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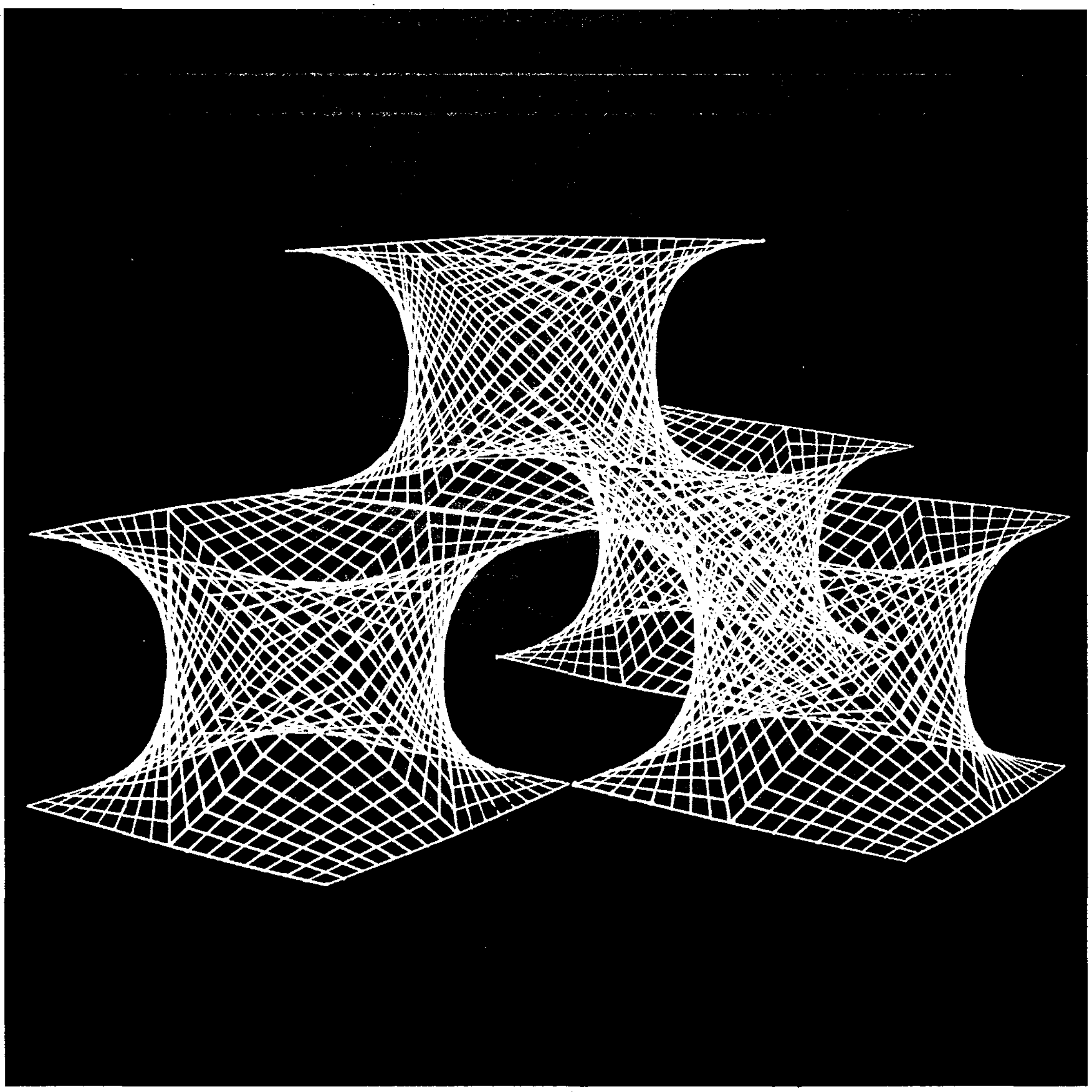

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AN INTEGRAL SPATIAL APPROACH TO COMPARATIVE EVALUATION OF DENSE ENVIRONMENTS

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Abstract: *Density measurements are conventional tools for space utilization and manipulation. All density measurements refer to ratios between dwelling units (number of houses or number of people) per area unit. A two dimensional density measurement can not reflect the spatial quality of an environment, particularly not of a dense environment. The paper describes an effort to develop a new conceptual approach and a method to 3-D density measurements and evaluation. This approach reflects the hierarchical-order, which is found in the urban environment. At the same time, it's disorder – the deviation from pure geometrical considerations. The target of this approach is to facilitate a reliable method for spatial quality evaluation, thus offering the basis of which an important urban planning and design tool can be constructed.*

INTRODUCTION

It is expected that around the year 2025 more than 60% of the projected 8-billion world population will live in cities. Furthermore, there is a tendency in many countries, mostly in Western Europe and the USA (as in Israel) to increase density in metropolitan areas. The reasons vary. In most cases this is due to environmental quality problems and of financial, transport and communication reasons. In Israel the main reason is to protect the decreasing reserves of land. In order to avoid dramatic damages to the environmental quality, this change necessitates new tools and strategies in urban design and urban planning. In the 21-century more planning efforts will be directed at coping with dense urban regions and, the interrelation of quality in dense built-up environments.

Environmental quality is an important component of our quality of life. It is related to many parameters, some quantitative and some qualitative. Quantitative parameters are related to climatic issues such as sun radiation, natural light intensity, wind forces and of course to conventional density measurements. Qualitative parameters refer to attractiveness, or repulsion, in which various features play a significant role, such as privacy, meaning, texture, colour, odour, quality of buildings, nostalgia, memory and more physical and psychological aspects. These aspects depend upon the cultural background of the population, socio-economic background and age; they sometimes depend on momentary state of mind.

This work focuses on the spatial configuration of the urban fabric, as we are convinced that "the physical environment and the configuration of the urban space, its qualities and characteristics have a major influence on the human perception and human behaviour" (Lang, 1994). In dense urban environments, spatial-organisations, has a great impact on perception, as they are more direct and more elementary experience than individual details. To anticipate spatial configurations that would reflect low perceived density and a way to identify and evaluate them, an objective index that would represent and evaluate the spatial quality in dense urban environments is required. This work introduces a new conceptual approach for an objective comparative evaluation of the spatial quality of dense urban environments, conditioned to human perception.

THE PROBLEM

Density measures are constantly used as design tools in many planning and design activities, such as architectural design, urban design, and urban and regional planning. The application of density measures is aimed at affecting the form and organisation of the built environment. All applied density measurements are ratios. The numerator may be the number of persons, families, households, habitable room, bedrooms, housing units or dwelling units. The denominator is a unit of area. It should be stressed that the present method of density measurements as a predicting and evaluating tool is quite adequate and relevant to the macro-scale planning (of regions and cities). As for buildings, city block or even neighbourhood scale, the spatial density perception could not be captured and adequately represented by the 'unit per area' ratios. On this scale the current tools are deficient to a point of irrelevancy.

For most of the built-up situations a two dimensional density measurement approach is bound to fail in representation of a three-dimensional spatial configuration, and clearly fail to predict spatial quality and evaluate a three-dimension perceived reality. A specific density measurement in itself *cannot* lead to a perceived quality of the environment. The same net-density measurement can be applied in many different spatial configurations, with different perceived densities and feeling of comfort. The problem increases with increasing densities, as the number of possible spatial organisations, in a given space, tends to infinity. Alexander (1988, 1993), points out that many density analyses raised the problems embedded with density measurements and their applications. These problems include indeterminacy and ambiguity, over simplification and possibly a weak relationship with perceived density, which after all is what measured densities are ultimately about.

THE NEW CONCEPTUAL APPROACH

The target of this work is to define an objective index to evaluate spatial quality, analogous to the human perception and evaluation. "We are aided in the *perception of space* by the effect of *movement in time*" (Gombrich, 1972). To develop a comprehensive evaluation for the built environment, it is necessary to visualise and perceive it from every reasonable viewing point, as it occurs in a space-time experience of the urban environment. Space–Time experience influences the viewer's perception and evaluation of that environment. Perception would result from the collection of views accumulated on the tour around the built environment. Hypothetically, the perception of space would be a function of all the views collected along a 'Space-Time' experience. The viewer's experience can be represented also as a collection of pictures from all possible angles on the tour, as illustrated on Fig. 1 and 2.

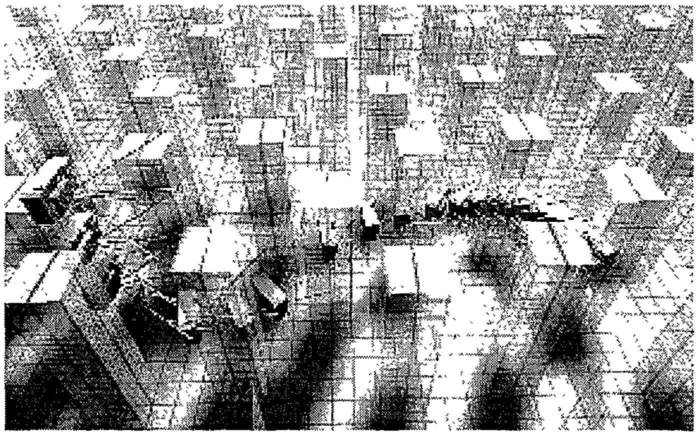

Figure 1: Illustrating "Space-Time" experience track

The collection of perspectives displays what is visually perceived through a spatial conical angle. The suggestion is that the sum of the overall 'Spatial Conical Angles' would reflect the human visual perception in the most appropriate way. This Spatial Conical Angle can be measured and used as a quantitative index, which reflects the spatial quality of the environment. Fig. 3 illustrates a spatial conical angle observed from a dwelling unit within a built complex. We name this index 'Spatial Openness'.

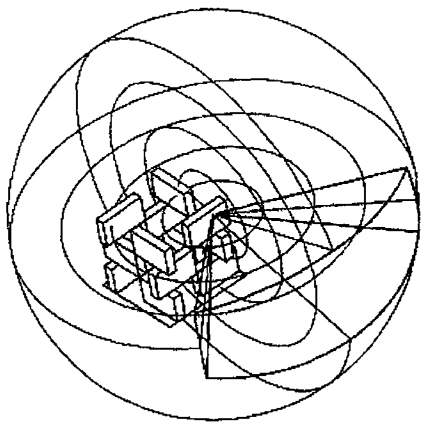

Figure 3: "Spatial Openness" Index (SOI)

The 'Spatial Openness' index measures the volume of open space, in pure geometrical morphological terms, defining openness to natural light, air, near and distant view. This quality index in quantitative terms can provide a comparative spatial quality evaluation of various spatial configurations. Our quality index actually refers to the volume of free space, which is observed from a specific viewers-position, as illustrated in Fig. 3.

As the urban environment is defined by the spatial organisation (composition and interrelation) of the built volumes and their density, there is high dependency among Spatial Openness on all urban fabric hierarchical levels. The dwelling unit, depends and influences the building compound, which also depends and influences the entire urban environment (on the neighbourhood scale). We assume 'Spatial Openness' on one level would reflect the integrated sum of 'Spatial Openness' of all lower levels. The 'Spatial Openness' of a specific building would be reflected by the sum of 'Spatial Openness' measured from all meaningful viewpoints (apartments and public spaces) relating to that building.

INDICATION TEST

Based on Rapoport (1977), who suggested that "Most times people see low perceived density as one of the characteristics of high quality environment" our hypothesis is: as the 'Spatial Openness' index would be higher it would indicate a higher spatial quality and lower perceived density.

We hypothised a correlation between the *'Spatial Openness' index* and a *'Perceived density'*. We assume that spatial configurations with a comparative high level of spatial openness would be perceived as less compressed and evaluated as more spacious. To obtain an indication for such correlation we synthesised five groups of alternative spatial configurations, all with the identical built-volume, and dispersed within a given volume of space. We measured an approximated 'Spatial Openness' to all alternative spatial configurations, so we could rank them within their groups. At the same time we asked a group of twenty-five participants to rank the alternative configurations by their relative "perceived density".

Architects and students of architecture were asked to participate in our indication test, as it was important that the participants would be able to make the analogy from models and computer representations to real environments. Fig. 4 illustrates part of the

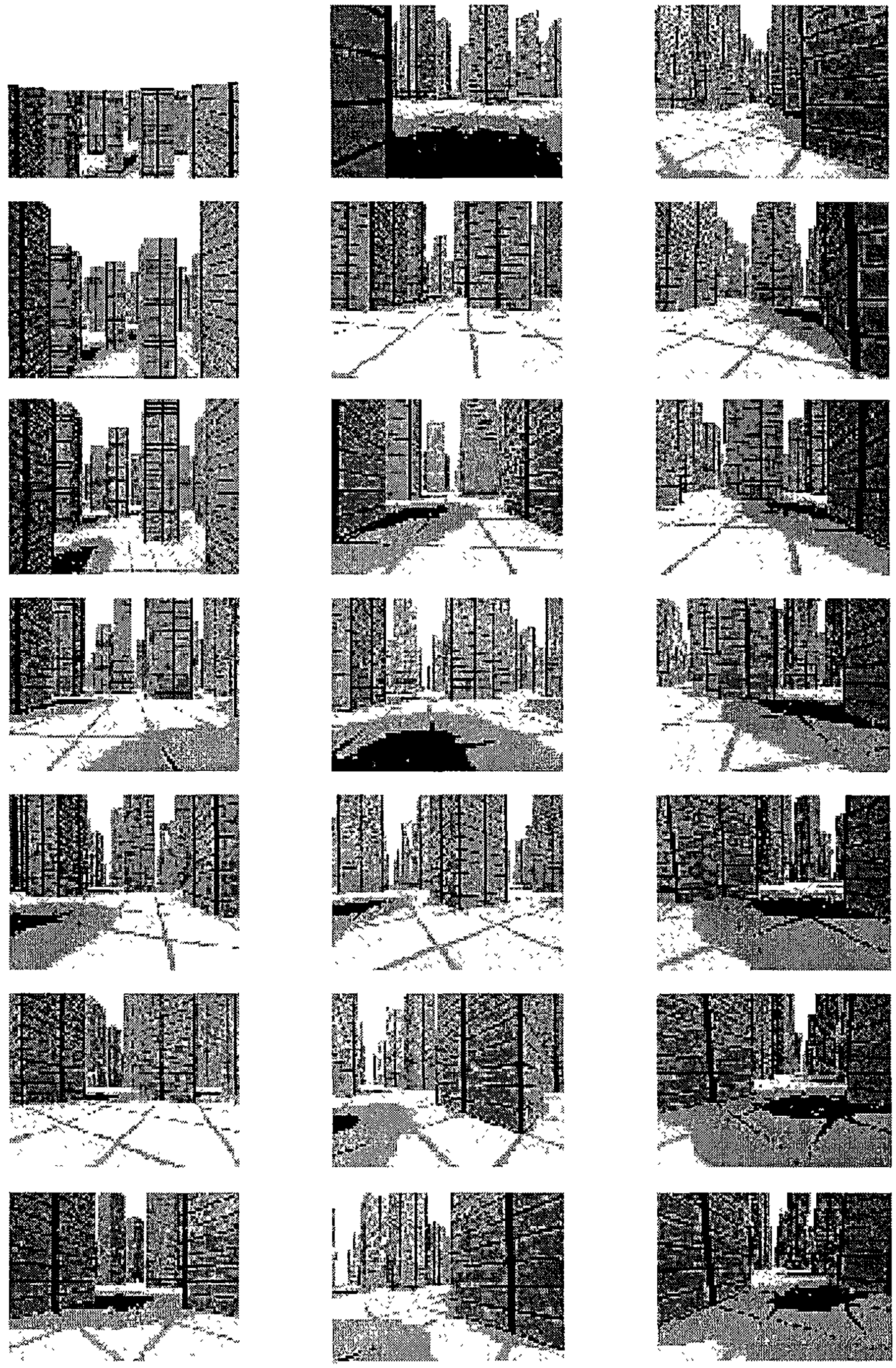

Figure 2: illustrating a collection of views from a 'Space-Time' experience.

information presented to the participants for one of the groups of alternative spatial configurations: it represents a basic spatial configuration, an urban fabric and a series of possible views taken within each alternative.

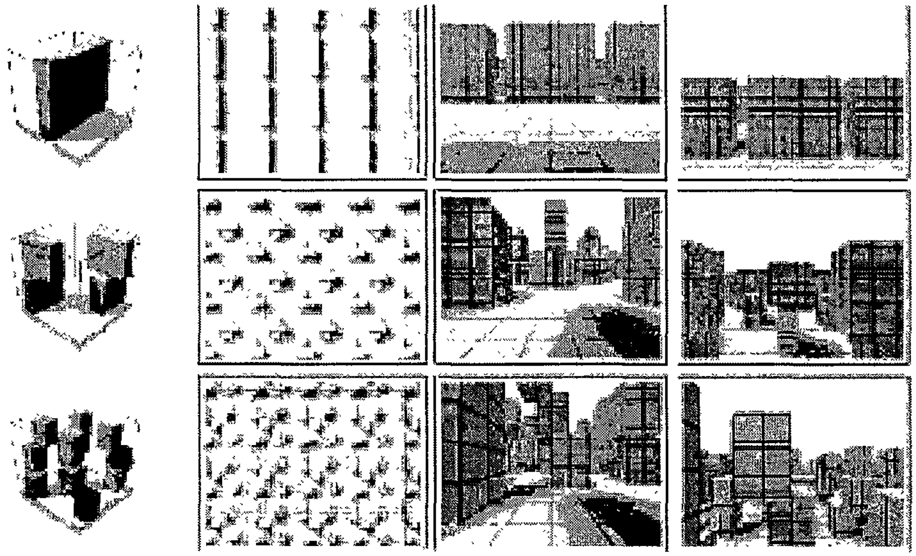

Figure 4: Comparative views from alternative spatial configurations.

High correlation was found in three out of the five groups, as demonstrated by the correlation graph, Fig. 5. This graph represents the correlation within objective measure of "Spatial Openness" with subjective "perceived density" evaluated by our participants. High correlation can give us good input for future tests. At the same time, group's (2) and (5), which had no correlation, may teach us more about the problematic aspects of subjective evaluation and propose the existence of extended aspects influencing the human perception and evaluation. These aspects introduce distortion and disorder into our system and must be taken into consideration in future development.

These preliminary tests gave us an important indication and encouragement for further development of conceptual background and a tool for objective spatial evaluation. We intend to develop this concept as a future objective spatial evaluation tool. This tool will relate in a better way to the structural and spatial organization of the urban environment and will be able to guide, predict and evaluate spatial quality of the dense urban environment.

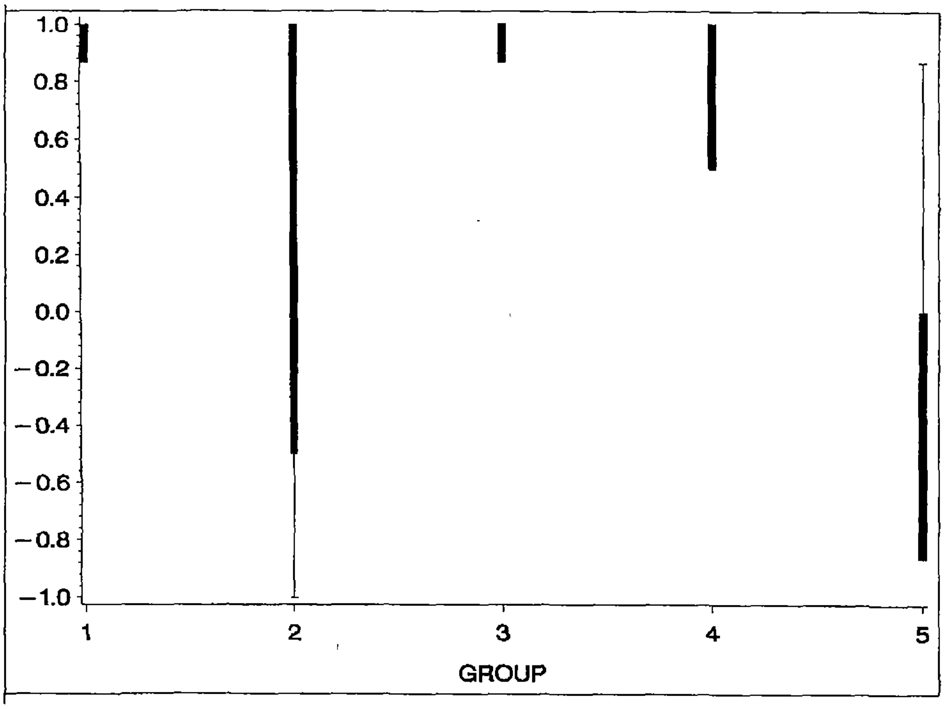

Figure 5: Graph representing "Spatial Openness" index correlation with "perceived density" evaluation.

SUMMARY

Density measurements are conventional tools for the examination of space utilisation and manipulation. A two dimensional density measurement can not reflect the spatial impression of the environment, especially not in dense environments. Our work, presented in this paper, proposes a new approach. We suggest a quantitative-index that applies comprehensive spatial quality information, which we name 'Spatial Openness'. We hypothised a possible correlation between the "spatial Openness" index and "perceived density" evaluated by people responding to alternative spatial configuration. Correlation was found among some groups of the tested spatial configurations. The correlation gave us indication and encouragement for developing the tool for objective spatial evaluation. At the same time the negative correlation had opened up many wonders, mainly concerned with subjective evaluation and emphasised the need for further research to be maintained in this field.

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