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SUMMARY

This paper will show building and structural techniques for providing foundations and external walling to existing informal settlement that is both weather proof and structurally so sound that it could withstand seismic forces. It will show how this walling will provide enhanced insulation, sound proofing where necessary and the possibilities of providing fuel-free passive energy heating and cooling.

The paper will further demonstrate how new roofing can be formed over the existing roofing with insulation and waterproofing properties.

The possible provision of suspended structural floors over the existing inadequate structures capable of adding an upper floor will be demonstrated. Easy ways to make staircases will also be shown.

It will be an essential aspect of this paper to show that the resulting structures will:
Be sufficiently fireproof to prevent or retard the spread of fires and the loss of life.

The paper will show that the resulting imagery of the conversions could be aesthetically pleasing in the immediate and urban scale.

The upgrading of informal housing illustrated could be carried out by the existing occupants, the unskilled and the unemployed.

The techniques illustrated make it possible for the existing dwelling and its contents and personalization to be reasonably undisturbed.

Previously refereed and published papers on Sustainable Development.
Passive and Low Energy Architecture Conference- Sustaining the Future. Brisbane Australia 1999, titled "Twin Thin Construction".

Technology and Management for Sustainable Building- CSIR May 2003, titled "Finding an alterative Way to Provide Sustainable Building".

Passive and Low Energy Architecture Conference – Santiago Chile November 2003, titled "Design Improvement for Sustainable Building".

THE TRANSFORMATION OF INFORMAL HOUSING INTO PERMANENT SUSTAINABLE SETTLEMENTS

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1 The problem

In a report by the BBC's news online correspondent (Oct 6, 2003) it was stated; *"The number of people living out their days in the squalor of a slum is almost one billion. The United Nations says – one-sixth of the world population. Without radical changes, it believes, that number could double in 30 years. By 2050, the UN says, there may be 3.5 billion slum dwellers, out of a total urban population of about six billion"*.

It seems clear that despite good intentions, authorities will never keep up with the demand by building formal housing alone. People who need shelter will have to house themselves as they have in the past, but with the added dimension of population increase.

Informal housing is considered urban blight and the festering sore of urbanization.

But transitory and impermanent informal settlement can become permanent desirable housing with constructive planning support, innovative methods of funding, permanent ownership and Context sensitive construction techniques¹.

The existing structures of informal settlement, however inadequate, can and should form the basis for enhancement.

This paper aims to

- A. Highlight the social aspects and potential good in informal settlement and
- B. Offer ways to tackle the problem of upgrading and enhancement. This paper will suggest a way that this might be done.¹

2 Value and quality in informal settlement

2.1 Affordability and participation

People choose or find themselves living in informal housing for many reasons, the main ones being the inability to afford any other accommodation and freedom from rent and civic obligations. The simple buildings they erect accord with their rudimentary building skills. They can be erected and re-erected at short notice. This way of building matches affordability and is free of long term financing obligations.

The rudimentary construction permits them to be closer to the design and building process than any other way of housing supply. It gives them the greatest personal contact and control of their shelter. Whatever construction method is chosen, this is clearly an incremental process that can form the kernel of enhancement and upgrading (which is always the ambition of the occupants).

¹ See Twin-skin Construction

2.2 Implementation – compared with formal housing

Formal housing is bedevilled by the implementation and contractual process. Housing authorities rely on 'contractors' to implement their housing. These contractors are sometimes incompetent, unable to price their product, and provide sub-standard work, resulting often in abandonment, dispute and fraud. The profit margin in low cost housing discourages competent contractors. The need to ensure contractor profit in formal housing (presumably to lure them to build) has resulted in the unrealistic reduction of a house size.

Even where the building work is acceptable there is a strong element of rejection because the occupants feel that the house design is forced on them. Informal settlement is not burdened by the questionable priorities that dependence on contractor organizations impose. In informal housing, defects are more readily accepted by people who design and build their own houses. They naturally want better but are more patient and accepting of the prevailing circumstances.

2.3 The use of unskilled and the unemployed

There is often an abundance of unemployed building workers in informal settlements; building workers with the lowest levels of building skills (mixing cement mortar and knocking in nails etc). The way they build their shacks accords with their skills. Skilled building artisans are in short supply throughout the world. However building technology has also in some respects advanced beyond traditional building techniques so that a high level of training is not always necessary. Some of this does not need heavy manual labour so that the erection of housing no longer needs to be gender specific. Whatever extra skills are needed can be obtained while building.

2.4 Family or neo-family focus

People living in informal housing settlements usually have a predetermined family structure in mind before they build their shacks. Illness, crime, birth and death, the frequent visitors to low income settlements are best handled with family or pseudo family support and the low cost of the physical shelter permits variable family compositions. The dire need for "family shelter" is most often the incentive to build. People build out of desperate need and can't wait for lengthy house or site allocation systems.

2.5 Adaptation and anticipation of change (housing a moving target)

The need for shelter varies in scope and extent much more than formal housing permits. Informal housing is much more adaptable as variable economic circumstance and family needs are more easily accommodated.

Accommodation needs expand and contract with circumstance and age. The composition and income of informal settlers varies greatly from the destitute to the reasonably well-off who choose to remain there. The social impact of unemployment, finding a job or the loss of earnings can change accommodation demands overnight. Transitory migrants or illegal immigrants constitute an important aspect of the floating population in informal settlements, suggesting that the 'family' composition can often be virtual and temporary.

The need for accommodation and 'visual' adaptation occurs rapidly with urbanization and acculturation. Impermanent housing offers the opportunity for staged enhancement that can accept cultural change without the need for translocation. The transition from informal to permanent housing can be geared to staged development and user experience. The impermanence of the structures offers options for beneficial change, in marked contrast to permanent housing, which is badly planned but costly to alter.

2.6 Segmental identity

Housing grouped around courtyards can lead to beneficial segmental identity i.e. related family or ethnic grouping, with the possibility of enhanced mutual support for children, the elderly and the sick. This grouping can more easily offer group security and identify and control crime and problematic social behaviour. (see *Figure 6.1*)

2.7 Densification

Where external living space is kept to manageable dimensions and unusable or 'derelict space' is eliminated, high-density accommodation can often be achieved without the loss of privacy or amenity.

Housing on sloping ground can often provide views and terrace roof areas, notwithstanding higher densities as illustrated in traditional vernacular hillside housing (see *Figures 6.2&6.3*). Building on sloping ground is climatically more beneficial, particularly for people with respiratory conditions because of the well-known phenomenon of "temperature inversion"(see *Figure 6.3b*).

2.8 Materials and processes

People building in informal settlements use cast-off building materials, second-hand corrugated iron, timber packing cases, plastic sheeting and discarded windows etc. (Some entrepreneurs even sell them shack building kits). The materials and processes used to erect their shelter are always few and simple and the choice of material is determined by availability. Amenity is imaginatively conjured out of the few simple materials. It is acknowledged that flexible and multiple use of amenities is essential for low cost building as distinct from general building, and these people come to use this naturally out of necessity.

2.9 Design under cost limitations

The sense of ownership and pride in their own creativity often makes the shack dwellers enhance their meagre surroundings in many original ways, so original that documenting these has become a sophisticated photographic exercise. A pot of paint, a recycled timber door, hanging drapes, the display of valued possessions and unusual ways to provide shelving and storage are all reminders that design is possible at any level of cost.

The internal space is generally used to maximum advantage with great innovation in overlapping use of space and furniture. Room use designation is free of convention and full of surprise. This all leads to a vibrant sense of personalisation which is a vital part of the well-being people have in their sense of place.

2.10 Aesthetic concerns (see Figure 6.4)

People, no matter how indigent they are, carry embedded visions of form and design in their consciousness. These may be from an ethnic past, religious symbolism or media hype. Given the opportunity to express themselves, they emerge as highly inventive

images. These ideas have the potential of making informal settlement surprising, original and interesting.

The kaleidoscope of people-driven inventive upgrading falls clearly in the realm of indeterminate spatial geometry, which seems ultimately to be preferred by the public, as distinct from the determinate geometry of township housing. It is not visually boring as it represents a variegated landscape full of interest and surprise. The streetscape often meanders and presents interesting views around every corner.

Photographers and artists are turning to squatter settlements, which reflect rich interesting art in addition to their sociological importance. It is interesting to note that picturesque vernacular housing, much admired, falls into the category of indeterminate geometry which can accept variation and change and offers a better visual option for higher density living (see *Figures 6.2&6.3*).

2.11 Spatial longevity (spaces people will want to preserve)

Social housing built after the second world war to meet urgent housing needs has had a terrible track record. Much of it has had to be demolished. Whatever large sums of money were invested in that way proved much more costly because of the short period of beneficial use. Building places that people will want to preserve i.e. places in which people have had a part in their creation, must be a more worthwhile long-term investment.

2.12 Personalisation and social capital

Township housing is universally condemned for its looks. It is considered ugly, monotonous and boring. The providers of housing ignore this because they believe that providing shelter is their foremost priority.

The enhancements people make and display in places they care for constitutes a build up of enrichment and social capital. This does occur in township housing but occurs much more readily in informal settlement. This accumulating enrichment eventually makes the housing far more valuable to the occupants and to society at large. All housing endeavours that ignore this ingredient of personalization must fall short of their intended aims.

3 Upgrading and enhancement

3.1 Space planning intervention

Shack dwellers need assistance with the external use of space. The use of outside space is traditionally in the street and the space between shacks is often 2 meters or less, resulting in unusable space that can only accumulate rubbish and exacerbate the fire hazard. External space should be configured as 'outside living areas' (see *Figure 6.1*). These should be sized not so large that that keeping them clean would prove a burden, yet large enough to provide opportunity for social interaction, and for children to play safely in the beneficial climate. This is where planners can assist, because private ad hoc development does not ordinarily perceive this as a need or provide for it.

It may be necessary therefore to form protected common areas for a group of residents to use as their defined external living space. This might entail removing certain housing to form common courtyards. With the advent of plastic piping it is possible to bring service reticulation to a cluster of informal houses in an economical way, particularly if a cluster is grouped around a courtyard, where piping can be serviced and dispersed with short branches to each house (see *Figure 6.1*).

Generally people will look after and protect what they consider their own and what they enjoy. Defined courtyard space has the added benefit of encouraging dwellers to take more personal responsibility for its upkeep.

It may also be advisable to close and fill with accommodation the unusable small spaces between units (possible by adding extra amenities such as kitchenettes or bath areas). This can be safely achieved using fireproof construction (see *Twin Thin-skin Construction Section 4.0*).

By filling the useless gaps between the houses with bathrooms and kitchens to consolidate the housing mass in some places, and by strategically removing other shacks to form large open courtyards elsewhere, it becomes possible to transform Informal settlement into very acceptable sustainable housing without the need to demolish many dwellings.

3.2 Upgrading of dwellings

In contrast with the uncomfortable image informal housing has, upgraded informal housing is considered highly attractive and sought after as a tourist destination in many parts of the world. It is an important section of this paper to show how informal housing can be transformed into good housing without the need to demolish. (see *Figures 6.2&6.3*)

Upgrading generally requires less cost and effort than demolition and rebuilding and, besides, the structure can sometimes remain in use while it is being upgraded, which avoids the problem of providing alternative accommodation

Structures in informal settlements, despite their flimsiness, define usable space. Their major disadvantages can be tackled by enhancement. Upgrading can also add upper floor rooms. The monotony of extensive social housing is often criticised, and upper rooms can both increase the house size and improve the urban silhouette of settlement.

Informal housing at present

- Shacks are usually rectilinear or polygonal in shape, made from discard corrugated iron and cardboard up-country, and timber kits and plastic sheeting at the coast.
- These shacks are stacked side by side approximately 2 meters or less away from each other. This separating space is too small for use and becomes storage for refuse. This useless abandoned space cluttered with debris is *Campus derelicta*. It does not protect against the spread of fires.
- The interiors are too hot by day and too cold at night.
- They are not waterproof and rain not only penetrates the roof and walls but, with inadequate floor foundation and perimeter site drainage, water enters through the floor as well. Flooding in low-lying areas, where informal settlements are often situated, is common.
- Newspapers constantly remind us of the spread of rampant fires and lives lost.
- Sanitation is mostly rudimentary or non-existent

3.3 Upgrading criteria

The author of this paper has spent ten years considering this problem in detail. The following criteria are necessary and vital:

1. Will the add-on structure be fully integrated and bonded so that new or added parts will not crack or fail in their cohesion?

2. Can the existing structure remain liveable, or must it be demolished for new foundations etc?
3. Will the enhanced structure offer improved climate control?
4. Will it require further finishing, maintenance and cost to make it waterproof and crack free?
5. Can the upgrading be done by the occupants themselves, assisted by nearby associates, or must specialist artisans be brought in?
6. How well can new or existing roofing be bonded to the walling?
7. Will the enhancement provide adequate support for additional structures such as upper floors?
8. Could new infill between buildings be blended with the existing in a seamless way?

Traditional building materials, such as brick or building blocks and alternatives such as adobe etc might provide some of the answers, but are generally not comprehensive and cohesive enough. Each is flawed in some respect.

In searching for an answer, a new way has been developed to build that synthesizes traditional and modern building know-how. The solution is a new technique (or possibly re-emphasizing known techniques) of building, using traditional building materials to enhance the flimsy structures. This building method is disarmingly simple, but it works², and more than fulfils the criteria necessary. Physical prototypes have been built with structural demands far in excess of the demands of informal settlement, and have in this way proved the viability of the proposed solution.

The cost efficiency of the system has been tested and verified by private funding. Notwithstanding its simplicity to implement, the method will require rudimentary training and supervision. This is one instance where sponsorship and seed development funding for a demonstration exercise for those who are faced with the problem of informal housing will be clearly worthwhile.

This system is known as “Twin thin-skin construction”.

4 Twin Thin-skin Construction (copyright) (see *Figure 6.5*) (first published in Plea '99, Vol 2, p 869)

(This building method was derived from a study of the principles of “Generic Cost Saving” by the author).

Twin thin-skin construction is a process of building where two or more thin skins of wire reinforced cement mortar (known as structural mortar) are used and separated by ribs made of the same material at regularly spaced intervals all bound together to form a homogeneous building system. All the planes are mutually integrated and supportive in what is known as monocoque construction. It is analogous to timber framed construction but different in that all the elements are made of the same material and eventually become integrally and structurally one. An important characteristic of the system is that the two outer skins are separated by an air gap of varying width, which ensures insulation and a layered moisture barrier in the manner of cavity wall construction. This variable air space can also provide ducting for services and induced thermal air movement (see *sections*). It also has exceptional structural, seismic, fire and soundproofing facilities that are beyond the focus of this paper. The author can demonstrate how this cavity in selected positioning can provide free heating or cooling to the interior (see *sections*).

² Actual built examples can be shown and demonstrated

- *Twin thin-skin construction* does not employ any new-fangled patent construction materials.
- It uses materials that are readily available even in remote locations.
- It can be used to strengthen walling and roofing to increase climate control, waterproofing and fireproofing .
- It can also be used to safeguard housing positioned on poor or seismic threatened land.
- It has further advantages in permitting low skilled artisanship, which will enable the residents, the unemployed and women to enhance their own living circumstances.
- It can be readily altered and added to and can even provide for second storey accommodation. In this way the upgrading can keep pace with affordability.
- The author is convinced (based on built prototypes) that in a properly managed programme this method of construction will cost considerably less than conventional housing.

Further technical details can be made available to bona-fide interested parties.

4.1 Twin Thin-skin Construction and informal settlement upgrading³

Shack dwellings do not have proper foundations, but do have rudimentary wall and roof surfaces. Using twin thin-skin construction they can be transformed into permanent habitable homes as follows: (see *Figure 6.5a*)

Foundations

Reinforced steel mesh can be positioned outside the walls lying flat against shallow excavated ground, with a vertical up stand section of the mesh positioned against the walling. In this way it is possible to create eccentric concrete footings that will support future structure and will also keep water away from the walling and foundations.

Walling

Steel mesh can be positioned against the existing walling using it as supporting formwork, as the first skin of the double skin wall. Reinforced vertical ribs to conform to the future wall width can be added at suitable intervals which will also act as the support for a new external skin. Allowance can be made to preserve existing doors and windows by lining them with ribs.

Roofing

In the same way steel mesh can be placed on the existing roofing using it as formwork for the bottom layer. Steel mesh ribs would then be attached over the bottom layer at suitable intervals. The ribs need to be concreted before the bottom layer is cemented. Their spacing and depth would conform to the span and loading requirements. A final skin would be placed over the roof ribs on permanent formwork (which can be insulated semi-rigid plastic) to produce a composite insulated concrete roof or floor. It is significant that this form of construction will structurally permit additional upper floors enhancing the accommodation and visual interest of informal settlement.

Special Properties

The construction method results in a monocoque form of construction which means that the walls, roofs etc are mutually supportive and structurally tied together in a way that would prevent any part collapsing independently. This is of special significance for seismic threatened parts of the world. The materials used offer fireproof properties and the double skin has intrinsic climate and waterproofing benefits.

³ Text first published in the periodical *Housing/Behuising SA* – October 1995
later included with illustrations in the periodical *Building Africa*, January 2003 Vol 3 No 1. and again as part of a paper for the CSIR Technology and Management Conference May 2003, p 73

4.2 Twin Thin-Skin Construction and Passive air Conditioning (copyright): (see *Figure 6.6*)

There are many parts of the world where the timber traditionally used for cooking and keeping warm is becoming critically short. Coal is seen as a serious health pollutant, and paraffin is highly volatile and increasingly unaffordable. There is therefore an urgent need for sustainable development to offer passive energy alternatives. Rampant fires are the scourge of informal settlements. Often this is caused by people trying to keep warm. This puts the individual shack dweller at mortal risk but also endangers other dwellings and the lives of many people. Twin thin-skin construction has the possibility of providing passive air-conditioning without the need for reliance on fossil fuel as follows:

- Every dwelling has a sunny side and a leeward side in shadow, offering a differential temperature gradient.
- By creating a glass sun-facing duct of suitable width within the twin thin-skin wall it is possible to form a passive heat induced rising column of air. This duct doesn't need special fabrication as it can be created by the positioning of the ribs and painting the inner faces black.
- If this duct has a controllable flap at the top and bottom ends it is possible to direct air flow internally or externally as required.
- In this way hot air can be introduced to a room in winter or directed outwards in summer.
- The use of the bottom flap will allow air to be drawn up from either the interior or exterior.
- As the rising column of heated air creates negative air pressure at its base it is possible to draw cool air into the interior from the shaded side of the building thereby cooling the inside in summer.
- Ducting in the roof space permits hot air to be directed to inner rooms as well.
- The use of twin skin permits the heating duct to be positioned as a corridor support outside the building or even angled correctly on the shadow side of a structure. These can then be ducted to the interior.

5 Conclusion

The enormous problem of housing a growing population will ensure that governments and housing authorities will inevitably come to realise that informal housing can and must be upgraded. This paper shows a way to do it that is structurally sound (even in poor soil and seismic threatened regions), that will provide more healthy living, and will guard against the spread of fire and other hazards. The methods illustrated show the potential for planning and aesthetic qualities that are superior to formal housing. This paper illustrates a construction techniques developed for lowly skilled (not gender specific) people to use. Successful built prototypes (some illustrated) will answer possible negative assessment. The system has inherent principles that make the process highly economical and affordable. The possible difficulties in identifying suitable settlements and the dealings with the existing residents will be a valuable social exercise that is beyond the scope of this paper.

Those authorities with obligations and limited budgets must realise that the time has come to try this system, even if it is in a limited initial test.

6 Illustrations

6.1 An aerial photograph of an informal settlement

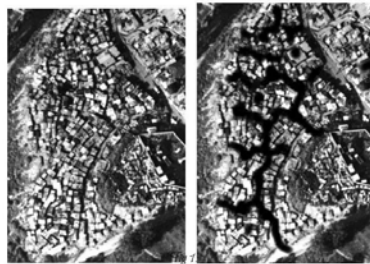


Figure 6.1.

- *The picture on the left is of a typical squatter settlement*
- *The picture on the right shows the settlement with certain shacks demolished to form linked courtyards*
- *The shacks that are left would be upgraded and have the gaps between filled and consolidated with new bathrooms and kitchens*

6.2 Informal Planning is often regarded as a desirable precedent

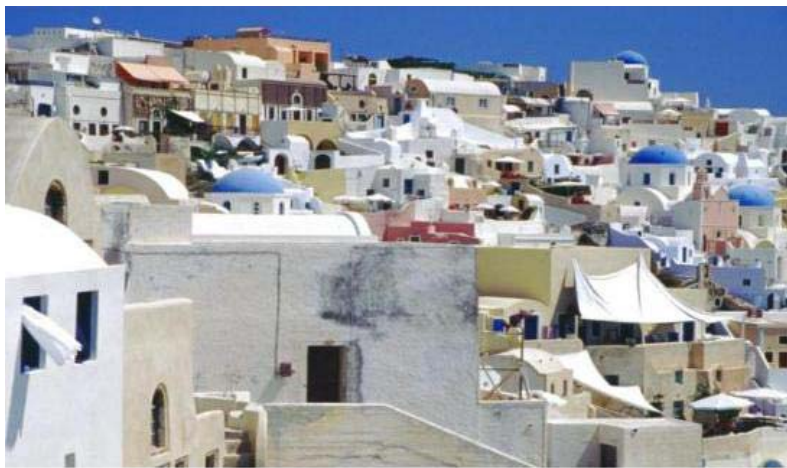


Figure 6.2

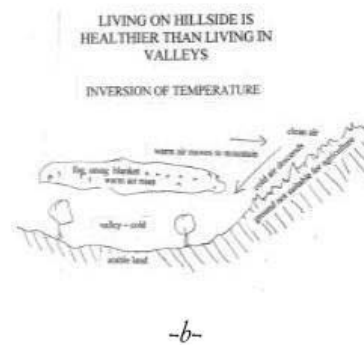
These are pictures of the Greek island Santorini which is a world renowned beautiful tourist mecca

- *The houses are irregular and close together*
- *The variegated image is typical of the interest that occurs when people build their own houses*
- *The materials used are few and simple.*
- *Is it possible that this housing started as “Informal Settlement”?*

6.3 Housing can be positioned on infertile slopes with health benefits to the people living there



-a-



-b-

Figure 6.3

- *Why do we use our precious fertile farmland for housing and ignore our plentiful infertile rock slopes?*
- *It is only "Contractors" who say building on slopes is difficult and expensive. People who build for themselves don't seem to mind.*

6.4 Twin Thin-skin construction enables buildings to be attractive and maintenance free



-a-



-b-

Figure 6.4

Figure 6.4a illustrates a garden cottage built on a hillside. Figure 6.4b illustrates a first floor addition to a garden shed. These structures were made possible by use of "Twin Thin-skin Construction", demonstrating the inherent structural flexibility and the tremendous design potential that the system offers.

6.5 Twin Thin-skin construction uses simple building techniques suitable for the unskilled

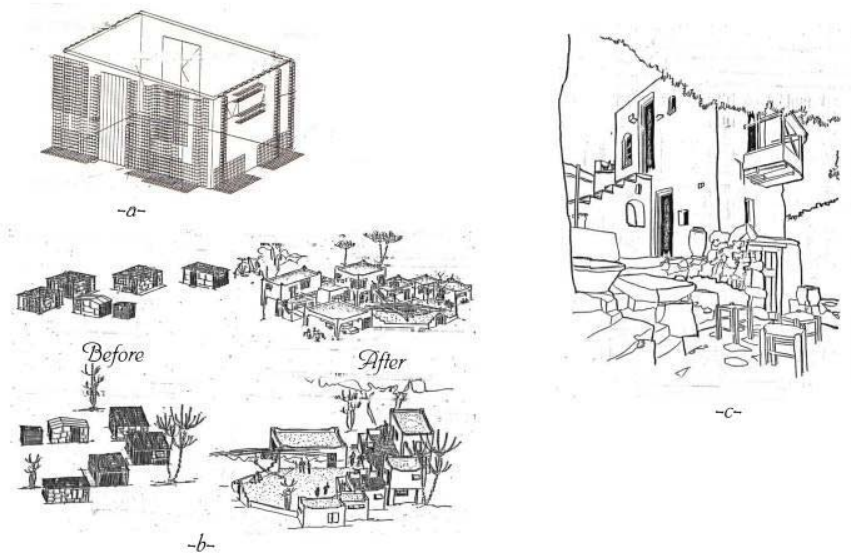


Figure 6.5

Figure 6.5a Illustrates diagrammatically how:

- *Foundation steel welded mesh is positioned up against an existing structure to provide reinforcement for an eccentric foundation and an up stand to splice to vertical reinforcement.*
- *Vertical ribs of mortar embedded mesh to suit the required wall thickness are spaced at convenient intervals.*
- *Structural roof or suspended floor beams can be made in a way similar to the wall structure (horizontally instead of vertically) varying in depth according to the necessary span.*

Figure 6.5b illustrates how

- *Random insubstantial shacks can be upgraded, also enclose manageable external space to form new cohesive living unit with both internal and external living spaces.*

Figure 6.5c shows

- *How the addition of upper rooms can break the monotony and silhouette of Informal settlement.*
- *Note also the use of external stairs possible in beneficial climates.*

6.6 Twin Thin-skin construction can bring free heating and cooling to housing

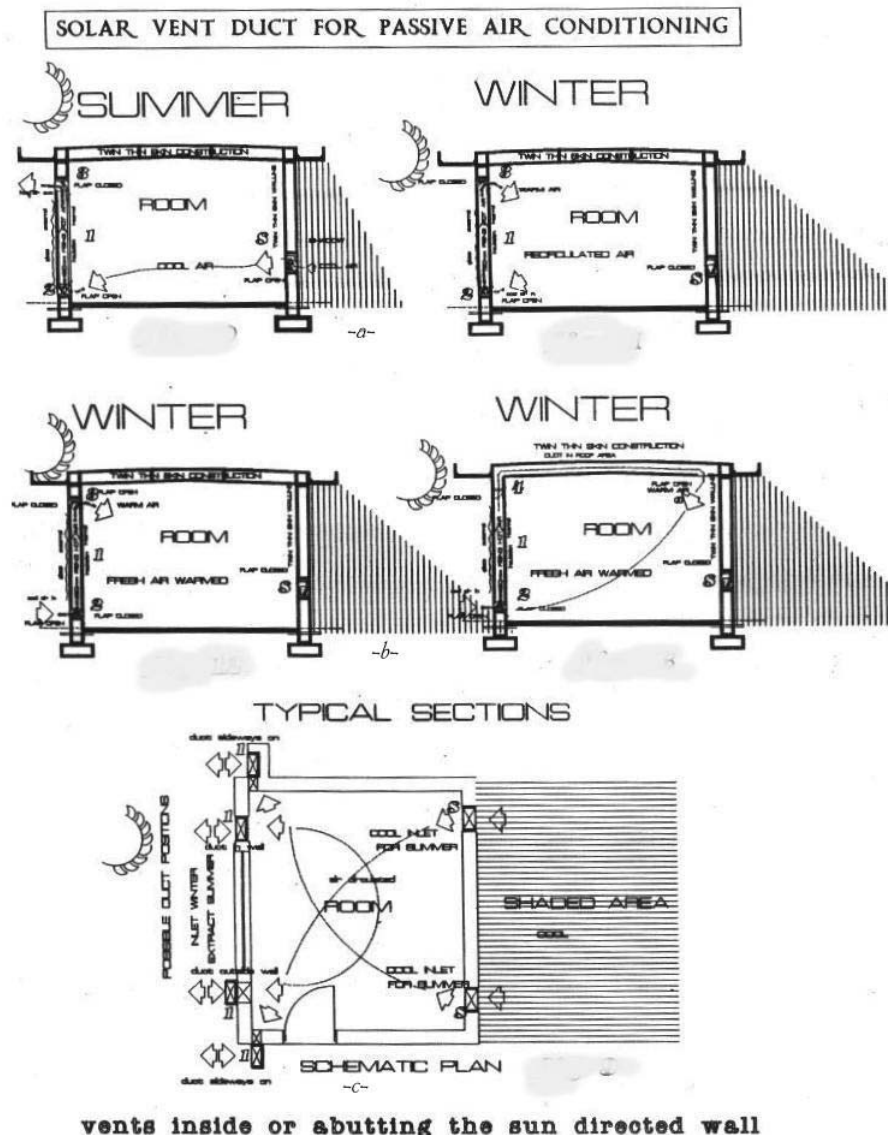


Figure 6.6.

The double skin construction permits portions of the walling facing the sun and fronted with glass to be used for passive energy induced thermal air movement which permits both heating and cooling of the interior when required.

- Figure 6.6a illustrates diagrammatically direct heating and cooling.
- Figure 6.6b illustrates diagrammatically heating and cooling where the induced airflow can be directed through the double skin roof to inner rooms and surfaces.
- Figure 6.6c illustrates the versatile positioning of the thermal air duct. It can even be positioned with the garden features away from the face of the house provided that there is ducting back to the roof.