OPEN STANDARD BUILDING IN SOUTH AFRICA: NEW CONCEPTS, STRATEGIES AND TECHNOLOGIES

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ABSTRACT

Purpose of this paper – The notion of "open building" arose out of a counter movement within the Congrès Internationaux d'Architecture Moderne (CIAM) to the promotion of modern mass housing theories in post-First World War Europe. The opponents argued that the "closedness" of the structures prohibited adaptation over time. This paper constructs a framework for developing, validating, and applying *Open Standard Building* in South Africa.

Methodology/Scope – The paper relies on a literature research covering the CIAM's mass housing building theory, the development of the counter theory, the emergence of the Open Standard Movement in computer software, and the theoretical application in contemporary construction methodologies and processes.

Findings – The paper finds that *Open Standard Building* concepts, strategies and technologies can deliver buildings that are more responsive to occupants' desires and their changing needs over time.

Research limitations - The research is limited to establishing the theoretical concepts of "open building" and testing for validity in South Africa. The paper will not review or assess the CIAM other than its relevance to the emergence of the open building approach. No quantitative analysis is done.

Practical implications – *Open Standard Building* facilitates the implementation of innovative building technologies and processes that will result in substantial improvements to the quality of life of many South Africans, particularly within the mass housing market, through reductions in resource waste, improved Life Cycle Costing, lower costs associated with facility changes over time, improved indoor and outdoor environmental quality, and enhanced facility performance.

Value – The value of the paper is to be found in developing a construction theory that's prime purpose is to deliver enhanced facility performance and self expression, particularly in the field of mass housing, by facilitating inter-operability and changeability through technological and process innovation.

Keywords: open building, participation, integration, innovation, technology, inter-operability, flexibility

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1.0 INTRODUCTION

South Africa faces severe challenges with regard to delivering the socio-economic infrastructure and services required by the majority of its people. Significant backlogs exist with regard to the provision of hospitals, clinics, schools, libraries, community halls, and sport facilities. Of particular interest to this paper is the backlog regarding housing and related services for the poor: according to the Community Survey 2007 (StatsSA 2007a):
- 15 per cent of households live in informal dwellings;
- 12 per cent of households live in traditional dwellings;

- 20 per cent of households do not use electricity for lighting; 33 per cent of households do not use electricity for cooking; 41 per cent of households do not use electricity for heating;
- 45 per cent of households do not have access to a flush toilet connected to a sewerage system; and
- 53 per cent of households do not obtain water from piped water inside the dwelling; 12 per cent of households do not have access to piped water.

In addition, the Department of Housing has a backlog in excess of 2.2 million units. To this must be added the approximately 121 621 dwellings required every year to accommodate the net population growth of 450 000 of the country at the current household average of 3.7 persons per household (StatsSA, 2007b).

The provision of housing to meet societal needs is of course not unique to South Africa: most countries around the world struggle to deliver affordable housing in sufficient numbers. However, what distinguishes housing delivery from many of those countries, specifically the developed countries, is that South Africa provides a simplex 'starter unit' (consisting of two rooms and a toilet) on an individual plot (low density), whereas developed countries provide a range of completed unit types most of which are low-rise and share a plot (high density). The expectation in South Africa is to accommodate every person needing a shelter in a basic unit that can subsequently be altered and added to meet the growing needs of the family.

Adaptability and flexibility to meet the needs of the family are thus key challenges that housing delivery must meet in South Africa. It is this requirement of public housing that this paper investigates.

2.0 CIAM AND ITS APPROACH TO MODERN MASS HOUSING

The condition of mass housing in Europe during the early part of the 20th century was not that much different from that described above for contemporary South Africa. Successive wars on the continent, together with the forces of industrialization and urbanization, all lead to a massive need for housing and infrastructure services in a rapidly changing social order.

The group of architects who gathered under the banner of Congrès Internationaux d'Architecture Moderne (CIAM) did so in the belief that industrial technology could be used to satisfy the demands of this emerging new societal order in much the same way that the automotive industry was bringing mobility to the masses. In its *La Sarraz Declaration* of 1928, CIAM submitted in Clause 4 that "the most efficient method of production is that which arises from rationalization and standardization. Rationalization and standardization act directly on working methods both in modern architecture (conception) and in the building industry (realization)" (Conrads 1970:110). Clause 5 of the Declaration goes on to claim that there are three drivers which rationalization and standardization exercise on architecture and building:

i) Architectural concepts must be done in a manner that simplifies construction methods and processes on site;
ii) Contractors can reduce the number of skilled workers as unskilled workers can construct the buildings under the supervision of fewer but more highly trained technicians; and
iii) Customers (the one that orders the house) must reduce their demands in accordance with the "new conditions of social life". The Declaration argues that a sacrifice is necessary in order to "foster the maximum satisfaction of the needs of the greatest number, which are at present restricted" (1970:110).

So committed was CIAM to this rationalization and standardization that it urged the reconceptualization of architecture in order to meet the requirements of this new industrial approach. Clause 7 states that "it is urgently necessary for architecture, abandoning the outmoded

conceptions connected with the class of craftsmen, henceforth to rely upon the present realities of industrial technology, even though such an attitude must perforce lead to products fundamentally different from those of past epochs" (1970:110).

CIAM however went further than advocating the adoption of rationalization and standardization for architecture and building only and submitted that it could be applied to town planning as well. In an almost mechanistic manner they posited that urbanization could not be conditioned by the claims of a pre-existent aestheticism, that it was essentially a functional order, and that it had three functions: "(a) dwelling, (b) producing, (c) relaxation (the maintenance of the species)" (1970:110). In the *Charter of Athens* of 1933 the three functions became four and were described as: "housing; work; recreation (during leisure); and traffic" (1970:139). Why recreation is redefined is not clear.

It was this reductionist approach to urban planning that sparked a revolt which later lead to the demise of CIAM. Frampton notes Reyner Banham's criticism of the *Charter of Athens* as committing the CIAM unequivocally "to a) rigid functional zoning of city plans, with green belts between the areas reserved to the different functions, and b) a single type of urban housing, expressed in the words of the Charter as 'high, widely spaced apartment blocks wherever the necessity of housing high density of population exists'" (2007:270). Banham goes on to note that the 'Mosaic' authority this statement enjoyed "effectively paralyzed research into other forms of housing" (Frampton 2007:270). Frampton does however also note that this dogmatic tone later softened into a statement committing CIAM to work for the "creation of a physical environment that will satisfy man's emotional and physical environment" to accommodate the views of other members of CIAM who believed that "people want buildings that represent their social and community life to give more functional fulfillment" (2007:271).

3.0 THE COUNTER MOVEMENT AND THE EMERGENCE OF AN OPEN BUILDING APPROACH

The counter-movement, which arose in opposition to the perceived urban sterility that would be a consequence of the proposals put forward in CIAM's *Charter of Athens*, crystallized at the 9th CIAM Congress held in 1953 when a group of architects, lead by Peter and Alison Smithson, challenged the four so-called 'Functionalist' categories of town planning (housing; work; recreation; and traffic). This rebel group posited that town planning and urbanism could not be abstracted down to a simplistic functionalist model: they argued for a more complex pattern that could be more responsive to what they referred to as the human need for identity engendered through a related sense of belonging. It was this new avenue of urban research which lead to the demise of CIAM in 1956 and the emergence of Team X, largely constituted by the counter-movement group lead by Peter and Alison Smith (Frampton 2007:271).

Team X's polemic focused on two components of urban transformation in particular: a) how to integrate new high rise development into the existing urban pattern, and b) how to replicate the social role of the street at above street level (although they soon came to realize that it was not possible to achieve any connectivity between high-rise dwelling in the air and streets on the ground). Notwithstanding Team X's continued belief in the multi-level city, they did come to acknowledge that above the sixth floor – the height of a mature tree – the inhabitants lost all contact with the ground. Frampton suggests that this height limitation may well have "exerted an influence in the 1960s on the general adoption of 'low-rise, high density' as the preferred policy for family residential development" (2007:273).

The first appearance of the term 'open' came in 1958 when the Smithson's presented their 'open city' thesis which argued that, as the accelerated movement and change in the 20th century were fundamentally incapable of relating to the patterns of any existing urban fabric, the creation of a new sense of place would have to come about through the use of architecture as land marks and the

creation of traffic-free enclaves. Their 'open city' thesis was essentially a pluralistic notion that acknowledged the existing urban pattern but sought to stitch a new urban pattern over and through it, using architecture to mark out significant new urban places for social intercourse. Richard Sennett in his essay *The Open City* (2006) echoes this view and blames over-determination of the city's visual and social functions as the fault-line. Although Sennett claims ownership of the term 'open city' (incorrectly, as this term had been used by the Simthsons in 1958 already), he gives the urbanist Jane Jacobs credit for the idea (also incorrectly). Sennett suggests that an open city requires, among other factors, incomplete form, that is to say, the designer needs to create physical forms of a particular sort, 'incomplete' in a special way. Sennett refers to Peter Eisenman's phrase 'light architecture' to indicate a building planned so that it can be added to, or more importantly, revised internally in the course of time as the needs of habitation change.

The final achievement as an anti-thesis to what Frampton calls the "Cartesian projections of the Ville Radieuse" (2007:278) came about through the Urbino proposal of one of the members of Team X, Giancarlo de Carlo, in which the insertion of the 'new' combined successfully with the deliberate reuse of existing stock wherever possible. De Carlo went on to review the consequences of the CIAM *La Sarraz Declaration* of 1928 in a critical article titled *Legitimizing Architecture* where he noted that the proposals of CIAM "have become the houses and neighbourhoods and suburbs and then entire cities, palpable manifestations of an abuse perpetrated first on the poor and then even on the not-so-poor" (Frampton 2007:278). He went on to question why inadequate resources should be used as the justification for building housing as cheap as possible when there are always resources available for other activities, such as the building of an arsenal of weapons.

Meanwhile, the search for alternative housing models continued: in Japan, the growing pressures of Japanese overcrowding lead, in the 1950s, a group known as the Japanese Metabolists to propose constantly growing and adapting 'plug-in' megastructures where the living cells would be reduced to prefabricated pods clipped to vast skyscrapers. A growing consciousness developed in the 1960s about the mismatch between the values of the architect and the needs and customs of the end users. This awareness lead to a series of reformist moves to overcome this chasm between designer and end user, including those poor sections of the community unable to afford the services of professional architects. One of the reformist architects was N. Habraken who, in his book *Supports: An Alternative to Mass Housing* (1972) addresses the challenge of designing dwellings that could meet the variable needs of its users. Frampton notes that "Habraken has opened up a line of research which has yet to be fully explored" (2007:290). One of the lines of research required must address how an open building approach can also overcome the loss of cultural identity that results from the largely reductive codes of modern mass housing practice.

Yona Friedman advocated an 'open infra-structural approach' with his 'mobile architecture' concept (Frampton 2007). His proposal was based on a low-rise, multi-storey, support structure whose plan was only fixed in terms of the required services (access, kitchen, and bathroom). The structure was to be enclosed with industrialized, modular components manufactured in much the same manner as automobiles complete with a similar high level of technical sophistication and structural tolerance.

Such a methodological approach was posited by the Dutch architect Herman Hertzberger who, in 1963 wrote, "What we must look for, in place of prototypes which are collective interpretations of individual living patterns, are prototypes which make individual interpretations of the collective possible; in other words, we must make houses alike in a particular way, such that everyone can bring into being his own interpretation of the collective pattern…Because it is impossible (and it always was) to make the individual setting that exactly suits everyone, we have to create the possibility for personal interpretation, by making things in such a way that they are indeed interpretable" (Frampton 2007:299).

Frampton, in adopting what he calls a taxonomy of six identifiably different aspects of architectural culture reflecting significant tendencies in current architectural practice today (topography, morphology, sustainability, materiality, habitat, and civic form), goes some way in providing a framework for this challenge. Frampton records that he used the German architect Gottfried Semper's essay of 1851, *Die vier Elemente der Baukunst*, as a base for his taxonomy. Semper posited four primordial elements of all building culture, namely 1) the elevated podium; 2) the framework and the roof, which provided the basic shelter; 3) the woven infill wall, which protected the hut from the elements; and, finally, 4) the hearth, which was not only the source of heat and food and the focus of social intercourse, but also the symbolic societal core (2007:346).

4.0 THE OPEN BUILDING APPROACH

The Open Building approach is largely being driven by two groups internationally: the first is the CIB through its working group W104; and the second is the European Union initiative ManuBuild.

Open Building (OB) is the international movement based on organizing buildings and their technical and decision-making process according to Levels (Habraken 1998): levels, in turn, are derived from the different scales of the city form, from the District Level down to the Level of the Room in a dwelling, a notion first used by Giambattista Nolli in his plan of Rome, the *Pianta Grande di Roma*, drawn between 1736 and 1748. Kendall (undated) argues that it is the formal recognition of these Levels that is a key characteristic of the OB approach.

While the origin of the concept of OB is clearly located within the thinking of the Modern Movement especially as expounded by CIAM, it differs in one significant way, namely that buildings are not isolated and static objects in space, but are subject to change over time, i.e., the built environment is and should be encouraged to be regenerative. Using this as a point of departure, Open Architecture goes on broadly to describe building design and construction practices which consciously create capacity for transformation.

Kendall notes that the key research question occupying proponents of OB has to do with how the built environment can be designed to support stability in the long-term interests of the community while accommodating change in respect of individual preferences. This stands in stark contrast to the position of CIAM that was prepared to sacrifice the latter in the interests of the former.

According to Habraken (1998), OB is the term used to indicate a number of different but related ideas about the making of the environment. These include:

- The idea of distinct Levels of intervention in the built environment where levels describe the interrelated configurations of physical elements such as urban design and architecture, and base building (I prefer the term platform as used in the automotive and aeronautical industries) and fit-out (again I prefer the term components for the same reason), a concept first articulated by Semper;
- The idea that users/inhabitants may make decisions as well as professionals;
- The idea that the interface between technical systems allows the replacement of one system with another performing the same function such that different infill systems fit any given base building;
- The idea that the built environment is in constant transformation and change must be recognized and understood; and
- The idea that the built environment is the product of an ongoing, never ending design process, in which the environment transforms part by part.

The challenge to proponents of OB, Kendall posits, is to formulate theories about the built environment within this dynamic context and to develop methods of design and building construction that are compatible with it.

ManuBuild's approach is closer in origin to CIAM than that of OB, being rooted firmly in the notion of industrialization and manufacturing. ManuBuild is a European Integrated Project on Industrialized Construction that has as its vision open building manufacturing, a new paradigm for building production and procurement by combining highly efficient manufacturing techniques in factories and on construction sites and open system for products and components offering diversity of supply and building component configuration opportunities in the open market. The ManuBuild Open Building Manufacturing System is an integrated system that incorporates Building Concepts, Business Processes, Production Technologies and ICT Support as well as Training.

5.0 PRINCIPLES OF HOUSING IN ALL SPHERES OF GOVERNMENT AND OPEN BUILDING

The delivery of mass housing by the public sector in South Africa is controlled by the Housing Act (Act 107 of 1997). The Act provides for the facilitation of a sustainable housing development process, including the laying down of general principles applicable to housing development in all spheres of government.

The Act recognizes that the Constitution of the Republic of South Africa (Act 108 of 1996) grants everyone the right to have access to adequate housing (section 26) and tasks the state to take reasonable legislative and other measures, within its available resources, to achieve the progressive realization of this right. The Act goes on to define 'housing development' as the establishment and maintenance of habitable, stable and sustainable public and private residential environments to ensure viable households and communities. The Act notes that all citizens and permanent residents of the Republic will, on a progressive basis, have access to permanent residential structures ensuring internal and external privacy and providing adequate protection against the elements. With regard to community participation, the Act requires national, provincial and local spheres of government to consult meaningfully with individuals and communities affected by housing development (section 2(1)(b)) and ensure that development provides a wide choice of housing and tenure options as is reasonably possible (section 2(1)(c)(i)) and encourage and support individuals and communities in their efforts to fulfil their own housing needs by assisting them in accessing land, services and technical assistance (section 2(1)(d)).

The Act requires the Minister of Housing to determine national policy, including national norms and standards, in respect of housing development. The Act further requires the Minister to publish a code called the National Housing Code. The Code must contain national housing policy and procedural guidelines in respect of the effective implementation and application of national housing policy.

5.1 The National Housing Code (the Code)
Chapter 3 of the Code sets out strategies for South Africa's Housing Policy. They are:

- Stabilising the Housing Environment
- Mobilising Housing Credit
- Providing Subsidy Assistance
- Supporting The People's Housing Process
- Rationalizing Institutional Capacities
- Facilitating Speedy Release and Servicing of Land
- Coordinating State Investment in Development

In terms of the strategy aimed at supporting the People's Housing Process, the Code notes that many South Africans have for many years been organizing and building houses for themselves and that they are able to achieve a greater level of value for money this way. The Code notes specifically that where beneficiaries are given the chance either to build houses themselves or to organize the building of the house themselves, they can save on labour costs by doing some of the work themselves or by getting their neighbours, friends and families or other persons to help them, save the profit normally made by the developer, and optimize their decisions by using opportunities for trade offs. The Code also notes that for this to happen successfully, beneficiaries must be given technical, financial, logistical, and administrative assistance. In terms of the Code, communities seeking to apply for housing subsidies using the People's Housing Process route, may apply for a Facilitation Grant which pays for community workshops. These workshops seek to, inter alia, develop a:

- Community Action Plan for the layout and the level of services for the development;
- Number of house designs and related costs including the building of skills within each family that enable people to alter and adapt both housing costs and plans if and when circumstances and the availability of resources change; and
- Printed set of community building guidelines for approval by the local government body.

It is thus clear that from a legislative perspective provision already exists for the implementation of an Open Building approach to public housing.

6.0 A FRAMEWORK FOR OPEN BUILDING STANDARD IN SOUTH AFRICA

A number of criteria for the construction of an Open Standard Building Framework for South Africa's mass housing crisis are readily available from the above. Some can be drawn from the Modern Movement itself, while others are quite clearly post-Modern in concept. Although the term 'mass housing' may imply a validation of modernist approaches, a backlog of over two million dwellings unit can only require a 'mass' approach if the shortfall is to be delivered in the lifetime of the beneficiaries.

The first criterion has to do with the role and development of technology in mass housing. One of the difficulties identified by the Modernists had to do with the use of contemporary technology, particularly with regard to its application by the construction industry. The South African construction industry is dominated by SMEs with low levels of skill and technological expertise. In addition, much is made of the current shortage of skilled artisans, a circumstance that is expected to persist for some time. Thus much of what gets constructed in the building industry is done with unskilled labour. Developing a new building technology that requires a few highly trained technicians overseeing its application by generally unskilled labour thus has much to commend it. A further local skill advantage is identified in the Housing Act, namely that for generations South Africans have undertaken the construction of their dwellings themselves, either directly or indirectly. Again, a technology that is able to be transferred has much to commend it.

A second criterion for such a framework has to do with the role of architectural practice in the provision of mass housing. Frampton quotes Donald Schon's 1983 *The Reflective Practitioner* call for professional knowledge to acknowledge human values and interests at all times, and to "recognize that the scope of technical expertise is limited by situations of uncertainty, instability, uniqueness, and conflict" (2007:328).

A third criterion for such a framework relates to the role of patrons, both public and private. Frampton argues that "Without adequate patronage, a reasonable standard of general production can neither be achieved nor sustained, for building is a public art that demands great social commitment

as well as high levels of investment, matched by an appropriate building capacity in terms of both craft and industrial production" (2007:329).

A fourth criterion for the framework has to do with the recognition and inclusion of the role of the natural environment in human settlement. Frampton quotes Vittorio Gregotti as stating: "The worst enemy of modern architecture is the idea of space considered solely in terms of its economic and technical exigencies indifferent to the ideas of the site. Indeed, through the concept of the site and the principle of settlement, the environment becomes the essence of architectural production" (2007:329). Notwithstanding this limited environmental view of Gregotti's, it does reverberate with a similar albeit more expansive position taken by Team X in their *Doorn Manifesto* of 1954 which posits an ecological approach integrating habitat into the landscape. Frampton argues that there is perhaps no area of human activity that is more in need of a new relationship with nature than the current model of suburban sprawl. He submits that the somewhat "effete" debates as to an appropriate architecture for our time pale into insignificance beside the apocalyptic prospect of the megapolitan explosion awaiting our cities, comparable – in his view – to the destruction of the rain forests and the depletion of the ozone layer. Returning again to Team X's early explorations, each housing development presents a unique opportunity when place and production can be merged together to deliver a quality of character which both informs our identity and is sustainable.

A fifth criterion for a framework has to do with standards, an area requiring substantial research for OB to be successful. A *standard* provides guidance to someone wanting to build something. A standard is more however because it has to have the agreement of a number of people to be accepted as a standard. The question of acceptance is a distinguishing feature between *standards* and *specifications*: specifications require no general acceptance. Standards are required when it is necessary to ensure that components made by different manufacturers will either work together or work in the same manner. This concept is well understood among software developers: OpenDocument Format (ODF), because it is a standard, can be used by anyone who builds software that complies with the standard. HTML is another important standard that facilitates interoperability by describing how pages for the World Wide Web should be formatted.

Standards may originate as a *de facto standard* by virtue of the popularity of a specification, Microsoft's Windows being a prime example. Unfortunately many *de facto standards* are controlled by a single vendor who may change the specification at any time thereby forcing users to convert or face obsolescence (again Windows is a prime example). An alternative to the *de facto standard* is the *community standard* which is created and owned by more than one person or company. Community standards may be endorsed or validated by a *Standards Development Organization* (SDO). The value of creating a community standard is that components from the participating community can work together to build solutions that solve real problems customers' experience.

In terms of open standards, the following needs to be remembered:

- The more transparent the standards process is, the more open the standard is.
- The more the community can be involved, the more open the standard is.
- The more democratic the standards process is, where the community can make significant changes even before Version One is released, the more open the standard is.
- The lower the standards-related cost to developers who want to use the standards, the more open it is.
- The lower the standards-related cost to the eventual consumer that uses the standards, the more open it is.
- When the licensing of the standard is more generous in the freedoms and permissions it provides, the more open the standard is.
- When the licensing of the standard is more onerous in the restrictions it imposes, the less open it is.

In reviewing *Design Like You Give A Damn*, edited by Architecture for Humanity and published in 2006 by Metropolis Books, New York, Jim Kennedy suggests what could be a useful framework for open building in South Africa: he summarizes the results in the book as a framework of minimum standards for material qualities and for physical planning into which localized design can be placed, a preference for flexible materials over finished structures, and an emphasis on contribution to the ownership by the beneficiaries themselves, all the while insisting that such efforts should come as a systematic programme for delivery embedded in a rights-based approach (Kennedy 2006).

Using all of the above, a Framework can be constructed based on the criteria and mass housing delivery stakeholders.

Table 1: Framework for Open Standard Building in South Africa

	State	Statutory Councils	SSO	Research & Academic Institutions	BEP	Industry	Users
Technology Development	Funding; Endorsement	Funding; Demonstration	Support	Products; Methods, Materials; Processes; Demonstration	Value engineering	Building Process; Manufacturing Processes; Mobile Factories; Component prefabrication;	Technology transfer;
Design and Construction Practices	Value-driven Performance Evaluation; Strategic Procurement	Best Practice; Guidelines; Manuals; Curricula Development; Qualification Setting; Training through Industry Councils	Support	Guidelines; Manuals; Performance Metrics; LCA; ICT Support	Product representation; BIM; People-focussed design; manuals; guidelines	Lean Construction; Manuals; Best Practice; Performance Metrics; Training; On Site Production; Rapid Assembly & Disassembly Methods	Community Participation; Interactive Design; Training; Manuals
Patronage	Legislation; Regulation; Policy Formulation & Implementation; Technical, Financial, Logistical & Administrative Assistance	Funding; Practice-based Training;	Support	Patent; IP	Demonstration; User-orientated Interactive Building Design; Decision Support & Visualization	Demonstration; Training;	Community Action Plan; Community Building Guidelines
Ecology	Legislation, Regulation, Policy	Best Practice	Support	R&D	Eco-logical design	Green Best Practice	Green Best Practice; O&M
Standards	Support	Participation; support	Validation	Participation; Support	Participation; support	Participation; Support	Participation; Support

7.0 CONCLUSION

Caution must be exercised when proposing new solutions to the housing provision crisis lest the mistake of the modernists is to be repeated, namely the assumption that the provision of housing can be overcome by technology-driven interventions. As Frampton notes, devising appropriate housing delivery strategies lies beyond the scope of architectural practice as "an autonomous discipline and even outside the process of land settlement and building as it is commonly understood" (2007:289). The whole approach needs to be rethought commencing with the revaluing of access to housing within the concept of constitutional rights.

Nonetheless, an Open Standard Building Approach would seem to hold significant promise with regard to righting the wrongs of the modern mass housing movement. Transferring technology in a manner that benefits the poor by significantly improving the performance of their dwelling while enabling transformation and cultural expression over time would alone bring about a step-change in housing delivery in South Africa.

Much research needs to be done: the OB movement is young, and the challenges to be dealt with enormous. This paper therefore presents work in this field which is very much "in progress" at the CSIR.

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