Movable Partitions – Flexible Dwelling: The Intersection of Dynamic Interior Space and Adaptable Dwelling Units

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INTRODUCTION

User flexibility is an important design objective of modern dwelling units. The provision of various possible spatial configurations of interior space sub-division, created within defined dwelling space, is a natural necessity resulting from altering dwelling needs over life span, change in living standards, use of modern household appliances and variation in life style and fashion. The majority of dwellers face the necessity of enlarging their dwelling space as a result of familial growth, conducting work from home and enjoying hobby activity. This process could later be reversed when grown up children leave home and the need for space is decreased. The possibility to move to another dwelling unit is not always attainable as a result of financial situation, social factors and children education. User flexibility is, therefore, called for to provide dwellers with a variety of possibilities to sub-divide given dwelling space and use it in the best possible manner.

Over the years various strategies were devised to address this goal (Habraken, 1971; Herbert, 1978), one of which is the use of movable, modular, light-weight partitioning sub-systems (Karni, 1983). Such partitions are easily transformed and relocated within the dwelling space, creating a variety of sub-spaces designed to meet specific dwelling requirements. The expected frequency of change in partition location determines the technology and building details enabling adequate assembling/dismantling procedure and re-use of material (Karni, 1996).

The flexibility potential achieved by introducing such a user friendly partitioning sub-system is not only derived from its design and technology but is also highly depended on its interaction with related building sub-systems such as construction (post and beam, bearing walls), envelope (exterior walls and roof) and technical sub-systems (water supply and disposal, electricity supply, hvac and communication). In other words, the alternative range of re-locating the partitioning elements in dwelling units is subjected to design constraints resulting from the architectural and engineering nature of the three interacting sub-systems. Free-standing structural elements placed within the dwelling space, openings in exterior walls, variations in facade geometry and location of "wet zones" may affect possible patterns and minimize the number of optional variations concerning interior space sub-division. Flexible dwelling units differ from static ones and, therefore, their architectural design should take into account such constraints and select the most appropriate solutions concerning interacting building sub-systems in order to maximize user flexibility (Karni, 1995, 1997). This concept is mainly applicable to design of apartments in low and high-rise housing projects, where floor area is usually smaller than in private houses and where addition of exterior space is normally difficult to attain.

DESIGN FACTORS AFFECTING USER FLEXIBILITY

User flexibility in dwelling units is depended on a variety of factors listed below.

1) Overall geometry and floor area of the dwelling unit

A large number of dwelling units can be geometrically classified into square, rectangular or 'L' shaped forms. The longer the exterior walls, the greater the possibility of arranging dwelling spaces along such walls. However, a rectangular unit, in which the ratio between the long and short edges forming its parameter exceeds 2:1 is likely to need a relatively long corridor, which may affect possible variations in dwelling space design. The larger the floor area is, the greater the possibility of variations in interior space sub-division.

2) Location of the entrance to the dwelling unit

The location of the main entrance to the dwelling unit determines the "movement routs" in it and the number of possible dwelling spaces, which may be arranged along the wall in which it is situated. When the entrance is located at the corner of the dwelling unit or, in the case of a rectangular unit at its short edge, it implies greater flexibility since most of the long edges are left free for interior space sub-division, however, longer traveling routs and corridors are usually needed in such a case. Location of the entrance around the

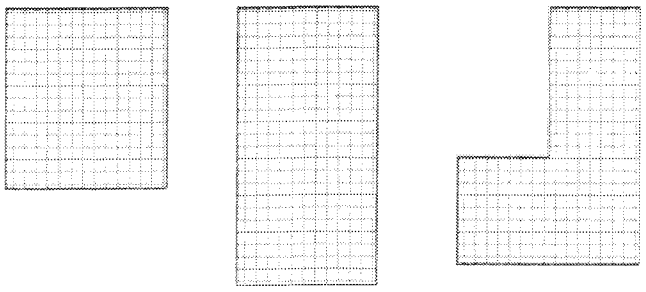

Fig. 1. Square, rectangular and 'L shaped' floor plans

center of the longer edge minimizes traveling routs and corridor length, however, it reduces the number of optional dwelling spaces along this wall. In figure 2 possible locations of entrances are presented.

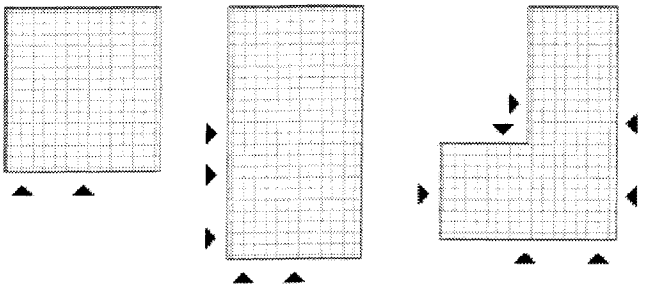

Fig. 2. Possible locations of entrance to the dwelling unit

3) Type of construction sub-system used

Free-standing supporting elements such as pillars and bearing walls may obstruct future alterations and re-location of partitioning, especially when situated inside dwelling space. Spans of dwelling units normally vary between seven to fourteen meters. Construction systems enabling such free spans are favorable for flexible dwelling units. However, should vertical supporting elements be needed in the dwelling space, locating them inside partitions of "wet zones" (bathrooms, kitchens and laundry rooms) is recommended since such partitions are usually static, unlikely to be transformed due to technological complexity and renovation cost resulting from such operation.

4) Number of "open facades" (exterior walls available for openings)

The number of "free open facades" is an important factor since it determines the variation potential of creating dwelling and works spaces, which normally need natural lighting and ventilation. The number of free facades of a dwelling unit (usually ranging between one to four) is derived from the overall design of the building, which is an outcome of landscape and site geometry, building regulations and design constraints. Various possibilities of open/closed facades in dwelling units are demonstrated in figure 3.

5) Geometry of exterior walls

Exterior walls are usually constructed as a single or multi plane element. A single plane wall is easier to be approached

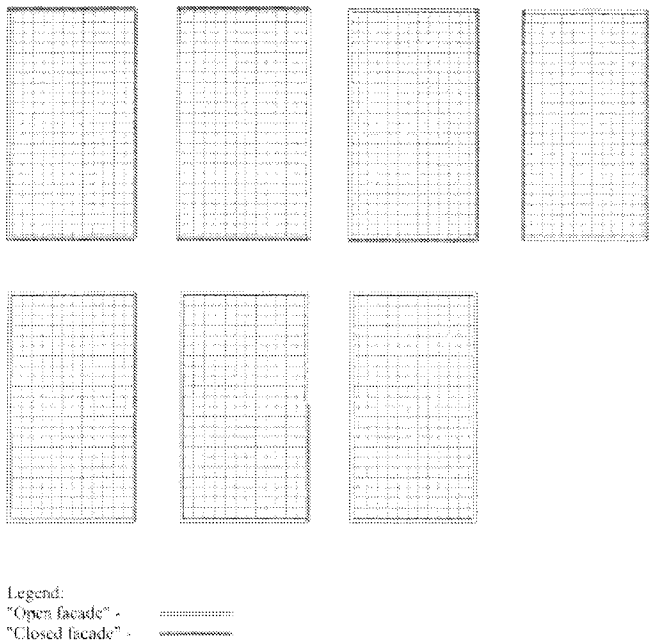

Fig. 3. Open/closed facades

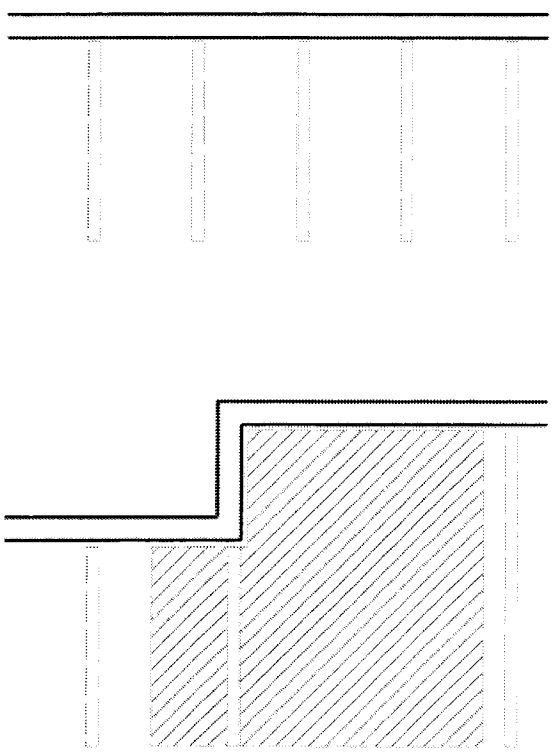

Fig. 4. Location of partitions as a function of exterior wall geometry

by movable partitions located anywhere along its surface. However, whenever several planes combine the geometry of facades, all areas where variation in facade geometry occur are less favorable for situating partitioning elements, due to constraints resulting from optimal use of floor area and comfortable utilization of furniture items. Such a case is illustrated in figure 4.

6) Location, size and geometry of openings in facades

Openings in facades need to be designed according to possible partition location so that when re-located, partitions do not obstruct present windows and doors. The size, geometry, location and method of opening and cleaning of all windows should be pre-determined in order to provide any optional dwelling space with sufficient day-lighting and ventilation. This could be done by multi-scanning various floor plan designs arranged in layers while placing the openings respectively in relevant areas along the free-to-use exterior walls (see figure 5 for a demonstration of three floor plan alternatives). Another method to approach this design goal could be to design flexible facades, in which openings may be created and changed according to future locations of partitions. This calls for a new technology of facades specifically designed to address this goal.

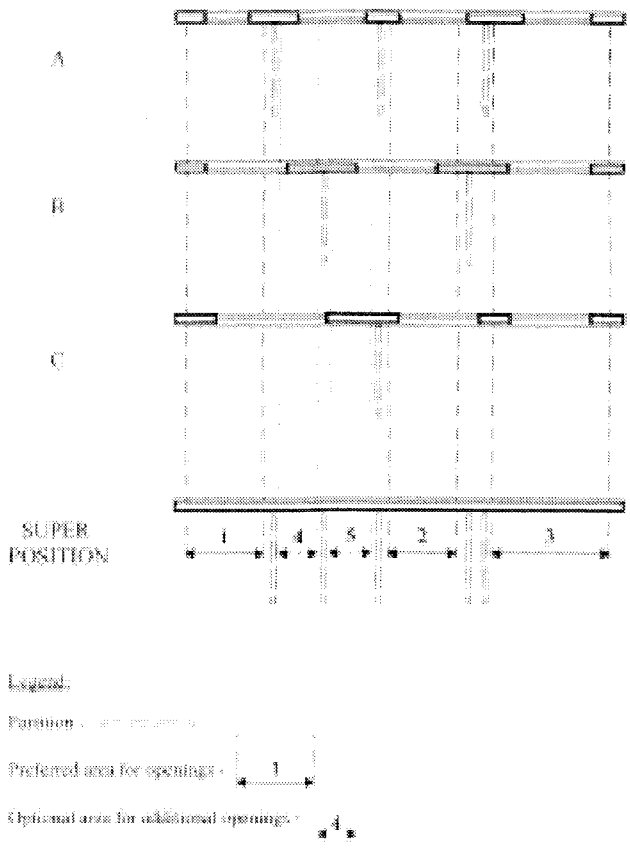

Fig. 5. Finding appropriate location for openings in facades - superposition of three floor plan alternatives

7) Location of "wet zones" in the dwelling unit

Modern dwelling units usually contain two or three bathrooms as well as a laundry room and a kitchen. Such functions are referred to as "wet zones" incorporating water supply and waste disposal. Although designers try to arrange these functions one close to the other in order to reduce length of pipe lines and minimize building cost, this goal is usually hard to attain and, therefore, separate wet zones could be found in such dwelling units. The size and location of wet zones is crucial to future interior space sub-division as a result of the complexity and renovation cost involved in mobilizing wet zones and their related technical sub-systems. Wet zones located around the center of exterior walls, usually don't leave much room for future space sub-division along such walls, however, designing such facilities near the corner of the dwelling unit provide longer free walls for optional location of partitions. In figure 6 various options for locations of wet zones are presented.

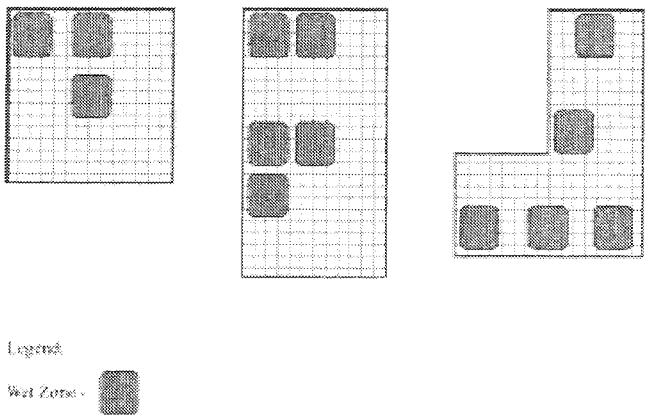

Fig. 6. Optional location of wet zones

8) Location of technical sub-systems (water supply and waste disposal, electricity and communication)

Various technical sub-systems may run through partitions. Among them are water supply and waste disposal, electricity supply and various communication lines (telephone, cable and intercommunication). Such sub-systems may enter the partition from the floor, ceiling or from adjacent exterior walls and then continue traveling through the partition space to neighboring partitions. In high-rise structures such technical sub-systems are usually organized in vertical cores in order to reduce cost and simplify maintenance.

Designing flexible interior space in dwelling units implies the provision of sufficient optional connections to such technical sub-systems from possible future locations of partitions. Designing a reasonable number of possible partitioning layouts in advance may provide designers with the appropriate location of such connections.

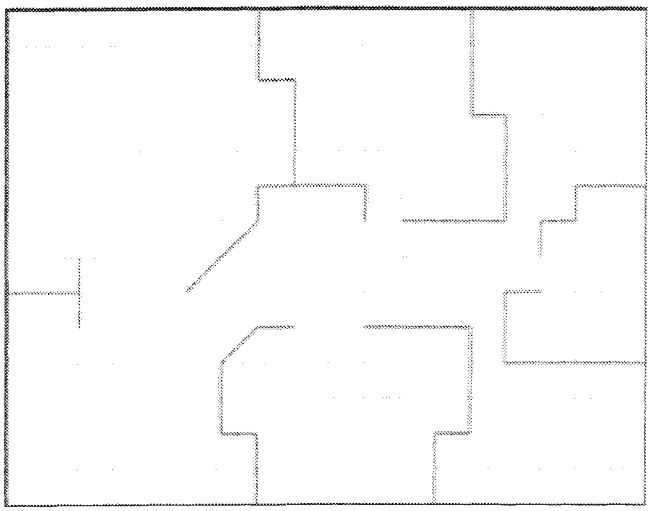

Fig. 7. Optional layout of partitions based on modular grid

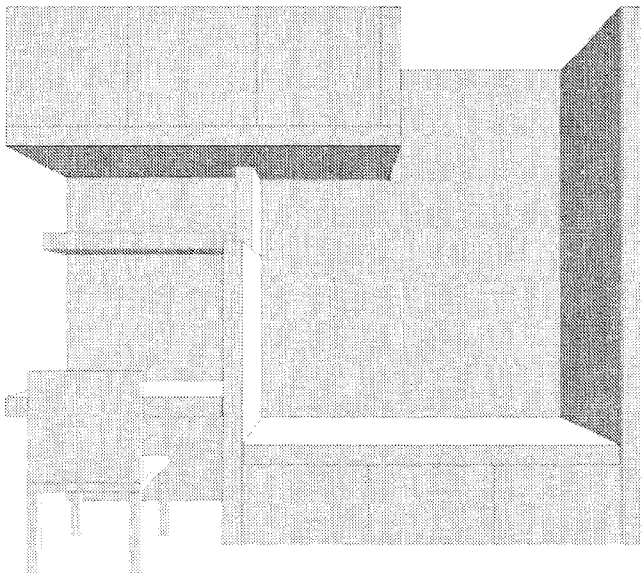

Fig. 8. Multi-plane flexible partition – perspective drawing

9) Modular dimensioning of building elements (modular co-ordination)

Dwelling units designed for user flexibility should be constructed using modular grids, according to dimensions of partitioning elements. Not only does such design eliminate the need for future adjustment of panels on-site, simplify assembling and reduce building time and cost, it also enables creating a variety of partitioning solutions based on a relatively small number of partitioning elements.

10) Spatial arrangement of partitions

Constructing movable partitions by using modular panels is an advantage. It creates numerous possible spatial configurations based on various combinations of such panels. Flexible partitions may, therefore, enjoy spatial geometry with regard to plan and section and provide space for a variety of dwelling activities such as work, sleep, storage and display incorporated within the boundaries of the partition. Such configurations may utilize the full height of partitions implying optimal use of dwelling space and reduction in floor area. This philosophy suggests perceiving movable partitions not only as technical dividing elements but also as furniture items and variable living enclosures. The drawing presented in figure 8 describes such a possibility.

CONCLUSIONS

Architectural design of adaptable dwelling units designed to enhance user flexibility should take into account, among other constraints, the interaction between dynamic partitioning and related building sub-systems such as construction, exterior walls and supply of water, hvac, electricity and communication.

The potential of interior dwelling space sub-division using a dynamic partitioning sub-system is depended on two factors:

- architectural design resulting from conclusions derived from the analysis of such interaction;
- available technology applied to building movable light-weight partitions

Architectural design which incorporates the know-how derived from these elements can supply potential inhabitants with sufficient alternatives of interior space sub-division designed to meet specific dwelling needs over life time and, as a result, create harmony between dweller and dwelling.

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