Architects, clients and bioclimatic design: a solar neighborhood POE

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ABSTRACT

A first Post Occupancy Evaluation (POE) study on a solar neighborhood in Israel shows there are certain discrepancies between the planner's intentions and the final outcome. These stem from each specific resident's acquaintance with the local climate and its constraints and potential for the operation of free running buildings, as well as from the commitment of specific residents and their architects to the goals and intentions of the master plan.

1. INTRODUCTION

Why is bioclimatic design still a marginalized issue among professionals and clients alike? How influential can information dissemination be? Is it possible that people think they are designing and building bioclimatic buildings, but actually are not? Is there a certain degree of tokenism alongside poor information, understanding and practices?

To investigate these questions, this paper used as a case study the first - and so far the only - solar neighborhood in Israel. The project is located on the Negev Desert Highlands, in the arid southern part of the country. Summer average maximum and minimum temperatures range between 32-18°C, and winter ones between 15-4°C, though absolute maxima in summer occasionally reach over 40°C, and winter minima may go below 0°C. Relative humidity during the day may often drop below 25%, whereas night maxima may reach above 90%. The prevailing wind is the Mediterranean breeze, blowing from north-northwest. Solar radiation is intense and in winter may exceed 3.5 kWh/m^{2}day on a horizontal plane (Bitan and Rubin, 1994; Meir et al., 1998).

The 79-lot cluster was designed by the Desert Architecture and Urban Planning Unit (DAUP) in the mid-1980s for the Ministry of Housing. Initiated by researchers, architects, and staff of the Sede Boqer Campus of the Ben-Gurion University of the Negev, and the Sede Boqer College, the planning process involved public participation with intense interaction between planners and the cooperative, through which bylaws were discussed, adapted and endorsed (Etzion, 1989).

The final detailed/master plan includes a set of bylaws which, unlike those common in Israel, define specific geometric relations between neighboring buildings to ensure solar and wind rights, i.e. the unobstructed exposure of each unit to low winter sun and summer night breezes; the relations between individual lots and between these and the adjacent public open space, including instructions on the construction of private walls built between lot and public space, and public pergolas built by the cooperative on these walls over the pedestrian walkways, so that sun and wind protection will be provided to pedestrians; the character of manageable public space landscaping, promoting paved areas that minimize dust sources within the built up space, and the use of drought and salinity resistant plants; the geometry and finish color and texture of building volumes; and numerous other bylaws intended to create an environmentally responsive and uniform cluster. Although the bylaws do not dictate the construction of bioclimatic houses, they ban the use of chimneys and even define the location of air conditioning units.

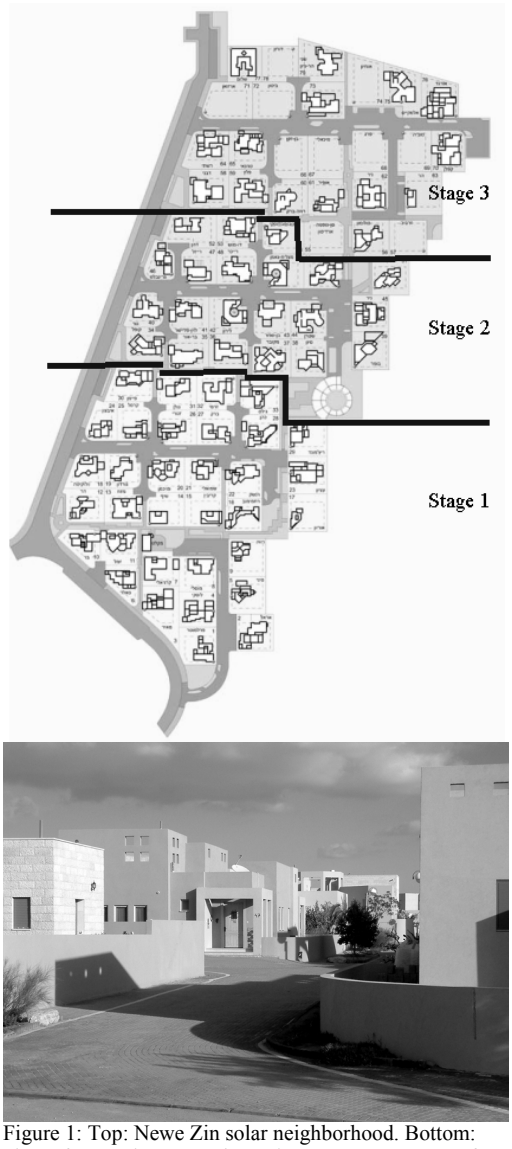

Figure 1: Top: Newe Zin solar neighborhood. Bottom: view of street demonstrating solar access on Dec.21 afternoon.

Due to the plan’s innovative and unconventional character, the cooperative was asked by the Local Planning and Construction Committee to form an internal technical committee whose purpose would be the implementation of the bylaws, by authorizing each plan before its submission to the local planning authorities, both for construction permit and for completion approval.

2. PROJECT EVOLUTION

The original cooperative was comprised of scientists and staff already living on the campus and thus acquainted both with the local climate constraints and potential, and with the basic bioclimatic theory and strategies. Several of the first houses were designed by the DAUP architects or by architects who were affiliated with it in the past. However, the houses in Stages 2 and 3 were designed primarily for new residents and by non-local designers, many of them with little or no acquaintance with the possibilities offered by the plan (although free consultancy was provided by DAUP). Thus many of the more recent houses do not adopt bioclimatic strategies facilitated by the plan and its bylaws.

A growing number of air conditioning units have been introduced, often after occupation, thus hindering the supervision of their location vis-à-vis the neighbors. This causes a nuisance

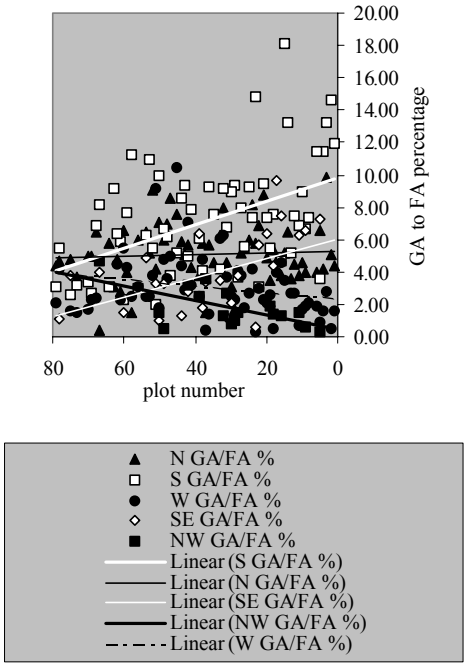

Figure 2: Comparison of the ratio of glazing area to the overall floor area (GA/FA), in different orientations, in 66 houses. Stage 1 houses are on the right, and Stage 3 ones are on the left. Note sharp decline of trend line of south and southeast ratio, as opposed to sharp rise of the northwest one.

during summer nights, and in some cases promotes the installation of air conditioners in houses that were originally designed for summer night cooling, but whose tenants suffer from the neighboring air conditioners' noise. Improper landscape design causes sun-facing glazing to be shaded by trees in winter, thus affecting the potential for passive heating. At least three of the houses have already installed combustion heaters, clearly breaching the bylaws.

The external finish originally defined as "smooth stucco in hues of white to beige" or delicately dressed stone, has been abused with many of the more recent houses being colored pink, peach, brown and even gray, obviously changing not only the aesthetic and visual character of the cluster, but also the absorptivity of the buildings' envelope. Additionally, as newer members joined the executive institutions of the cooperative, construction of public pergolas intended to provide shading over pedestrian paths was discontinued and public open spaces were redesigned to include large lawns and other water intensive plants (Meir and Hare, 2004).

3. STUDY AIMS AND METHODS

The POE intended to examine the relations among previous acquaintance of client and architect with the theoretical and practical issues of desert and architecture; the perceived versus the actual commitment of architect and client to the plan and its bylaws, as well as to principles and concepts that guided them, namely bioclimatic, environment-informed architecture; the period a client or architect have spent on the site and the subsequent outcome of the plan.

These and other aspects are investigated through quantitative and qualitative analyses of the individual building plans as submitted to the planning authorities, subsequent changes and modifications, structured interviews with residents and architects, as well as questionnaires.

3.1 Plan analysis

Out of the 79 lots, 70 are already built. 66 of the plans for which full documentation existed were selected so that each of the three stages is represented accordingly. The data collected from each plan and tabulated included glazing size in each orientation as a percentage of the overall floor area (GA/FA); wall and roof sections and insulation. The former posed an analysis challenge due to the variability of building size and form, window types etc. It was decided to use a semi-arbitrary index – the threshold of south- and southeast-facing windows of an overall size of 15% relative to the overall floor area. This was calculated in the 1980s as the minimum ratio of south-southeast glazing to floor area (SGA/FA) for a detached house to be at least 70% solarly heated for the Sede Boqer climate and provided it complied with the Israel Standard for Thermal Insulation (ISTI). It should be noted that this threshold was established relative to concurrent design and construction practices.

3.2 Questionnaires

Questionnaires were completed by the residents of 35 of the houses whose plans were analyzed. These included questions on the number of tenants in each house, their occupancy patterns, previous acquaintance with and importance attributed to environmental issues, details on the house architect and the extent to which environmental issues were discussed with them, use of auxiliary heating and cooling devices, their type and relative energy consumption, technical details of the construction, overall daily time invested in the operation of free-running buildings, and satisfaction with the overall house performance.

3.3 Structured interviews

Structured interviews were held with residents from each of the three stages, ensuring they represented different occupation backgrounds, degrees of previous acquaintance with environmental and energy issues, and with the local climate. At least three houses have been monitored and their data could be compared with the residents' statements regarding their houses' performance and their subjective perception of it.

3.4 Walk-through and visual analysis

These allowed a better understanding of the extent that the bylaws are actually being observed, enforced and maintained over time, through the different construction and occupancy stages. Information collected thus was compared with that collected through the questionnaires and the interviews.

4. RESULTS AND DISCUSSION

The plan analysis of fenestration as a percentage of the overall area of each unit shows a gradual decline from the 15% SGA/FA threshold reached primarily in several houses in Stage 1, but less common in the newer ones. The latter have not only less south-facing glazing, but also more north and northwestern ones. These two trends can be explained in one of two ways.

The Stage 1 houses are located facing a breathtaking canyon to their south. On the other hand, the houses in Stages 2 and 3 have little exposure to this view and thus orientate their main fenestration areas to different types of landscape to their north. This may sound like a fair assumption of the reasons for changing trends, yet in Stage 1 it is only the houses located on the periphery that enjoy the view, whereas those on inner lots still follow the original trends of larger south-facing fenestration, despite their being blocked from the view.

The second reason for this changing trend may be the acquaintance of residents and their architects with the region, site and master plan, and their commitment to principles and bylaws that guided the original design. A comparison of data derived from the plans with the replies in the questionnaires shows little correlation between residents' statements on the importance of environment-informed building design and the actual design of their houses; 92% of the interviewees stated that climatic issues were of importance, and only two of them stated that they had no understanding of or interest in such issues. The same 92% stated that they had involved their architects in discussions on environment-related issues of their house design.

To better understand this discrepancy, structured interviews were carried out with residents of different professional background, having lived in the region for different periods and living in different stages of the neighborhood. One of the interviewees from Stage 3 stated explicitly that climatic issues were of great importance and had in fact influenced the design of the house. However, the house has a negligible amount of south-facing windows (less than 7% of the overall glazing, accounting for 1.46% SGA/FA), whereas most of the windows face north (44% of the overall glazing or 9.34% NGA/FA) and west (25% of the overall glazing or 5.45% WGA/FA). Not surprisingly, monitoring showed indoor winter temperatures to be significantly below thermal comfort, ranging between 13-17°C, with auxiliary heating backup. A greenhouse constructed post-occupancy around part of the south-facing courtyard proved of little advantage to indoor temperatures, due to wrong design, though temperatures within the greenhouse itself were very comfortable.

How can this discrepancy between perceived and actual house performance be explained? It is our understanding that this stems from a misinterpretation and misconception of principles and targets. The specific house is made of compressed, unburned adobe bricks, with raw material extracted during the excavation and cleaning process of archaeological sites located in one of the dry riverbeds of the region. As such, they are definitely the product of a broader sustainable practice. The house design is based on a historical prototype common in this region as well as around the Mediterranean coast, of three wings built around an elongated courtyard. It was therefore assumed by the house owners that it is an environmentally adapted prototype – an assumption that has been shown to be wrong in many cases (Meir et al., 2004). It is obvious from the interview that the interviewees are confusing different aspects of their house, and that they are influenced by a significant "forgiveness factor" stemming primarily by their involvement in the conception, design and construction of the house, so much so that they are disregarding the actual poor climatic performance.

In another interview the interviewees stated that although climatic considerations should be taken into account, they themselves disregarded them because they saw in them factors constraining the use and operation of the house. Nevertheless, they stated that since the house is insulated (albeit minimally!) and with appropriate orientation of fenestration, it is comfortable with an air conditioning system half the size that would be required for a house, which is totally non-responsive to the environment. This specific interview shows again a certain ambiguity of terms, principles and concepts and their understanding, that may be held responsible for a limited implementation of the potential embedded in the master plan.

In at least seven other cases from Stage 1

houses were identified as complying with the SGA/FA threshold, as well as having incorporated various passive systems and devices, and at least two of them have been rigorously monitored and shown to use minimal or no auxiliary energy for back up heating in winter, and none for cooling in the summer (Etzion, 1994; Meir, 2000). All of these were designed by architects of DAUP, or such that were related to it in the past. Four of them were designed by DAUP architects for themselves and their families, three others for families of physicists specializing in alternative energies research.

Whereas most of the interviewees stated that the amount of time needed to operate their free running buildings is negligible – 83% stated that they spend up to 10-15 minutes per day – 31% of them used air conditioners. A walk-through and follow up study showed that in the case of Stages 2 and 3 air conditioners were installed as part of the original building systems, whereas in the case of Stage 1 these were installed in smaller numbers and post-occupancy, for a variety of reasons, among them a series of exceptionally hot summer spells that occurred in the last few years, and a vicious circle stemming from noise produced by air conditioners on summer nights, causing neighbors to close their windows, and thus lowering their house's ability to cool itself by night ventilation.

In a number of cases vegetation in private spaces was identified as one of the potential reasons for the need for auxiliary heating in winter: plants, especially trees and climbers that reached mature height, tend to overshadow south-facing glazing, and thus significantly reduce heat gains. It should be noted that most interviewees showed no awareness of the interval between seasonal changes and the reaction of deciduous plants, or of the fact that even when the latter are totally bare, their branches can still cast a shadow of over 85% of the plant's profile, depending on its morphology (Kohler and Lewis, 1981).

5. CONCLUSIONS

Following are some of the main conclusions of this study:

- residents from among the founding members of the cooperative showed a deeper commitment to the master plan, mainly due to their understanding of its goals and the potential these provide;
- architects and those from among the residents with a theoretical or practical background relevant to the plan's goals could accommodate different design briefs within the plan's intentions, providing better environmentally adapted houses;
- architects with little or no appropriate acquaintance with environmental issues designed according to "gut feelings" – often counterproductive! - despite the accessibility of information at DAUP, *in situ;*
- information for architects/residents in the form of leaflets explaining the rationale and potential of the plan, as well as basic principles and practices of bioclimatic design might have had a positive promotional effect, especially among the newer residents;
- mandatory bioclimatic design might have made deviations harder;
- design for a changing climate may prove to be one of the major challenges, so that buildings will have to be made resilient to climate changes and changing needs of residents (Roaf et al., 2004).

The POE results show clearly that unless the general public and professionals develop a deeper understanding of environmental issues and the potential of sustainable design, it is highly unlikely that design trends will change for the better. This becomes a major issue as these lines are typed, parallel to the Kyoto protocol becoming officially adopted among skepticism on its ability to bring forth any significant changes. It is highly unlikely that architects, planners and building users will be able to comply with and take full advantage of environment-informed legislation and planning unless they develop a better understanding of the issues at stake. It is definitely not enough to be able to use the right buzz-words, even if in the right context, unless their use is backed by the true understanding of their meaning and implications.

Although limited in its extent, it is hoped that this study has been able to show how a limited understanding of and commitment to environmental issues can cause a significant deviation from a well-equipped master plan and its by-

laws, even if appropriate checks and balances have been introduced. Finally, it is only critical analysis of projects and their POE that will enable identification of loopholes and bridging of gaps between planners, designers and users.

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REFERENCES

Bitan, A. & S. Rubin (1994). Climatic Atlas of Israel. Tel Aviv: Merav Productions Ltd.

Etzion, Y. (1989). A desert solar neighborhood in Sede-Boker Israel. Architectural Science Review 33: 103-109

Etzion, Y. (1994). A bio-climatic approach to desert architecture. Arid Lands Newsletter 36: 12-19.

Kohler, J. & Lewis D. (1981). Let the sun shine in. Solar Age 6: 45-49.

Meir, I.A. (2000). Integrative approach to the design of sustainable desert architecture - a case study. Open House International 25: 47-57, 2000.

Meir, I. A. & S. Hare (2004). Where did we go wrong? POE of some bioclimatic projects, Israel. Windsor Conference-Closing the Loop: Post-Occupancy Evaluation: The Next Steps. (Proc.on CD).

Meir, I.A., Y. Etzion & D. Faiman (1998). Energy Aspects of Design in Arid Zones. Jerusalem: Ministry of Energy and Infrastructure.

Meir, I. A., S.C. Roaf, I. Gilead, T. Runsheng, I. Stavi, J. Mackenzie Bennett (2004). The vernacular and the environment - towards a comprehensive research methodology. In de Wit M.H. (ed.) Built Environment and Environmental Buildings. Proc. 21st PLEA Int. Conf. Eindhoven, Vol.II pp.719-724.

Roaf, S., D. Crichton & F. Nicol (2004). Adapting Buildings and Cities for Climate Change. Oxford: Architectural Press.