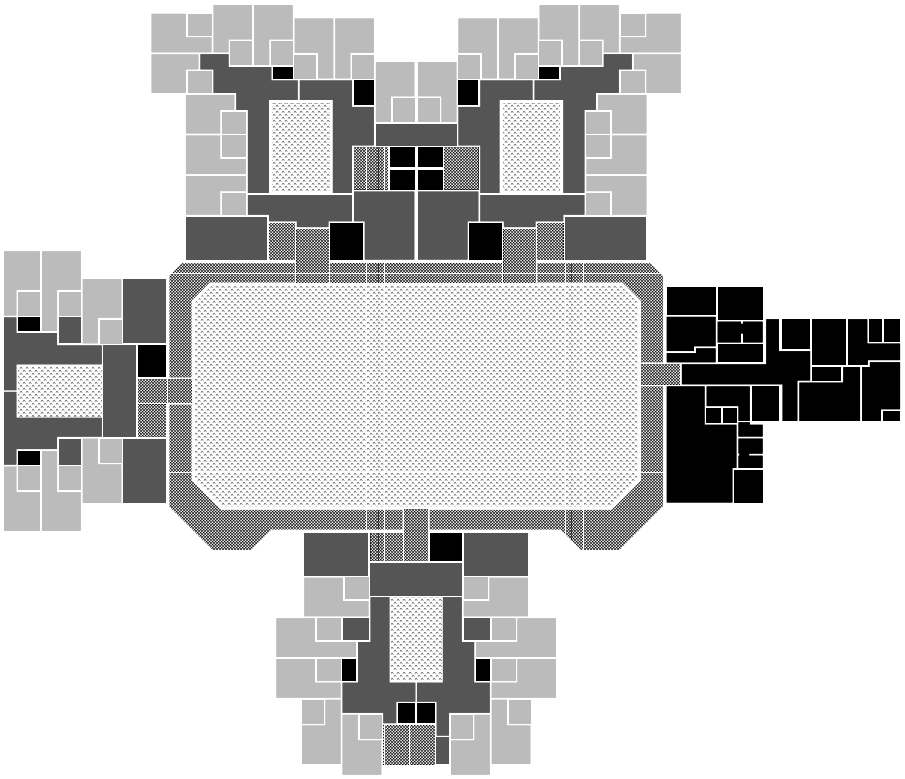

Figure 50: Restrictions on Access in Home (01)

designed to accommodate sub-groups of residents, and for these cases a typical group living unit was analysed separately. Plans were also produced to highlight the circulation and social areas that formed the public realm of each care home that spatialised interfaces, co-presence and encounters between the different actors.

The second class of representations were based on an access graph of each home, where each room shown in the plan was represented as a node and the nodes were then numbered and connected to one another by lines so as to reflect the accessibility between the spaces / rooms. Overlays on these graphs were colour coded to show the range of building functions, see Figure 50, restrictions on residents' access to the different areas of the building (as above) and the connectivity conditions (a,b,c and d-type spaces) of each space. The third class of representations showed axial (linear, one-dimensional) representations of the public realm of each home, see Figure 51. All the measures of spatial configuration generated by the UCL team were derived from these representations.

Normally, a configurational (syntactic) approach to building layout studies the distribution of syntactic variables across all the spaces in each building, and correlates the purely spatial pattern with the occurrence of directly-observed behaviours, such as the pattern of movement within the building or the amount of social interaction in each space. In this study, because of the complexity of Sheffield's approach to multi-regression

modelling, UCL was restricted to providing ten candidate measures to encapsulate the syntactic properties of each building. Each measure had to be a single, overall measure, not a distribution of values. The selected measures included: (1) the mean convex global integration of the whole building; (2) the mean convex local integration of the whole building; (3) the mean global axial integration of the public realm; (4) the mean local axial integration of the public realm; (5) the mean global convex integration of the local living unit measured separately, where these exist; (6) the mean depth of the building taken from the main entrance; (7) the mean convex intelligibility of the public realm; (8) the mean axial intelligibility of the public realm; (9) the convex difference factor for the circulation, social and private spaces; and (10) the axial difference factor for the circulation, social and private spaces.

5. Findings

At this point, the syntactic data were compared with the DICE team's physical design parameters in order to identify those layout characteristics that were related either to the SCEAM variables or to the residents' quality of life scores for each building. Reliance on just one summary measure to capture each aspect of a building's performance was a departure from previous practice and, methodologically, this would be a strong test of the robustness of the syntactic measures. Due to the sensitive nature of the DICE data, particularly the ethical issues entailed in gathering quality of life data from older residents in residential care and nursing homes, the UCL team did not have direct access to the DICE statistical databases, and the multi-level regression analysis was carried out at Sheffield. This meant that the exchange of data was 'blind'; that is, the UCL team was not aware of any of the Sheffield team's results for each building or for the sample as a whole when we carried out our configurational analysis. Conversely, the multi-level regression analysis was carried out 'blind'; that is, the DICE team did not know which properties of the buildings each measure represented or which were likely to be the most promising candidate measures. Whilst this approach worked and can be justified on methodological grounds, it did restrict both teams' capacity to explore first hand the relationship between the 'syntactic' variables and the quality of life data.

None of UCL's syntax measures correlated with any of Sheffield's architectural variables, thus demonstrating that syntax had added a genuinely new dimension to the account but, as expected, the ten syntactic measures were inter-related with one another to different degrees. Two of the ten syntactic variables showed significant associations with quality of life outcomes, and these turned out to be the two most important configurational measures of all - axial global and local integration of the building - that have already been validated in numerous studies as important predictors of human co-presence, pedestrian movement and social activity in urban spaces and complex buildings, table 13. The mean global axial integration of the public realm was positively associated with the proportion of residents' time active, with more integrated buildings leading to residents being active for longer. The mean local axial integration of the public realm was positively associated with residents being engaged more frequently in enjoyable activities and having more choice and control over their local environment.

What, then, might explain the association we found between the syntactic variables and quality of life variables shown in table 13? Theoretically speaking from a 'syntactic' perspective, we would expect whole building layout, as measured by the integration

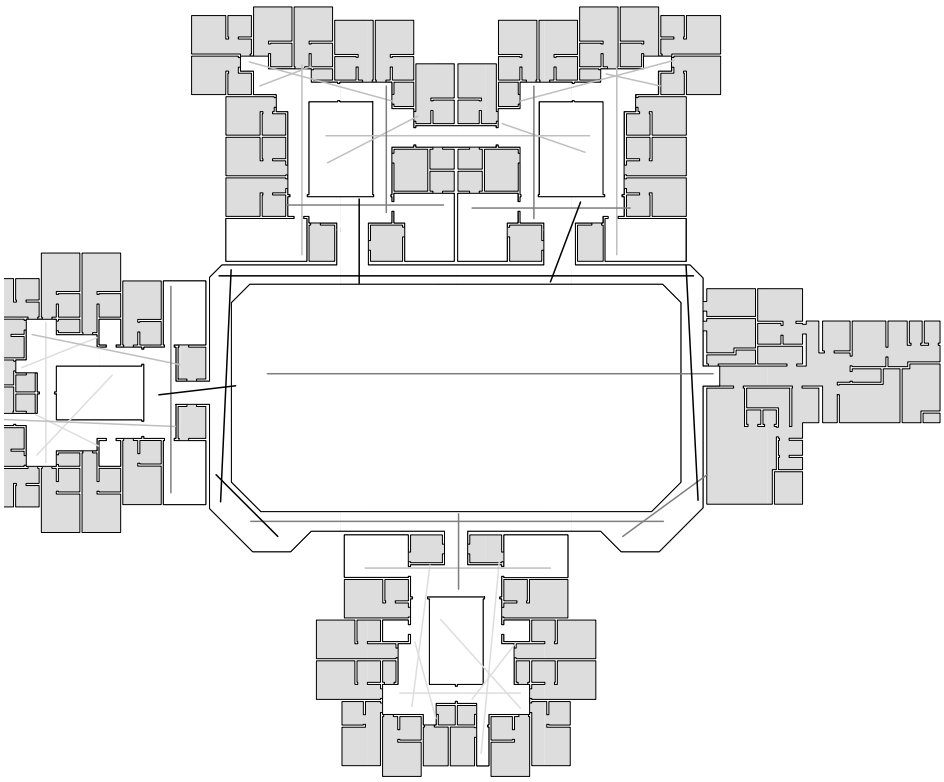

Figure 51: Axial Map of the Public Realm of Home (01)- Global Axial Integration

Table 13: Associations between syntactic variables and quality of life.

UCL Variable	Coefficient	Standard Error	95% Confidence Interval	Chi-squared	Significance Level
Resident proportion of time active (observation) 1-100 scale					
Axial mean global integration	+37.94	11.91	+14.61, +61.28	10.16	0.001
Resident frequency of enjoyable activity (proxy) 0-40 scale					
Axial mean local integration	+4.78	2.05	+0.76, +8.79	5.44	0.020
Resident choice and control over environment (proxy) 0-16 scale					
Axial mean local integration	+3.11	1.41	+0.35, +5.86	4.89	0.027

variables, to influence the proportion of time spent in moving about the building, the proportion of time spent on interacting with others, especially on the unplanned interaction of 'bumping into others' whilst en-route to a destination and the proportion of time spent in watching other people's activities or in 'watching the world go by'. In general, these activities could be expected to impact on people's level of physical activity, on their sense of being socially engaged with others, on their sense of having choice and control over their environment and on their perception of engaging in enjoyable activities.

The co-efficients in table 13 show the increment in quality of life score associated with a one-point increase in the syntax variable. In this sample, one point is approximately the difference in syntax score between the highest and lowest scoring buildings, and it is more useful to look at the effect of a smaller change. For every increase of 0.1 in mean global axial integration, residents proportion of time active increases by 3.8 points (95% confidence interval 1.5, 6.1) on a scale of 0-100. For every increase of 0.1 in mean local axial integration, their frequency of enjoyable activity increases by almost 0.5 (95% CI 0.1, 0.9) on a scale of 0-40, and their choice and control over the environment increases by 0.3 (95% CI 0.04, 0.6) on a scale of 0-16. The underlying message for architecture is that even in a highly programmed building such as a residential care home or nursing home, quality of life is higher if people live in a building that has a strongly well-integrated public realm.

6. Conclusions

This is the first large scale study of its type that has related quality of life data to syntactic configurational variables. The contribution to knowledge that is specific to the design and management of care homes is that we have shown, for the first time, that the design of the whole building layout has a direct association with key observations based measures of activity of residents and consequentially on key proxies for quality of life. The findings suggest that whole building layout has a clear role to play in supporting important aspects of the perceived quality of life of residents living in care homes.

One of the drawbacks of 'space syntax' is that it is a specialised approach to building configuration that can only be administered by a trained researcher but the syntactic variables involved, which are not currently represented in the SCEAM matrix, could be added in the form of additional questions in section 3 (building form and internal circulation) in the domains relating to choice and control and to community. For example, the question "Is the circulation generally simple to understand and easy to navigate? Yes / No" would add an intuitive syntactic dimension of whole building layout to choice and control, and the question "Are residents and staff generally aware of and can see what is happening in the social spaces when moving around within the building? Yes / No" would achieve a similar result in respect of the domain of community.

The results of this research are significant, in that they verify intuitions that architectural design matters. Current design guidance emphasises the importance of localised and segregated building layouts, particularly for dementia sufferers (Hollingberry, 1993). The results of syntactic analysis suggest that the alternative, hotel type of home, where all the residents have access to a shared, well-integrated public realm, may actually result in a better (more active, more self-determined and more enjoyable) quality of life for older residents.

It should not be inferred from the fact that the axial representation gave rise to the significant results, that the remaining syntactic measures are not important in contributing

to quality of life in care homes. These may relate to dimensions of quality living that were not measured by the DICE team. On the other hand, only ten syntactic measures were tested by multi-level modelling against the SCEAM variables. Other syntactic measures that were not selected for testing, could well have yielded significant results. Moreover, the mean integration value utilised in this study provides a rather crude litmus test that the configuration of space has a part to play in respect of residents' quality of life. The findings from this pilot study should therefore encourage further, in-depth studies, in order to develop a deeper understanding of the mechanisms that link building layout to quality of life variables such as engaging in activity or having choice and control over one's environment.

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