THE INTERFACE BETWEEN USERS' NEEDS AND TECHNOLOGICAL DEVELOPMENT

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ABSTRACT

This paper puts forward an argument against the conventional method of translating users' housing needs in terms of minimum standards and norms that have to be satisfied by housing designs and construction technologies. Evidence is given that this approach fails to optimize the users' satisfaction in any particular situation, because it ignores one of the basic characteristics of human needs; that is the willingness to sacrifice the satisfaction of part or all of a certain need, if it could be substituted by a sufficient satisfaction of another need. Also, cases will be described to show that this approach does not enable the full exploitation of the potentialities of technological development.

It is proposed: (a) to formulate users' needs for each housing category in terms of their relative substitution value (indifference curves); thus reflecting the possibilities of tradeoffs between the various needs (e.g., space and finish); (b) to represent technological potentialities in terms of "production possibility curves" showing the ability of different technologies in producing dwellings having combinations of various characteristics at the same cost (e.g., large modestly finished dwellings and small well-finished dwellings). When these two formulations are interfaced or "solved" together, a new point of equilibrium will be found, a point which maximizes users' satisfaction in a particular technological and environmental setup.

A limited application of this proposed approach is being attempted in the Egyptian mass housing context with particular emphasis on showing a way of improving the economy and utilization of the newly introduced prefabrication industry in meeting users' needs.
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When the introduction of new house building technologies is one of the major elements of a national housing policy, as in the case of Egypt, the problems of evaluation and choice of the appropriate technologies (or more specifically building systems) as well as the various ways of exploiting their potentialities, takes a special importance.

The methodology that was proposed at the early stages in the CU/MIT joint research work to perform the above mentioned tasks of evaluation of new technologies was basically made in three stages.

1. Describe the various building systems by a set of their performance characteristics; space generation capabilities, costs, finishes, etc.

2. After defining meaningful users' categories (according to income, social characteristics, expectations, etc.); Develop for each of them (through the use of surveys and other users, studies) a solid set of housing standards (users' standards) adopting the same indices or characteristics, space, cost limits, type of finish, flexibility, etc.

3. Matching the two sets, we can hopefully define the most appropriate technology for each of the users' categories. Furthermore, if acceptable matches could not be found, modifications could be introduced in the systems to adapt them for the users' needs.

In this, and in similar methodologies, failure to understand or misinterpret these needs may lead not only to disqualifying a certain technology that might be appropriate or losing a chance to optimally utilize it; but also, as we will try to show, it could inhibit technological development in the long run. The same results will also occur if we cannot understand the potentialities of the technologies under consideration in meeting those needs.

This paper proposes a new approach to the formulation of users' needs and to the presentation of technological potentialities in a way when put interface or solved together will enable an optimum choice of technology which maximizes users' satisfaction. This paper is organized in three sections.

I. The Nature of users' housing needs and the proposed formulation

II. Some characteristics of house building technologies and a proposal for their representation

III. Interface between users' needs and technological development

I. The Nature of Users' Housing Needs

If we use the previously mentioned method of describing users' housing needs as a function of dwelling characteristics as defined by an ordered set of coefficients, it would be possible to conceive that in a given situation, a household having a defined income may describe his housing needs by such characteristics as, e.g.,

100 m² dwelling
4 rooms
10 minutes walk from work
20 LE rent per month
500 LE key money

In the context of mass housing, authorities might also agree that these are the "Minimum Standards" this household
If the standards are set in the traditional manner, specifying for example, minimum space, minimum open space, a grade of finish, thickness of walls, etc., or in the more developed manner of performance requirements, fixing the activities that have to be accommodated in the house, the thermal performance for walls, etc. Both of these formulations, if adopted, will result in:

a) In evaluating a building system, if it does not conform to those stated standards, it will be disqualified.

b) It gives the false impression that we have to achieve the combination of standard at any cost, or in other words, it ignores the resources and technological possibilities situation.

c) It ignores the possibilities of trade-off between needs.

Now, how could we represent the phenomena of substitution and of trade-off between the various needs in precise and operational terms?

**Representing the Phenomena of Substitution Between Housing Needs**

We will use the elementary tool of economic analysis, the indifference curves which reflect an individual's scale of preferences. It shows the individual's choice between alternatives.

Suppose that there are a number of dwellings varying in the two characteristics; the area of open space and the area of the enclosed space. These two characteristics could be represented on a two-dimensional diagram (diagram 1). It is possible to find a number of dwellings $d_1$, $d_2$, $d_3$, which give an individual the same level of satisfaction or he is indifferent to them.
• $d_1$ represents a dwelling of 40m$^2$ enclosed space and 4m$^2$ open space
• $d_2$ represents a dwelling of 30m$^2$ enclosed space and 6m$^2$ open space
• $d_3$ represents a dwelling of 20m$^2$ enclosed space and 10m$^2$ open space

If put in a graph form they will give the well known indifference curve ($L_2$). Any point (dwelling) on it is equally agreeable to him. Similarly, further indifference curves can be added giving higher levels of satisfaction ($L_3$ and $L_4$).

It is possible to construct these curves through direct questioning or alternatively through the revealed preferences which individuals have shown through actual choices.

In a survey conducted by the CU/MIT housing project team, it was found, for one income group (400-600 LE per household per annum) that households were living in varying types of dwellings. Some of the characteristics of the dwellings were common and some varied.

Two of the main characteristics that did vary were:

The area of enclosed space
The class of finish and fixtures

The various dwellings were plotted in a two dimensional graph representing the relationships between these two characteristics (Diagram 2). Although we have some reservations about the way this diagram is drawn, it reflects the range of acceptability and preferences of this housing category between those two characteristics. Some prefer smaller dwellings with higher grade of finish and others prefer a larger dwelling with a lower grade of finish.

Similarly, we have constructed other curves for some other housing categories, as represented in Diagram 2. Although the size of the sample was small and the curves were adjusted: it is believed that, for our purpose, these curves could be equated with the indifference curves (in spite of the fact that other characteristics were not exactly equal and the preferences have not been made at the same time).

Having established the vocabulary and the form of representation, we have now reached the stage in our exposition to investigate the problem of housing standards and to introduce our new propositions in representing users' needs and for setting standards.

**Why do we need "Standards"?**

In “mass housing” governments need tools to enable them (among other things):

a) to regulate and control the design and production of dwellings in the hope of balancing needs and resources
b) to determine the resources requirements
c) to evaluate technologies and building systems

**Requirements from a System of Standards**

An acceptable system of standards must meet in our view the following criteria:

1) Realistic and offers real improvement
2) It must interpret users needs in a broad and sufficiently flexible manner to be able to incorporate the full range of individual needs and preferences within each socio-economic group. Also to open up the possibilities of using a variety of designs and technologies. In other words, it must allow trade-offs.
3) It must be sufficiently precise in technical terms to be of practical use for policy makers.

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1 Cairo University/MIT Survey 1977
2 This is an index number we are introducing (an ordinal scale) made up of classes of floor, wall, and ceiling finishes, classes of sanitary fixtures.

* The two upper curves were constructed from another source.
4) Relatively simple to be directly applicable by designers and builders, etc.

These conditions could be satisfied by the preferences curves already represented in Diagram 2. That is, to put the standard in a graphic form, specifying for each housing category a minimum or desirable "level of satisfaction" irrespective of the means of achieving that level whether, for example, by smaller well-finished dwellings or large and moderately finished dwellings.

In other words we do not specify a minimum standard for space and a minimum standard of finish independently. But we define a range (all points on one indifference curve) of combinations of space and finish that will be equally acceptable to that category. Points below that curve would be of a lower standard. Points above that curve will be of a higher standard.

If we take the equation of this curve, taking $X_1$ as the amount of space and $X_2$ as the grade of finish.

This formula would be the 'standard'. Any combination of space and finish that satisfies this equation would be acceptable. If we have the grade of finish that a building system can give, we can find out the other unknown, that is, the space we must supply at that level of finish to meet the standard.

Thus, different building systems, each having its own cost structure and capabilities, can compete in a 'fair' manner.

This mathematical formulation could be extended multidimensionally to cover a wider range of variables which a comprehensive set of standards would have to cover. This extension will be attempted in the future.

However, it is clear now that this formulation satisfies all the criteria we have listed earlier. Evidence to support this conclusion will be driven in the last section of this paper.

How to set the standards

At what level to set the standard? Which curve for each housing category? This problem of setting standards is usually one of the most important and difficult decisions in forming a housing policy.

It is obvious that if the standards are set at a too high level, the number of households that would be served will inevitably be limited. On the other hand, if set at a very low level, it will be unacceptable to the population and the dwellings will be obsolete in a very short period of time (if the rate of economic development is high). It is a political decision in the first instance.

With the prevailing economic conditions in Egypt with its relatively low rate of economic development and the large discrepancy between needs and resources we agree with the view that housing standards must inevitably be kept close to what the population have or can achieve by their own means with a slight improvement. If this is acceptable, the approach to setting standards would then be to try to determine in reality (through the use of surveys and other methods of user needs studies) the norms actually adopted by the various categories. Then we slightly modify or improve them. Alternatively, we propose to take the "statistical mean" for each category. That is to exclude both the lower and higher 25%. This 'mean' of the revealed preferences for each housing category could be recommended as the minimum standard for that category.

II. Some Characteristics of House Building Technologies and Systems

Each building system has its own potentialities and its own structure of production costs. For example to produce

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1 A.I.D. joint housing team "Immediate Action"
80 m² dwellings at a standard of finish grade 4 in a prefabricated system may cost more than the same dwelling if produced by traditional methods. On the other hand a dwelling of 120 m² having grade 7 finish may be cheaper in the same prefabrication system than the traditional dwelling of the same area and finish. Thus each system possesses certain advantages or potentialities over a certain range of dwelling types.

For each system, it is possible to construct what could be termed as equal cost curves. As represented in Diagram 3 for the traditional methods of construction in Egypt. Each line represents all the possible combinations of space and grade of finish that could be produced at the cost written on that curve. Similarly we could construct equal cost curves for one of the newly introduced prefabricated buildings systems (Diagram 4). Although these curves are preliminary and are based on estimates rather than actual costs, they portray that this system possesses different potentialities (notice the inclination of the lines and their spacing) when compared to the traditional system.

If we overlay the two sets of curves, we can eliminate the inefficient parts (inefficient, in the sense that more space and higher grades of finish could be produced at the same cost. The resultant curves will be the efficient housing production curves for Egypt, if we assume that only those two systems exist in Egypt.

It is apparent that for certain combinations of space and finish, it is cheaper to use traditional technologies and for some other housing types prefabrication may be the answer. It is not always true that one building system dominates the other over the whole range of dwellings possessing various combinations of space and finish.

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2 Worked out and modified from the previous report at 1977 costs.

III. Interface Between Users' Needs and Technological Possibilities

If one indifference curve of Diagram 2 representing the users' needs and preferences between space and finish for a specific housing category (income per annum 600-1000 LE), is overlayed (or put interface) with the set of production possibility curves for the traditional methods (Diagram 3) it will be found that the cheapest traditional dwelling that could meet the minimum standards for this category is dwelling "a" costing 3000 LE having 45 sq.m² and a grade of finish "d".

What happens when a new technology is introduced? This could be predicted if we repeat the same exercise for the same housing category (i.e. curve) and the set of production curves for the prefabricated system (Diagram 4). The result indicates that the cheapest prefab dwelling that could be produced meeting the users needs of this category is dwelling 'b' costing 2800 LE and having a space of 60 m² and a grade finish 'j'. This is another point of equilibrium or balance between needs and technological and resource potential.

In 'Natural' situations where people decide and choose, it will be expected that in the long run people would choose the new technology and new type of dwelling. But in 'Mass housing' situations where some authority must define the standards and interpret the users needs, something else will happen, as follows.

The long established equilibrium point 'a' or some where around it will be the current 'norms' for that category. The standards adapted by the government in the traditional way of setting minimum standards independently for each characteristic would be 45-50 m² minimum area of dwelling, grade 4 minimum standard of finish.

This means that the same dwelling type 'a' must be produced. If we insist on producing this dwelling by the new building system it will cost us 3200 LE with increasing the level of satisfaction of that category. If however the
together it will be possible to introduce the new technology and achieve a reduction of cost at the same level of satisfaction or alternatively achieving a higher level of satisfaction at the same cost.

This exposes an important idea of this paper; the type of dwelling produced is the result of an interaction or interface between the system of users needs and the available resources and technology. It is not the result of an independently determined set of requirements without reference to technology.

If these interdependencies are not taken into consideration there will be a great loss of efficiency. Some people may argue, however, that the users' requirements are determined independently according to the attitudes of the people towards the world around them, their way of life and their psychology and physiological set and up is not, and should not be, affected or modified by technological and resource conditions.

This paper indicated and indeed all history of man reveals that its development was a spiral process, new needs created new technologies and those, in their turn, have stimulated new products. It may be acceptable in conditions of stable economic and technical growth to set the standard required in terms of specific independent dwelling characteristics or performance; i.e., the present equilibrium point, because the efficient technology is known and only marginal and incremental changes happen.

However, in conditions like those prevailing in Egypt where technology has been stable for very long periods, the designs of dwellings have established a reality of their own, designers and to a less extent users take it as an end to be achieved. They forget that it was a result of interaction under special circumstances. Thus when these circumstances change and technology change the designers cannot change.

produce a given product. This has reduced the scope of technical development and consequently causes a loss value. Many specialists have observed that it is this practice that gave the false impression that the prefabrication systems possess not great economic advantage when compared to traditional techniques.

Because of the special relation, technical and economical, between building technique and type of dwelling, particularly in developing countries where technology is transferred, the change of dwelling type or its modification should be sought. In fact, the acceptability of certain techniques may hinge on modifications of the dwelling types. This is only possible when we see needs in terms of the formulation which we have proposed in this paper.

This approach if adopted in a developing country would certainly increase its chances of finding among technologies and building systems available in other countries, something that suits its own conditions and help in solving their acute housing problems.
DIAGRAM 1: Indifference curves for households with a yearly income range of LE 180-400. (1977)

DIAGRAM 2: Housing indifference curves, plotted for ranges of yearly incomes.
DIAGRAM 3: Equal cost curves for dwellings combined with a housing indifference curve of households with a yearly income range of LE 600-1000.

DIAGRAM 4: Equal cost curves for dwellings combined with a housing indifference curve of households with a yearly income range of LE 600-1000.