Theory, Context Design and Technology

TRANSPORTABLE ENVIRONMENTS 2

Edited by Robert Kronenburg Co-edited by Joseph Lim and Wong Yunn Chii

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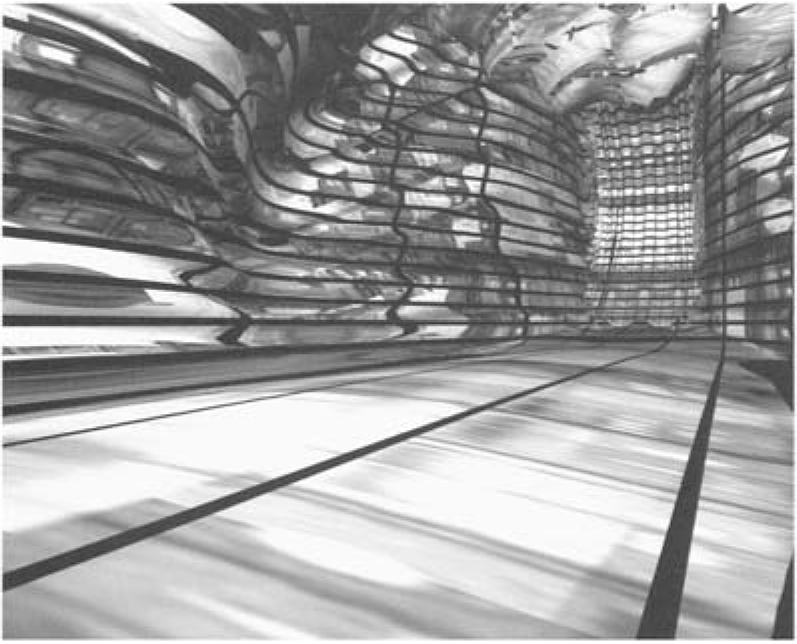
Foreword

This is the second book in the *Transportable Environments* series. Like the first, it is based on the proceedings of a conference, 'Transportable Environments 2001', the objective of which was to examine transportable architecture and its context. A transportable environment might be a building, a landscape or an interior design, which is brought into existence in a specific place for a limited time, though its impact may continue for much longer. Unlike conventional buildings, transportable ones are designed to take move-ability into account— when their value at a particular place is expended, deployment, rather than destruction, is their key feature. Because of the way in which the world is changing, technologically, socially, economically and culturally, it is probable that flexible, transformable, transportable design is as important now as it was when, in past millennia, the nomadic way of life was the dominant one across the planet.

The first conference was held in London in 1998, this second one at the National University of Singapore. The organisers specifically chose this dramatically different geographic context because, although the concept of mobile building is undoubtedly a global one, regional conditions can have dramatic effects on the form that architecture takes. By situating the event in South East Asia we hoped to attract delegates with different objectives, different problems and consequently different experiences to relate. This in fact proved to be the case—though there were delegates from Europe and North America, many more came from Singapore, Malaysia, Japan, China and Australia. Consequently we were able to hear presentations about buildings built for transportation into tropical rain forests and to remote sub-Antarctic islands, and in the discussion sessions talk about the particular issues of local climate, construction and special problems such as shelter after disaster. There were presentations on the use of transportable design issues as a vehicle for architectural education in Singapore and Tasmania and we also saw some sophisticated experimental design proposals by postgraduate architecture students. Something new for this conference were several papers examining the way that portable and flexible elements can be used within permanent structures to create transformable space that more closely fits the desires and needs of inhabitants. Another issue was the manner in which recycling of materials and components in buildings that are in themselves completely reusable at different locations adds double value to the increasingly important issue of sustainable architecture. it was also notable that there is much new work exploring how the impact of information technology is driving architectural theory —speculations on how future mobile architectural environments may be transformed by our relationship with virtual space formed the core of three very different presentations. Though this book stems from the conference, it is not a recording of that event, as each of the contributions has been reviewed and updated to form an essay that can be appreciated outside of the symposium context. However, this publication can be seen as a sort of 'space in time', a gathering of diverse viewpoints and research opinions that stems from a particular moment in architectural development. In that way it is rather like the architectural manifestation we set out to explore—ephemeral, contextually based, but, we hope, with some lasting, useful and trans-portable impact,

I must thank Joseph Lim and Wong Yunn Chii of the National University of Singapore for coordinating the conference and inviting Shigeru Ban and myself to contribute the keynote speeches and Vladimir Krstic to chair the discussions. The management work they did for this event was highly valued, as were their intellectual contributions In the presentations and discussions. My thanks also go to Caroline Mallinder for her commitment to this second book in the series, and to Helen Ibbotson and Claire Dunstan for their careful help and guidance.

Robert Kronenburg, University of Liverpool, 2002



Kas Oosterhuis, computer generated interior view of his Trans-ports project

Theory

1.1 Nomads at a waterhole near Arak (courtesy of Rob MacDonald)

Freedom and Transience of Space (Techno-nomads and transformers)

Gary Brown

Centre for Architecture, Liverpool John Moores University

Movement and growth

Architecture is in motion; it is kinetic both literally and phenomenally. Of course we all know this everything is in motion relative to something else. Kinetic motion, however, is now becoming an integral part of architectural thought and realisation. Architecture has adopted kinetic motion as a process of growth. We now consider architecture as extendable and changeable in time as well as space. This growth is not merely relative to size or motion but concerns energy and the transformation of spatial forms and material substances. Architecture has matured back to its roots. It has become integral with the cycles of the earth—a holistic, open system. The influences that have brought about this change in the approach to architectural design have come from many different sources. The conceptual model of the environment has changed from a mechanical model to an organic model. Computers have made handling the mass of ever more complex information easier and more visual. Communication has become mobile, linked to individuals rather than social or communal provision. Ecological issues and sustainability have reintroduced the importance of appropriate architectural interaction with the local and universal environment in which it is built.

Machine system-organic system

Recent theory has altered the system reference we use as a basis for design conception from a machine system to an organic system. Organic theory emerges from nature, an environment that possesses evolutionary patterns that have a base code, and an inherent programme where information is strategically interrelated to produce forms of growth and strategies of behaviour, optimising each particular pattern to the contextual situation. Codes are fixed, but the way they are expressed or repressed is dependent on the environment in which they exist. 'The forms and strategies are the result of extrapolated codes to environmental optimisation' (Frazer, 1995). This natural cycle produces the strategic patterns from its code repository that are necessary for survival. Each entity remains individual through its inherent individual programme, but is also an integral part of the overall natural cycle. The entities in this natural order are no longer conceived of as singularities. The entity can, in itself, be the medium for other entities or can form systems of entities like flocks of sheep or blades of grass. These systems of entities can be said to form a context. There is some kind of relationship between the entity and the system where the entity should be seen primarily as emerging from the system, rather than being distinct from it. its existence is interdependent with the system. Open systems are delocalised and are interdependent with other open systems.

Environmental patterns can therefore be envisaged as ephemeral, continually reforming in response to environmental flows, fluxes and rhythms, creating a multitude of space, times and objects. The prevalence of organic systems theory over the former machine systems theory has altered the conceptual model that we apply in order to comprehend our environment and consequently design in our environment. Mae-Wan Ho in his article 'The New Age of the Organism' sets out what he considers to be the main differences between the mechanical universe as it was conceived and the new organic universe.

> *Mechanical Universe;* Static, deterministic; Separate, absolute space and absolute time, universal for all observers space time frames; Inert objects with simple locations in space and time; Linear, homogeneous space and time; Local causation; Given, non-participatory and hence, impotent observer;
>
> *Organic Universe;* Dynamic, evolving; Space-time inseparable, contingent observer (process) dependent; Delocalised organisms with mutually entangled space-times; Non-linear, heterogeneous multidimensional space times; None-local causation; Creative, participatory entanglement of observer and observed.
>
> (Ho, 1997)

Flows-flux

Our adoption of an organic conceptual model over the mechanical model can influence the way we actually see. The organic model diminishes the importance of determined territories and formal bodies and emphasises the importance of the programmatic factors that govern the perpetual development of environmental form. Change in the mechanical world is cyclical, but there is no development; instead, the same factors and programmes are continually repeated. The organic world is also cyclical; however, this system is developmental. Organisms respond to environmental clues and cues and adapt their behavioural strategies to take advantage of environmental changes. These adaptations to the organisms' strategic behaviour may then reciprocally generate changes in the local environment. The organic model is constantly altering and is reciprocal; there is a feedback and response mechanism. If we look for a geometrical analogy of these two system models then a closed circle could represent the mechanical system and

1.2 Interactive sprites. The being of things in this natural order consists of open systems that are delocalised and are interdependent beside other open systems (1996)

an endless spiral could represent the organic system. The organic model is progressive: programmatic flows, fluxes and rhythms within the environment continually generating strategic patterns as temporal, ephemeral forms through their convergence and divergence. These strategic patterns form in response to the environment and are therefore relative only to a particular moment in time. We can interpret these patterns as a language of environmental flow, and can formulate theories that can be applied (and constantly amended) in relation to the flow of information from the changing environment. This ability to abstract and formulate theories from environmental pattern recognition has enabled us to intervene in them successfully.

These theories, when applied, reciprocally affect the way that we view the environment. There is, however, a world of difference between the reciprocal pattern language resulting from 'inhabiting the landscape' and 'inhabitation as landscape'. The complexities of nature prevail in 'inhabiting the land-scape' whilst in 'inhabitation as landscape' the complexities of our own nature prevail.

Temporal-transient

How we see the world affects the way that we interpret it and respond to it. If we interpret our cityscape using an organic theory the city patterns can be considered as having emerged from the topography in response to programmatic forces emanating from a holistic matrix/milieu amalgam. The patterns are a strategic material redistribution of the earth, similar to Gottfried Semper's 'mound' (Semper, 1989). This strategic, formal, distribution is a reflection of the local milieu as programmatic requirements are laid down (and adjusted) over time. The patterns can consequently be envisaged as sets of interrelated spatial matrices (three-dimensional patterns) with interrelated flowing programmatic forces that are constantly influencing both the emerging and emerged forms. City form is never more than a result of the temporal existence of things. It can be described as a single frame in the animated growth of appropriate solutions from one super-positioned state to another. This movement reveals the patterns of a city's strategies and consequently the programmes that constitute its haecceity, i.e., what makes its unique existence so unique. Form is temporal and transient—space, and its 'potential of becoming', is a more desirable design reference.

Static-stasis

Greg Lynn explains a conceptual viewpoint in the way designers conceive of the urban landscape: 'Architecture is by definition the study and representation of statics. Architecture of the city must however embrace motion, classical models of pure static essentially timeless form and structure are no longer adequate' (Lynn, 1997). Lynn goes on to explain that neither architecture nor urbanity need be viewed as static. Although architecture has a stable role, urbanism is characterised by more 'diffuse and transitory interactions', and both architecture and urbanism need to be conceived of 'as in motion, liquid mediums' related to 'graduated motions and forces'. In *The New Vision*, Moholy-Nagy uses water to describe this formal flux as a response to environmental changes: 'If we turn to water we come upon a surprising phenomenon, surprising not in its strangeness but its common-placeness Its changes arises from an extraordinary adaptability to the forces acting on it' (Moholy-Nagy, 1939). The use of water as an example suggests a structure that possesses a complex dynamic balance where there is a continual altering of the 'balance' of the form in relation to local and universal stimuli.

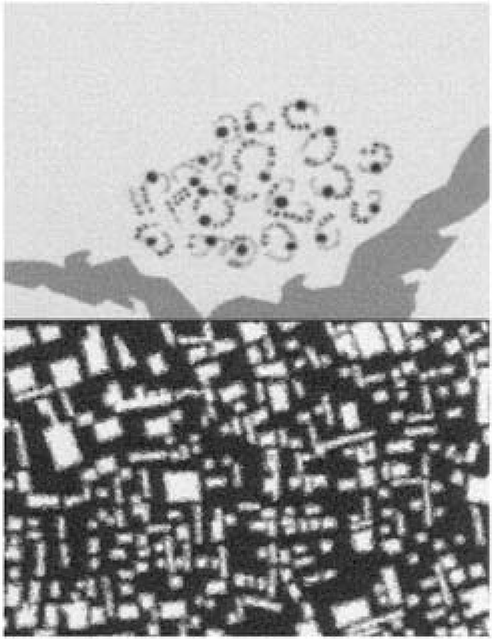
Stable, strategic

Our urban landscapes are, however, already ubiquitous. The patterns, related to past theories (or past ways of seeing) have in many cases reached a mature state which, in their formal aspects, are considered static. It is this static nature which has become the problem. The city is an artifice, reflective of human actions and social strategies, but the patterns of the city do not adapt rapidly enough relative to the dynamics of human nature. The urban pattern is an artificial landscape that is likely to remain predominantly historic, referring to past theories and past social strategies. In the organic theory model which is derived from natural patterns, form is generative, reciprocally developmental, the constituents recyclable. City patterns have, in many cases, failed to evolve and are more often abandoned than recycled—they become patterns in the dust. Urban patterns need to become more motive, more adaptive in order to remain appropriate to the needs of the inhabitants.

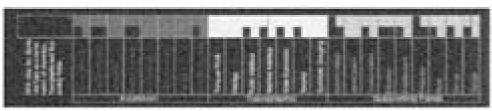
This is not to infer that stability does not have a role to play in the urban environment. There is, however, a difference between 'static' and 'stable'. Stability in architectural and urban terms has a distinctive role as a supporting platform for motion. Certain elements of our artificial landscape need to stand as a defence against entropy, strategic platforms are important for the launch of movable objects. 'Every mobile artifice springs in some way from a fixed material base, cars rely on roads, radio waves on a mast, planes on a runway' (Hatton, 1989). Any concept denying the importance of the stability of Semper's 'mound' to motion is a fallacy; there is a distinct relationship between infrastructure and mobility. Perhaps in terms of infrastructure, it is our relationship to scale that has changed, where the earth itself is now seen as an infrastructure supporting our needs. Particular forms of infrastructure are pinched, kneaded and condensed from the earth to become facilities, both as launch platforms for our mobility and as psychological, existential footholds in the form of monuments that remind humanity of its roots. The application of organic theories to the design of cities needs some kind of recognition of the historic 'dead wood', which, after all, also exists in the natural world (from which organic theory derives) as launch platforms for new life.

Permanence-polemic

This lack of adaptation of the urban landscape means that today's cities constitute a polemic of permanence and transience, as a reflection of their milieus' conflicting change within permanence. Permanence in urbanity consists of a multitude of stable forms, image and infrastructure, that the people recognise and

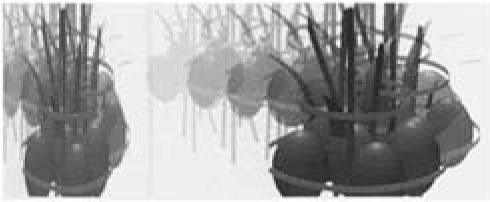


1.3 The pattern language of dwelling as a variable density, inhabiting the landscape and inhabitation as landscape (2002)



1.4 The inherent programmatic nature of a facility within the city represented as a DNA strip; accretion refers to the flocking or grouping nature; topographic refers to the environmental location nature and supporting fields refers to beneficial facility adjacencies. Weightings are from one to four (1998)

relate to. These stable forms aid the generation of ‘place’ from ‘space’ and emanate a feeling of social continuity. They generate a psychological foothold, a mark upon the earth (even though the mark may just be a launch pad for a transient event). Facility and fashion, influenced by technology and the media, are ephemeral. Ever changing they often go hand-in-hand, for example, facility being presented in a fashionable/stylistic way. The difference between fashion and facility in the city is similar to that between fashion and clothing. Clothes are what we wear to facilitate ourselves within our environment in terms of social acceptance, comfort, and bodily protection. Fashion is more frivolous and chameleon-like. Considered by some to be ‘useless’ it is associated with changing moods, modes, shifting erogenous zones and is essentially ‘symbolic gossip’ at a social event. Similar to the garments we wear, facility and fashion have become inextricably linked in the urban landscape and have become, essentially, symbolic gossip that permeates the



1.5 Delineated 'free radical' as an electronic sprite, an animated spatial form that has inherent programmes of accretive and topographic location within the urban matrix (1998)

city. The contradiction is that this symbolic gossip has become one of the ways that we remember the city. The relative hierarchical importance between permanence and transience of form as generated by space as place in our memory has been amended. The prevalence of a consumer society based on instant image has made the facility and fashion events within the city monuments in our memories. The general social acceptance and economic need for the event/ obsolescence cycle mean that stability, despite its necessity as a launch pad, is considered an impediment to change. Monuments have become backgrounds to the continuously changing events of consumption.

Event-facility

Urbanity and architecture can, however, be conceived as a flow within this permanent/transient polemic by developing a conceptual system in which the physical arrangement of event-facility spaces is disassembled. 'Event spaces' become platforms of programmatic use without formal bounds in such a way that space is formed of 'free radicals' that can flow unheeded, creating new configurations and permutations. This conceptual approach is hierarchically more concerned with space making that is inspired by environmental behaviour, than form making. This change in the design approach to the urban landscape has the potential to maintain a mobility and flow of new event-facility space generating patterns with new morphologies for different urban locations. The flow of these event-facility spaces does not necessitate the destruction of historic fabric. As with MoholyNagy's flow of water around and through obstacles, new facilities and events can likewise flow around and through the historic monuments. In fact, the adjacency of such flows to these monuments is vital as they may then be reintroduced into the facility matrix of the city as important psychological footholds (or be naturally eroded by more relevant contemporary event-facility space).

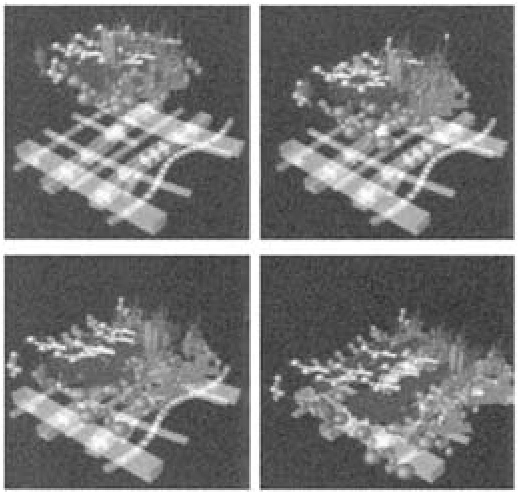
Contemporary-temporary

The flow, as a reflection of the pace of change within our society brings increasing pressure for designers to move towards the total commodification and consumerisation of architecture and urbanity. This combined with media expectations of the fast image and event, pressures architecture to sit increasingly on and above the earth rather than be a part of the earth. Examples of this sort of development within cities are already apparent; transient, tectonic solutions are increasing in both incidence and scale as a means of resolving the ever-changing demands of a media and technology driven society. This has had the effect of altering the city's permanent/transient urban balance. In addition, existing patterns and typologies are being subverted through internal transformations in an ever-changing series of interior based 'set designs' within existing buildings. Similar to a black box theatre, existing shells become the framework for facility fit-outs as stage pieces. Shops, cafés and bars refit their premises on a five or 10-year cycle and office environments change scenery on a weekly basis as staff and technology rotate through their shells. Within this context it is then hardly surprising that most architects and developers have started to talk of a 20-year cycle in terms of a building that remains clearly linked to the particular function for which it was intended. 'The division line between contemporary and temporary has become remarkably thin' (Korteknie and Stuhlmocher, 1999).

Techno-nomads

This emphasis towards transience is not only driven by the pace of facility obsolescence it is also due to a change in the emphasis of the technology market. There has been a shift away from social technology to individual technology. Technology is now aimed at the provision of machine enhancements for individuals rather than shared social facilities such as the public telephone, the post box and the bus stop. The creation of mobile machine enhancements for the individual has led to the creation of a technological élite who, through the freedom this gives them, and their personal self-sufficiency, have become techno nomads. Traditional nomads are 'mobile pasteurisers', they roam 'areas too sparse to be cultivated economically' and hold no interest in the land itself but 'claiming a right of passage' (Chatwin, 1995). This right of passage, moving freely from one feeding base to another, is essential to nomads' lifestyle, as without it their animals would die, therefore, traditional nomads regard political frontiers as a form of insanity. Modern day techno-nomads are similar in certain aspects; they are keen to break boundaries or to escape the confines of fixed identities in order to 'be' as in Michael Onfray's libertarian freedom (Onfray, 1989). Techno-nomads expect to feed freely without boarders or boundaries. Techno-nomads browse 'information', and expect the information routes and 'rhizomes' to be navigable. They regard information boundaries as a form of insanity.

Techno-nomads do, however, require a base. They have to move within and through the artificial land-scape utilising it as a launch platform for explorations into 'the beyond'. Whether these launch platforms be physical or digital, the techno-nomad remains tied to the social infrastructure, not just for the facility of power (which could perhaps be solved by something similar to Archigram's 'plug-

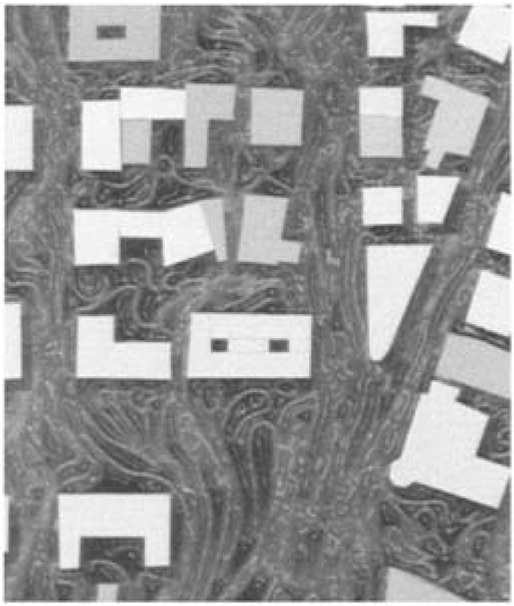


1.6 Delineated ‘free radicals’ as electronic sprites relocating onto the urban matrix (major and minor route ways) relative to their inherent programmes (four parts) (1998)

in log’) but also for the social and financial prerequisite of being traceable to a geographic location. In order to exist and remain viable in our consumer culture a permanent address is required by banks and governments. Mobile phone sales increased by 44 per cent last year and laptop sales increased by 57 per cent. This techno-nomadic facilitation has had a series of profound effects on our social behaviour and subsequently the facility spaces we require. Geographic distance has effectively been shortened and consequently the basis of a community’s relationship to a particular physical locality has been changed. Communities can now exist through remote social connections, rather than actual physical contact, and this has led to an arrangement that is more tribal in nature. Associations and relationships are more often formed through interest or age proximity rather than geographic proximity. Architectural and urban space has also lost its ‘specificity’. Space as definition or enclosure can in many cases no longer be considered as particular to the provision of a particular programme. Facility space has become a holistic flow where the differentiation between typologies has been reduced, as has the difference between outside and inside. Integrated and interdependent with their machines, members of the technonomadic society have in many ways become free from geographical and typological boundaries.

Typology-technology

The traditional definitions of building typologies are shifting in response to these technologically influenced social changes. The general direction of the shift is centred on flow, mobility and transformations, through and in response to our new mobility. A number of building typologies which were formerly distinct because of the defined character of their internal activity programmes have come closer



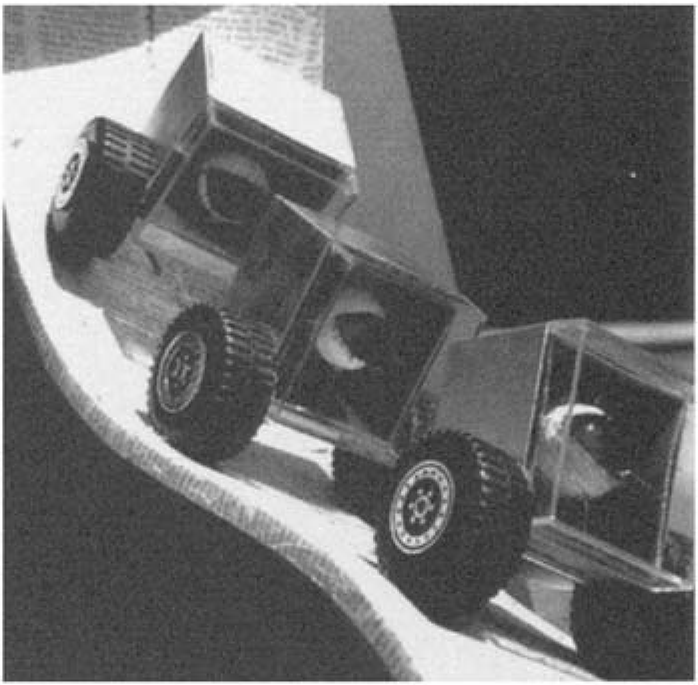
1.7 Flow does not necessitate destruction; rather, the flow can occur in and around the existing historic formal aspects that may be naturally eroded by the flow (2002)

together, and in some cases have become inter-changeable, The personalisation of the computer has driven this amalgamation of building type; it is a natural outcome of the computer's amalgamation of the formerly distinct tasks of information storage, retrieval, visualisation and communication. A universal type of space has developed, designed around this man/machine relationship that has drawn together the formerly distinct typologies of education, administration, servicing and certain aspects of production, communication and entertainment. The general characteristics associated with these universal spaces are the use of large span, loose-fit, space that is over serviced for flexibility potential and has zoned (rather than enclosed) circulation.

Symbols-space

This reduction in architectural typologies in response to the man/machine amalgam is intensifying as machines become smaller, more mobile and more essentially nomadic. A 'plug-in anywhere' culture abounds that allows the base parameters of information generation and transfer to proceed. It has already permeated many semi-public areas of the city with the resurgence of the avant-garde bar/coffee house culture that once pervaded 19thcentury Paris. 'The cafe was a library, study, meeting place and address, a place which blurred the distinction between being at home and being out and about' (Wilson, 2000). Thus,

(a)



(b)

1.8 Traditional nomads regard political frontiers as a form of insanity. Techno-nomads regard information frontiers as a form of insanity. (a) Tuareg in the Haggar (b) Sculpture (1996) with this technological facilitation comes the blurring of the boundaries of work and home and inside and outside.

These new type of universal spaces can be defined in two main ways. They can be 'non-spaces' possessing no definition as place—'anywhere' spaces to which either the user, as experiential consumers of space, must bring their own imagery, or to which the 'media' has already attached universally recognised images. This term 'non-space' is already used to describe the style of architecture used for many corporate building types, and refers to a form of internationalism in which no specific place can be recognised. For example, airport buildings often have an ambiguous 'international' appearance—an airport building does not signify any particular country because it allows people who are leaving to recognise that they are at a gateway or portal to another place. Airports are rarely symbols of arrival. Alternatively, universal space could reference one of the oldest design influences; genus-loci—human nature initiating with the individual's physical presence a perceptual/conceptual experience. Universal spaces could foster a personal event, generating experiences of the body and mind and therefore creating the essence of place on both a local and universal basis. Such experiences might be ephemeral and transient and the buildings' reflection of this may also be ephemeral and transient however, it does not necessarily mean the event has only a temporary existence.

Immutability-immortality

The only barrier to stop architects adopting free experiential space is the human conceptual notion of the past as a source for producing the future. In a consumer society architects find themselves undecided between the philosophical dialectic of permanence and transience as a means for tectonic salvation. Architecture has developed in an insular way, its philosophical, historic and cultural basis perpetuating a relationship between 'immutable' form and mortality that leads designers astray in their attempts to create relevant form related to contemporary life. This insular progression is exemplified in the current introduction of a 'new geometry' into architecture. Euclidean influences on form have simply been transformed into non-Euclidean. Straight lines have simply been replaced by curves. The complex forms of phenomenally motive architecture actually produce even more 'static' monuments (for example Daniel Libeskind's extension to the Victoria and Albert Museum in London and Frank Gehry's Guggenheim Museum in Bilbao). Such buildings are still conceived of as forms in perpetuity, a lasting example of art that extends beyond human mortality. They therefore are only representative of a new geometry rather than an adoption of a holistic standpoint. Physical permanence of form, in perpetuity, is not necessary for psychological permanence within our contemporary culture. The ideal architecture of the past (most commonly recognised in creative classical gestures), recorded in physical form, existing in layered perpetuity as the background to life, is actually a stagnation of form—it is a product of our fear of the future. 'Architecture is a deep

1.9 Techno-nomadic facilitation of the individual means the freedom to be anywhere defence against the terror of time' (Karsten, 1982). The universe as we now comprehend it is not constructed of matter that is solid or defined; it is a collection of subjective ephemerality in which the only immutability is transience. Heraclitus was near to the truth thousands of years ago in stating, 'nothing ever is, everything is becoming' (Russell, 1961).

Radical-redundant

Technology has become less dependent on the specificity of tectonic space as a supporting infrastructure—event as consumable monument has hierarchically replaced static monuments. Architecture therefore has the potential to become free, the potential to fulfil Bernard Tschumi's description of becoming 'useless but radically so' (Tschumi, 1990), facilitating our transient experiential desires whilst enabling nomadic facilitation to flow through its spaces. Architecture is initiated with humanity; man is the measure of all things. Somewhere in the abstract production of universal form as 'immutability' we appear to have lost the sensitivity to design the built environment for our own bodily experience. Geometric abstractions and the instant media image appear to have taken over from experiential discovery. Architecture does not exist as a singular perspective or an iconic photograph. In fact architecture has no static appreciation mode. Architecture can only be understood in a mobile manner, as time is an essential element of spatial discovery that is related to the kinetics of our body and senses.

Sensations-skin

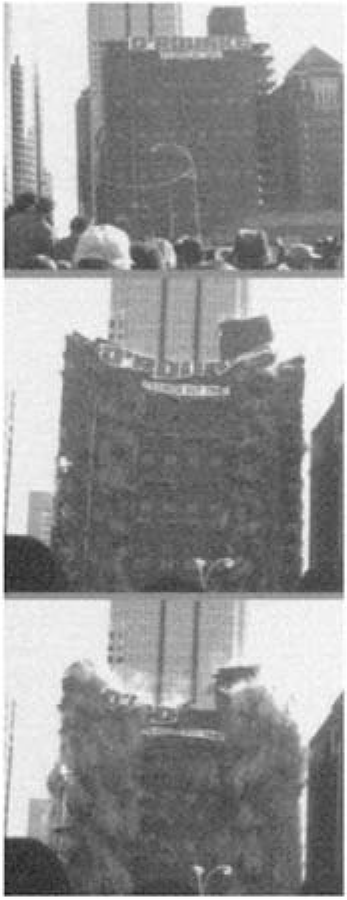
Experience itself is animate; we move through space experiencing and consuming qualities of form, space, and scale which are perceived by the eye, ear, nose, tongue, skin, skeleton, muscle, in a simultaneity of sensory interaction. The skin is the interface between the inner mind and the outer environment. It elegantly and elastically encapsulates and moves over its muscular and skeletal frame, functioning as protector, water retainer, heat regulator, excreta container, sensor and sexual attractor. Skin is our holistic window onto an experiential world; our senses are specialised elements of the skin's function that have evolved from it as extensions of touch. 'Touch is the sense that became differentiated into the others, it is the mother of senses—I perceive in a total way with my whole being. I grasp a unique structure of the thing, a unique way of being which speaks to all my senses at once' (Pallasmaa, 2000). 'Touch is the unconsciousness of vision mediating messages of invitation or rejection, courtesy or hostility. My skin projects all its senses as touch in anticipation, we touch before we reach through sight, sound and smell, through vision we touch the stars and the sun' (Merleau Ponty, 1964).

Motive-perceptive

We know our bodies intimately, a three-dimensional mental map is imbued into our subconscious repository as an 'ideal' image. This constructed image has preferences in terms of those primary desires of reproduction and sex that leads us to analyse and criticise other bodies referencing this ideal. We 'anthropomorphise', generating a tendency to appreciate other bodies that exhibit similarities to our own ideal, and we also project this ideal onto the 'aids' and 'artifices' that we construct. We possess special facilities to identify the attributes of an anthropomorphised object. When we look at it, its characteristics become key features—reliable cues for our interest. Recognition, detection and interest are, however, not only based on the recognition of the static form of the entity, pattern or field, but on our animated relationship to these. 'There is an observer-object motion presenting partial rotation and scaling such that a set of critical points and their motion relative to each other defines a spaciotemporal signature' (Stone, 1989). The motive anthropomorphising of objects means that our perception of 'form in space' and 'space itself as a defined form' is more than mere 'image' that can be represented in perspective or reproduced in photographs or film—it is a holistic experience of the body and mind. Contemporary architectural theories that are influencing built form appear to aspire to a continuity of 'in-house' abstract universal ideas that attempt to conquer the foreground as 'image' rather than creating supportive matrices for simultaneous, experiential activities as three-dimensional art. Architecture has become a master of the 'fast image' accelerating experiential space and condensing spatial experience as a singular surface sensation.

Fast-slow

Similar to the skin's holistic connectivity to the body and mind, the human experience of space is also holistic, involving all our senses and their peripherals. Time is integral with space; these two are indivisible. As Hermann Minkowski stated in 1908, 'Henceforth space alone or time alone is doomed to fade into a mere shadow; only a kind of union of both will preserve their existence.' Time and space are revealed through growth and the animation of the observers' motions. In order to give meaning to our created 'artifices' as edited versions of the real, as 'existential microcosms, embodied representations of the world', architects need to experience the 'real' and 'mediate our relation with the frighteningly ephemeral dimension of time' (Pallasmaa, 2000). We are within and part of the temporary continuum as transient custodians of an environment that is alive and ever changing through its cycle of birth, growth, death and decay. These experiences are undoubtedly all 'real'. The artificial environment of architecture should incorporate simultaneous experiential depth for all the senses to appreciate a sense of time, revealing and revelling in the temporary continuum. In a culture that has liberated space from servitude, spatial experience should be created based



1.10 Kansas City; demolition of a skyscraper

on the stimulation of our body and mind more as a 'verb' than a 'noun', becoming a sensory interaction that includes participation, interpretation and improvisation. Architecture can create slow space with layers of depth that are unveiled over time and reciprocally 'live' within a human temporal continuum. Here, space is a consumable experience that is reciprocally consumed by itself. The creative gesture becomes apparent as it is a variation of life itself, it has a similar existence, living and dying as we live and die and, consequently, human beings can empathise with its life and its fate. The immutable creative gesture exists in a moment of time and through its appropriateness in space/time this gesture develops a cognitive perma-nence as subject matter in human memory. The creation of physical objects in perpetuity is not essential to human immortality. Architects create architecture that generates gestures as events formed of matter and space—this is an architecture of bodily experience. Contemporary architects need to become 'gods' who are unafraid of death.

1.11 Organic Building, Gaetano Pesce, Osaka, Japan (1997)

Para-site-parasite

Some architects are already considering inner-city sites for transient functions. This approach retains the idea of building location as context, consequently it is termed a para-site, which in this case does not mean parasite as a 'successful bloodsucker' but refers to a conceptual difference in the approach to the site usage. It promotes the retention of site for its future potential through transient usage. The site becomes the location for facility, functions and experiential events within the cycle of the city and exhibits the transient acquisition of the site as a design feature. Originating from the Greek para- (against, beside, near) indicates a sense of time or extent of space, or indicates the object or recipient of a perception, desire or activity. *Para-* in this context is used to mean a temporary or transient structure —a kind of bridging facility, a ride, an experience of some duration within an extent of space (similar to that of a descent by parachute). So a para-site is essentially a site that is intended for transient use (or re-use) by the use of formal gestures with in-built obsolescence. The building, and consequently the site, responds to an ever-changing cycle of facility and fashion. This notion accepts that the function for which a particular building is built may be changed within a short period of time (typically one or two decades). Within the cycle of the city, the central challenge of these para-sites is how to design facility spaces for a kind of transience that maintains real, contemporary, symbolic, permanence within our temporary continuum. What might the alternative architectural scenarios for an approach to the para-site be? Five specific examples of para-sites within our cities can be examined here to represent some possible design solutions to the polemic of transience as permanence.

1 Architecture can be pre-programmed to self-destruct on a certain day at a certain time. This proposition might at first seem excessive or reactionary; however, the explosive demolition of buildings is one of the most popular urban events. The site as a para-site can become an integral part of a larger urban scenario where sequences and/or fields of temporary buildings form another layer to the city life cycle through their perpetual design, construction, use, demolition, redesign and re-use. The constructions become constant reminders of the event and through this attain a kind of permanence. Examples: demolition of skyscraper, Kansas City, USA: Study no 2 for an End to the World, Jean Tinguely, USA.

2 Architecture can grow over time, be part of a cycle that performs on a city scale, similar to a clock, in that it yields an awareness of time. This organic growth has traditionally been difficult to accommodate architecturally as it is difficult to control. The growth may jeopardise the facility offered by the building and/or become unsightly. Also there remains a social intoler-ance to ruins in our urban environment. The architectural form can, however, adopt a series of layers making the architectural form more like a set of clothes on a body which rot and/or are constantly added to, decorated, or mended over a 10-year cycle. The growth could also be a machine process where time and event are cyclic and consequently controllable. Examples: Organic Building, Gaetano Pesce, Japan; Hairy Buildings, Terunobu Fujimori, Japan; Best supermarkets, Site Architecture, USA; lce Walls, Michael Van Valken Associates, USA; Cloud Canyons II, David Medalla (artwork); Tower of Winds, Toyo lto, Japan; Stopline, Studio Archea, Italy.

3 Architecture can be designed to be constructed with its imminent disassembly in mind. The assembly of the components can also be designed to infer this disassembly making the arrangement clearly apparent. The event of this architecture is phenomenal transparency, the construction being capable of disassembly both in reality and in the anticipation of the observer. This realisation generates permanence as an event or anticipation of an event. Architecture becomes transient and mobile, but also permanent as event, even though the eventual re-use of the components does not have to be the same as for the original use. Examples: Swiss Pavilion, Peter Zumthor, Hannover Expo, 2000; British Pavilion, Nicholas Grimshaw Associates, Seville Expo, 1992.

4 Architecture can be designed as a framework for universal facilitation; this approach is similar to a loose set of clothes or the elasticated 'one-size-fits-all' philosophy. Facilities can constantly flow through its framework with the minimum of refurbishment. This is probably the most usual example of a parasite within our cities, which we rarely think of as transient because one part of the form is a stable frame. The permanence as event is set up by the rigour of the framework, which contrasts with the ephemeral facilities that inhabit it. Examples are ubiquitous in the sensitive conversion of historic buildings but good contemporary examples of such frameworks are rare. Examples: Domino House, Le Corbusier, 1914 (project); Kunsthal, Rem Koolhaas, Holland; Cartier Foundation, Jean Nouvel, France; the public buildings of Kazuo Sejima, Japan.

5 Architecture can be designed as a transformer, adopting more than one geometrical form of stasis. The building is specifically designed to adapt its form and consequently its format and spaces. This may mean that different facilities can be accommodated at different times of the day, and/or that the building becomes a different experience in different seasons of the year and/or at different stages in technological development during its period of use. The event emerges from the real or anticipated motive adaptation of the buildings. Examples: GucklHuph, Hans Peter Worndl, Austria; Fred Kaufman, 96 Architektue; (mobile building); Casa Latapie, Anne Lacton and Jean Philippe Vassal, France; Venezuela Pavilion, Fruto Vivas, Hannover Expo, 2000; 9 Square Grids House, Shigeru Ban, Japan; Concept House 2020, Melon & Expedition (Project); Elastic Space, Gianni Colombo (artwork); Orange Seller's orange stand, unknown designer, Turkey, 1998.

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Logical Spaces for Urban Nomads

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A nomadic society

In 1999, *Wired* published an article that detailed the flying habits of a select group of 'New Economy' types (Berger, 1999). The article was of interest not only because of its informative expose on the number of frequent-flyer miles accumulated by people such as Nicholas Negroponte, but also because of its compelling demonstration that the era of the 'Global Citizen' has well and truly arrived.

While an itinerary which sees one fly in excess of half a million miles per annum may not be normal for most of us, it serves as an, admittedly extreme, example of the fact that, ever increasingly, we live in a mobile, nomadic society.

The attraction of mobility, seemingly evident through-out society without prejudice, may be observed in our normal daily lives. As a person passes us on a scooter with improbably small wheels, we pause briefly to receive a call on our mobile, barely noticing that we are surrounded by any number of other people performing similar activities.

It is true that the above example projects a certain world-view that is not representative of all social groups in all cultures. It is, however, representative of the status quo in cities as divergent as Melbourne and Kuala Lumpur. This society is not homogenous but consists of many discrete groups, each with their own specific mobility criteria. Nomadism may be voluntary, as in the case of someone who travels extensively because of work commitments. In this scenario, there is a strong possibility of a home base to return to. It may also be a lifestyle choice, perhaps as part of retirement; selling up the family home and travelling around by car or boat is a dream secretly harboured by many Australians.

It is common to find this form of mobility both enabled by and dependent upon technologies of one form or another—mobile phone, laptop, or camper van. Almost all are mandatory accessories. This also implies a certain socio-economic profile, one that permits a level of choice in decision making, control over outcomes and, most importantly, enabling one to remain in the loop, in contact, plugged in to the communications networks that are an intrinsic part of any society. Although giving up one's home and possessions in this way may be voluntary, the reality of much domestic nomadism is that it is often involuntary, a desperate act of a person who has lost the power to choose. The modern, urban, domestic nomad is therefore also likely to come from a less fortunate socio-economic profile, one that is perhaps a long way removed from that of the traditional nomadic worker.

While the logical workspace is largely weighted towards technology, rather than shelter, the domestic situation is quite the reverse and focuses on hardware in the form of shelter as its first priority. As mainstream society becomes more comfortable with the Internet as a channel for information transfer, those that have traditionally been located at the periphery of the mainstream will be even further marginalised. Increasingly, people who are not connected will find themselves outside the general communications loops and networks.

Technological responses to the state of nomadism

Throughout history, the technological tools developed by humans to support and enhance traditional nomadic lifestyles have been in the form of hardware. A wide variety of solutions to the requirement for shelter have evolved over time as specific responses to climatic and cultural differences, for example the yurt and the tent. As contemporary societies have become more mobile, a dramatic increase in the number of tools available to support the new forms of nomadism has occurred. Today there are a large number of soft, information-focused tools, although even these generally require some form of hardware to act as an interface. If one were to generalise, it could be said that hard tools, being real and physical, have direct application to the provision of shelter, whereas soft tools may be perceived as cerebral, providing access to networks, community and information.

From Archigram to wearables

While vernacular responses to nomadic patterns of life have evolved over thousands of years, in relatively recent times there have also been a number of speculative design propositions on this subject created by architects, designers and artists. No one group has been more prolific in the production of designs for the contemporary nomadic condition than the Archigram Studio. The *Cushicle,* designed by Mike Webb in 1966–7, was to be a fully serviced, semi-autonomous nomadic unit (Cook, 1999). It comprised two main components—a chassis, or spinal system, to provide the structural support to carry the required appliances, and an inflatable enclosure to provide shelter, along with a series of viewing screens. The enclosure and appliances could be operated independently of each other. The identity of the *Cushicle's* user was left deliberately ambiguous, and could be an explorer, wanderer or other itinerant. Mike Webb also proposed the *Suit-aloon,* conceptually an extension of the *Cushicle,* in 1968 (Cook, 1999). In this design the suit became the base unit that provided movement, a large envelope, and power. The possibility of community development was enhanced by the inclusion of a key on each suit, which allowed envelopes to be grouped together if desired. The exhibition *Milanogram,* a group Archigram project, at the fourteenth Milan Triennale (Cook, 1999) was launched in the same year. For the installation, David Green produced an *Inflatable Suit-Home,* which was worn and converted into a shelter when required. The catalogue provoked the imagination with a hybrid interplay of hardware (visible place and objects) and software (logical, computerised systems that are unseen). Although the anticipation of exponential development and growth of information, or soft technologies during the past 30 years would have been difficult, it was interesting to note that the conceptual design themes first explored by Archigram in the late 1960s still appear fresh when compared with investigations made by many contemporary architects, designers and artists.

Nomadism and the ephemeral habitat were explored in the next decade by the Italian designers Alberto Rosselli, Joe Colombo and Ettore Sottsass, who proposed a series of flexible solutions for interior spaces in the 1972 exhibition *Italy; the New Domestic Landscape,* held at the Metropolitan Museum of Modern Art (New York). For those designers nomadism was both the new condition of life and the new big deal for designers. Nomadism, flexibility, transportability and ephemeral design were the main themes proposed in their projects.

The same themes were later explored in many of their other projects, from the design of single objects to the design of entire spaces representing a new way of living. The *Valentine* typewriter designed by Sottsass, for instance, was inspired by the need to transport work wherever it was required, instead of moving ourselves to work. In this sense, *Valentine* was an ancestor of today's laptop computers.

The evolution of personal computing undoubtedly encouraged new projects focusing on nomadism. In 1984, the American advertising company Chiat Day opened its New York offices, designed by Gaetano Pesce. The inspiration for the designer was the concept that portable computers could generate a logical link between workspaces, which could allow for a continuous relocation of work activity. Office spaces were designed to be extremely flexible and open. The space for work intersected with physical meeting spaces, while a software application for online conferences created a link with those who were working somewhere else. Although the project was not completely accepted by the company's employees, the design concept referred to a new paradigm of work, which is still being explored today.

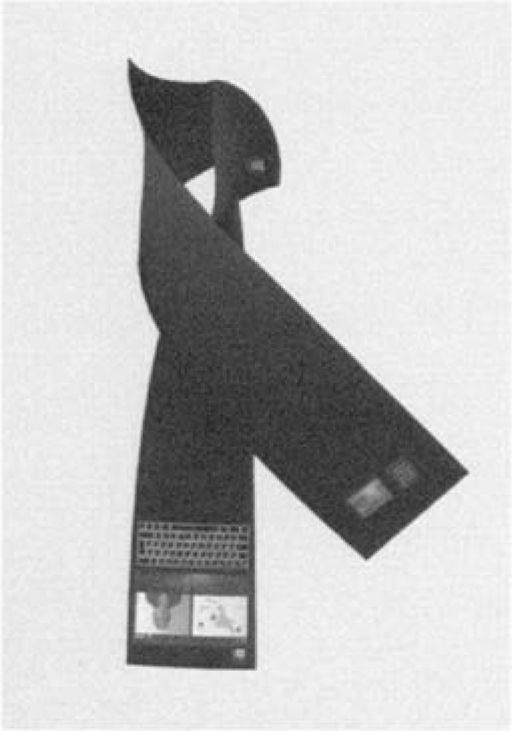
The issue of nomadism in work activity paralleled the problem of involuntary nomadism, generating further inspirations for design projects, in which transportability referred to a whole set of elements generating a *personal* environment. Fashion designer/artist Lucy Orta has, for the better part of a decade, explored the territories of shelter, clothing, homelessness and community through projects such as 1993s *Refuge Wear* (Orta and Restany, 1998). This is one in a series of projects that explore design interventions in contemporary urban homelessness. The genesis of these garments, referred to as Body Architecture, was initially rooted in a desire to assist the Kurdish refugees during the Gulf War, although the garments have the potential for universal application. Made of high-tech fabrics, with details used in outdoor wear, the clothing was capable of significant adaptation, transforming from a full body parka, to a sleeping bag, to a tent-like shelter. Many pockets were provided to hold water, food and other essentials. The Modular Architecture project of 1996–7 extended the themes developed for Refuge Wear, and introduced a communal dimension through the ability to combine individual units into collective shelter.

> Four men and women may travel separately during the day, each wrapped in a waterproof, insulated, hooded body-suit made of aluminium-coated polyamide, in which myriad pockets store water, food and medicine. At night, these people meet in a designated area or by chance—and, after removing their body suits, they zip them together to make a roomy, warm four-person tent. Hoods dangle at odd angles from the tent's peak, empty 'legs' are pegged to the ground.
>
> The next day or during the night, after everyone has slept, they unzip the tent and climb into their body-suits to continue their travelling. Later they meet again with other people and the same tent, or another, is reconstructed.
>
> (Orta and Restany, 1998, pp. 64–5)

Anthea Van Kopplen, a Melbourne-based fashion designer, recently exhibited her LIDA project, in which a series of prototype garments for global citizens were developed (Van Kopplen, 2001). Her focus was not specifically homelessness as it is traditionally understood, but rather to provide a range of options that extend protection and shelter beyond the possibilities of a conventional garment. A series of zips and fasteners allows a variety of configurations that include a cape and sleeping bag.

While these contemporary solutions focus primarily on supplying physical shelter, others focus on tools that provide an interface to the information networks that facilitate the development of communities within contemporary nomadic societies. In 2001, the electronics company Philips and the clothing company Levi's collaborated to release the world's first commercially available electronic clothing. The jacket featured an in-built mobile phone, audio headphones and remote control. In the recent exhibition *Worksphere* at MoMA a communicating scarf designed by Naziha Mestaoui and Yacine Ait Kaci integrated a wearable element with the most advanced communication technologies. The scarf was used to isolate the surrounding world from one's personal work/communication environment (Antonelli, 2001). With its Media Lab-based Wearable Computing Program, MIT is also attempting to redefine the relationship between computer and user. Their aim is for computers to be worn like glasses, or clothing, and to interact with users in a more user-specific context.

Technological responses to nomadism are no longer restricted to physical solutions. Digital work-spaces now exist, such as *virtual offices* and *computer*



2.2 Communicating scarf, Naziha Mestaoui and Yacine Ait Kaci © Image from the movie coproduced by France Telecom R&D studio Creatif and Electronicshadow

supported cooperative work (CSCW) solutions, with online file and personal information storage that allow for cooperation and interaction. The result is that people are able to move from place to place without carrying physical objects (not even a laptop), as long as when they wish to work or communicate they have access to a computer and to the Internet, where their files are accessible. Such facilities enable communities to share common interests, thus generating logical propinquity between people in different locations. Nomadic workers are currently engaged primarily in the use of soft technologies, often to maintain contact with a centralised head office. Shelter has not yet been perceived as an issue relevant to the work situation; however, should travel time increase, one could speculate that the need to maintain a traditional house/home also becomes questionable. Conversely, the central issue for the homeless has been, first and foremost, one of providing physical shelter. However, as population growth and economic globalisation lead to a crisis in accommodation and more people remain without a home for even longer periods of time, the need to provide services that extend beyond immediate physical requirements may also increase.

2.3 Information and communication overload in the contemporary city—Kirin Plaza neon advertising, Osaka

Implications of logical space

Propositions regarding the use of logical space, especially for the homeless, cannot be developed in a social vacuum. Any discussion should transcend purely technological limits to deal with the social and environmental issues encompassed in the application of a potential solution.

Social change, technology and the dual city

Work activity, which is now independent of work location, offers the opportunity to improve previously neglected family and community links. This perspective has been offered as the solution to several social and environmental problems. Webber predicted that cities would no longer be necessary, as people would be able to work in locations of their choice to avoid the overcrowded urban environments (Webber, 1968) and Toffler predicted a society in which the sense of community is empowered by the opportunity for everyone to work from home (Toffler, 1980). Nilles proposed an appealing perspective of reorganising work and family life with the possibility of working from home, through telecommuting (Nilles, 1976).

However, others argued that if it was possible to transport work, cities risked the loss of their main cultural and social functions with the perpetuation of low quality urban sprawls.[1] Castells (1991) warned that the traditional city would become a *dual city* that offered enormous possibilities only to certain social groups whilst marginalising the others. The groups of people, according to Castells, lived in geographical proximity, but were separated by the social gaps between them. Those who worked benefited from technological advantages with the ability to choose their own work location; others, living in the same environment but without access to knowledge-based and information technologies, did not have any of those choices.[2] Maldonado speculated a more extreme scenario whereby he stigma tised the creation of physical barriers in the design of new buildings in major city business districts (Maldonado, 1997). Such barriers were created by making attractive semi-private internal environments in urban buildings rather than wholly accessible areas in the rest of the city, and separating the contiguous worlds of two groups of people: those who populated the city centres during the day (employed resident population) and those who populated them after business hours (the urban/ homeless nomads).

While technology has liberated certain social groups by creating opportunities further to move through different geographical places whilst linking them with logical connections, by contrast low-income nomads inhabit contiguous spaces, relying on an informal economy which re-use leftovers from technological and industrialised culture. M.C. Loschiavo Dos Santos (2001) observes that the informal habitats generated in cities such as Los Angeles, São Paulo and Tokyo have their own identity, interpreted by the residual value of urban wastage: 'An informal habitat is a protective ware, a subversive housing system that is used to sustain human life and to provide inhabitants with some semblance of privacy and domesticity' (Loschiavo Dos Santos, 2001). Low-income nomads re-use whole products or part of them, together with packaging elements, mixing materials such as timber, cardboard and plastics. Furniture and design is decontextualised in this work and re-used in unexpected ways that are not intended by their designers.

The space created by low-income nomads is also a logical space, its character dependent on the quality and quantity of remainders from home environments. But, unlike the spaces created by technological nomads, these spaces are local and disconnected. While nomadism is usually an unstable and weak condition, connectedness, on the other hand, generates a sense of stability. Wherever people travel, their team will always be available, as long as they remain connected. From another perspective, the environmental modifications generated by the two groups influence the quality of the places they inhabit in different ways.

Low-income nomads provide local environments with a new identity generated by their modification of space, in the displacement of objects, and the development of new meanings from existing objects. By contrast, technologically-based nomadism generates no local quality, as their presence is almost unperceivable in the way they use public spaces. Technological nomads derive their personal identity from a strong *diffused* sense of identity, and from being part of a global network.

Technological nomadism: technological boundaries

As technological nomadism is also limited by the intrinsic nature of the information infrastructure, nomadism does not imply a ubiquitous condition. Gillespie (1992) noted that, although electronic grids were flexible in deployment to any location, they remained inherently nodal and a market-based use of telecommunication increased its nodality. Gillespie used the metaphor of railways

2.4 Communications are changing the way we live; home and dish, USA

2.5 Descendants of the nomads? Homeless shelters in Tokyo

(instead of the usual metaphor of highways), to emphasise the limitations of the physical infrastructure in diffusing information technology.

Nomadic workers were also limited by asymmetrical data-flow, where upload speeds were significantly slower than those for download. Mitchell (1999a) observed that it was much easier to distribute information like a blanket on the geographical territory than to give the recipients of information the possibility to pump back the same amount of data. This condition had the potential to result in the development of information-rich nodes, with corresponding data deserts, rendered geographically, in real-time.

Technological nomadism: social boundaries

As global business expansion is facilitated by the growth of the Internet and the World Wide Web, the need for high-level face-to-face meetings is actually increasing. This means that some employees are travelling more than ever (Berger, 1999). While the imagery of the digital briefcase and the global portable shelter conjures an image of the freedom to work in any location (with the subtle implication of increased leisure time) the reality is the reverse. This is because, as there is no downtime, there is a tendency to work more rather than less, blurring the barrier between work and leisure. Under these circumstances, traditional

2.6 Cardboard tunnel, Broadway, Los Angeles. Photo: Maria Cecilia Loschiavo dos Santos (1996)

relationships can be put under significant stress, and may become compartmentalised by geographic location (Berger, 1999).

Low-income nomadism: access to hardware/interface

With the increase of value related to knowledge, information is correlated with economic wealth. In a knowledge-based society, material wealth would be facilitated through access to information and, conversely, poverty becomes correlated with the exclusion from the information network implied by the lost potential to gain material wealth. Consequently, the use of information technologies to reduce the gap between social groups in urban environments has been targeted at proliferating computer use in community centres or computer clubhouses, where it is possible to learn how to facilitate learning of information technology and how to access to the network (Schön, *et al.,* 1999). The access to this information (and social) network is obviously potentially invaluable to someone who is without a home. Until recently, the lack of a physical address was a significant impediment in remaining visible in society at large. This can now at least be partly ameliorated by providing access to e-mail and a digital address.

Experiments such as those described above can be compared with the physical shelter projects of Lucy Orta and Anthea Van Kopplen. The former aims at providing a logical identity to social groups traditionally excluded from the networked space, and who are denied the opportunities offered by the networked economy. The latter proposes a physical identity for the same groups. Both experiments, however, are not readily implemented because of potentially high production costs. For example, the infrastructure costs and facilities for a clubhouse were not easily affordable and neither are the high performance shelters proposed by Lucy Orta or Anthea Van Kopplen. In the case of the homeless, it is therefore important to consider the nature of an interface, which can be provided, funded and easily understood by users.

Mitchell (1999) warned that even where access to an information network was possible, low-income communities might not necessarily benefit from it. This raises the question of which investor will be able to guarantee the access for these groups (Mitchell, 1999). Mitchell, however, was not completely pessimistic about future possibilities to expand access to information technology.

> Unfortunately, having the digital 'pipes' is not enough; you do not have useful access unless you have an appropriate electronic appliance to connect to them. Typically, such appliances have been expensive—creating another access barrier for low-income communities. But this is likely to change as the demand for access grows, as the market for inexpensive access devices correspondingly expands, and as industrial capacity to serve that market develops.
>
> (Mitchell, 1999a)

Sustainability

In addition to the social issues discussed, it is necessary to understand the environmental implications of a nomadic society. Would this new world of work and domesticity be more sustainable than previous and current ones? Optimists foresee a substantial environmental improvement brought about by information technology based on three assumptions:

- That part of the physical flow of people and goods will be replaced by information flow (Toffler, 1980; Manzini, 1995);
- That the availability of a constant connection with the office would reduce the need to travel to work and encourage people to work from home (Nilles, 1976);
- That the possibility to establish working communications with colleagues would reduce the relevance of geographic distance and the need for physical travel to overseas conferences and meetings.

Conversely, increasing human/cultural interaction and logical links between people in different geographical locations which encourage nomadism require personal contact between people and this would be likely to increase distant travelling, again contributing to a negative environmental impact.

These contrasting perspectives refer to two different paradigms: first that the optimistic view was based on social and economic conditions in which information technology was fully integrated with working operations. Such a paradigm assumes that access to IT infrastructure is easy and reliable enough to transfer a large part of information resources from hard supports to logical supports and to create versatile communication linkages between people working in different places. Second, the current limitations of information technology infrastructure (low reliability, low band-width) limit the present way of working, which is consequently still heavily reliant on physical contact. The issue of sustainability is centred on the intersection between these two paradigms. In a scenario where access is possible for nomadic workers, the need for travel would reduce both the volume and the need for transportable objects and the corresponding labour and industry associated with these products and services. IDs and passwords would be all that was needed for nomadic workers to access their logical workspaces. A network of physical/logical point of access, which provided both shelter and communications, would afford the flexibility of not having to return constantly to the home base location on completion of every assignment. However, in the current condition, nomadic workers have to adapt their innovative lifestyle with physical environments that were not designed to support such 'technological nomads'. The sustainability of logical spaces for the homeless suggests a different environmental scenario. The eco-system would be less adversely affected by the homeless, who would remain located primarily within the same urban environment, than by those who were financially mobile. For the homeless, the sustainability implications are more likely to be social, rather than environmental.

Conclusion

In spite of the growth in the number of homeless people in cities, or an increase in the number of executives 'living' in airports, it seems that the globalised society is leading more people to lead significantly nomadic lifestyles. Transportability can now be defined as consisting of either logical recreation of an environment, or its physical relocation. It would seem that a transportable environment is recreated or relocated depending on the user and his or her socio-economic background. The nomadic worker relies on both the hard- and software that is necessary to access virtual work environments. The issue of shelter in this context is secondary, while to the urban homeless, the issue of real, tangible shelter is of paramount importance. Perhaps physical and logical spaces are in fact complementary, each enhancing the experience of the other. Currently such complementarity is not completely realised, as nomadism is a condition that requires much adaptation on the part of the individual. Technological nomads use a hybrid combination of physical transportable objects and logical spaces, whilst the low-income homeless, excluded from economic opportunities, readapt objects left over by other affluent users. In an ideal world, it would be possible to envisage a dot.com user sleeping in his apparelshelter in an airport waiting lounge whilst a homeless person received e-mail on his mobile phone.

1 The different aspects of the relationship between telecommunication and urban sprawl have been analysed in several publications, including Brotchie (1995), Castells (1991), Graham and Marvin (1996), Hall (1990), Mitchell (1995), Mitchell, W. (1999), Morelli (1999), Morelli (2001) and Sassen (1991).

2 Mitchell's perspective is confirmed by Wolpert (1999), who provides an accurate quantitative description of employment changes brought about by information technology.

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About other Constructs and Spaces

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> The life of the nomad is the intermezzo. Even the elements of his dwelling are conceived in terms of the trajectory that is forever mobilizing them.
>
> (Gilles Deleuze/Felix Guattari[1])

> It is to the psychoanalyst Michael Balint that we owe a most recent double portrait in the gallery of human character types: *ocnophile* and the *philobate.* If the former can be said to be tied primarily to objects, with a dread of empty spaces, the latter can be said to love precisely such open expanses, everything stable and heavy being for him burden and obstacle….
>
> Architectural thought was long incompatible with lability, the hazards of movement in contradiction to the safety of perseverance. The home was permanency, a person on the move being in danger or already lost. However, for the person who, like the *philobate,* makes the whole reaches of the earth his home—with a faith in suspended ropes—tents, ships and all road and air vehicles may also be residences.
>
> (Gerhard Auer[2])

A nomadic perspective

The idea of (trans)portable architecture undoubtedly has its origins in the nomadic tendencies of the human nature. Even the most sedentary practices of individual and collective dwelling are parallel to, and secretly overshadowed by, the desire for uprootedness and flight from the tyranny of place, if only for a weekend—the archaic dream of infinite space and the liberative reordering of existential parameters of life. What that dream, and the whole nomadic perspective presupposes is the existence of the open, unconquered and uncultivated space (the 'smooth space' in Deleuzean terms).[3] However, the possibility of the real existence of such a space in our contemporary circumstances, where the information and communication processes eclipse every physical and geographic dimension, is a very dubious proposition. This does not necessarily imply the closing of the nomadic perspective but its conceptual reframing and eventual reversal. It denotes a changed spatial realm (regime) in which all points are made equal and interchangeable based on the flow of information/communication that intersect in and emanate from them—the present-day phenomenon of the ultimate uprootedness and obliteration of place where any prospect of fixed destination is neutralised and exchanged for the circulatory constancy of information flow trajectories. With this comes the question of the possibility of meaning of any migratory form of existence since, to paraphrase Paul Virilio,[4] one arrives without having to depart, or, more explicitly, one is already there in advance of having to travel, so that any trajectile duration—the nomadic experience of the 'in-betweenness' of moving—is deprived of its vectorial dimension. Consequently, it could be argued that this necessitates the conceptual reframing of the nomadic perspective whereby the literal idea of movement (of living on the move) is supplanted by the surrogate notion of temporariness of inhabitation (and construction) unrelated to the potentiality of the departure but the realisation of the uniformity of all places and the perpetuity of uprootedness regardless of the locale. A mode of tenuous and transparent occupation of place that is uncommitted in terms of topological presence and contextual bonds wherein transience is constituted not as a function of time but the function of the expression of the manner, or mentality, of occupying (the place)— a paradox of 'permanent transience'.

If the idea and the production of (trans)portable architecture is considered within such a set of cultural parameters then it appears that its conceptual basis extends far beyond the technocratic preoccupation with the ingenious pursuit of flexible and portable constructions. Indeed its conceptual implications address, and are grounded in, a larger question of the very perspective of architecture today. This primarily relates to the consideration of the relation of architecture and the city.

An urban perspective

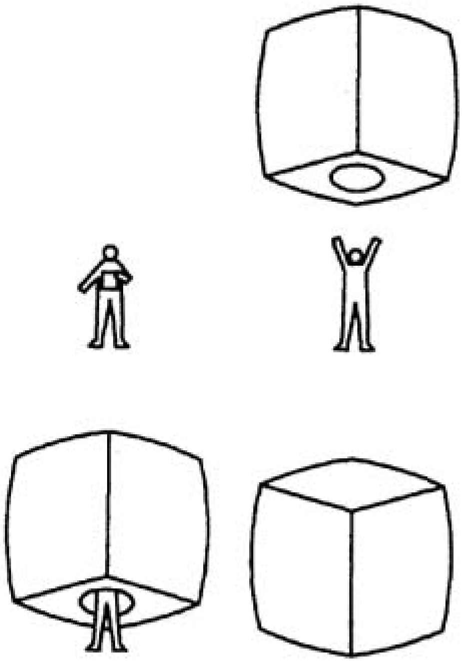
The neo-rational urban theory, especially the writings of Aldo Rossi,[5] still holds its relevance as one of the more coherent attempts of postmodern thinking to reconsider the idea of city in relationship to architecture and re-establish the urban significance of the latter. As such it denotes a nominal reference point against which any formal and morphological changes in the disposition of the unfolding fabric of the post-industrial city have to be measured and considered. However, given the present urban perspective, the neo-rationalist postulate of formal and ideological analogy of architecture and the city (city as architecture) according to which a work of architecture belongs to the city as an embodiment and the generator of the specific idea that constitutes its reality—a constituent part that signifies and produces a larger whole—has been put to unprecedented question by the ongoing shift in the means and the processes through which, at least in part, the condition of urbanity is being constructed today. The analytical considerations of the expanding 'telematic' nature of the city and the ensuing arguments that any physical production of the urban environment is parallel to and, eventually, superseded by the proliferation of communication technology and telecast networking, cast doubt over architecture's capacity to retain its status as an instrument of the making of the city, and dictate the need for re-examining the parameters of its urban conceptualisation. If indeed, as Virilio[6] argues, we are today involved in urbanisation of time over urbanisation of space and if the state of being urban, of accessing and partaking in urban culture, is relegated to the realm of telecasting and networking, then the very idea and the role of architecture as an (urban) artefact that participates in the physical, formal and symbolic production of the city (its analogous neo-rationalist function) has been made uncertain. Its physical veracity and permanence appear contextually less consequential then ever before.

An architectural perspective

This, arguably, constitutes a critical intersection in conceptual reconfiguration of architecture vis-à-vis the idea of city that is both liberating and marginalising. It is liberating in the sense that architecture has eventually become freed from the obligation to produce (urban) context, and the city by implication, and be an integral and cohesive part of it, and has, consequently, become open to the pursuit and exploration of other ideas that inform its constitution and purpose in equally relevant ways (marginalisation resides in exactly the same parameters as the reverse effect, namely the measure of the withering of architecture's significance in making and marking the city). The single most important conceptual and material shift here, particularly in relation to the subject of (trans)portable architecture, is demarcated by the transformations in the nature of the urban context. The urban context itself—the city as an artefact—seen from the perspective of architecture emerges as an independent construct, an extraneous thing produced through non- architectural means and received as a given. It materialises as an autonomous territorial structure incarnate in its own measure of time and space—an analogue of nature that imposes itself as a given (condition) which simultaneously antecedes and supersedes architecture—no longer the context but a topography impenetrable to architectural action and inhabitable only from the outside as a surface-like residue of its space simulation effects. Consequently, if it is understood that inhabitation without marking, the absence of the capacity or interest to affect that which allows for and precedes it, namely space and territory, and which it receives solely as a support structure (ground)[7] that endures on its own, constitutes a nomadic paradigm, then it appears that architecture subjugated to the effects of the 'telematic' mutations of the city has itself become muted into an object of a different physical presence and meaning. This primarily denotes the short-circuiting of the sedentary urban function of architecture founded in its capacity and purpose to generate permanence (of place and environment), and its subsequent conceptual transformation into a *'philobate-ian'* instrument of the nomadic occupation of urban space. Seen in such a way the contemporary paradox of urban architecture and its place—'the crisis of the dimension'[8]—becomes complete. The lost geographical dimension of open (uncultivated) nomad space emerges reconstituted (albeit by the same mechanisms of communication and information circulation) in the 'telematic' folds of the city as an unconquerable and uncontainable extension of its spatial measure turning it, by conceptual implication, into a hypothetical nomadic domain. Accordingly, (trans)portable architecture, given the nomadic proclivity that informs its ideological and physical makeup, surfaces in such a context as profoundly urban in bias and potential, resonant with the capacity to frame new architectural possibilities within the shifting contextual circumstances, and thus its critical relevance.

A case for (trans)portable architecture

Relative to the sedentary architectural typology, the idea of (trans)portable architecture is based in the programmatic difference of its tectonic, spatial and material constitution. This difference is primarily grounded in the function of a specific mode of inhabiting and relating to the external world, and providing the means of mediation between it and the inhabiting subject (collective or individual). The most critical question in that regard is the way in which (trans)portable architecture produces (interior) space and objectifies its anthropomorphic measure. It could be argued that its spatial preoccupations are born out of close considerations of the human body free from the interference of geometric preconceptions and therein enclosed tendencies to materialise space in symbolic and meaning-generating terms. On the contrary, space appears to be conceived in strictly functional terms as a programmatically necessary minimum extension of the human body whereby the distinction between that which encloses the body and that which encloses the space of the body—clothing and architecture -becomes blurred (one is reminded of works like Toyo Ito's 'Pao 1' and 'Pao 2' projects for Tokyo Nomad Women,' and Martin Ruiz de Azua's 'Basic House' project).[9] Such a strategy of spatial production is ostensibly rooted in the cognisance of the tenuous dialectics of inside and outside which, in the case of the city, transpires through the 'telematic' unfolding of its space. The pervasiveness of the space of totalising presence of communication transfer, does not only displace the chance of topological differentiation of one's relative position within it; more importantly, it pre-empts the possibility of sustaining the meaning of architecturally produced interior space because it itself constitutes a condition of interiority to the extent that it is domesticated and knowable (in terms of electronic log-in protocols and telecast networking) and, hence, no other interior, or for that matter, exterior position appears tenable relative to it. Consequently, granted that what architecture traditionally used to produce and contain—its raison d'être—has become appropriated by other generative mechanisms which supply it in advance of all architectural construction, any creation of interior space other than the most reductive support of elemental functions of physical inhabitation of a given environment is threatened with tautological irrelevance.



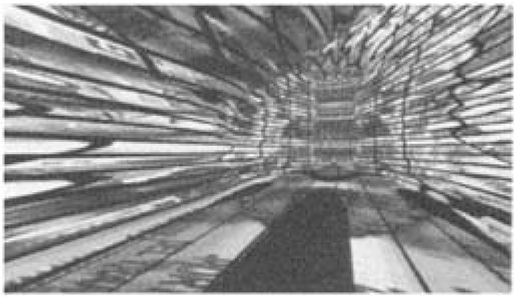
3.1 Martin Ruiz de Azua's 'Basic House' project, house d

Herein resides the premise of the phenomenal shift in urban conceptualisation of architecture from an instrument of emplacement to one of immersion. The transformation of interior space into a domain of osmotic transparency permeable to, and continuous with that which lies outside of it—the only remaining point of discontinuity being the difference in physical climate and the need to provide protection from it— leads inevitably to the reconsideration of architecture's material presence and constitution. Seen in such a context the actualisation of its materiality emerges as a function of its capacity to produce spatial interfacing (modulate permeability) between that which it is supposed to enclose and contain and the environment it is placed in—a sort of negative materialisation or materialisation through relative dissolution where it is the effect of materialisation rather than the material itself that produces the sense of architectural existence sublimated into unrestricted experience of space. (A literal analogue of this would be the selective permeability of hi-tech materials used for tent and protective clothing constructions, which allow inhabitation of inhospitable environments. While on the one hand these materials produce internal conditions aimed at preserving undisturbed functioning of the human body, on the other hand, they allow for the maintenance of spatial continuity with the outside world—one always remains outside or inversely inside the outside world.) The resonance of this situation and its potential to animate spatial and material reframing of architecture has been most clearly demonstrated in Kas Oosterhuis' installation

3.2 Martin Ruiz de Azua's 'Basic House' project, house b

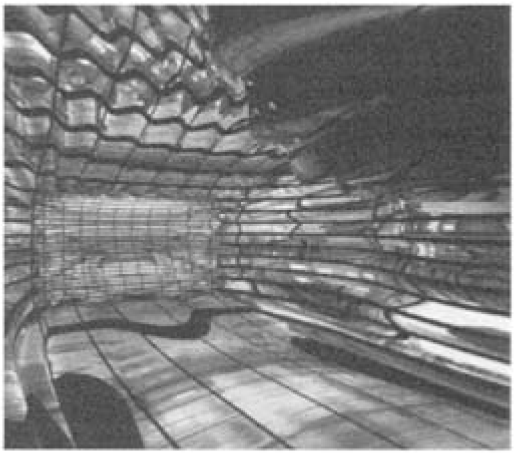
project 'Trans-ports' at the 2000 Venice Biennale[10] which was cantered, among other conceptually related issues, on the investigation of the possibility of the creation of electronic architectural skin composed of RGB LED elements and digital sensors embedded in a flexible fabric. The changed spatial paradigm created through this investigation has presented an important constructive step forward in reconsidering the correspondence of space and matter in the phenomenal conceptualisation of architecture relative to the latency of its communication technology-based dimensional parameters.

Subsequent to the realisation that architecturally produced interior space is neither topologically nor dimensionally fixed—it is portable in a sense that it is brought into existence through interfacing rather than containment—comes the

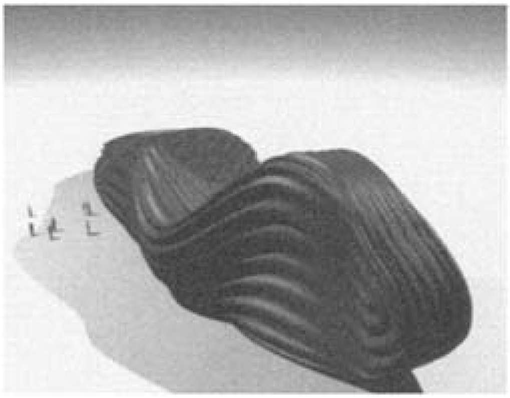


3.3 Kas Oosterhuis' installation project 'Trans-ports' at 2000 Venice Biennale

question of the relevance and the nature of architecture's formal presence, particularly in relation to the 'telematic' nature of urban space. This question, to the extent that architectural form is understood as an outward sign and the resultant of the contained space as its meaning, has been in part answered by the previous discussion implying a degree of formal dissolution of architecture into an object of uncertain physical presence. In addition to this, it could be further postulated that in the case of (trans)portable architecture its exterior form is primarily conceived as a residue of its internal function of providing means for physical inhabitation of a given environment—its purpose is to allow for the inhabitation of a place rather than to partake in its creation (to the extent that a tent structure is universal in its form and disconnected from any specific location it may occupy). Its formal presence is thus circumscribed by the vacancy of symbolic and aesthetic concerns of a contextual nature whereby architectural form materialises in an almost unconscious fashion of technological matter-of-factness. Given the 'telematic' eclipse of sedentary architecture's capacity to partake formally and physically in the structuring of urban space, the idea of the disconnection of form and context propagated by the conceptual configuration of (trans)portable architecture offers, in its urban extension, a perspective for the redefinition of terms under which an architectural object comes into formal presence. The consequential engendering of instrumental understanding of urban context as a domain of nomadic action exchanges the question of (architectural) form for the question of (architectural) function in terms of the capacity for allowing the sustainable occupation of a territory identified as such. Therefore it is the potential to functionally connect, to interface in a 'telematic' sense, with a given location and its space that determines (urban) contextuality of an architectural object while its form, rendered irrelevant, is abandoned to its own unfolding. This, however, does not denote a point of nihilistic closing of the perspective of architecture's formal presence; rather it inscribes a promise for its formal and phenomenal reconfiguration true to its changed contextual circumstances while accepting the pending uncertainty of its constituting parts. The potential of the technologically dissolved architectural form to inscribe a compelling and viable work of architecture is most convincingly perpetuated through the projects of Wes Jones, such as 'Mountain Cabin' prototypes and 'Redendo Beach House'[11] design.



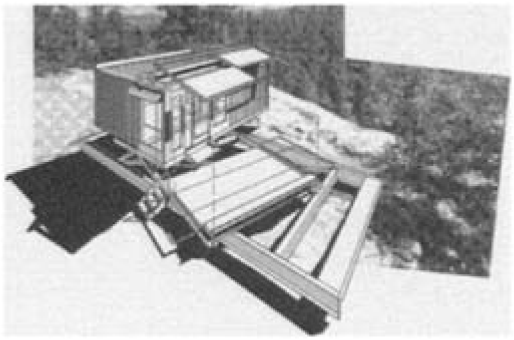
3.4 Kas Oosterhuis' 'Trans-ports', interior



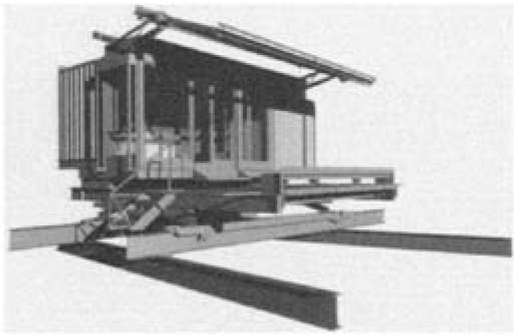
3.5 Kas Oosterhuis' 'Trans-ports', exterior

Moreover, these designs, in addition to kinetic architecture studies by Michael A. Fox[12] and the work mentioned earlier by Kas Oosterhuis, simultaneously demarcate the possibility of an entirely different formal dimension of architecture where the embodiment of real time as a kinetic rate of change stands to redefine architectural form as an independent object and with that extend the very conceptual boundaries of architecture's phenomenal essence.

In conclusion, what has been argued here is the fact that (trans)portable architecture by its conceptual reaches and the specific ideology of contextual relating offers an uninhibited perspective for casting a critical view at the meaning and the possibilities of architectural production in a world that changes at an ever-accelerating rate. Hence portability is not to be understood in solely literary terms as a capacity to be moved but as a transparency of architecture to its place—as a particular mode of relating to and understanding the context and the circumstances



3.6 Wes Jones' 'Mountain Cabin'

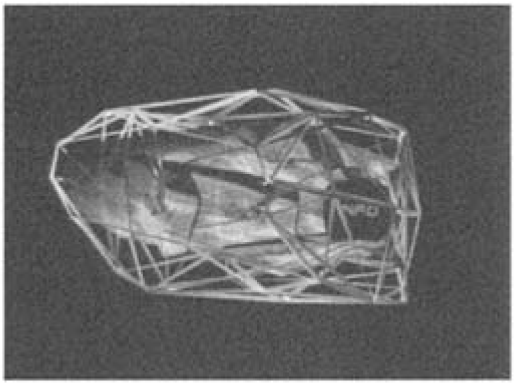


3.7 Wes Jones' 'Mountain Cabin'

under which architecture comes into being. In that regard (trans)portable architecture materialises as an acute reflection of our own contemporary world encompassing the extremes from the theoretical postulations presented in this text to its most fundamental humanitarian function to shelter life and alleviate human plight. The 'telematic' dilution of the meaning of the corporeal city is juxtaposed to the violence of its physical destruction; Shigeru Ban uses same structural materials and the same construction systems in Tokyo and Rwanda. The question that remains, notwithstanding the progressive intentions, is on what basis can human identity be preserved and enhanced when such architectural ideas advance from prototypical and experimental considerations to what is inherent in the very concept of (trans)portable architecture, mass pro duction.

Notes

1 Gilles Deleuze and Felix Guattari, *A Thausant Plateaus,* Minneapolis, University of Minnesota Press, 1988.
2 Gerhard Auer.



3.8 Kas Oosterhuis' 'Trans-ports'

3 For the discussion of the difference of nomadic versus sedentary space concepts see Gilles Deleuze and Felix Guattari, *A Thausant Plateaus* (particularly the chapter, 'Treatise on Nomadology—The War Machine'), Minneapolis, University of Minnesota Press, 1988.

4 For further elaboration of the effects of the proliferation of communication technology on the conceptual perception of space, city and architecture see Paul Virilio's seminal essay 'Overexposed City' in K.Michael Hays, ed., *Architecture/Theory Since 1968,* Cambridge, Mass., MIT Press, 2000.

5 Here I primarily refer to Aldo Rossi's idea of 'primary elements' and 'urban artefacts' proposed in his book *The Architecture of the City,* Cambridge, Mass., MIT Press, 1984.

6 For further elaboration of this argument see Paul Virilio's essay 'The Third Interval: A Critical Transition' in Andermatt, Conley and Verena. *Rethinking Technologies,* Minneapolis, University of Minnesota Press, 1993.

7 In discussing the way in which nomads understand and receive territory Gilles Deleuze and Felix Guattari are making the argument that: 'The land ceases to be land, tending to become simply ground (so/) or support' See p. 381, *A Thausant Plateaus.*

8 This primarily refers to Paul Virilio's argument of the effects of telematic changes imposed on the city which demarcate the loss of the measure of a visible reality and the destruction of an official (geometric) discourse by way of which we could 'assert, describe and inscribe reality'. For further consideration of related ideas see 'Overexposed City' in K. Michael Hays, ed., *Architecture/Theory Since 1968,* Cambridge, Mass., MIT Press, 2000.

9 Martin Ruiz de Azua's project is of particular interest here since it virtually represents an inflatable pocket house made of double-sided metallic polyester material which, when self-inflated, produces 8 cubic metres of inhabitable space. This idea is best described in the author's own words: 'I propose an almost immaterial that expands when triggered by body or solar heat. A house so versatile that, by turning it onto one side or the other, it protects from cold or heat, so light that it floats and, moreover, that can be folded and stored in a pocket.' For more details on the design see Phyllis Richardson, *XS: Big Ideas, Small Buildings,* New York, Universe Publishing, 2001,

10 For more information on the project see Kas Oosterhuis' essay 'Game, Set, and Match' in *OZ,* Volume 23, 2001.
11 For more information on these projects see Wes Jones' essay 'Stillness' in OZ, Volume 23, 2001; and Richardson, XS: *Big Ideas, Small Buildings.*
12 For more information on Michael A.Fox's work see his essays in this book and 'Ephemeralization' in OZ, Volume 23, 2001.

Trans-formation in the Age of Virtuality

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The liquid architectural object and its context in the age of virtuality

The contemporary city is a material and virtual plain emitting bits of information. Urban landscape can be defined by the points of view and review, departure and destination, focus and reference, ugliness and beauty. Urban plasma extends from the place of one's presence to the present infiniteness. The last decade of the twentieth century contributed new phenomena to the urbanisation process, such as the creation of the global world—MacWorld or e-world, and global information network (Barber, 1997), changing the concept of man's life and his environment from the mechanical to the relative, from objective to subjective, productive to sustainable, and functional to the fictitious concept of human activities and their settings (Kwiatkowska, 1997). The concept of the human being has changed from one described by the physical features of the body to one defined by Pearce (1995) as the visually oriented features of the mind.

The massive scale of urbanisation processes and the information revolution dictate the development of the present city structure. The design of cities prioritises its visual aspects. The language of art movements and information theory formulated in the twentieth century influenced the way in which we perceive our surroundings. The history of modem art reveals the struggle of artists to gain acceptance for different and subjective points of view in describing the world, where description is no longer based on objective and scientific reconstruction, but instead on subjective visual impressions. The art critique André Breton believed that the impressionistic painters depicted the outer object as consisting of many parts, defined by material or light (Breton, 1945). The Futurists expressed the simultaneity of events and the energy and dynamism of the spatial object, influenced by machines. The Cubists fragmented the outer object into smaller parts, and showed them from many points of view at the same time. The Dadaists set free the object from its context and played down the object itself. The Surrealists explored the reality of dreams and put the object into mental and metaphoric landscapes, opened up to accidental events. These perspectives of modem art are now assumed in contemporary perceptions of its context.

The information theory created, for example, by Hartley, Szilard, Gabor, Shannon or Weaver (Rosnay, 1982), is another important factor that has influenced modem knowledge and perception. Architectural theory explored the information field as information in action (in the creative power of giving form to matter). Information is codified in the aesthetic interpretation of architectural forms and information acts as communication in the interactive relation between object and context. Architecture that tried to express information by dimension, attempted so in the literal sense. The architecture of the information age in the twentieth century, however, was determined by architectural software. It did not create new information patterns of design but instead built only the screens, which represented transmitted information. Now, at the threshold of the age of virtuality, we observe new design patterns and the new concepts of man, place and space, which I will refer to as the telecommuter, liquid object and liquid context respectively.

The telecommuter is void of the physical features of the human body, such as gravity, density or mass and is reduced to the visually oriented mind without fixed features of age, gender or own identity (Franck, 1995). The telecommuter interacts directly with other telecommuters using the network. Such interpersonal relations create informal and changeable contact groups.

The liquid object is void of traditional materials and aesthetic features of place. The importance of place seems to be reduced to the computer terminal as a point of in-out connections, The place has no limits, only time is present. It is imagined and programmed by the telecommuter-self (Tabor, 1995). Place is a changeable, illusionary and self-generated structure (e.g., flexible, portable, dismantled). The place now means a time to perceive. The traditional, harmonious relation between place and space, expressed in ideas of home and voyage, will no longer exist in the age of virtuality. The barriers of place and space are overcome and the concepts of the environment are created in the form of a liquid context and network.

Liquid context and network are new representations of space (Mitchell, 1995). Near and distant places are connected together through time and no longer through the mediation of space. The network geometry reflects a new structure of space, e.g., the network is not oriented to cardinal points and distances are measured by numbers of via-connections and not by length, width, etc. A network may be defined as a model of time and communication.

The concept of the telecommuter living in the liquid object within the network represents the values expressed in the notions of relativity, virtuality, chaotic-higher order and fictionalism. Here, architectural and urban forms are relatively subjective because multivalent virtual images and messages represent many points of view at the same time where every receiver perceives the sense of message individually. Perceiving the form is a singular act of information in the presence of the pulsating images and messages in the network, which describe a seemingly chaotic or higher ordered environment. Form as message creates and focuses on fiction—'form follows fiction' (Novak, 1995). Here, the context of form does not exist in the traditional meaning. The new concepts of form and context transform the meaning of the architectural object in the virtual age. The liquid object becomes the context for itself, while the liquid context becomes the object.

Design patterns of the transformation of the architectural object in the age of virtuality

The principles and patterns of the transformation of the architectural object in the virtual age are analysed in the following ways: form as informed matter (liquid architecture), information flow (self-steering, convertible structures), transmitting wall (narrative structures), trans-forming space (topological space) and nanotopian form (genetic code of architecture).

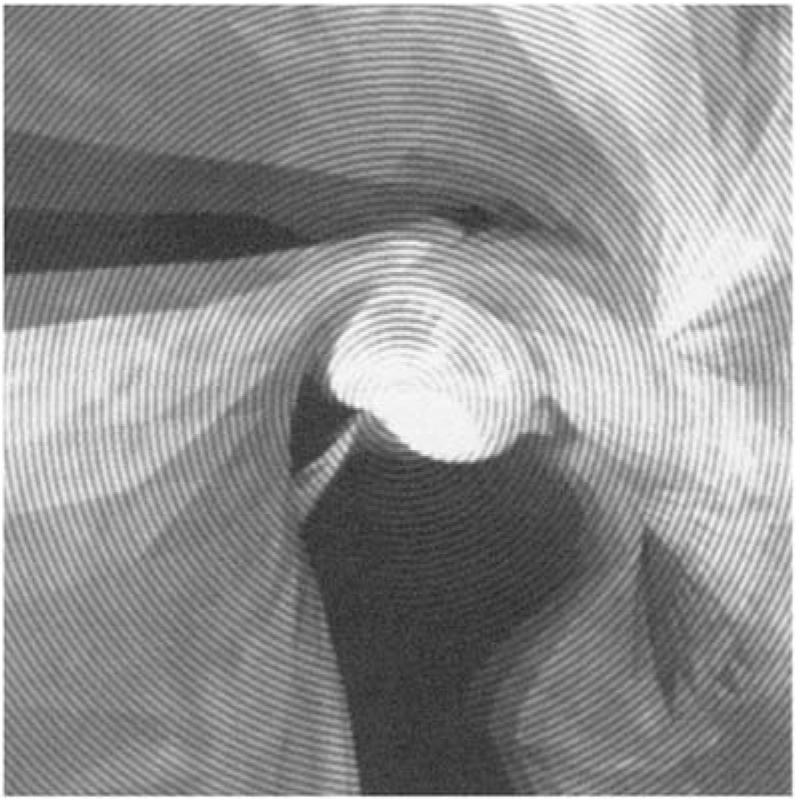
Form as informed matterÐtransformation through information

Most philosophical theories express a duality of life matter in the meaning of physical and thinking matter (Tatarkiewicz, 1978). Plato distinguished spheres of matter and of idea. Christian philosophy divided the world into spheres of mortal bodies and immortal spirits. Aristotle identified form with energy and force, which in information language could be described as informed matter or matter organised through information. Seneca defined form as the breath of matter, matter filled with *pneuma,* which also signified organised matter. information means content and acting power. As a consequence, information as acting, organising and creative power opposes the chaos and disorder of the world. Therefore information as acting power can signify the process of negentropy, because of the ability of information to cause an action and to order part of the world.

Architectural patterns relating to questions of order in the age of virtuality seem to be replaced by patterns of disjunction, discontinuity and disorder as a mechanism for reaching a higher order or higher complexity of systems (for example, the designs of Spiller Farmer Architects (Novak, 1995), Stephen Perrella or Oosterhuis Associates (Zellner, 1999). The idea of liquid architecture is understood on the basis of a higher order, which is closer to the potential of natural rather than architectural things (see Figures 4.1 and 4.2).

Information flowÐtransformation of the architectural object according to the direction of the info-energy transmission

The idea of the monad as created by Bruno is similar to the idea of information as quantum energy (Tatarkiewicz, 1978). Monads are identified as integrated units of matter and spirit—units of informed matter. Information theory formulates the principle of fusion of information and energy—every quantum of energy is connected with information defining the direction of energy transmission. The most important info-energy pattern relating to spatial composition focuses on the

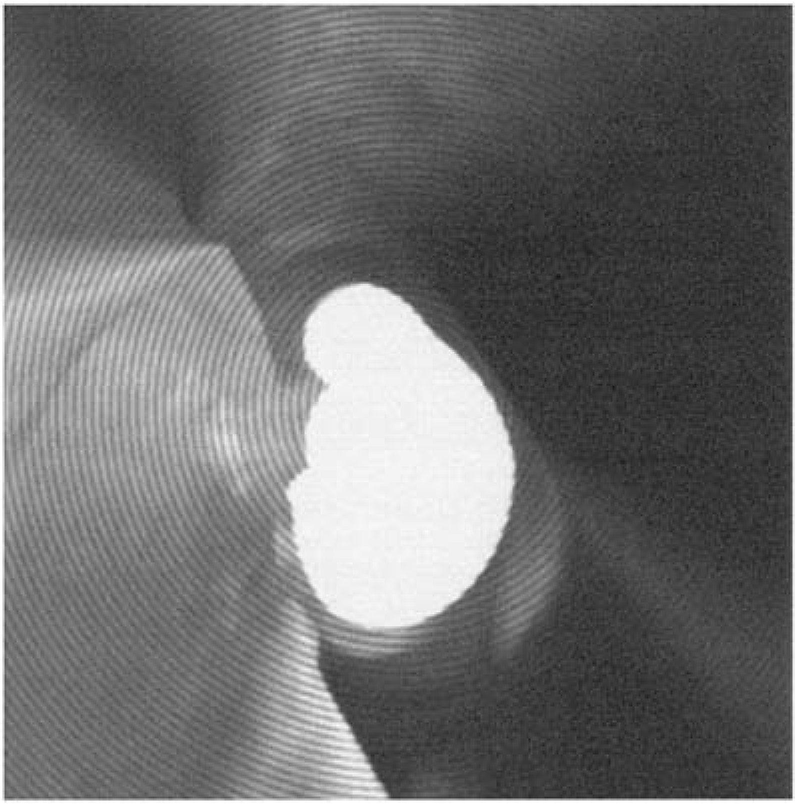


4.1 Liquid architectural context as an object (all drawings by the author)

concentration of objects, conserving energy use, converting one energy form into another, circulating energy, re-using space, regenerating energy, recycling matter. Here, the energy transmission and changeability of virtuality expresses a degree of energetic order in the structure (towards negentropy). Informed energy means direct, suitable transmission of energy to definite parts of the structure, ensuring its suitable use. Architectural objects are created in response to economy and sustainability keeping the info-energy balanced in their structures, for example the designs of Ken Sakamura (Sakamura, 1990) and NOX (Zellner, 1999).

Transmitting wallÐtransformation of the architectural object by the language of communication

In information transmission, the sender is at the point of input whereas the receiver is at the point of output. Information is identified with the act of communication between sender and receiver. In Vaihinger's philosophical theory of fictitious

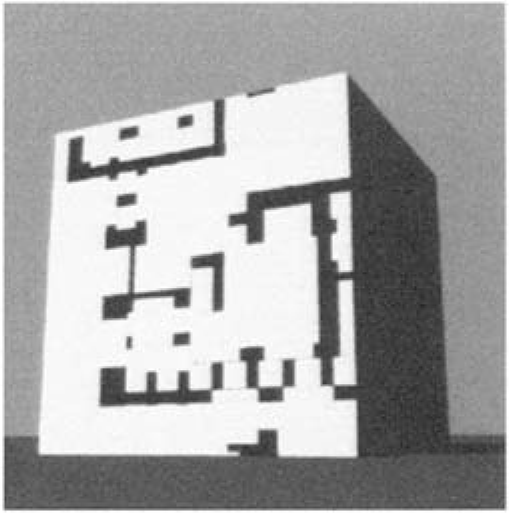


4.2 Liquid architectural object as the context itself

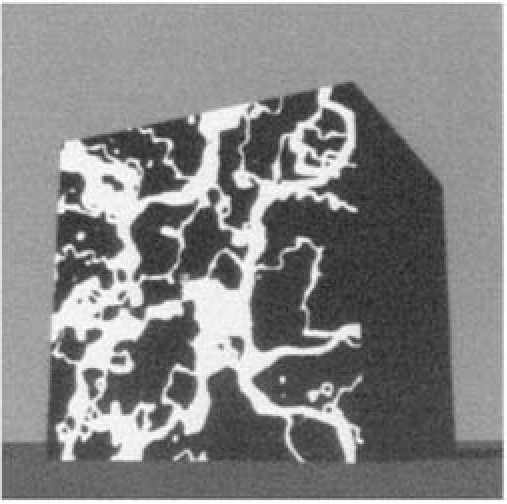
reality (Tatarkiewicz, 1978), based on the subjective perception of the world, communication is a very abstract phenomenon, embedded with errors and manipulative agenda. Architectural composition in the virtual age relates to different codes of communication. Most of the virtual design patterns are the reflection of movie codes, such as ‘stop’, ‘action’, ‘instant replay’, ‘docu-dramas’; for example, the designs of Morphosis (Rand, 1989). Soft architecture is treated as text, based on well-known cultural codes, signs and myths as in the designs of Ettore Sottsass and Stanley Tigerman (Klotz, 1985), using literal expressions such as metaphors, metonymy or paradox (Kwiatkowska, 1995), emitting narrative images or creating interactive relationships between sender and receiver (see Figures 4.3 and 4.4).

Trans-forming space—the info-space relativity

Information exists in fusion with other world’s dimensions, such as matter, space, time and energy. It means that information is a relative quantity, which can be

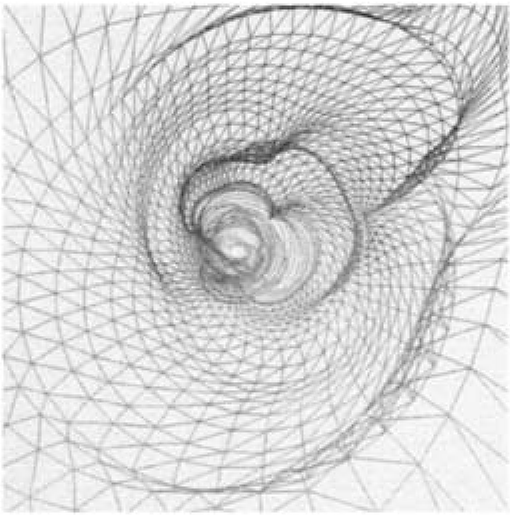


4.3 Transmitting wall—pulsing images and messages



4.4 Transmitting wall—changing appearance

transported (or converted) into other dimensions. Informed space expresses the possibility of space transformation because of the information contained in the informed matter (see Figures 4.5 and 4.6). In this case, informed space can be the extension of human imagination. Informed time means 'the real time' (Rosnay, 1982), being in different places at the same time, interacting with many subjects and objects simultaneously. The principles of shaping architectural objects in the dimension of informed space (topological space) relate to different interactions between user and structure on the levels of matter, space, time, energy and



4.5 Topological space

4.6 The info-spatial code of topological space

information—interacting within the programme of structure simultaneously; for example, the designs of Marcos Novak or OCEAN (Zellner, 1999) and the interactive images of Notnot (Notnot, 2000).

Nanotopian formÐtransformation by interfering

in the info-spatial code

Information is based on code notation, which can be expressed as molecular, genetic (DNA), chemical, numerical, letter, timing, machine or operation codes. These codes are revealed in the form of visual, acoustic, touchable or abstract signs. The notation of codes is connected with problems of information decoding and with interference in code transmission and communication circuits. When informed matter is understood as a new generation of materiality, the structure of such new materials will then contain information on the variable components of the whole structure. This would be analogous to DNA, which contains information on the structure of the entire human body. The user is able to programme the nature of the material in changing the shape and altering or transforming that shape resulting in an interactive design process. Informed matter is characterised by the possibility of recapitulation, recycling, self-regeneration and reactions to changing situations.

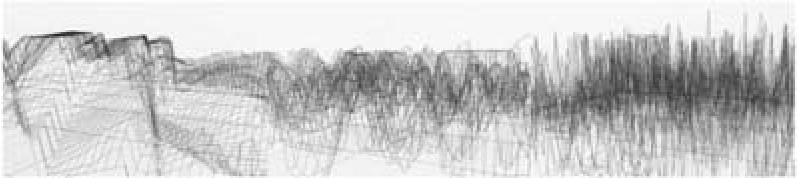
Spatial soft-structures based on organic, genetic principles of transformation (nanotechnology; Titman, 1995) express the relative-ness of the whole. They signify the 'open-ended-ness' of soft structures as the structures of exchange, growth, movement and spatial transformation (see Figures 4.7 and 4.8), in which 'the physical urbs [*forma urbis* - the city, *Lat*] are replaced by bits' (Pearce, 1995), and 'archs [*architektoniké, architektonikós*—structural form, *Gk*] by bits' as well. For example, see the designs by Oosterhuis Associates, Greg Lynn or NOX (Zellner, 1999).

Design patterns of the transformation formation of the architectural context in the age of virtuality

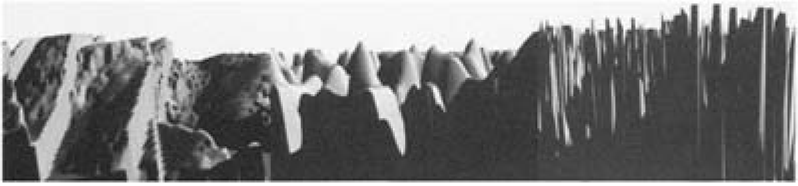
The principles and patterns of transformation of the architectural context in the virtual age are analysed by examining the character of urban channels and milestones.

Urban channelsÐthe liquid context

The space of an urban channel is archetypical. It is defined by the walls, floor and ceiling, which construct the one-point convergent perspective. The urban channel is connected with movement of the liquid mass of people, cars, trains, etc. It is a very dynamic space, which consists of sequences of different frames. These are the spatial bits, which are emitted in relation to the speed of the observers. The urban channels of present urban agglomerations divide the urban structure into many different parts. They are difficult to traverse, as they become barriers, which disintegrate the continuity of urban space. These urban channels may be transformed in various ways in which their potential may be utilised to activate the urban structure, analogous to the building of bridges to cross rivers. Generally,



4.7 Nanotopian form—interfering in the info-spatial code of topological space



4.8 Open-endedness of the soft structures

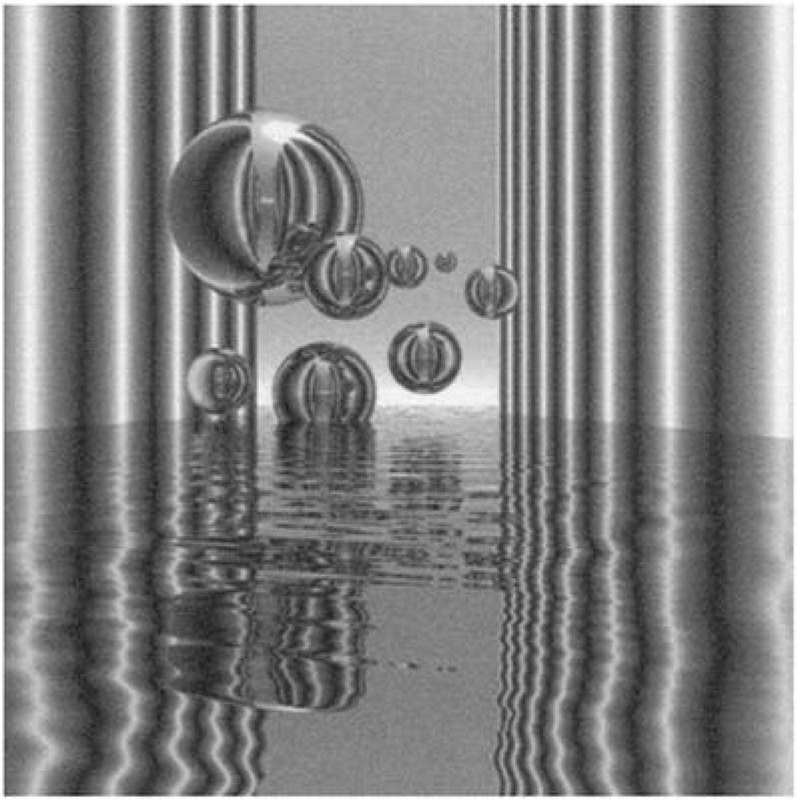
there are two models of spatial transformation of urban channels: the membrane (interactive walls of the multi-users' dimension) and the canyon.

The membrane is a zone of mutual communication between the functions of the channel and its surroundings. It is influenced by both function and surroundings at the same time (see Figures 4.9 and 4.10). It becomes a new entity existing in between the channel or in the contiguous space. Membranelike solutions in the European context arise from the harbour, or industrial developments along a river, and where new functions are introduced into abandoned areas to revive them, for example the Borneo-Sporenburg housing complex in Amsterdam (Maar, 1998), the Docklands regeneration projects in London, and the Helsinki Visions (Helsinki-Tampere Visions, 1993).

The model of the canyon expresses a structure that is superimposed onto the channel. It creates the scenery observed during moving through the channel, using graphic narration and movable or animated signs, which interact with passers-by. For example, see the designs of the Esplanadi pedestrian area (Helsinki-Tampere Visions, 1993) and the Hypersurface by Greg Seigworth (Seigworth, 1999).

MilestonesÐlooking for moral and spatial order in the liquid context

The model of milestones confers a symbolic meaning upon the channel and liquid context. The monuments are set up at the sides of the channel, reinforcing its importance for the urban structure and revealing its beauty. The memorised image of the city is a collage of the images and signs of the seen and never-seen places. It seems that virtual representations of the city image (photos, postcards, films) are the most important factors in our imagination, because they can be embellished, reproduced and collected out of our memory. The virtual images of the urban

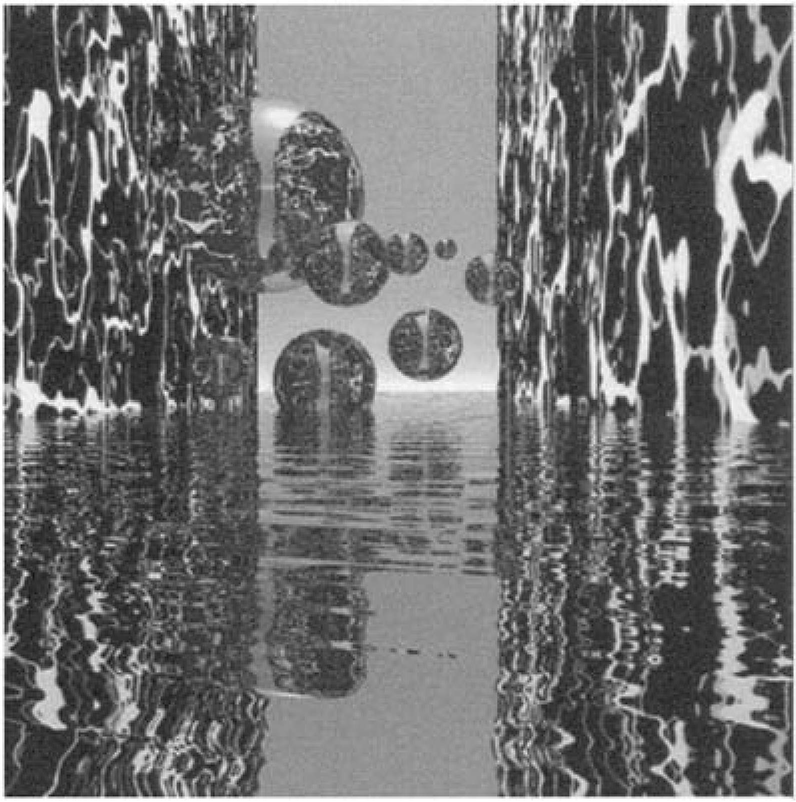


4.9 Urban channel of the liquid context

agglomeration live their own life, independent of the real world, such as in Bernard Tschumi's Park de la Vilette, Paris (Tschumi, 1997).

There is also another process relating to the perception of the urban landscape in the age of virtuality. This is the possible absence of the urban agglomeration topography in the mental maps of the city's inhabitants, because they experience the urban space as the space between the places of departure and destination; home-highways-workplace; home-metro-the mall; home-airport-hotel, etc. The every-day trips to the workplace or journeys to other countries are canalised in channels and guided by the information signs. Therefore the representations of the network, and not of the urban topography, are created in the mind.

It is possible that the spatial representation of the urban network will not be necessary for future inhabitants of the metropolis. They will be able to travel to other places in the virtual dimension, making real changes at their virtual destinations, for example by Internet shopping, working in Internet offices, participating in Internet conferences, or meeting in Internet chat-rooms. Network representation could be replaced by representations of time-connection, and urban

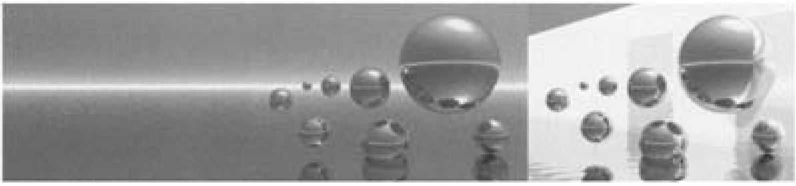


4.10 Urban channels with interactive membranes

topography by the virtual images emitted in the digital network. Everyone could receive and create at the same time, changing and intervening in pictures or animation subjectively—from visions of emptiness to ones of dense space, in which architectural objects might appear and disappear (Figure 4.11). The idea of a virtual cage, which creates the illusion of real infinite space, has its prototypes in contemporary computer games and multiplex cinemas. They take the form of the 'virtual black box', like Jean Nouvel's DUMBO (Nouvel, 1999), whereby the quality of environment is not dependent on the aesthetic value of the space, but instead on the technological parameters of the virtual machine producing its virtual images.

Conclusions

Thus architecture of the virtual age can be evaluated using such criteria as conversion, conformity to the principles of trans-formation and liquidity. Changes in the forms of expression—transformation, transgression, translation and transmission provide the challenge in shaping the architectural object and its



4.11 Fictitious milestones of the urban liquid context

context. Liquid architecture implies a polymorphism of the amorphous matter created through an interaction between architects, users and information. The aims of architecture in the virtual age should be redefined according to the cybernetic criteria relating to form and network. Time is an active factor expressed by motion without action and therefore soft architecture simulates ever-changing life processes instead of attempting Vitruvian durability.

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Context

Transformable Personal Space within a Communal Setting: Housing for the Homeless

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Introduction

The condition of the ever-increasing homeless population in the urban core of Toronto provides an opportunity around which to base a discussion on the issue of transportable architectural design. The situation of more or less permanent displacement from a fixed living condition raises questions about conventional assumptions and approaches to housing in architecture and interior design. Issues of private and public space, individual and community, shelter and home, gender and personal space, personal security, relative stability and mobility—all must be reinterpreted when the perspective of the forced mobility of homelessness becomes the basis of design. Strachan House is a special needs housing project where the city's chronically homeless have been actively involved in the planning and construction of their 'home'. This involvement led to the re-examination of conventional design assumptions about housing in the making of an alternative communal structure that accommodates the conditions of a transient culture.

Home-less-ness

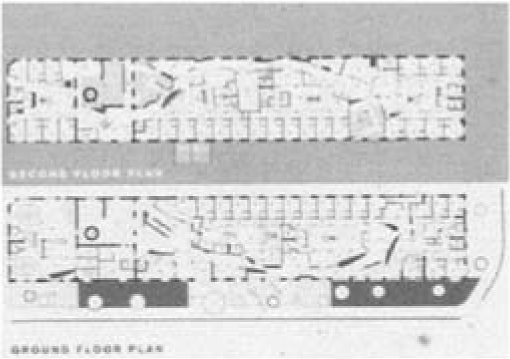
Essential to the fulfilment of one's life experiences, to having a sense of self and well being, is having a place that one can call 'home'. A home means many things: it means having choice and control over one's personal environment; it gives us a sense of identity, a sense of place (Wekerle et a/., 1991); it provides a base for privacy, safety, and a place for regeneration; it provides a place to nurture one's own being and identity within society; it provides a physical (geographical) location and an address in the world.

A home is part of a larger context of urban spaces where a sense of community sets the stage and fosters a sense of belonging for the individuals who make up a society. Ideally, the complex network of public and private spaces constitutes a healthy urban environment for individuals to live in. Yet, it is evident that people in various societies cannot make themselves at home within houses or cities. For many homeless people 'home' or 'city' is not a safe, happy place. These spaces have become a place of (personal) degeneration and humiliation rather than a place of regeneration for increasing numbers of women, children and men.

Social, cultural, economic, as well as personal issues are all contributing factors to homelessness. Through increased research and social interest into the phenomenon of homelessness it is evident that no one definition defines this phenomenon or describes the people who are called homeless. There is increased awareness and recognition of the complex nature of the problems and personal situations of homeless people. What does it mean to be homeless? Who are homeless people? The general public impression is that homeless people do not fit or belong within the existing public and private spaces of our urban environment. They are quite often stigmatised as vagabonds, addicts or mentally disabled, and perceived as undeserving, disturbing or even threatening, and not needed in the society (Ruddick, 1996). The phenomenon of homelessness is mostly attributed to large cities. However, if we leave these widespread myths behind, there appears to be no specific characteristics that distinguish the 'homeless' from other people.

It is known that to be 'on the streets' or without 'shelter' is to be without means and for the majority, to be poor. Yet, the diversity of the homeless population ranges through different age and gender groups, from very young children to the elderly, and exists both in large cities and small towns (Laberge, 2001). Physical and mental health problems associated with homelessness can be the cause or the consequences of being homeless. The visibly homeless represent only 5 to 7 per cent of all homeless people. Ninety per cent are 'invisible', an indication that not all homeless people are recognisable within the commonly accepted myths about the homeless. Approximately 70 per cent of all homeless people are male and 30 per cent are female. Twenty-five per cent of homeless people are children who are aged 16 and under (Springer, 2001).

In the Toronto Report Card on Homelessness 2001, the condition of homelessness is described in the following terms: people who live outside (on the streets, ravines or parks); who stay in emergency shelters; spend most of their income on rent; live in overcrowded, substandard conditions and are therefore at serious risk of becoming homeless. In this report card, factors contributing to homelessness are summarised as follows: low-income levels do not keep pace with the rising cost of basic necessities, such as rent and utilities; the supply of new rental housing is not keeping pace with the demand; vacancy rates continue to drop; rental housing is less affordable due to changes in rent legislation that leaves low-income tenants at risk of eviction; the supply of affordable rental housing continues to decline; more people are applying for subsidised social housing; eviction applications continue to rise; not enough supportive housing is being built.



5.1 Strachan House, plans

Transition/shelter

Assistance to the homeless quite often constitutes an immediate attempt to satisfy the basic necessities of life by providing 'shelter' and/or 'services'. However, the desire to ensure the relative well being of homeless people often results in providing assistance with constraints; queues for food, blankets, and the use of washroom facilities, rationing of necessities, and regulating hours of operation and personal activities, to name a few. In a quest to be egalitarian, this form of so-called 'assistance' appears rather to be a 'form of control'. This situation creates difficulties for many of the homeless, who may avoid seeking assistance and may not accept offers of places in residential facilities where conflicts and confrontations are common.

Hostel systems or 'Out of the Cold' shelters in Toronto are found to be insufficient in numbers and inefficient in helping homeless people regain their independence. Regardless of the diversity of personal situations, needs and requirements, hostel systems put everyone under the same conditions, making this form of shelter unattractive to many homeless people and encouraging them to return to the streets. When the environment that one is supposed to take refuge in is cold, oppressive and impersonal, where desolation and desperation take precedent, many people prefer to avoid these situations. Many others who cannot avoid these oppressive environments may suffer from somatic disorders, anxiety and irritation, resulting in feelings of anger, hostility and withdrawal from or numbness to their surroundings (Sommer, 1974).

Therefore, one may view homogeneous facilities created 'for' the homeless as having, in turn, a further negative impact on the phenomenon of homelessness. If the form of assistance is to play an important role in how the homeless adapt to the conditions of their life and in helping them develop a choice over their survival strategies, then alternative sorts of shelter are required to respond to the specific issues that homelessness brings.

The idea of having a ‘place’ of one’s own, whether a cardboard box, a bed or a nook, is still important for people who live on the streets or who use shelters. If the intention behind provision of services is to reintegrate the homeless back into society and help their transition to independence, homeless people require spaces to meet, socialise, relax and make themselves at home along with spaces to eat, sleep and store their personal belongings, Personal appropriation and transformation of public and private spaces becomes a key issue. The act of appropriation/transformation and having control and choice over one’s personal space is essential in shaping an individual’s sense of identity and belonging. In turn, having control results in taking charge; taking responsibility to protect and feel protected in one’s own environment. Personalisation, the ability to put one’s imprint on one’s environment, is a prime ingredient in forming a self-governing community.

Strachan House

The Homes First Society, a non-profit housing provider that manages 17 facilities in Metro Toronto including Strachan House and Street City, took on an ambitious challenge in the late 1980s and early 1990s to provide shelter for people who live on the streets as well as those in the ‘hardest to house’ category (so called due to their extreme emotional or violent behaviour in shelters). An enlightened municipal government at the time provided funds for initiatives that helped find routes to permanent housing, income and support services more than for temporary shelter or food. Further, the city provided space in a city-owned warehouse for Strachan House and also its predecessor Street City, a self-help transitional housing project built by and for the homeless (Wekerle *et al.,* 1991). (The original Street City location, intended to be a temporary solution, is still in operation although it was scheduled to close down when the permanent location in Strachan House was opened in 1996.)

The purpose of Strachan House, designed by Levitt Goodman Architects (1999), is to provide short- and long-term shelter to chronically homeless people. Significant in the design and construction process was the consultation and active involvement of the future residents of the house, the majority of whom came from the original Street City. This process of consultation helped define the social and political framework within which a group of men and women, living solitary lives excluded from society, could imagine how to come inside and live together in a communal setting. The clients’ only precondition for the architectural design was that it should work for the residents. This requirement nevertheless posed a challenge for the designers to generate a solution that in itself questioned and expanded the architectural conventions of ‘home’ and ‘community’.

The programme for this unique community addresses the special needs of people who have come directly from the streets, as well as the provision of specific houses for longer-term shelter, and health houses for short-term care to homeless residents just released from hospital. An autonomous unit is targeted for ‘hardest to house' women who have difficulty finding tenure at other shelters. Further support facilities include a community kitchen, town hall, bank, reception and staff areas.

Through the involvement of the tenants of Strachan House, an architectural and spatial concept was developed that incorporated the experiences and perceptions of street life. Specifically, the design strategy was based on city streets where the home- less have been most accustomed to living. An interior street structure with transitional spaces, analogous to city streets, provides a gradation of public, semi-public and private spaces as an architectural solution to the needs of a transient group of users. These streets provide many alternatives for navigation and social interaction and provide vantage points for comfort and security. In this way, the project addresses the needs of many of its users who stated that they were fearful of conventional living situations and consequently might feel more secure, even comfortable, sleeping in a protected corner beside their packed belongings rather than sleeping in an enclosed room. The interior streets, defined by coloured concrete paths, provide an organic streetscape meandering among the little plazas, gathering spots, living and dining rooms, balconies, nooks and culs-de-sac.

In this community model, personal living space is not a fixed architectural or spatial structure but is highly transformable to each individual's sense of being and security in relation to the communal setting. Although the architectural plans may seem chaotic at first glance, they are intentionally fragmented to reflect the non-hierarchical (in the traditional sense) placement of public spaces without an administration zone. Transitional/unplanned spaces are located along the neighbourhood streets that give the community the opportunity to individualise that space. The process of carving out the voids of public and transitional spaces contrasts the dense patterning of the housing fabric. The building is organised as a number of 'houses', four to a street, linked horizontally by a neighbouring street or public corridor. A suspended trellis that marks the threshold from the public street to common spaces defines the front porch of each house.

Each house is organised in a manner that encourages the tenants to watch for each other and their own house. Thus a sense of social awareness, identity and belonging is encouraged. The house kitchen, a common place of conflict and confrontations, is intentionally left open to encourage participation in cooking activities but also to discourage people from activities, such as vandalism or theft, that might occur more in tight or confined spaces.

Porches in front of bedrooms mark the transition from the collective house to each private bedroom, allowing the tenants to privatise, appropriate and claim that part of semi-public space as their own and also to discourage others from trespassing. Bedrooms have both a full conventional door and a half door looking out towards the shared spaces, providing the tenants with the option of complete privacy or the possibility of controlled social contact to avoid isolation while in their rooms. The importance on one's well being of natural light is recognised with the provision of a window for each bedroom and ample natural light for shared spaces, further reminiscent of the outdoors and the streets. This was seen

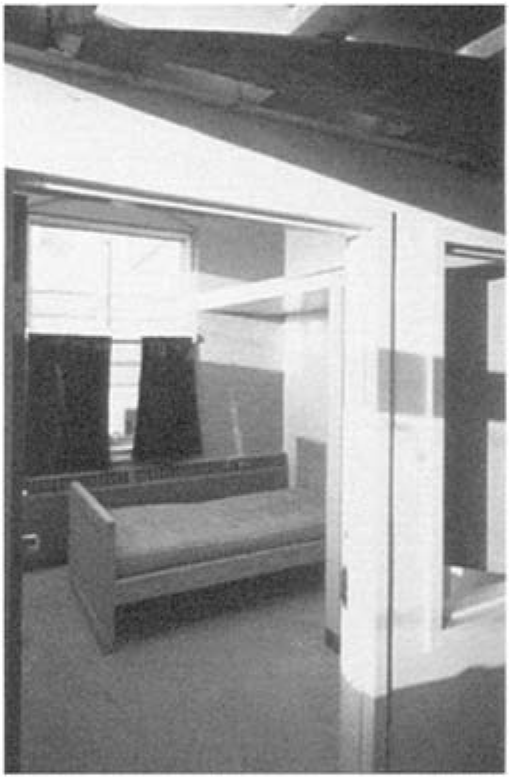
5.2 Kitchen

as a key element in contributing to the de-institutionalisation of the residence and to the breakdown of the hierarchy created by window spaces, Having a window became a right for everyone rather than a privilege.

Vertical connections between each floor are established by two, three-storey high atriums that contain the stairs. These two vertical spaces anchor the ends of the building and allow people to move continuously through the various public rooms sited along the way. The organising principle for the programme is made evident with a hierarchy of spaces ranging from the most private to the most public: the bedroom and the porch each resident calls their own, to the collective house, to the neighbourhood streets and finally to the Town Hall—a space large enough to accommodate the entire community. Proportionately, the largest area of Strachan House is given over to public and semi-public uses. This is a startling contrast to conventional apartment living in which private space is privileged over shared common space.

The masonry chimney, a landmark of the building's industrial heritage, is retained as part of the Town Hall. The main staircase connects all three levels of public space, weaving its way up alongside the chimney, through and around an existing three-storey masonry wall. During bi-weekly Town Hall meetings the stair is transformed into part theatre, part observatory, as residents participate in the discussions from various levels, perches and vantage points. Strachan House has an elected mayor. Decisions affecting tenants and issues related to the day-to-day running of this community are taken col-lectively by tenants and staff during the Town Hall meetings.

The use of timber columns and beams, rough cut lumber and peeled logs, and oversized steel light fixtures are some of the ways that the design further references the larger conceptual and narrative thread of the 'outside coming in' (Levitt Goodman, 1999). These structures are not viewed as precious, allowing the residents to leave their imprints. Further, the architects worked collaboratively with a number of artists on the project to extend art based methods into the architectural process. The artists' early involvement in the process allowed the architects to stretch the conceptual and aesthetic assumptions and limitations of



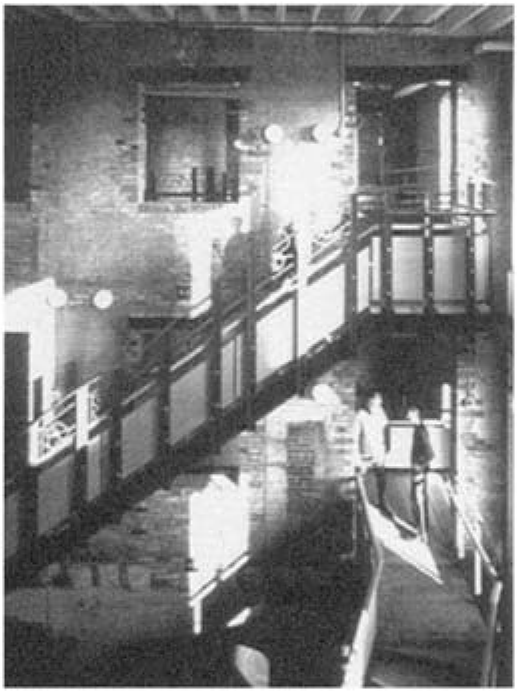
5.3 Bedroom with full and half door

the project to achieve an enhanced expression of the public and private realms that make up Strachan House.

This unique project received international attention for its success in developing a new housing prototype that creates a highly sensitive response to both the physical context and the peculiarities and idio syncrasies of the client group, chronically homeless adults. In 1999, it received a Governor General's Award of Excellence in Architecture that cited its innovative approach to public spaces, supporting a healthy collective life offering both transformable private enclaves and shared spaces (Baniassad, 2000).

Conclusion

Strachan House, conceived and built with the direct participation of the homeless, substitutes a richly developed public space for the conventional form of architectural and administrative control as experienced in typical shelters. This is a radical shift in emphasis that provides the means for attaining autonomy and encouraging integration of the homeless back into society, above and beyond the conditional provision of basic needs.



5.4 Atrium

The lessons of Strachan House regarding the transformation of public and private spaces go far beyond the specific issues of homelessness, suggesting the possibility of many other forms of dwelling alternatives for the diverse residents of the city. The process by which this project came about also presents a challenge to teaching and learning in design studio environments. Design inquiry into transformable personal space and the community can be inspired by collaboration, budget restrictions, and hope. This project can serve as a provocation, both for those who are established in their profession and for emerging designers to consider the importance of this type of transformable architectural vision.

Project credits

Architectural Team: Levitt Goodman Architects

Dean Goodman (partner-in-charge), Wyn Bielaska, Filiz Klassen, Greg Latimer, Marko Lavrisa, Stephen Leblanc, Janna Levitt, Richard Milgrom and David Stavros.

Artists: Scott Childs, Steven Marshall, David Warne, Paul Raff, Rae Bridgman, Robert Burley and Debra Friedman

Structural: Balke Engineering Inc.

Mechanical and Electrical: Lam and Associates Ltd.

5.5 View towards the Town Hall

Restoration: E.R.A. Architects Inc.
Fire and Life Safety: Arencon Inc.
Environmental: Holocene Consultants
Construction Management: JAC-Anderson
Photography: Robert Burley/Design Archive

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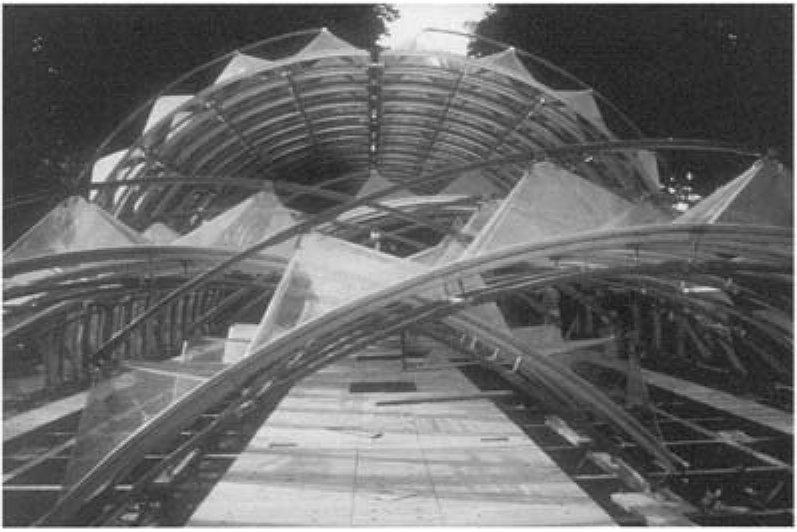

6.1 Renzo Piano and Shunji Ishida's realisation of the Archigram dream of 'Instant City'; the IBM Pavilion, 1982–4

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Transportable Environments: Experiment, Research and Design Innovation

Robert Kronenburg

School of Architecture and Building Engineering, University of Liverpool

In writing the Introduction to his 1970 book *Experimental Architecture,* Peter Cook felt compelled to state his position as a protagonist for a form of architecture whose primary purpose was to terrorise the mainstream.[1] In that time of youthful revolution, paper designs could be a powerful, antagonistic tool in preparing the ground for an age of 'new' architecture, in this case at least partly realised in the ensuing decades by Renzo Piano, Richard Rogers, Nicholas Grimshaw and others. At the close of the twentieth century Peter Buchanan cited contextual conditions as the catalyst for experimental architecture. The recent phenomenon of radically different architecture that has emerged in the Netherlands by architects such as Rem Koolhaas, MVRDV, Mecanoo, and Neutelings Riedijk, results from a strong economy and a high demand for buildings, coupled with a physical environment that is not restrictive in a formal sense—in Holland, this is the archetypal man-made landscape reclaimed from the sea.[2]

These two respected commentators on contemporary architecture have perceived the role of architectural experimentation as something quite differenteither as a stimulant to change in a static situation, or as a characteristic feature of an already changing situation—in short, either as a cause or as an effect. Nobody can refute that experimental groups like Archigram in Britain, Haus Rucker Co. in Germany, the Metabolists in Japan, and Ant Farm in the USA, helped determine the course of architectural design; however, it can be argued convincingly that this was primarily by their influence on those who were to follow rather than by their own work. Proactive, concept-oriented groups and individuals are essential in preparing the circumstances for experimental architecture to be built. The rational, pragmatic building processes that for a time seemingly prevent the manifestation of visionary, fantastic architecture subsequently play an important role in realising the experiments at the point in time when real life experience establishes that the economic, environmental and cultural context is right.

This possibility that experimental architecture may be built once the circumstances become appropriate does not, of course, mean that such design progress is inevitable—innovation still has to be fought for, often against seemingly unbeatable odds. The construction of most buildings can be undertaken in a myriad of ways ranging from the prosaic well-tried solution to the new and

6.2 Portakabin UK's commercial portable solution used to ship buildings around the world

6.3 Bedouin tent and geodesic dome at Expo '92, Seville

exotic. Though the designer may identify programmatic benefits for the introduction of new forms and techniques into his proposal, most permanent building types have many precedents that can lead the client to be hesitant about accepting these innovations. Ultimately, in these cases it is the client's decision, and in the world of publicly accountable corporate and government client bodies, it is becoming much more difficult for the innovative designer to assure the financiers that such 'risks' are worth taking.

However, where the operational parameters for a building are extreme and where its successful function is completely dependent on these parameters, innovation is embraced as the most certain route to the problem's solution. One of the few fields where building designs with such extreme design criteria operate routinely is the transportable environment a situation where a need for a building structure is established but to build permanently is not desirable or not possible. In the past it has been the latter condition that has led to the creation of most portable buildings—lack of local resources, harshness of the environment, and transient lifestyles or activities have meant it was easier to take your shelter with you than build at each stopping place. Our current cultural situation has been described as an ecological postmodernism in which there is a propensity to take into account the biological and sociological impact that we have on the world around us. When we build it is now desirable to do so sensitively, with low impact and with the wish to leave our building site, whether it is in the fragile wilderness or the historic city, as it was before we came.[3] Typically, buildings for such situations are required to be as light as possible, easily transportable, demountable, and erected in a matter of hours or days rather than months or years, and yet the desire of the client is the same—to have a high quality, successful solution. The design of transportable architectural environments is an area of contemporary experimentation that deals with the research and exploitation of innovative techniques as a normal resource for the solution of difficult problems—and some of these solutions, for example, the use of membranes, may even make their way through into permanent architecture.

Transportable environments and the established construction industry

Building for the transportable environment will never be more than a part of the entire output of the established construction industry. Permanent buildings are an intrinsic part of the aspirations and requirements of society as a whole and a replacement form of architecture is neither required nor desired. However, an examination of the history and development of portable architecture does reveal that this significant part of constructional design has been largely ignored, both in terms of the opportunities it presents for appropriate solutions to specific problems, and as a source of theoretical, formal and technological inspiration in the creation of architecture in general. The form of early transportable buildings (which persist into contemporary vernacular architecture such as tents and domes) undoubtedly influenced the first examples of permanent architecture. New lightweight architectural forms utilise innovative yet appropriate construction methods that can provide a valid contemporary source of influence in the same way. Materials, systems and techniques devised for such buildings possess the potential to be transferred into other areas of the building industry.

The way our cities, towns and buildings are being made is clearly subject to change in response to the massive technological revolution of information technology and the ecological demands of more efficient and cleaner energy use. Now, more than at any time in history, an appropriate response to changing external influences is clearly necessary. Further research is required to determine the forms of architecture that will provide an adequate response to these changing conditions. The flexible characteristics inherent in portable buildings may prove a valuable resource in the search.

The importance of research and design innovation

Building is one of the oldest examples of humankind's creativity, yet it is still a problem to find an appropriate research paradigm applicable to its pursuit. Traditional scientific research finds its solutions by repeating modified experiments until a uniformly successful model is identified. The tactic of the arts is to establish by debate and critique the most pertinent pattern of acceptable argument or creative form. It is clear that architecture does not fit well into either of these models as the design process is redefined every time it is carried out, by complex factors such as context and project brief. It is precisely because the problem of design relates to a specific set of contextual issues that design innovation, which might also be called applied experimentation, is such an important tool in building research. Though the programmatic brief for a specific project may have led to the investigation and application of a new solution, the wider implications for its success and failure are important factors which form the more generally applicable research part of the project. If effectively communicated, these factors have the capacity to inform design problems in other, perhaps quite diverse, situations.

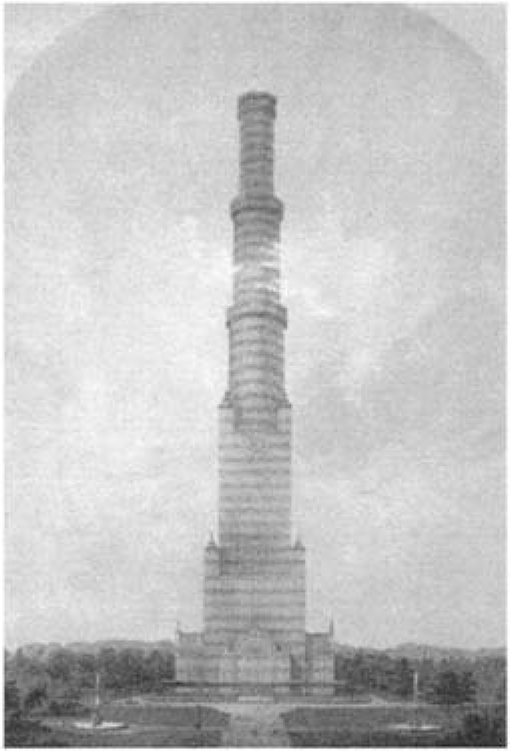
A common perception of portable building is that it is generally a poor quality product and unfortunately, in many cases, this image can be seen as accurate, as economy has been high on the agenda for clients who plan to discard the building when it is no longer required. Therefore, an important factor in the development of the role of architecture designed for transportable environments is to make it clear that in every case, temporary does not necessarily mean disposable. A greater understanding of the value of the building type will result in an eagerness by the client to seek greater performance and a higher quality product. Like permanent architecture, portable building design should be seen as the creation of specific solutions to specific problems, not as the expedient provision of loose-fit, low-cost, projects with minimal satisfaction thresholds. An accurate comparison of different strategic approaches in order to find the most appropriate building solution is required. New research proposed at the University of Liverpool aims to explore methods that will enable objective comparison between a static building and a portable building by evaluating their respective life-cycle costs, not only in economic terms but in environmental, utility and performance.[4] Some of these quantitative factors, such as the purchase, operation and income related to a building, are relatively easy to assess. However, other qualitative factors are more difficult to determine, for example, the advantages of relocation, of rapid deployment and of the public relations value of a high profile event on arrival. Dealing with these elements of opportunity and risk is where the appraisal difficulties arise.

The search for new building types is also a search for new applications for existing and new technologies to fulfil requirements which cannot be met by the use of existing methods. Recent studies of the value of technology in the development of the design process have shown that experimentation in this area is essential.[5] However, research in the building industry is in general not part of a correlated continuum of experimentation and it does not consistently result in the overall development of the building type. Usually it is carried out in response to specific legislative requirements rather than a desire to increase the overall quality of the product.[6]In all areas of the building industry there is a need for genuinely investigative work which should be coordinated and disseminated more efficiently to enable pooling of knowledge and information, transference of ideas, and the identification of legitimate research aims. Furthermore, this research should not cease at building completion, but should continue to examine the logistical problems that surround the implementation of promising ideas to the prototype and eventually to the manufacturing stage.

The active pursuit of these research ambitions is particularly important for the commercial portable and prefabricated building industry if its products and range of deployment opportunities are to achieve their full potential. In this research, use should be made of design, manufacturing and materials expertise in other industries, though it is important that this should be carried out in a way that adapts new techniques in a sensitive manner. New technologies can be seen as problem forming as well as problem solving and should be used only in response to established requirements—they are not a universal panacea. Without a careful investigation and analysis of specific issues (that result in a realistic understanding of the design situation), the application of new technology may lead to alienation and the development of unforeseen sociological and environmental problems.[7]

Developing a research agenda for portable architecture

Though the transportable environment is one in which one can feasibly encompass urban design, landscape design, rural planning, furnishing and interiors and engineering structures, the author's main work has primarily been in the field of portable architecture. The potential for such careful and considered research in this field would appear hopeful. There are already many interesting and innovative solutions that are proof of the existence of a viable and relevant contemporary portable architecture. The value of these good ideas should not be seen as one-off phenomena but as precedents which others might use in the development of similar though unique solutions. The following summary of criteria and objectives for research and design innovation are offered as a readily accessible resource for further discussion and investigation.

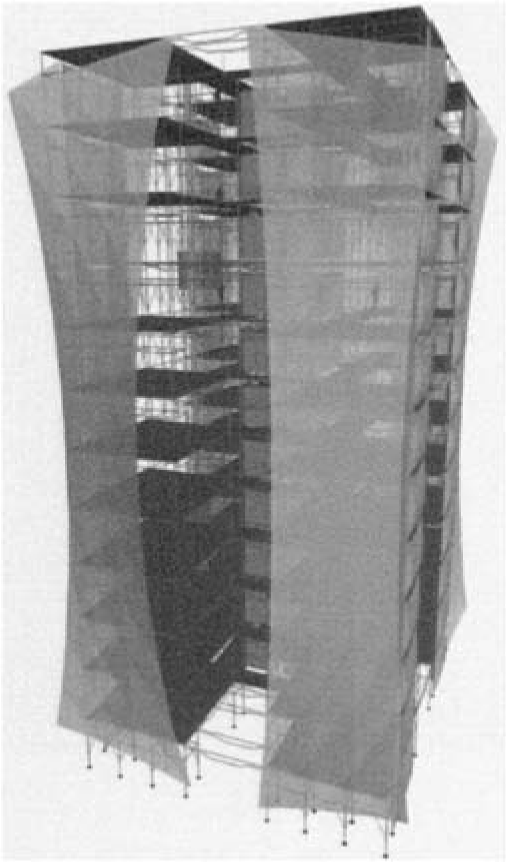


6.4 The Crystal Palace reconfigured as a skyscraper by the builders Fox. Henderson and Co. (c. 1851)

Advantages of portable architecture

Appropriately designed portable buildings have specific advantages over alternative solutions which should be used in communicating the importance of their further development:

- Appropriate solution—they can function as well as static buildings, be beautiful, contribute to the activities they contain, and are sensitive to local conditions;
- Ecological approach—they are recyclable, can be built using renewable resources, have a low site impact during deployment and minimal residual effect after departure;
- Affordable cost—they provide a high performance facility in temporary situations, use contemporary mass production methods for efficiency in manufacture;
- Unique advantages—they are capable of instant response, remote manufacture, adaptable to change in disposition and layout and can be substituted if functional requirements alter.



6.5 FTL Happold Design and Engineering's design for a tension membrane skinned skyscraper (2001)

Sample design objectives for portable architecture

The design objectives that may be adopted for the creation of portable buildings are synonymous with those that may be used for mainstream architecture. This characteristic reinforces the place of portable architecture within the general canon of architectural thought and experience. Though each project must have its own recognisable objectives there are a number of identifiable areas which will be of concern in all projects. Typical yet by no means exclusive objectives are:

- Image—the visual concept of the building as expressed by its formal response to its purpose;
- Identity—the symbolic identity the building generates in relation to society, culture and community in a local, national and international context;

- Function—the efficiency with which the building responds to the processes and activities which it contains;
- Security—the building's ability to respond to external and internal physical, acoustic and visual segregation requirements;
- Flexibility—the ability of the building to respond to expansion, contraction and rearrangement of activities;
- Energy use—the type and amounts of resources used in the building's construction, operation and maintenance;
- Reliability—the performance of the building's operational, mechanical, electrical and other support systems;
- User friendly—the provision of a physically and psychologically rewarding environment for the building's users and occupants;
- Life-cycle costs—the long-term value of the building in capital, maintenance and operating costs.

Research aims for portable architecture

If portable architecture is to have a significant place in design strategies for the future there are a number of specific tasks that need to be undertaken to develop the understanding and communication of its potential. Important research aims for portable buildings that also have general architectural interest would be:

- To understand and utilise the precedent of vernacular architecture;
- To investigate and understand the changing requirements of architecture;
- To encourage research into innovative areas as well as developmental work;
- To explore the opportunities of technology transfer in an appropriate manner.

Areas of importance with more specific relevance to portable architecture are:

- To co-ordinate all aspects of the research to increase its effectiveness;
- To evaluate experience from one-off projects for general application;
- To encourage research into the successful implementation and use of portable buildings as well as their design and construction;
- To explore the potential of precedents from portable architecture for use in permanent architecture;
- To develop an operational model for comparative appraisal of portable architecture versus permanent architecture.

To achieve a substantial improvement in the quality of portable architecture it should be perceived as:

- A part of mainstream architectural and industrial development;
- A valuable logistical solution to specific problems.

This may be achieved by adopting the following strategies:

- Perform objective comparative appraisal to determine the true cost in comparison to static solutions;
- Make use of experience in other industries to communicate its advantages;
- Use the high-quality image of one-off solutions to communicate general potential;
- Rekindle its dynamic qualities by association with the transport industry.

Communication

Once real, coherent advances have been made in the purpose, image, design and manufacture of portable architecture, effective communication of its advantages can begin. This will not be easy; because of the limited manner in which the opportunities of the type have been exploited, most users of portable buildings wrongly believe that they already understand the products' failures and successes. It is important that people discover that portable architecture does not consist solely of the site hut and the mobile home, This understandable prejudice must be overcome not only in the minds of the users but also in clients, designers, manufacturers and legislators.[8]

Notes

1 'Experimental work frequently finds its grit and inspiration in the desire to undermine and explode all rival positions.' Peter Cook, *Experimental Architecture,* London, Studio Vista, 1970, p. 7.

2 Peter Buchanan, 'Dutch Divergence' in *Architectural Review,* March 1999, pp. 35–7. One can see similarities here with Japan in the 1980s and 1990s where a powerful economy and high land prices synthesised to create a situation conducive to architectural freedom, where the building could be almost anything at all because its value was so small compared to the overall investment.

3 Buchanan attributes this description to Charlene Spretnak, p. 37.

4 André Brown, Robert Kronenburg and John Lewis, 'A Conceptual Model for Appraising Portable, Reusable Architecture'.

5 Robin Spence, Chairman of Cambridge Architectural Research Ltd. comments, 'we need to strive for a new understanding of the possibilities implicit in building technology. Not as a process of gradual indoctrination into "the way we build now"; but as a process of invention and selection from among an infinite variety of options, some already in existence, some easily achievable, others still awaiting discovery or invention. New materials, new structural forms, new approaches to energy conversion, new ways to build.' Robin Spence, 'Building technology: master or servant?', *Scroope: Cambridge Architectural Journal,* 6, 1994–5, p. 20.

6 The engineer Peter Rice believed that the general attitude of industry to research into new areas (as opposed to developmental work) is 'no time is a good time to start'. When Fiat commissioned Rice and Renzo Piano to create a new car design it was in

recognition of the fact that even within their industry (which maintains research as an integral part of their product development) 'everyone else knew the answer before they studied the problem'. Peter Rice, *An Engineer Imagines,* London, Artemis, 1994, pp. 135, 142.

7 Remote decision making in the field of shelter after disaster is a significant example of this problem. In many cases, the type of overseas aid that is provided is decided by the donor rather than those who are to be helped. This has resulted in the costly provision of inadequate and inappropriate housing aid being supplied too late. See Office of the United Nations Disaster Relief Organisation (UNDRO), *Shelter After Disaster,* Geneva, UN, 1982, pp. 24–9.

8 This paper is part of a continuing process of investigation and is based in part on the author's essay, 'Building on the Edge: Research and Design Innovation in the Design of Portable Architecture', contained in the conference book of the Delft University of Technology Faculty of Architecture and EAAE/AEEA international conference, Research by Design, 1–3 November 2000, pp. 200–4.

Innovative and Prefabricated Timber Buildings on Australia's Sub-Antarctic Islands

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School of Architecture, University of Tasmania

Introduction

The Antarctic provides one of the harshest environments for building on the planet. The extreme cold severely limits the time available for construction and the tasks that can be accomplished. Similarly, high winds and the necessary temperature differential maintained between the interior spaces of the buildings and frozen conditions outside lead to condensation in the structure and deterioration of materials in often unpredictable ways. Constructing prefabricated buildings from timber helps to overcome these problems.

Prefabrication is a favoured and economic method of building if the tasks of fabrication are significantly easier, simpler and more economic at some other location than at the building's final position. Often, this is when conditions at the site impose a premium of time or cost on construction there, or a large number of identical or modularised buildings are to be constructed. In Australia, prefabricated buildings or building components form an important but relatively small proportion of the building industry. The ready availability of most materials and a skilled and mobile trades labour force makes 'stick' or piece assembly on site both economic and effective in most cases. This means that the additional cost generally associated with the prefabrication and transportation of whole buildings or building components is generally more than builders or building clients will accept. However, when material and labour have been scarce or local conditions extreme, Australia's design professionals and builders have shown themselves to be very adept at building both prefabricated and transportable buildings.

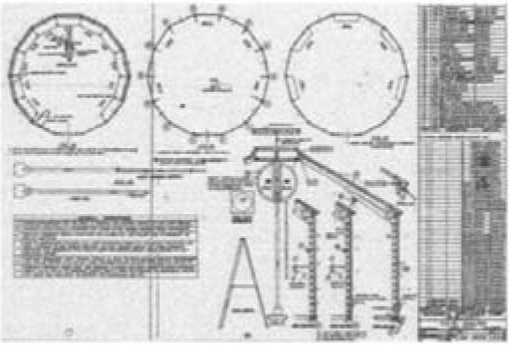
Prefabricated and transportable housing has been and remains a continual feature of Australia's regional development. In country centres, like Wagga Wagga in the south west of New South Wales, it is possible to find firms who capitalise on that town's established building trades workforce. They construct and transport conventional brick veneer houses, complete with concrete slabs, from their yards in town and deliver them to sites in outlying areas, often hundreds of kilometres away. Probably the most intense period of prefabrication in Australian history occurred between 1943 and 1944, during World War II, when thousands of timber buildings were prefabricated and dispatched for assembly

7.1 Macquarie Island, erecting a US signal hut, often referred to as Alaskan huts. Drawings detailing their construction were from the Technical Appliance Corp., New York

throughout the Pacific. At the beginning of the war, timber was not seen as a vital war material. However, this quickly changed in 1941. In his report for 1943, the Controller of Timber stated:

> During the year immediately preceding the war, 1938/39, Australian consumption of sawn timber (native and imported) totalled 975 million square feet. Heavy wartime requirements superimposed on civilian needs would have meant a demand far in excess of supplies. Accordingly, civilian uses of timber were dramatically curtailed soon after the outbreak of hostilities, mainly by gradually tightening control of civilian building activities, total prohibition of which, without Government consent, were imposed as from the middle of 1942 Wartime demand for construction timber has been exceedingly heavy.
> (Controller of Timber, 1944, p. 345)

Experiments with the prefabrication of timber huts and entire camps began as early as August 1942. The Allied Works Council (AWC) constructed several military and Civil Construction Corp (CCC) camps by transporting prefabricated buildings by train from the population centres of Brisbane and Sydney to remote northern locations and then erecting them. Though apparently a successful exercise, the AWC did not pursue prefabrication further in Australia. The benefits were not held sufficient to warrant the cost and inconvenience of the additional organisation and transport required. Consequently, most building projects in Australia continued to be constructed on site by local or CCC labour using local material. However, as the active theatres of war moved away from Australia's northern shores, the need to house Australian and US troops deployed in the Pacific Islands became critical. As there were no materials or skilled labour force available on these islands, the AWC operated prefabrication depots in Sydney from May 1943 till the end of August 1944.



7.2 Working drawings for the US Signal Corp's Alaskan hut

> during the 16 months…the Council supplied to the US Army…prefabricated material amounting to 1.7 million sq. m of hutments, hospitals capable of providing beds for 28,250 inmates, with another series totalling 9,000 beds which were completed by October 31, 1944; warehouse units to a total area of 750,000sq. m; 250 Air Force control towers; and 140 cool stores with a total space of 1,700cu.m The (US Prefabrication) programme itself consisted of seven structures —huts 16.5m×6.0m; warehouses, 27m× 120m; hospitals in units of 500 and 1,000 bed capacity, cool stores with a capacity of 122cu.m; Air Force control towers; and power and transmitter huts.
> (AWC, 1944)

The components, pre-cut and assembled timber frames, fastenings, cladding and roofing, were assembled in depots before being dispatched to sites where they were to be erected by military or local personnel. In the process, considerable expertise and skill in prefabricated building was developed.

Antarctic building

Prefabricated timber buildings have been in use since the first Australian explorations of Antarctica. Hudson Fish, a Sydney building company experienced in timber prefabrication, prefabricated Mawson's Hut of 1912 at Cape Denison. After World War II, in an effort to keep out the United States and other claimants to the islands, including the Soviets, the Australian government established outposts in an effort to claim several sub-Antarctic islands and part of the Antarctic continent. In the consequent planning and preparations for both the 1947 and 1949 expeditions, prefabrication was recognised as a strategically appropriate form of construction. For the hastily organised and secret expedition to Heard Island in 1947, surplus World War II buildings were used.

In addition to the Admiralty Hut originally erected in 1927, there were two types of huts deployed at Atlas Cove on Heard Island in 1947 and at Macquarie Island in 1948. One such type was the 14-sided plywood sandwich panel hut designed for the US Signals Divisions, which was a timber-framed portal structure clad in stressed-skin plywood panels with sandwich fibreglass insulation wall and roof panels.

The other type was the ex-Royal Australian Air Force prefabricated huts called Borden huts, which had been designed for the tropics with ventilation slots at the top and bottom of the wall panels. Lined externally with Masonite, these buildings had no insulation. They also had a ventilated timber roof cross-section. To these two basic prefabricated building types at Heard and Macquarie Islands, there were a number of adaptations and modifications, and even whole huts constructed from packing cases or from salvaged and recycled material. The various cold porches and the D-4 Tractor garage are two examples.

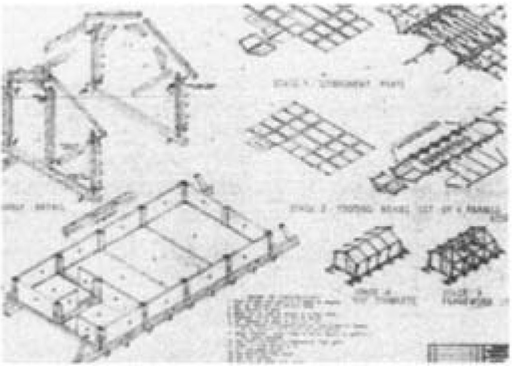
From 1948, there was a record of difficulties encountered with the use of these early buildings. In 1950, 1951 and 1953, major developments in building technology for prefabricated insulated huts took place, which influenced the design of new types of transportable structures for Heard and Macquarie Islands. These were based on the need to have reliable, convenient huts that were easy to transport by boat and easy to land in military amphibious vehicles (DUKWs), quick to erect with unskilled labour, easy to maintain and efficiently insulated.

The breakthrough in design came with the ANARE Mark 1 by the Commonwealth Department of Works & Housing's Victoria & Tasmania Branch Office (the Department of Works & Housing replaced the AWC at the end of the war). A refrigeration company was then used to fabricate and transport six prefabricated buildings to Heard and Macquarie Islands in the sub-Antarctic. The huts employed refrigeration cool store construction techniques of that time. They combined the advantages of the plywood stressed-skin construction of the 14-sided 'Alaska' huts with the simple building form of the Borden huts.

The ANARE Mark 1 system provided a building spanning 3.8 m in the transverse direction with a length determined by the number of repetitive 1.9 m (6ft) bays deployed. Buildings up to six bays in length were documented. The system comprised plywood panels with integral 'Onazone' insulation, set between a timber portal frame structure. In plan, these buildings had equally spaced timber portal frames with the bay formed between the first two frames, forming a separate single airlock or two equal and interconnected rooms. One room, called the porch, opened directly to the outside and had a floor set down about 65 mm below the remainder of the building, while the other room was used as an inner airlock. The remainder of the building was one open space.

The design of the Mark 1 allowed for a carefully planned construction sequence (see Figure 7.4). A concrete strip footing was laid below the longitudinal perimeter walls before simple pad or plate footings were established. Nominal 200×75 mm foundation beams (or bearers) were then levelled on top of the strip footing and fixed in position. The portal frames were assembled separately. Each portal had nominal 150×150 mm Oregon posts, rafters and primary floor joists. Tenons were formed on both ends of the posts and these were received by mortises cut into the

7.3 Atlas Coves Station, Heard Island, 1951. A 14-sided Alaskan hut is seen on the left with an ANARE Mark 1 behind it and a Borden building behind the Mark 1



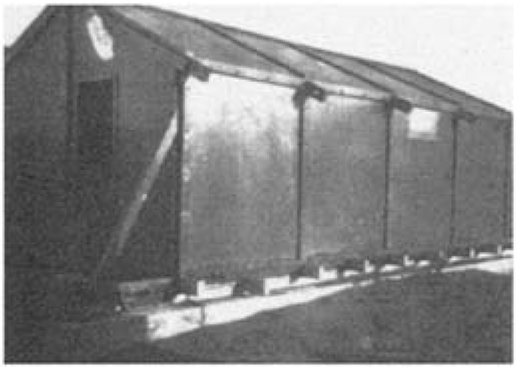
7.4 Construction sequence for an ANARE Mark 1 building

joists and rafters about 300 mm in from their ends. While the porch and end frames incorporated a post between the ridge and the joist, the other frames spanned between the posts and incorporated bolted knee blocks at the frame springing points and at the ridge.

All posts and rafters supported either wall and roof panels and were rebated on the top and outside surfaces ready to receive them. In the frames with central posts, the panels were installed after the frames were raised. As the building was erected, the frames were spaced at the springing by 150×75 mm struts fixed with bolted steel angle brackets. Similar struts were used to space the base and were fixed to the foundation beams shaped to receive additional transverse floor joists and positioned halfway between the frames. A composite ridge beam was positioned between the portal rafters to receive the ends of the roof panels.

The panels for the building were of plywood sandwich construction, filled with ‘Onazone’ insulation. The floor panels’ framing members were nominally 60 mm thick and 80mm wide whilst the full panels were 3.65 m×1.8 m (12ft×5ft 11 ins) in plan and were checked in at each corner to fit around the portal frames. The top layer of plywood was 12.5mm (½in) and the bottom 6.5mm (¼in). The long edges of the floor panels were slightly bevelled, opening out towards the top. Placed on top of the floor joists, the panels fitted snugly between the walls and were held down by bevelled strips fitted between them. These strips were then screwed to the floor joists and finished flush with the top of the ply. The wall and roof panels had a similar frame and insulation, and were 2.2 m×1.57 m (7 ft 3 ins × 5 ft 2 ins)

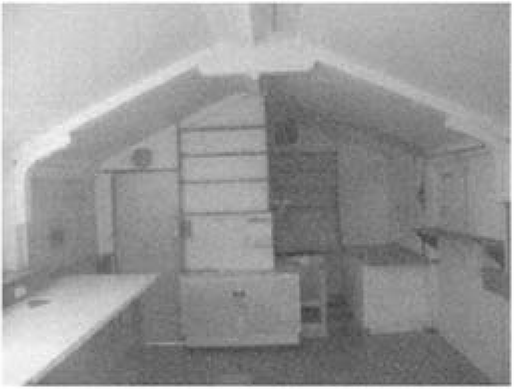
7.5 A four-bay ANARE Mark 1 building being erected. This is the second time it was erected as they were test-erected in Melbourne prior to departure



7.6 The completed structure with end braces

with one long edge bevelied. This allowed for the juncture at the ridge and the connection at the springing to finish flush. The wall panels were clad with 8mm (5/16 in) ply externally and 6.5 mm (¼ in) internally. When they were installed, the panels sat slightly proud of the portal frames. Cover strips, fitted over sealing beads, retained them by bolting through the portal frames.

The finished structure was a simple gabled ply building with regular cover strips and several distinct features. Each of the portal's floor beams and rafters extend about 300 mm past the cladding and featured a tie-down hole. This was to secure the building in extreme conditions. Also, the foundation beams extended past the ends of the buildings and received a longitudinal brace from the last portal frame. The structural design of these buildings thus followed a 'belt and braces' approach. The portal frames were relatively heavy and had complex joints and significant rebates, while the plywood panels braced the building far more than the inclined timber braces at the end of the buildings.



7.7 Inside the ANARE Mark 1 after 50 years in service

Used as the Meteorological, Recreational or Seismic huts at Heard Island, the ANARE Mark 1 design was so successful in keeping out the weather that condensation built up in them and a small ventilator had to be devised to overcome the problem. Three of these huts survive to the present day. One is on Heard Island and two are at Mawson Station in Antarctica where they were relocated from Heard Island in 1955. The Heard Island building is the Recreation hut. Though the site has not been maintained for 45 years and conditions here were more aggressive than in Antarctica, due to the increased moisture and wind exposure, this building remains standing although several roof and floor panels have detached and blown away. The building was repaired in November 2000 and 25 per cent of the panels were replaced. Its future is still to be decided. Mawson expeditionery personnel recognise these buildings as the Met/Tech and Weddell huts at the Antarctic Station that were relocated from Heard Island in 1955. The Met/Tech hut from Mawson (see Figure 7.7) is due to be returned to Australia for future display while the Weddel hut remains in service as a carpenter's workshop.

In 1950, the ANARE Mark 1 went through some minor modifications (see Figure 7.9). The end braces were abandoned and curved moulded plywood cover strips were detailed for the vertical external corners of the building and the ridge. The ridge beam was also simplified while more effective gaskets and caulking were used to seal between the wall and roof panels and the cover strips. This building was deployed at Macquarie Island in an extremely exposed position and has been replaced in the last 15 years.

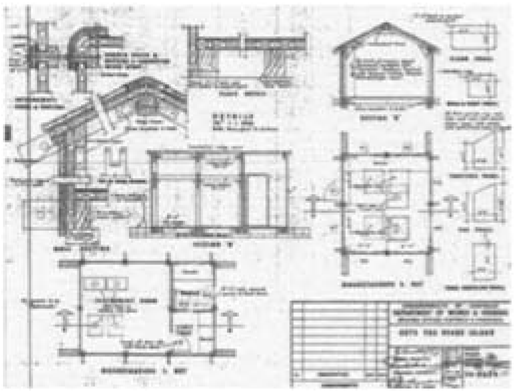
In 1951 and 1952, the ANARE Mark 1 design was further refined with new engineering techniques using plywood shear skins. Instead of relying on a heavy portal frame and its accompanying struts and bolted cover strips, the new design used the innate strength of the plywood shear skin panels as a lighter surface structure for quicker assembly. This system was used for the Absolute Magnetic (Primitive) hut and the Variometer hut, originally erected at Windy City West Bay, Heard Island. The Department of Works produced the drawing for these two buildings, dated 14 November 1952. The Variometer hut is a simple gabled roof structure 5.2 m (17 ft) long and 3.73 m (12 ft 3 ins) wide internally. The floor to springing height was 2.03 m (6 ft 8 ins). In plan it has two small rooms, a porch and light trap at one end of the building. The porch opens to the outside and into the light trap. This in turn opens to the open instrument room that takes up the remainder of the building.

While similar in basic form, the detailing and construction sequence of this and the ANARE Mark 1 buildings was considerably different. First four nominal size 200×150 mm bearers were laid transversely and fixed to concrete pad footings with steel stirrup braces. The bearers were then spaced at their centre line with other 200x150 mm noggins fixed with metal angle cleats. At this point, the floor panels were put in place but were probably not fixed down. Unlike the full width panels used in the ANARE Mark 1, these were only half-width panels, about 1, 700 mm wide, with matching tongue and grooves on their transverse edges. They were supported by the bearers and intermediate noggins on three sides but were supported on the fourth by a cleat at the bottom of the plywood wall panels. The two panels of the gable ends of the building were then probably raised. These sat on the end bearers and a groove in the bottom of the panels provided a key for a tongue in the edge of the floor panels. A 150x100 mm ridge beam then joined the gabled ends of the building, fixed to the plywood panels with screwed metal angle brackets.

The roof and wall panels (which were also about 1,700 mm wide) were then fitted to this carcass of floor, gable end walls and ridge beam. The longitudinal wall panels were supported on and spanned between the transverse bearers and, as mentioned above, incorporated a bottom cleat that supported the outside edge of the flooring panels. They also had a bevelled top edge that incorporated a tongue ready to receive and seal with the roof panels. The roof panels featured grooves to receive the tongues in the top of each wall panel, and matching tongues and grooves on their transverse and ridge edges.

As the panels tended to lock together with the tongues and grooves, the only other necessary fixing were those that held the building down and the panels together. The floors were fixed to the bearer noggins and each other by longitudinal 65×50 mm joint strips that fitted into a rebate between the floor panels and were screwed to the noggin. Holding the tongue and groove joints together was much simpler. Small metal brackets made of 75 mmx50 mm angle, reinforced at each end, were screw-fixed generally to two matching positions on each abutting edge of each panel. Bolts were then fitted between the matching pieces of angle on adjacent pieces and tightened. These pulled the panels together and made sure that the tongue and groove connection performed effectively. Similar brackets were used to fix the wall panels to the bearers and roof panels to the ridge beam and each other. Considerably greater attention was given to sealing each connection. Every joint featured a gasket on the flat surfaces between each panel and splayed fillets were fixed onto each internal corner. The ridge was packed out and finished with a lead ridge flashing dressed down onto the ridge panels. All materials were

7.8 The Mawson ANARE Mark 1 Met/Tech buildings packed ready to return to Australia

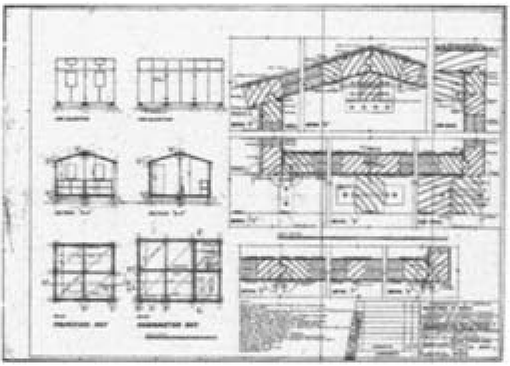


7.9 The refined Mark 1 design

also treated to limit damage by the weather and wind. The bearers were coated with aluminium in a bitumen emulsion while all the rest of the timber was coated with phenolic resin.

While this system eliminated the need for the heavy internal frame of the ANARE Mark 1 building, the panels were generally of heavier construction. The finished panels were about 116 mm thick, with the centre 100mm filled with insulation. All the framing was from 150x100 mm material generally with 200x100 mm material used in some of the larger corner joints. The wall panels generally have 150x100 mm outside frames and a 100x100 mm intermediate vertical stud that supports a join in the ply. The floor and roof panels were similar. All the ply was 8mm thick set with phenolic resin.

These buildings demonstrated sophistication and simplicity, yet with a high degree of practicality. For example, eliminating the cover strips removed both an onerous task from construction and a ledge and joint where moisture and blown grit could speed deterioration. One of these buildings is still performing the



7.10 Working drawings for the Absolute Magnetic (Primitive) hut and the Variometer hut

7.11 Absolute Magnetic hut at Mawson Station, February 2001

original role it was designed for, 50 years later. It has been moved twice as it was first erected in Melbourne then disassembled and dispatched to Heard Island in 1951. It was packed up and moved from Heard Island in 1955 and it has been at Mawson Station in Antarctica ever since.

The details pioneered in the Heard Island building, where the panels became structural and were connected with tongue and groove joints, represented a major step forward in the evolution of building design for this climate. These innovations made the huts easier to erect and provided a superior joint in terms of wind, grit, rain and water shedding. Australia went on to develop a whole series of prefabricated designs based on the use of rebated timber frames clad with various metal sheeting externally and employing Masonite, asbestos reinforced cement sheeting or laminate internally. This technique was subsequently employed in a range of buildings known as post tension boxes (or PTBs) starting with the ANARE Mark 3 in 1954 at Mawson Station and lasted for the next 20 years. Though a number of these have been refurbished and remain in use at Macquarie

Island in the sub-Antarctic, they have generally been superseded and taken out of service on the Antarctic continent, primarily because of metal corrosion and difficulties in repair.

The buildings that remain are a testament to the improving development in their construction and provide an understanding of the performance of materials in these harsh environments. These buildings proved the durability and ecological sustainabil-ity of insulated plywood panel constructions in Antarctica. They surpassed later designs, which corroded or failed under the same environmental conditions despite the relatively low level of technological sophistication of these buildings by modem standards today.

Conclusion

Architectural design can rely on exemplars to inform current practice. In an examination of transportable and demountable buildings, reflection on previous experience can provide a valuable reference for design decisions today. The buildings designed for Australia's Antarctic and sub-Antarctic in the 1950s demonstrate that straightforward systems constructed from both natural and renewable materials withstood one of the most extreme weather conditions in the world. These were innovative solutions in their time and easily understood in form and assembly. In comparison, contemporary US and Northern Europe huts were heavier in style, less useful in form and shape, less practical in erection and amenity, and did not provide the insulation of the first ANARE buildings. The later ANARE buildings, with simplified erection procedures and smoother surfaces, were still superior to their US and Northern Europe counterparts.

While there is a seemingly irresistible urge by some to radically change the technological solution of these huts, others are taking stock of the past 50 years of Antarctic experience and are attempting the ecological restoration of sites adversely affected by less effective or sensitive construction forms. A simple lesson emerges from this: a prefabricated timber building, with simple maintenance, can survive and be of good utility over a period of more than 50 years. When it is no longer needed, it can be disassembled and returned to its country of origin. This is a serious performance consideration for shelters under the Madrid Protocol on the Environment that applies under the Antarctic Treaty System.

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Modelling gets underway

Teaching

8.1 Ban Patai village environment

A North Thailand Village School Hall Constructed by Singapore Architecture Students

Joseph Lim

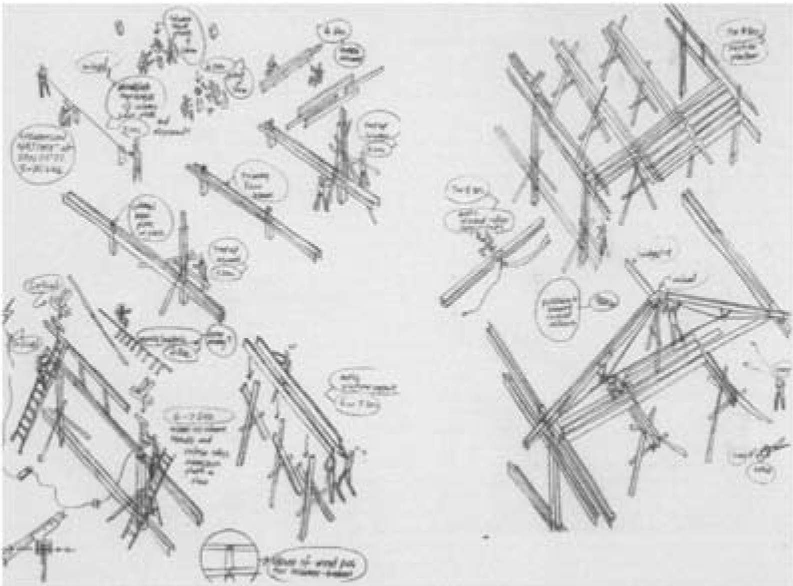
Department of Architecture, National University of Singapore

Project background

The Ban Patai village school was identified by the Singapore International Foundation (SIF) as one of six needy cases in North Thailand previously visited by the author and SIF representatives in a reconnaissance trip two months before the expedition date. Ban Patai was selected because it offered, in building project terms, a time frame, scope of work and complexity that suited the educational objectives of a hands-on learning vehicle for the architecture students. On site were the basic infrastructural provisions of electric power to operate our portable tools, water, shelter and vehicular access for the delivery of timber and other building material. Most importantly, evacuation was uncomplicated in the event of medical and other emergencies (there were occasional skirmishes between drug syndicates and the Thai army at the Burmese border near the Golden Triangle, but these were more the exception than the norm). The school was located in one of the most beautiful highland sites of the Northern Thai region and this situation provided the team with opportunities for trekking, rafting and outdoor activity within the 18-day expedition. The villagers and school teachers were most hospitable and there was much to be learnt from the culture and environment of the Lahu people.

Design

The school principal required an open sided shelter (15 m×9 m) to function as a canteen and meeting hall for teachers and village representatives. The structure was to be permanent and the original request was for a reinforced concrete frame and brick infill building. The school did not appreciate indigenous material such as bamboo and thatch as choices appropriate for the purposes of upgrading. The school principal and staff eventually agreed on the proposal of a timber structure with sheet roofing to match the existing building on site. The new structure would be set at one edge of the school compound overlooking the Lahu village down slope.



8.2 Sketch of roof construction

In terms of construction detail, the design took into consideration the following points:

- The reduction of dead weight of structural timber in the structural configuration to facilitate the handling of individual members by student manpower. To this end, timber sections sizes did not exceed 200 mm×50 mm and timber lengths of not more than 4m were used in the fabrication of structural components. Overall dimensions of connectors were not to exceed 500 mm in any dimension.
- Constructional connections were to be built by unskilled student teams using portable electrical tools. Three mm thick galvanised mild steel plates with 10 mm and 12 mm bolts were used in connecting the timber structure.
- The erection of the structure was to be carried out with scaffolding and props improvised on site. Initially, the trusses were expected to be constructed on an elevated scaffolding and lifted up on to column heads without mechanical aid. This, however, was not to be, as the roof trusses had to be rigged on a flat surface and hoisted up by crane. Although 10 students could physically lift one truss (each truss was estimated at 211 kg of weight), the decision was taken to use a crane, due to the need for manoeuvring the trusses onto the beam at an elevated position, and the lack of sturdy scaffolding to support both students and trusses.
- Structural components were to be made out of standard sections of steel and timber in order to ensure their availability and supply and the timely prefabrication of galvanised mild steel connectors. The construction plan was

to join the locally-sourced timber with structural steel connectors fabricated in Singapore. A local Thai engineer confirmed that reinforced concrete pad foundations would suffice on the laterite soil and the footing design for a bearing pressure of 90 kN/mm^2 was detailed by a Singapore-based structural engineer for construction in Thailand two weeks before the team arrived on site.

- The structure was to be completed within a construction period of two six-day periods amounting to 12 days with working hours of 9am to 1pm and 2pm to 6pm. (In December in the North Thai Highlands, the daylight hours are short and whereas it is still misty at 8.30am, dusk sets in by 6pm. At noon, the sun is extremely strong and there is no shade on the site in the afternoon.)

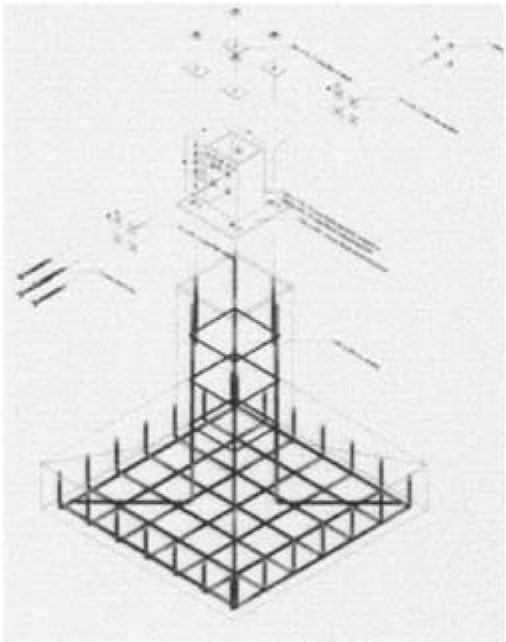
Development of the roof structure design

In the initial plan for the roof structure, small members were used to lighten the dead load, and to simplify fabrication and jointing. To span 15 m× 6 m and to support sheet roofing, the first option (see Figures 8.4a and 8.4b) was to have a longitudinal spanning beam at the ridge position, acting as a structural spine that would divide the transverse spans into a manageable 3 m length using trussed rafters (as configured in Figures 8.4a and 8.4d). However, this option implied a 15m spanning truss. The fabrication and hoisting of a single element of this size would be problematic, requiring substantial temporary propping and scaffolding.

The next option was to use trusses configured for minimum dead weight in the transverse span of 6 m at 1.5 m centres. The structural form of the truss would comprise elements sized only for primary axial forces, thereby reducing their cross-sectional areas (find deadweight) to a minimum (see Figure 8.4e). The roof trusses were designed as single entities to be connected to the roof beams at column heads 3 m above the timber deck level. Columns at 3 m centres would support the roof beams and the roof trusses would span 6m. This latter option was used and the roof trusses were eventually designed with their bottom chords in steel and the upper chords in timber. These top chords were originally conceived as twin timber sections with dimensions of 125 mm×50 mm. The sectional sizes were later required by the structural engineer to be twin 150 mm×40 mm allowing for inconsistencies in the quality of the timber. Twin stainless steel cables of 4 mm diameter were used as tension chord members. This resulted in the total weight of each roof truss amounting to 211 kg (see Table 8.1). The cables with crimped heads and claris-pin connections were ordered from a Singapore supplier and a Singapore steel fabricator produced the galvanised mild steel connectors.

Table 8.1 Roof truss components and weights

Breakdown of weight of truss according to components for assembly	
Rafter	154.8 kg
Brackets	36 kg
Filler pieces	9.6 kg



8.3 Design of foundations

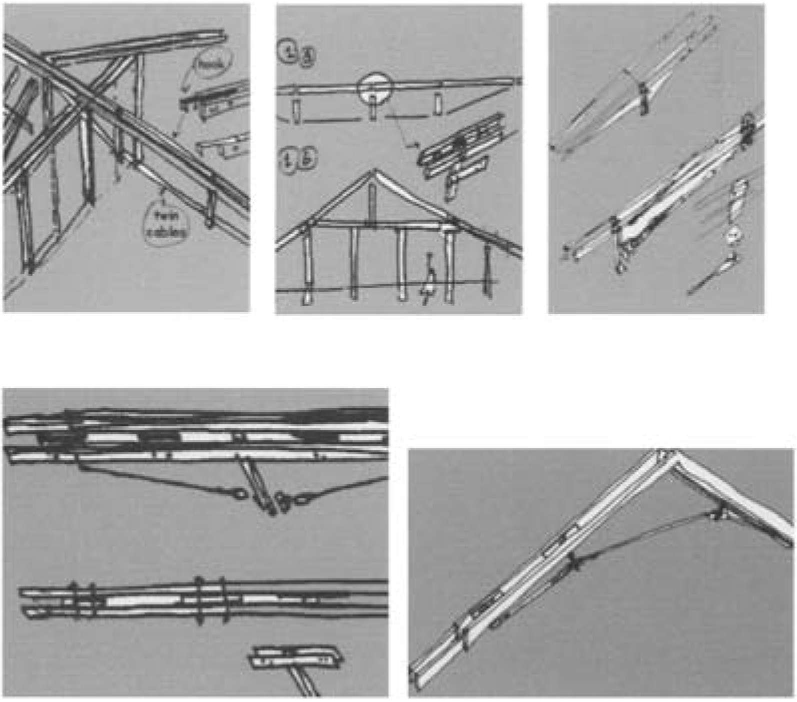
Breakdown of weight of truss according to components for assembly	
Bolts	2.16 kg
Steel cables and connectors	4.5 kg
Total weight	211 kg

Logistics

The total number and specification of bolts, nuts and galvanised mild steel connectors was estimated from drawings and priced by suppliers in Singapore whilst the timber was priced by a Thai sawmill, 50 km from the village site. In anticipation of the unavailability of the supply of building materials near the site, the essential tools, instruments and fasteners were brought up from Singapore one week before the team began construction (see Table 8.2). The final construction cost of the structure including Singapore fabrication costs and Thai hardwood was US$10,000 (see Table 8.3).

Table 8.2 List of tools and components

Tools	Metal parts
Handsaw/circular saw/jigsaw	Handrail post



8.4 Roof construction drawing

Tools	Metal parts
Adjustable spanner	Beam column connector
Hammer/screwdriver	Ridge connector piece
Pliers	Mid-rafter connector piece
Extension cable	Beam rafter connector piece
Levelling hose	Metal shoe
G/F clamps	
Power drills	
Planer	
Crowbar	
Torque wrench	
Safety belt/helmet/goggles	

Table 8.3 Costs

Construction costs	
Stainless steel cables	US$2,514
Pre-fab connectors	US$3,055

Construction costs	
RC foundation, Thai hardwood	US$4,431
Total costs	US$10,000

Modifications to the design due to problems encountered in the course of construction

Footings

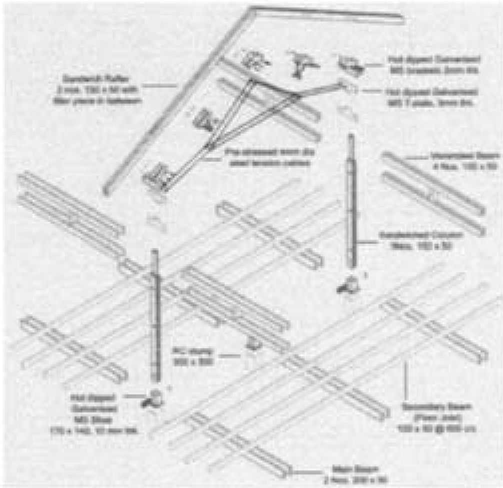
On site, the first operation involved the levelling of the top of the reinforced concrete footings before bolting down the galvanised mild steel column-shoe connections. This was done on arriving at the site and the next morning. The footings were completed to a reasonable level of workmanship and required little corrective levelling. However, the spacing of the footings was slightly off and this resulted in a span reduction of the roof trusses. Another deficiency in the workmanship was with two members of base plates that could not be properly secured to the two footings because not all four bolts passed through the reinforced concrete footing head and shoe plate.

Columns

The next operation included the measuring, cutting and bolting of primary floor beams and the fabrication of the 10 built-up columns. Problems emerged with the construction of the columns that were caused by discrepancies between timber sizes and galvanised mild steel column-shoe sizes. The galvanised column shoes were fabricated to fit timber sections assumed to be cut in metric dimensions, but the Thai timber was cut in imperial units of measurement. The column now had to be built up of three 2-inch ×6-inch pieces instead of 150 mm × 40mm. The difference was 30mm total and the team had to notch away 15 mm on the two extreme column sections. The notching with handsaws and planes was not consistent and in some cases, more than 15mm was removed, resulting in a 'loose fit' at the column-base connection. This loose fit resulted in a column which was not rigid at the base, which allowed the overall structural frame to sway. This problem was resolved by eventually strutting the top chords of the roof truss to the insides of the column, creating a portal frame-like 'action' in altemate structural bays.

Beams

Several three- to four-man teams working from scaffolding erected along the column positions fabricated the vierendeel beam. The vierendeel beam had the



8.5 Roof component drawing

8.6a Construction of footings

advantage of providing rigidity in the longitudinal direction, obviating the braced bay configuration that would have affected the usefulness of the pavilion structure. This beam was originally structured to bear the weight of 11 roof trusses, hence its heavy configuration. Fabrication of this part of the structure was limited by the available amount of metal scaffolding that could be borrowed from local Thai sources. The method was to arrange the metal scaffolding adjacent to the column positions and to use floorboards to span the distance between scaffolds. This would allow three teams of three to four men to work at the three-column head positions

8.6b Footings

8.7 Cutting primary floor beams

at any one time. This arrangement was also limited by the number of power drills, some of which were deployed with the roof truss fabrication team.

8.8 Columns

Omission of T-plates

In making the entire length of the vierendeel beam, GMS T-plates were used to connect the vertical struts to the top and bottom chords of the beam to increase the area of connection between the separate pieces of timber to be joined both along their lengths and perpendicular to each other. T-plates connectors were not easily constructed and the procedure took some time to align bolt holes with pre-drilled plate holes. These connectors were confined to only four column heads (two on each side of the structure) by using 6 m and 4.5 m lengths of timber to make each vierendeel beam in three sections.

Roof

Initially a small part of the team was deployed to fabricate the 11 roof trusses. When the first truss took a whole day to complete, including its fabrication template, it became apparent that at this rate only five would be completed within the limited time period allowed, Decisions were therefore made to re-configure the roof structure using only five primary trusses. The extra timber sections that

8.9 Erecting columns

were unused from the balance of the trusses would be used for purlins to support the corrugated sheet roofing.

To divide the 3 m span of the purlins in half, an additional four secondary rafters spanning 6 m were introduced between the 3 m column spacings, supported off the vierendeel beam. The secondary rafters were made out of welded 100 mm×50 mm mild steel sections purchased from a store 80 km away. When the reinforced concrete pad footings were built too close to each other in the transverse axis of the buildings, the effect was that the roof span was reduced to an extent whereby the positions of the truss-beam connections could no longer maintain full tension of the stainless steel cables in each truss. This meant that the roof structure could not fulfil its load-bearing function. Since the position of the truss-beam-column connectors was fixed by the footing positions, it was suggested by a student that the positions of the lugs be moved outward to gain the extra distance required for the cables to be in tension again. The decision was thus made to weld new lug positions, having sourced a local Thai metal worker. (The cost for this variation for 10GMS saddle plate connectors was 150 *baht* or US$6.)

After propping the columns with floorboard pieces wedged to buttresses nailed to floor joists, a crane was rented to hoist each of the 211 kg trusses. During the first attempt at lifting one truss, the truss sagged and the cables slackened. This

8.10 Fixing top chords of roof truss to the insides of the column

was because the tension in the cables could not be activated by the dead load of the truss before it sat on the beam supports. It became necessary to prop the truss before lifting in order to maintain its geometric configuration for fitting on to the vierendeel beam (and to avoid fracture). This was done by nailing a 100 mm×50 mm timber piece across the face of the truss and wedging another piece between the forked galvanised mild steel connectors.

Completion

On Thursday in the second week of the expedition, the primary structure was completed. Local Thai roofers subsequently completed the roof cladding and a local Thai electrician completed the electrical installation with a DFB for 10 lighting points and two power points.

Design learning in relation to assembly process

Students learnt much from the assembly and jointing procedures and discovered the difference between theory and practicality in the construction of a building initially conceived on paper.

The design was conceived in relation to consecutive stages of assembly carried out by dedicated construction teams. Students envisaged the assembly in relation

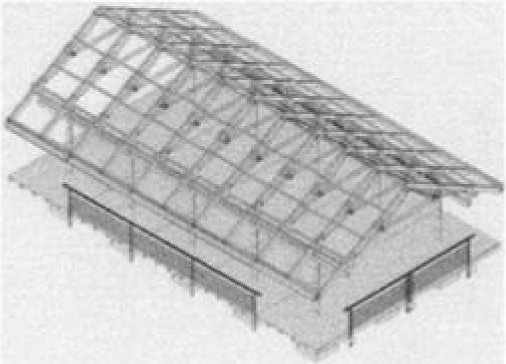
8.11 Beams

to a perception of their individual and collective abilities. The project was planned according to the time constraint of 12 days for a 15 m× 9 m single-storey timber structure. This meant that a minimum number of joints were required in order to connect efficiently the structural members necessary for a stable structure of the required span. In addition, the joints were assembled (drilling and bolting) by students with limited construction skills and coordinated with an anticipated assembly process consisting of similarly experienced student teams. The timber elements were sized to be kept to a minimum and though all structural members were initially intended to be assembled and lifted into position manually, the roof trusses (which weighed 211 kg) were lifted by a crane hired from a location 60 km distant from the site). Though the necessary on-site adjustments to the construction and assembly process of the superstructure were problematic, the students' experience particularly benefited from these unplanned variations to the intended programme.

Logistics planning

Power supply was limited and it was uncertain if the hardware stores stocked the fasteners, tools and equipment required to complete the construction of the building. For this reason, students itemised every tool fastener and piece of equipment that was to be freighted on site before the team arrived. The footing

8.12 T-plates



8.13 Drawing of roof design

plans and details were issued early so that the foundations would be constructed prior to the arrival of the team. Even this aspect of logistic planning was peculiar to the pragmatic paradigm because only the necessary resources (tools) were identified for the task at hand. At all stages students were made aware of the relationship between the building's assembly process, the nature of the assembly components, and the tools and parts necessary to effect that assembly. This was

8.14 Truss-beam-column connectors

8.15 Propping truss

an important factor in developing *associative thinking* abilities for the architecture students (Peters, 1996).

Cultural experience

Students realised that their notion of culturally appropriate schemes for the vernacular context were not necessarily the ones useful to the client. Student studio designs featured bamboo and thatch as construction material. The clients preferred concrete for durability and robustness (as the structure was to be used as a student canteen). Local tropical hardwood was eventually agreed upon by both the 'architects' team' and 'client' so that the construction system could be completed realistically with limited student skills, within a short time period, and an economic

8.16 Lifting truss

8.17 Fitting truss onto vierendeel beam

budget (vernacular materials could only have been utilised with skilled craftsmanship). This was important as students now understood the limitation of academic solutions when they were tested with the real-world needs and expectations of a real client. In the epistemic approach, the client profile was often a figment of the students' (and tutor's) imagination by theoretical argument. Sometimes, the perception of the client's character and aspirations was a projection of the tutor's or the students' personas, and these were far from reality. Conway and Riggs (1994) articulated the educational goal of introducing the value of technology to design students, saying they

> become aware that technology is used to make judgements about other people; it is easy to assume that a society without 'high' technology is more 'primitive' merely because its level of technology is generally lower than ours. Yet often a lower level of technology may still incorporate a fine balance of needs and available resources. Students soon realise that the assumptions they have about the needs of other people must be challenged.
>
> (Conway and Riggs, 1994)

Lessons learnt

Limitations of the Ban Patai design

The original idea to design the 'minimum' joint to facilitate transportability and to reduce prefabrication costs was now evaluated in respect of construction ease. In this respect, the key limitations to the idea of minimum joints were centred on the dependency of the joint design on site accuracy. Problems arose from:

- The inability of the roof truss/ beam connection to adjust to inaccuracies in the column position caused by inaccuracies in the footing positions.
- The demand for precision drilling through more than two or three layers of timber members and connecting plates in order to make a structural joint.
- The demand for straight pieces of timber of exact cross-sectional sizes to fit the column-footing shoe.
  The shoe might have been designed to fit a range of sizes.
- The roof truss could not be constructed if there was no existing physical level floor to work on.

In addition, another important limitation was in the physical weight of the roof truss, which required a crane for lifting. The building erection was designed to be conventional in method, requiring conventional scaffolding to complete its construction; however, the modified erection process using a crane would not be realistic for most remote locations.

Positive points of the Ban Patai design

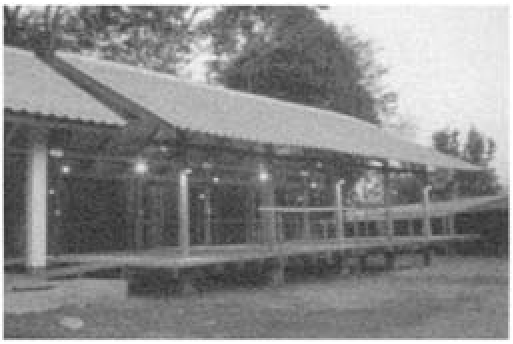
The primary roof structure was stable whilst under construction. The saddle clamp connection for the roof truss-vierendeel beam was stable for ridge top access (one could climb on to the truss rafter to construct the rest of the roof). The vierendeel beam obviated the need for a cross-braced bay and this freed more space without physical encumbrance.

Conclusions

The following design principles were inferred for greater deployability from the limitation and negative and positive points of the Ban Patai project:

- The design of prefabricated metal connections should ensure geometric accuracy and structural continuity without being affected by member misalignment caused by factors on site.
- In the case of transported components to be assembled by unskilled workers, the designed connections should not demand a great level of skill, precision or

8.18 Interior lighting



8.19 Exterior lighting

workmanship, neither should the structural integrity of the whole structure be compromised in the event of inconsistencies in workmanship.

- The design should allow for one element of the structure to be stable before the next one is added to the configuration.
- In this respect, the structural elements could be designed as scaffolding for teams to access elevated positions and for hoisting tools and roofing material.
- Where prefabricated components were to be used, their design should be simplified to avoid costly mouldings or expensive workmanship. Manufacturer's profiles cut and joined by continuous welds would be a first choice for making such components, cost effectively.
- A composite structure requiring on-site material should not demand a great deal of consistency in the quality and accuracy of the site-sourced material(s). Precision and adaptability of the fabricated joint to varying site-sourced material should be factored in at design and planning stages.
- Deployable structures should be built without the need for scaffolding cranes or complex equipment.

An important consideration for future proposals might be to investigate if a structure could be designed to allow for the incorporation of locally developed materials and building systems. These might be traditional or improvised. In this regard the Ban Patai project posed a particularly pertinent question in respect of future planning—would a structure with disintegrated components and conventional joints be easier to assemble than a structure with special joints and integrated components? In a well-conceived design, it is possible that both approaches could be equally effective in terms of ease of assembly, although the structure with special joints and integrated components could perhaps be more appropriately designed for unskilled laymen to work with.

Project credits

Expedition team leaders Joseph Lim(Deputy Head, NUS)James Leow(Principal Architect, Design Group Inc.)Virendra Kallianpur(Research Assistant, NUS) **Technical support**Chua Beng LeongChan Chee Lam(Construction IndustryTraining Institute Trainers)**Design**Dr Joseph LimDr Hossein Rezai-Jorabi (Web Structures)Virendra Kallianpur**Members****M Arch Level 1**Seng Siang HouLai Hong WhoTham Ban FattYip Weng TuckHo Yuen PuiChong Keng HuaTeo Hui LeongWong Wai YeeTay Wee LengChin Chwee KimQuay Shey-YeeLai Swee LengChan Ee Mun**M Arch Level 2**Koo Kin MengLim Tian PingChoo Wee Chyn**Industrial design**Chia Hui EeLee Hui XianNg Hwee LingTay Wee Kang**Suppliers of galvanised mild steel connectors**Sin Yu Lee Engineering**Suppliers of stainless steel cables**Lian Hup Seng

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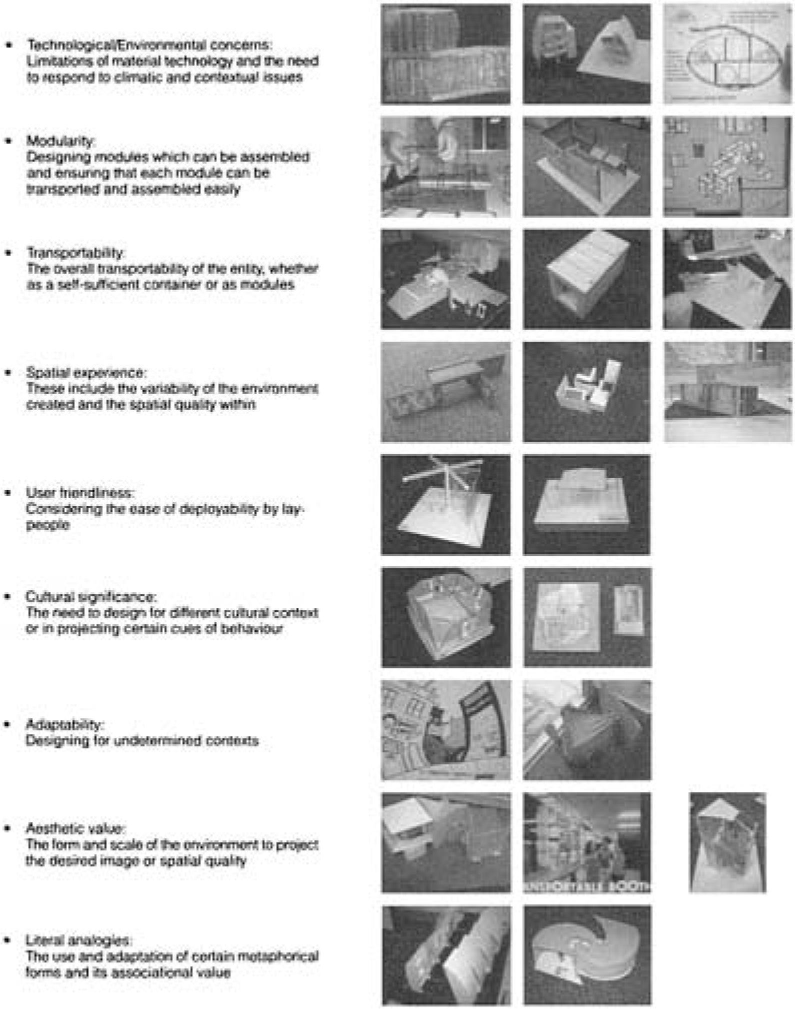

9.1 Transportable Environment Design Constraints

Transportable Environments: Modes of Inquiry in the Design Studio

Hee Limin and Colin Seah

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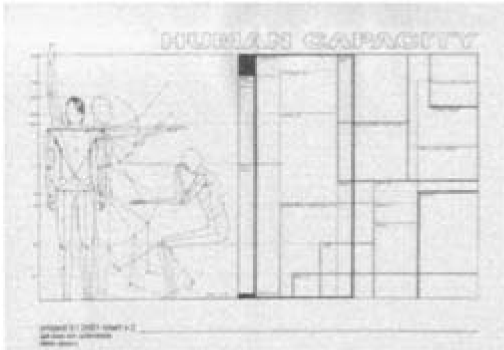
Pedagogical objectives

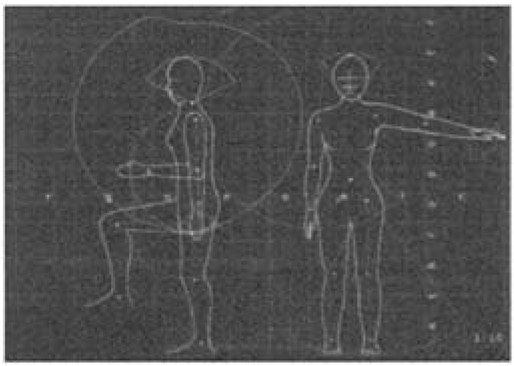
The first year design studio at the National University of Singapore, Department of Architecture consists of 38 architecture students. The pedagogical objectives of this foundation-course level studio programme were two-fold. The first objective attempted to chart design methodology in a studio setting where a 'student-formulated' programme was used as the design brief instead of one written by the tutor. This process of formulating the design brief demanded that students examined with greater clarity the basis of their architectural agendas and design motivations. The personal authorship of the design brief provided students with the opportunity to begin developing their individual attitudes and positions with regard to architecture. The second objective was to reconsider the paradigm of architecture as permanent and 'gravitas' in the contemporary cultural, social and technological context. The design vehicle of the 'transportable environment' was used for the purpose of meeting both the objectives. This mode of inquiry necessitated thinking from first principles, i.e., re-examining issues of space definition; scale and anthropometrics; structures and building systems (portable in this case); the critical issues of assembly and deployability; and functional operation in its most efficient form. The studio was thus a laboratory in which the design process transformed the notions of transportable environments into pluralistic design solutions.

Design vehicle and structure

The six-week studio comprised two main phases that were preceded by a primer on the issue of scale. The first phase involved the formulation of an architectural manifesto that formed the basis of the student-authored programme brief. This period was essentially a discovery and exploration of 'first principles'. The second phase involved the application of first phase findings to the design of a transportable environment.



9.2 Anthropometric Chart I



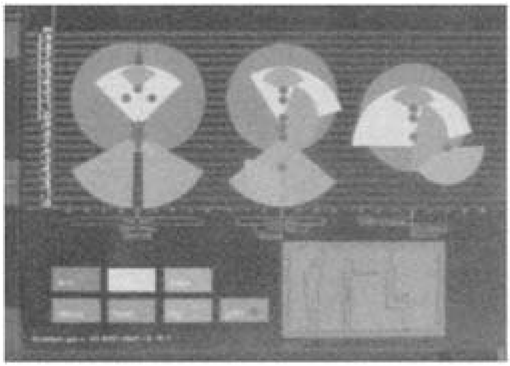
9.3 Anthropometric Chart I

Anthropometric charting

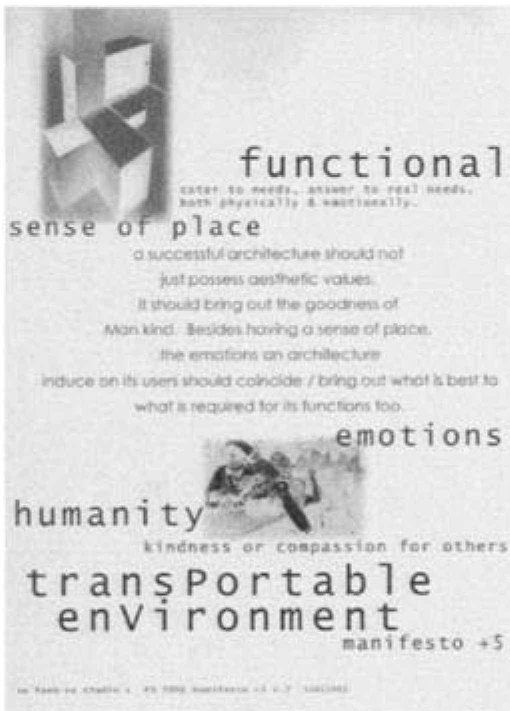
A primer study on the issue of scale was necessary as understanding it formed a basic tool for design. Students would find the detailing of elements and the understanding of kinaesthetic spatial experience difficult without considering them in relation to direct contact with the human body. Studies on anthropometrics and ergonomic issues of scale formed the foundation platform for students to develop and explore solutions with greater sensitivity and sophistication.

Students did not rely on existing anthropometrics and ergonomic charts but instead used them as reference points in creating their own charts. Two main student approaches to these charts were identified:

- The ‘total body chart’ (Figure 9.2) that focused on the reach, span and dimension of the human form was the most prevalent one developed by individual students. By leaving user activities and actions undefined and rendering the body as the absolute measure, the chart worked as a measure by which the designer determined the optimal dimensions for any given action against the corresponding body part(s).

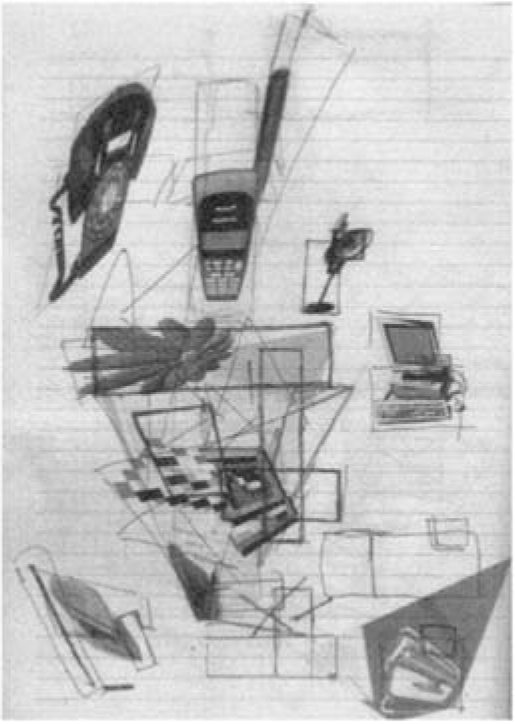


9.4 Anthropometric Chart I



9.5 Design Manifesto I

- The second approach had a primary focus on user activities and actions. The students studied a series of general sets of activities/actions encountered in relation to a small shelter when laying down, kneeling, squatting, sitting, standing, etc. Several of these also included the dynamic motions of walking and jumping (Figure 9.3). This approach abstracted the absolute dimensions



9.6 Design Manifesto II

> of the body by disregarding its actual measurements and applied them instead to a range of common activities for which accepted standards had been predetermined by industry. It was possible that at this initial stage some students had already conceptually linked the charting task with later design development. There was, however, a discernible disadvantage to this approach —that was the tendency to predetermine or limit the type of activity designed for. The chart's limitation was that it could not include situations that had not yet been designed for.

In addition to charting the body and its activities, a number of students acknowledged sight and peripheral vision as one of the body's reaches, at least equal in importance to its limbs. These students recognised that the physical body navigated space with its supporting senses (Figure 9.4).

The students utilised these charts as a means by which to measure their design proposals. Despite this intention, the effort invested in the accuracy and legibility of these charts was not reflected in their use at later stages of design. Significantly, in these cases there was a missing link between the documentation of scale in the abstract and the application of actual scale.

Design manifestos

Following anthropometrics charting, the next stage of the design studio focused on identifying 'first principles' in determining the design problem. A prelude to the main design exercise, its aim was to distinguish authentic design intentions from arbitrary preconceptions. This comprised a critical distinction between what a transportable environment *should be* and not what it *should appear to be*. Drawing from varied sources of inspiration including prose, graphic art, sculpture, photography and other non-architectural sources, students described their intentions in a short essay. This manifesto then formed the basis for the programme brief (Figures 9.5, 9.6 and 9.7). This cross-referencing between manifesto and programme brief acknowledged the notion that architecture exists simultaneously as an idea as well as materialisation—as a concept as well as an object (Zumthor, 1998). A common observation was that students used each source of inspiration independently, defining with each source a new and unrelated principle. This lack of convergence made the relation-ship to the actual design brief tenuous. Many of the students found it too difficult to create a coherent problem that allowed them to explore each and every one of the often divergent and varied principles previously determined. Such an example would include radically diverse intentions like 'the transportable environment must be energy efficient; should be able to vary its shape, size, function to adapt to its environment; must provide a sense of homeliness; must create a colourful and lively atmosphere'.

Design approach

Design is much more than mere problem solving, but here we need to define what constitutes the design problem. To use Thorndike's definition, a problem can be said to exist if an organism wants something but the actions necessary to obtain it are not immediately obvious (Thorndike, 1931). This definition includes both problems, which are predefined, and those that appear in the defining and redefining of the design problem. This paradigm formed the basis of the design brief formulation in the studio experiment.

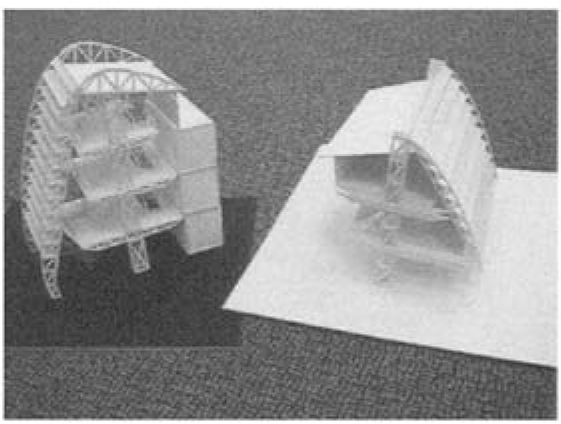
Types of design problems

The students' efforts to formulate their own design brief revealed some generic approaches in framing the design problem (Rowe, 1987):

- *The closed brief: well-defined problems:* through the use of the manifesto and design brief, some students had defined clearly the ends or goals of the design problem, in which the solution was limited to providing the appropriate means (Newell et *al.,* 1967). Examples of such problems included re-thinking the use of existing shipping containers as living and working quarters for construction sites (Figure 9.8). The existing use of such containers and its inherent problems were investigated by the student, who then thought of the range and degree of the problem to be solved—would the solution be limited to space-planning problems within a defined context? Was it associated with the configuration and layout of such containers? Or was it necessary to add an organisational framework to the use of such containers? The defined problem approach covered the range of mobile containers that had the ability for extension through the use of 'slotting' or telescopic devices (Figure 9.9). Here the design problem included the space planning and userfriendliness of such environments as well as the incorporation of appropriate technology and construction methods. The ensuing environment and its spatial aesthetics also had to be considered in such an approach. Another example was the adoption of a particular system or mechanism, like the use of a spring-loaded fabric roll that might be snapped back or pulled out for assembly (Figure 9.10). The assembly methods were clear for such a system and the problem was limited to how to configure a suitable spatial form with such a system and the subsequent incorporation of furniture and other systems within such a structure. Such a design process always embodied a recognisable element, with no drastic change in the overall design concept. It also allowed students some rigorous parameters with which to explore in detail the resolution of their design. These problems or design briefs generally also set out clear criteria for the ultimate assessment of the design outcomes.

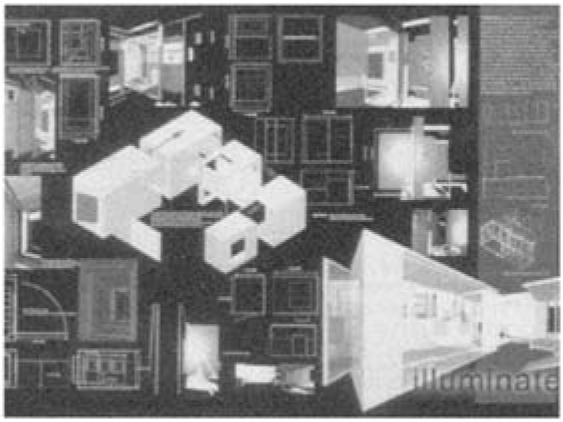
- *Open-brief: ill-defined problems:* for design problems which were termed ill defined, the ends and means of the solution were unknown at the outset of the design exercise (Newell *et al.,* 1967; Bazjanac, 1974). The general thrust and qualitative characteristics of the outcome may have been clear, but quite some time was spent defining and clarifying what exactly was desired. Some examples of this approach included the conceptual design of elements, which might be assembled in some ways not known to the designer at the outset of the problem definition. The solution had to include the design of the yet unknown system, its degree of compatibility and ease of setting up, its possible configurations and possibility in spatial definitions, etc. Such an approach might entail several drastic changes in the form of the design solution with each refocusing of the design problem. Another example of this approach started with general intentions and functional guidelines, but required clearer definitions to be established along the way. Many of the projects in the design studio fell within this type of approach. The investigations of these problems included several projects dealing with underwater environments, deployable structures for exhibitions, sales booths, portable shelters, and movable stages (Figures 9.11, 9.12 and 9.13).
- *Wicked problems:* some design problems may be so ill defined that they are termed 'wicked' problems (Churchman, 1967; Bazjanac, 1974). This design approach starts with problems without a definitive formulation or even the possibility of being well defined. Asking more questions may lead to further reformulation of the design problem, which may then be constantly in flux. As

9.7 Design Manifesto I

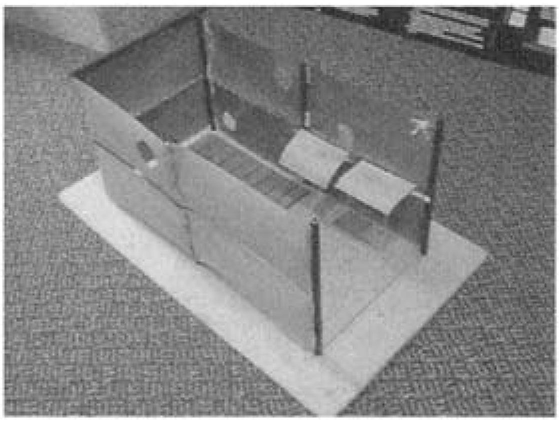


9.8 Live-Work containers

the problem is ill defined, there is also no clear point of having reached a suitable solution, or knowing when to stop the design process. The solutions explored may also result in reformulating the design problem and the process goes into a reciprocal mode of inquiry. The design brief may also be called into question

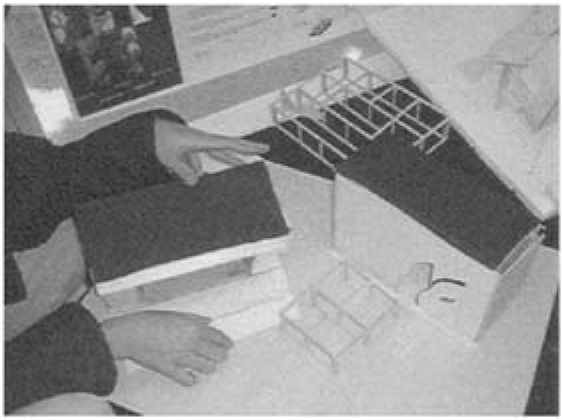


9.9 Telescopic workspace

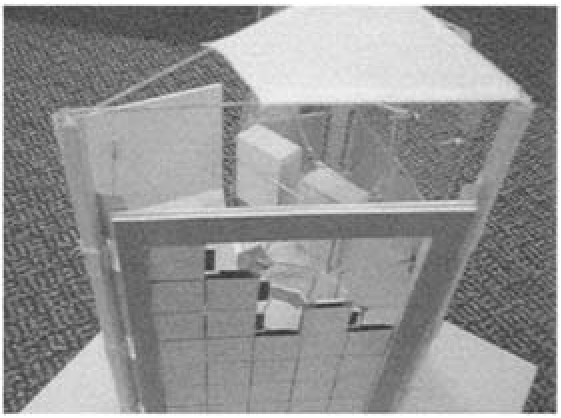


9.10 Roll-out workspace

from time to time, and deliberations like ‘what is meant by transportable?’ and ‘what constitutes environments?’ may be asked during the design process. It had been our speculation that such a process would benefit experienced designers but might lead inexperienced students into tangential trajectories which vastly exceeded the set time-frame given to each design project. Some students who adopted such an approach had figured that it might be more worthwhile to transport the person’s mind (digitally or through virtual reality) to different environments rather than physically transport the person. However, they also came to the realisation that such solutions were far removed from space-design paradigms and consequently might then not be tenable in the design studio. Another project had questioned the tailoring of solutions to fixed forms and built expressions and also the idea of comfort as a necessary prerequisite of design for the human interface—the resultant design solution

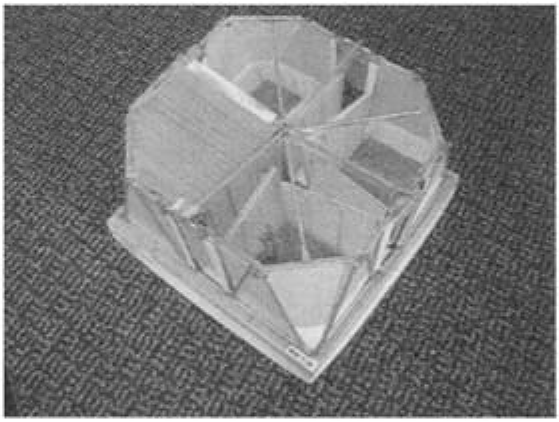


9.11 Portable stage

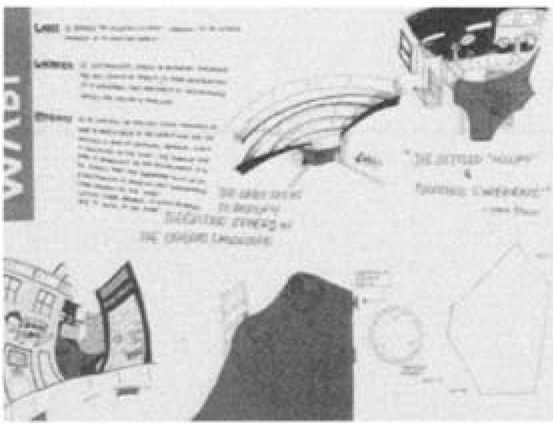


9.12 Deployable exhibition booth

was an innovative attempt to create a portable home for an urban nomad which could be attached to different urban surfaces (Figures 9.14 and 9.15). Another student attempted to invent a movable astronomer's observatory that challenged all conventions of type—unfortunately they did not manage to resolve the solution to a satisfactory extent (Figure 9.16). Such types of design problems, whilst serving to break down existing paradigms, might also only end up being 'frozen' at a rather conceptual stage due to a continual flux of ideas which were irresolvable to a satisfactory stage within the given time-frame.



9.13 Mobile shelter

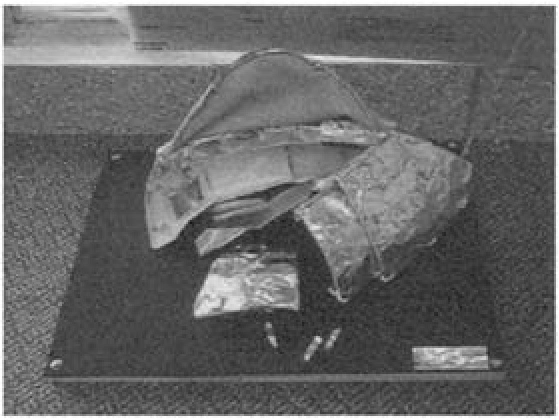


9.14 Urban nomad sketch

Design process

The design structure put in place for this project was one which was based essentially on describing the design process as a logical structure of activities or 'steps'—such as analysis, conceptualising, synthesis, evaluation, and communication—in order to arrive at the design solution. This structure was rather a mechanistic one similar to what Asimow had modelled: a vertical structure involving a sequential phasing of design activity and a horizontal structure involving a decision-making cycle which included a feedback and re-evaluation process in the design studio (Asimow, 1962). This structure assumed that design students were able to work within the distinct phases of the design cycle and develop a progressive solution. In this particular project (Figures 9.17 and 9.18), which involved the design of a portable gymnastics prop, the student was able rigorously and progressively to develop the design solution through a process of

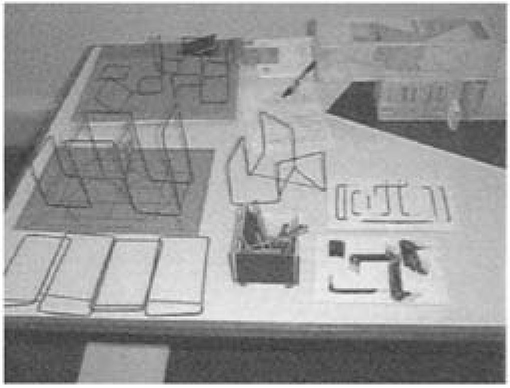
9.15 Urban nomad tent



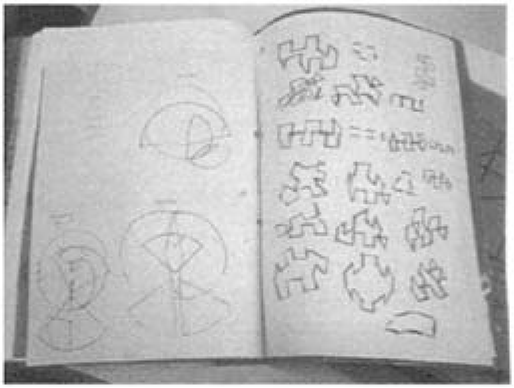
9.16 Movable observatory

analysis of needs, investigation of collapsible systems, synthesis of findings and testing of assembly methods to continually evaluate and refine the design solution.

However, within the design structure specified for the process, students did not have to adhere to the 'progressive spiral' structure as they were allowed to re-visit earlier formulations of intentions and their design manifestos whilst working on their design. Indeed, some students who chose to use Computer Aided-Architectural Design (CAAD) as a means of design and visual communication found that they were forced to make decisions early in their work a process that shaped considerably the eventual outcome of the design solution. What could be discerned here was the employment of the 'decisiontree' problem-solving method, or the use of the 'information processing theory' (Newell *et al.,* 1967). This scheme of working assumed the existence of a 'problem space' in which elements were grouped in 'knowledge states', some of which present solutions to the design



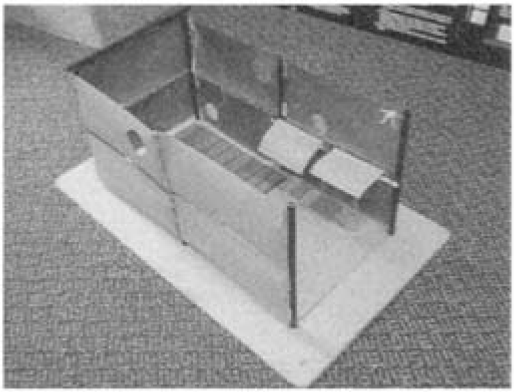
9.17 Assembly for Street Gym



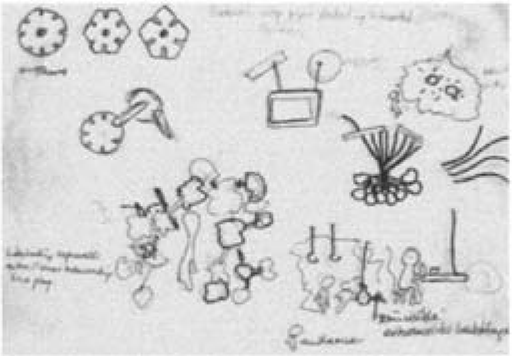
9.18 Process sketches for Street Gym

problem. These 'knowledge states' were then input into the design process through 'generative processes' or operations, which transformed the problem space. 'Test procedures' enabled the designer to compare various 'knowledge states' and to decide which operations and which knowledge states to apply in order to reach the particular design solution. Using the decision-tree model, combinations could be tried and tested against the intentions stated in the design manifesto and in the functional brief, as well as the scale requirements generated in the charting exercise.

This method helped to structure the problem-solving process by adopting a combination of courses of action through the most economical means towards a design, or range of design solutions. This process seemed to be possible only with the well-defined design problem as the 'problem space' needed to be already well established before the decision-making process was initiated. The use of this method was illustrated in this particular exercise in which the student adopted a particular system of assembly of parts (Figure 9.19) with limited range of configurations within the 'problem space' of possible transportable environment



9.19 Collapsible workspace



9.20 Process sketches

designs. The process was manipulated through a series of procedures to generate possible design outcomes that were then tested by functional criteria developed along with the design brief.

Design tools and influence

The reciprocity that occurred in the design process, between the hand and the mind, was explored through the use of different modes of representation freely chosen by the students in the pursuit of the design solution. The primary three modes of visual representation were chosen: drawing, physical models and CAAD modelling. Whilst drawing (i.e., using orthographic projections) would not capture spatial qualities as fully as 3-D model-making, the act of drawing helped to delimit concepts and was essentially the making of diagrams of intentions.

Intuitive designers who dealt perhaps with 'wicked problems' tended to use sketching methods; they were more likely to end up with a conceptual scheme than a highly resolved one (Figure 9.20). However, there were also students who kept meticulous sketchbooks documenting the whole process of the design search and who also addressed very thoroughly the need for detail resolution. The edge that actual model-making had over digital modelling was in the understanding of the tactile experience; for example, the feel of wood panels sliding over well-made slots could not be adequately explained in words. The designer consequently saw, understood and produced some-thing as a means of expression (Figure 9.21). While 3-D modelling enabled visualisation of spaces and scale, the incorporation of the temporal dimension and the movement of the body through space were more easily captured using CAAD. As mentioned earlier, the use of CAAD also forced earlier decision making and thus often allowed the student to resolve the design to a higher detail than the more fluid process of drawing and model making (Figure 9.22). It was also observed that the decision-tree or information processing method was more likely to be used by those who were able to start with a welldefined brief.

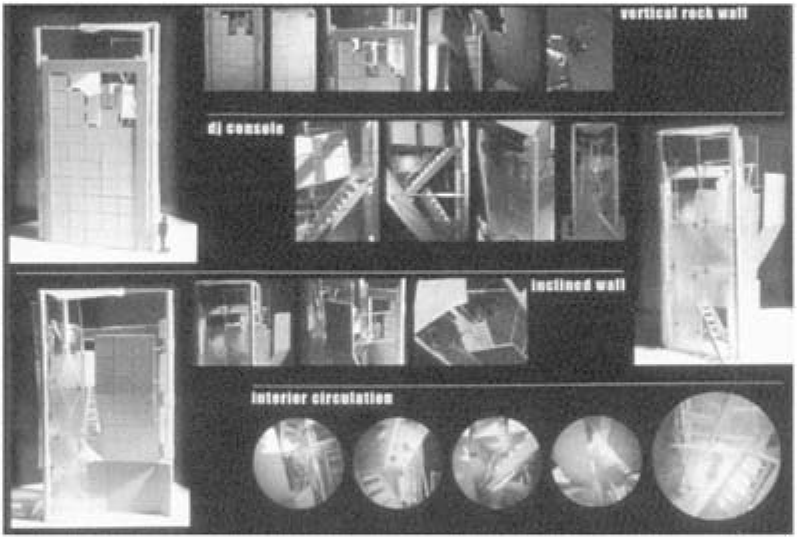
Design output

The design studio's output fell into two main categories:

- Transportable environments that featured a single entity (prototype based) approach (for example, Figure 9.23);
- Transportable environments that featured a combination (systems based) approach (for example, Figure 9.24).

The latter could be assembled in more ways than one. A further way to classify the output would be by explaining the concerns that helped to constrain the design problem and thus the design outcome;

- *Technological and environmental concerns:* limitations of material technology and the need to respond to climatic and contextual issues;
- *Modularity:* designing modules which were to be assembled, therefore ensuring that each module could be transported and assembled easily;
- *Transportability:* the overall transportability of the entity, whether as a self-sufficient container or as modules;
- *Spatial experience:* including the variability of the environment created and the spatial quality within;
- *User friendliness:* considering the ease of deploy-ability by lay-people;
- *Cultural significance:* the need to design for different cultural contexts or in projecting certain cues of behaviour;
- *Adaptability:* designing for undetermined contexts;
- *Aesthetic value:* the form and scale of the environment to project the desired image or spatial quality;



9.21 Model as a design tool

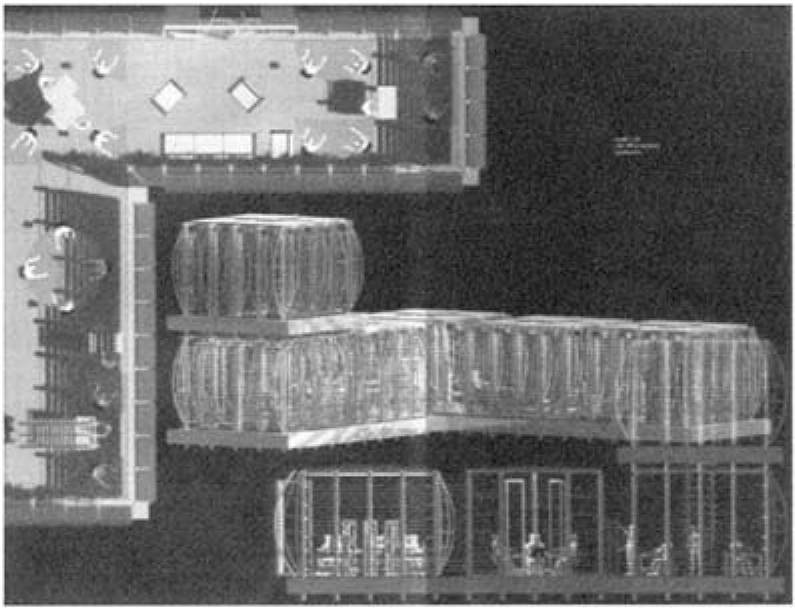
- *Literal analogies:* the use and adaptation of certain metaphorical forms and their associational value.

Analysis and conclusion

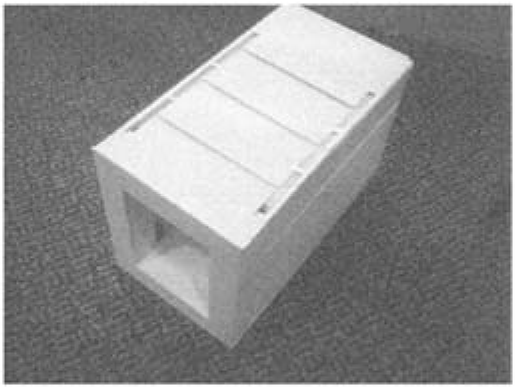
Design pedagogy and vehicle

The design of the transportable environment had proven well suited as a vehicle to explore the pedagogical objectives established. The multiplicity of architectural readings inherent in the realm of the design of transportable environments allowed students to define effectively their individual briefs against the collective backdrop of such environments. The collective backdrop served as a common ground, allowing the resultant projects to be critically assessed based on similar criteria. The vehicle for design was suitably provocative in challenging the tenets of conventional architecture when faced with issues such as deployability, portability, technology and contextualism. By critically assessing the results from the manifesto exercise, several observations could be made:

- By specifically excluding from the list of possible inspiration all architectural precedents, the students were generally effective in putting aside their pre-conceptions concerning built forms. The search for inspiration led them to many rather original sources. Although there was a tendency to sum up each source on a superficial level, those who investigated and understood their sources deeply gained more from the exercise. The manifesto exercise might



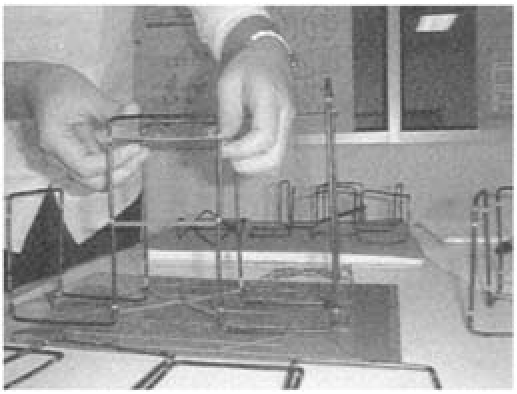
9.22 CAAD modelling of portable office



9.23 Prototype-based design scheme

have been more effective in encouraging the students to shed their preconceptions than it had been in the discovery of a complete set of 'first principles'.

- Students who were able to work with combinations of issues generated by anthropometrical concerns, a coherent manifesto and a well-defined brief were also able to furnish solutions with a high degree of resolution. Such design solutions were also most cogent in that the solutions related well to the problem formulation. Conversely, students who did not start with a well-scoped and



9.24 System-based design scheme

formulated problem tended to work in a more linear mode of analysis, synthesis and evaluation and often made major changes in the design approach when the problem was refocused. These design solutions were not as well resolved as with a well-defined brief. The most innovative solutions came out of 'wicked problem' formulations, but this process also took the longest and the solutions were not well resolved due to the lengthy reformulation process.

- The staged structure of the design programme did not benefit students who worked with ill-defined briefs or with 'wicked problems' due to their inherent need for a longer design development process that was not offered in such a structure.
- The use of CAAD as a design tool tended to push students towards the 'information processing' (decision-tree) model of problem solving and they generally achieved a higher level of design resolution. There was a tendency for students who worked with the 'information processing' model to develop schemes which fell into the systems-based approach as they had already established combinations of possibility within the 'problem space'. In other words, by delimiting the problem space, a 'kit of-parts' seemed to evolve which ultimately fell into place as a system-based solution. Conversely, students who continually reformulated the problem tended to create prototypes that were generally self-sufficient. This might have some implications on the design of transportable environments in that it is hypothesised here that *the design approach or method may actually define the outcome of the design process*, The other constrains, namely, technological and environmental, modularity, portability, spatial-cultural, user-friendliness, adaptability and aesthetic values further shaped the outcome, but did not influence the solution as much as the design approach.

One of the benefits of the open mode of inquiry in the design studio, includes the rethinking of existing paradigms and the questioning of first principles, which enables the problem of transportable environments to be seen in a new light. This way, it was possible to reframe the scope of the problem and premises on which design solutions were based, rather than solely on the types of solutions produced. However, it was recognised that one of the inadequacies of studio-based design was the lack of opportunity to create real situations in which to test the design solutions. This could perhaps be alleviated through the participation of industry in the design investigation process in the near future.

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Developing Architectural Skill by Making Temporary and Transportable Buildings

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Introduction

At the School of Architecture at Australia's University of Tasmania, designing and building small timber structures and installations in special studios is a part of a broad architectural education. The primary purpose of the project is not just to construct a building with a particular function but also to provide students with the experience of designing, documenting and constructing it.

Architecture is a practising profession primarily concerned with the design and construction of permanent buildings that match a client's brief and are sited within a particular context. The architect's professional skill is the ability to combine technical understandings of structure, material and construction with the 'art' of design to shape the form and fabric of a building. To achieve this synthesis and accommodate the practical requirements of client, site and cost, the architect relies on judgement tempered by experience to design a solution for each unique problem. On this topic of professional thinking, Schön (1983) describes judgement informed by experience as tacit 'knowing-in-actions' and states that it cannot be attributed to direct technical knowledge. He maintains that:

> the workaday life of the professional depends on tacit knowing-in-action. In his day-to-day practice he makes innumerable judgements of quality for which he cannot state the adequate criteria, and he uses skills for which he cannot state the rules and procedures…
>
> (p. 138)

> The practitioner [builds up] a repertoire of examples, images, understandings and actions…[the architect's] repertoire ranges across the design domain. It includes sites he has seen, buildings he has known, design problems he has encountered and solutions he has designed for them…
>
> (p. 49)

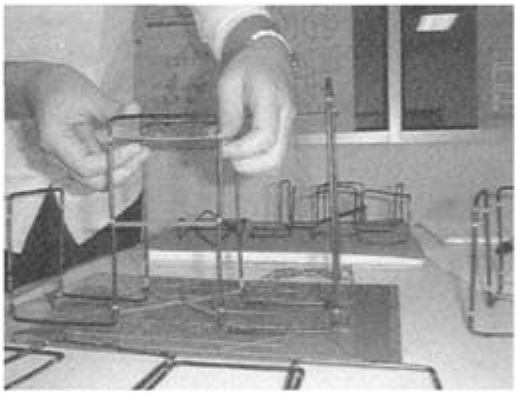
In architectural education, conventional studio techniques seek to develop reflective architectural skill and judgement by progressing students through series of graded design problems. Yet the students rarely have the opportunity to build the designs they conceive because of limited resources and the cost of building. As such, they miss the experience a practitioner regularly faces in resolving the problems of structure and material, connection and detailing, and forego the lessons gained from realising designs. This is problematic for a practising profession and for those seeking to educate students in that profession.

Learning by doing

> Theory separated from concrete doing and making is empty and futile.... The problem of the relation of theory and practice is not a problem of theory alone; it is that; but it is also the most practical problem of life. For it is the question of how intelligence may inform action, and how action may bear the fruit of increased insight into meaning.
>
> (Dewey, 1958)

> The strategy of building is not intended as a nostalgic refusal of the broader social obligations of architecture but rather as a beginning, a grounding of architectural understanding in the built environment before applying it to more complex issues.
>
> (Cadwell, 1996)

To learn by doing, students need to engage physically with structures, material science, connection and detailing. To develop a repertoire of successful solutions, students should see what others have done and must realise the product of their own designs. There are several ways this can be done in an educational context: by drawing, site visits, modelling and by building. Drawing is the simplest method and used universally in architectural education. However, it is probably the least effective way of making the connection between design conception and reality. Drawings are convenient and accepted two-dimensional representations of three-dimensional objects. However, they take skill to produce and to read and a level of understanding of what the design and physical arrangement are so that they can be drawn. Unfortunately, at the beginning of training, students do not have these skills. Visiting construction sites exposes students to the environment where drawings are interpreted. They require students to see structures, materials and making in a real environment and develop understanding of capacity, size and assembly. Modelling can be a sophisticated way of learning by doing as students can model their designs or exemplars, as do experienced professionals. The more complex or complete the model, the more valuable it is for experiencing structures, connection and detailing. Building can be the most educationally rewarding of all the methods discussed as it replicates the task that the architect in practice must detail for others to do. However, it is also the most risky. Building is an expensive, time consuming, and very public activity.



10.1 Prefabricating part of the building

At the University of Tasmania's School of Architecture, building is used as a primary method of exploring the juncture between theory and practice. Since 1993, this method has been regularly used in design and construction studios. The rules of the studios are straightforward. The students have to design a structure to match a brief, often from a community-type client, using a restricted palette and quantity of materials, primarily timber products. They have to detail and construct their design and erect it on site. To help them achieve this, staff structure the exercise strongly to limit unforeseen constraints and ensure a satisfactory solution can be achieved within the time, skill levels and materials at hand. The buildings are conceived as temporary. They are prefabricated in a workshop before being transported to site and the primary materials of their construction are timber products.

These are temporary structures, and declared as such to all involved. For the staff, the awareness is always there that the building is not the object of the exercise, education is. Yet, designing and constructing even a small building is a strong and definite act and the investment of material, time and emotion is considerable. The complete structure is on display as a public artefact, critiqued and tested vigorously both as a physical structure and an architectural composition. While such exposure is the *stuff* of the practiced professional, architecture students, especially those early in their professional education, often do not have the experience or repertoire of solutions to handle such situations with confidence. The 'temporary' tag marks the building as a trial and a prototype. This assists the process, as the expectation regarding the students' achievements is reduced and this encourages greater experimentation, improvisation and explor-ation within the set limits of budget and materials, The students make the design and building their own, as they must if they are to gain from the experience.

Identifying the structures as temporary also diminishes potential obligation from the client. This is occasionally useful. The generally adventurous and innovative designs of the student's work can exceed the boundaries of expected built solutions for generally conservative institutional clients, such as local government authorities or schools. Experienced in conventional building acquisition, most equate temporary with impermanent and, if need be, can equate the installation as a more disposable item. For those in these organisations promoting more adventurous building forms, the students' work provides a ready opportunity to trial concepts in locations where 'permanent' structures cannot originally be justified, in materials and arrangements not normally considered.

The buildings are almost always prefabricated in the school's workshop before being transported to site for erection. There are two major reasons for constructing any building as a transportable prefabrication. First, it enables the building to be preassembled before it is finally located. Second, it usually allows the building to be erected in its final location much more quickly than would otherwise be the case. For these studios, both are important. The advantage to be gained in the school's workshop is control of the building process. At the most obvious level, the workshop is protected from the elements, has secure, all-hours access and is fully stocked with tools, equipment and facilities. Work can progress there quickly, safely and with little unnecessary interruption. It is also contained within a designated work area. At a more discrete level, staff can support and supervise the students' progress and development much more effectively within the university's institutional context than on an open building site. In one sense, it protects the students while they assemble the solution that is soon to be made public and allows the teaching staff to work with them as they overcome potential shortcomings of their planning and detailing. Mistakes can be recognised and corrected. Prefabrication also encourages greater planning by the students. Since site time is limited, all connections must be detailed, constructed and tested in advance. This develops the students' self-confidence as they can practise assembly and erection prior to being seen and being judged in the public realm.

Erecting the building on site quickly and with apparent ease also greatly helps the construction process and allows a greater focus on education and achievement. Building sites are generally open and unpredictable places. Weather can turn bad, necessary equipment can be forgotten or mislaid, and curious bystanders can disrupt the work. All result in a loss of time and focus. As all the design and construct studios tend to push time and other resources to the limit, any shortfall in productivity can only be made up by scheduling more effort beyond the expected end of the project. By comparison, a completely transportable building can be installed very quickly, reducing site congestion and providing a notable occasion for students and client to enjoy. It is then an immeasurable boost to students' confidence to be seen building publicly in an efficient and seamless operation. As the on-site erection process often involves the support of outside professionals and the attendance of the client, the students rehearsed and proficient public building performance is a key in the measurement of success of the erection and final outcome.

Timber is the preferred medium for construction. Using wood, either sawn timber or products such as LVL and plywood, maintains the potential for design expression and speeds construction. Sawn material can be used as struts, props, slats and seating while plywood box beams provide light and strong elements in many shapes. To provide a coloured surface, the timber can be painted, or it can be oiled, leaving the natural grain as part of the design. Timber is also easy to use. It can be worked with relatively simple and inexpensive tools and can be assembled by a variety of methods. It is easy to nail, screw or bolt. Building with timber is also conceptually easier for students who have little constructional experience or skill. They can learn about it relatively easily and can contribute to the construction process, even if they have no building experience at the beginning of the programme.

The studios aim to imitate that portion of architectural practice that relates to a small building commission and reflect processes and decisions encountered in many design challenges. The methodology adopted is student centred with staff focusing on guidance and assistance. As in prac-tice, the design is developed through various stages including group work and modelling. Drawing as the tool for design is discouraged in most cases. It can become problematic if the educational objectives include team design skills, collective ownership and pride as key learning outcomes and measures of success. Drawing is a vehicle used by one student and then interpreted by others in discussion. With a single author, it inevitably carries a perceived singular ownership of ideas. Also, drawing is unreliable when the students' drawing skills are not highly developed and can waste valuable time. Further, drawing is just a two-dimensional representation of a three-dimensional idea, and hence relies on specialist reading skills for consistent interpretation. Model-making, on the other hand, if controlled by timing and repeat exercises, can overcome the problems associated with drawings. Fast, experimental model-making generates large numbers of design options, and if the team makes the models, the ownership of the design is collective. The models represent a distillation of ideas and, being quickly built, never become precious objects in themselves. Models allow and encourage team exploration of the constructional and expressive opportunities of materials and assembly through experimental fabrication, assessment and testing.

In addition to formal instruction on timber design and construction, new construction skills are taught and existing ones developed. Construction scheduling is explained and timing discussed. It is now standard practice that extensions of work schedules are agreed by all and take into account staff members' energy levels and safe work practices. While much of the apparent pride and display after the studio is given to the completed structure, the primary outcome of the studios is the education of architecture students. The building is just an enduring sign of their achievement. The life of the small buildings is important educationally, as well. Students are often required to review a building they designed and built in previous studies. The out-comes of this are often revealing and directly instructional as students revisit and reflect on their prior design decisions and construction efforts.

10.2 The seat group assembling their section

Case Study 1: Tamar Island Gateway Project, 1996

The Tamar Island Gateway Project (CHASA, 1997) introduced 32 first-year students to designing and constructing their first building. The programme, designed by lan Clayton, Robyn Green and Gillian van der Schans, explored the potential of learning through making. The resulting buildings excited the students and challenged the conservative architectural concept of the client. While truly temporary and lasting only a few years, the structures extended the boundary of acceptable design for the site and, when demolished, made way for a much larger permanent structure of similar form and material.

Preparation for the project

Teaching experience indicates that staff tend to underestimate the enthusiasm and ability of the student body. Therefore, a challenging and public project was sought for this studio. An opportunity presented itself at Tamar Island, a picturesque and popular visitor destination about 10 minutes north of Launceston on the West Tamar Highway. The Department of Parks and Wildlife, responsible for the island's management, was approached to allow the students to construct a building at the beginning of an elevated boardwalk that joined an adjacent wetlands reserve to the island. The site was a timber deck on the boardwalk, 6m in diameter, and originally constructed to accommodate a small interpretation building. This had never been built. While the request and approval to build on the site were informal, Parks and Wildlife retained the right to remove the buildings if they were dissatisfied with the results. From the start, the buildings were seen as temporary.

Prior to the studio, students were introduced to the design brief and the site. The class was then divided into six groups and each assigned one area of the design to develop, coordinate and build. The design tasks were defined by the staff after an initial client discussion and site visit but phrased so they were left open to interpretation. Each group was allocated a specific quantity of materials and had access to a pool of other materials that had to be shared between the six groups. Groups were allowed to exchange materials but the overall material allocation for the project was firmly fixed.

The design process

On day one, Monday, everyone was in the workshop, making models, thinking and designing. The students were only 12 weeks into their first year of architectural study and had neither designed a structure nor built one. Previous experience was restricted to model-making and an introduction to workshop practices. The students worked in their groups, designing with models at 1:10 scale. Brought together at different times to assess the progress of the building as a whole, students constructively critiqued each others' work. The initial models represented elaborate and overly complex buildings as they included many ideas bundled together. These were not rejected but the staff continually emphasised the amount of materials available. Technical questions arose as students realised they needed to consider issues of structure and anthropometrics. Consequently, they began to use span tables and other information sources. The sophistication of the models improved, now built at the same large scale but from pre-cut timber sections and sheet sized model-making materials. This tied the aesthetic design decisions to the material limitations and constructional constraints. 'We have learnt that cooperation is important in achieving a goal. The process took heaps of time and some-times made us angry and upset, but the joy and fun we had was above everything' (written student feedback).

On day three, the client visited the department to view the progressing model. Although still a working tool, the model clearly presented the potential of a carefully refined design. Students described the various elements of the building to the client. Colour was discussed and approval given for students to finalise the design. The groups then coordinated their controlling measurements and began to consider the detail connections between the separate elements. The initial design work was to be finalised by Friday morning, day five, when 1:1 construction would start.

Construction

On Friday morning, fabrication began. Studs were docked, columns fabricated, sill sections manufactured, and edges rounded over with a router. A great deal of re-evaluation took place as students encountered the changes that occur when elements designed at 1:10 are manufactured at 1:1. Feeling the heft and size of elements, students began to understand the relative strengths of materials. Timber sizes were re-evaluated and connections rethought. Technical information was informing and reforming the design.

> We learnt a great deal about structures andfixings. We found that a blob of glue on a 1:10scale model is equivalent to a heap of nails andbolts. Furthermore we discovered that anunbraced model held together with glue in reallife would not be structurally sound. Luckily welearnt this before the building was made.
>
> (Written student feedback)

In the following days, construction gathered momentum. Staff and students worked consistently over the weekend. On both days the workshop operated from approximately 9am to 10.30pm. By the end of Sunday, the bulk of construction was completed. By the end of Monday, all the individual components were assembled in the workshop and clamped together. Finishing work proceeded at a more relaxed pace, until the components were transported to the site on the Friday. Installation took a full day with each group installing their own component.

By the end of the Tamar Island project, students were asking challenging questions about design and architectural detail, and demonstrating an active attitude towards open inquiry. They exhibited confidence in using the workshop and were willing to experiment with basic construction and materials. They developed a strong and unified team spirit, appreciating the complexity and coordination required to design and construct a small building. Over the 10-day programme, the students demonstrated major shifts in perception, relating to their views and understanding of architecture. The building that resulted excited the students and challenged the conservative architectural concept of the client. They received the buildings with a combination of delight and anticipation. Local officers explained that such colours and forms would never have been approved through the department's formal committee structure but they were sure the park's users would appreciate them. The public response was unequivocal. They liked the buildings and used them regularly as a meeting place or a handy spot to relax on their trip through the park. While truly temporary, lasting only a few years, the buildings extended the boundary of acceptable design for the site. They were demolished to make way for a larger and permanent structure of similar form and material.

Case Study 2:2001 Australian Timber Design Workshop

For 17 days from 29 January 2001, the School of Architecture ran the 2001 Australian Timber Design Workshop. It was held in two distinct streams. Stream 1 was an intense five-day course of lectures, site visits and workshop exercises, attended primarily by architectural, engineering and other building industry professionals. Stream 2 was similar to one of the school's normal timber design and construction studios but included much of the Stream 1 lecture series and ran for the full 17 days. Twenty took part in Stream 1 while 40 architecture students from around Australia participated in Stream 2. These students approached the studio differently from the school's regular students. As they had to pay up-front

10.3 The student-designed and constructed Tamar Island Gateway Project 1996

10.4 The permanent replacement building

fees to attend, they were highly motivated, and knew the buildings had to be finished before the time came to return home.

The project for the workshop's studio was to design and construct two structures for a local shopping precinct. The local City Council planned to upgrade traffic and pedestrian facilities in its main street. When approached by the school, the City Council agreed to incorporate two new bus stop shelters in the redevelopment and to contribute to the cost of building them. As the chief client, the City Council coordinated community comment in the development of the designs and provided rapid building approval prior to construction commencing.

The two sites provided particular design challenges for the students. Both were adjacent to the main street, a busy and noisy road, with surrounding visual environments crowded with advertisements, signs and various building forms. One site was in front of the car park for the local Pizza Hut take-away food store, while the other was adjacent to a Chickenfeed variety store. Chickenfeed is a local chain of discount stores, notable for their cut-price goods and very distinctive red buildings. Both shelters had to provide basic protection from the elements while allowing a clear view of approaching buses. The City Council also provided a

10.5 Students begin fabrication

strict building envelope for the designs and listed a range of other basic requirements.

On the first day of the workshop, the students were broken into two groups of 20 and taken on a tour of the sites. The programme was explained in detail. The students were to attend a proportion of the technical and professional lectures with the Stream 1 participants and prepare working models of the shelters in the first five days. In the remaining twelve days, they were to develop the designs and construct the buildings. The palette of material they could use was fixed; plywood of various thicknesses, sawn hardwood, sawn softwood, paint and limited quantities of 'special' items, such as metal roof sheet and steel. Both shelters were to be fully transportable and require minimal on-site assembly. They were to fix onto a concrete slab 3 m long and 1.5 m wide provided by the council at each site.

Design began the first day with students working through functional requirements, exploration of forms and assembly, through a sequence of modelling exercises. Drawing as a design tool was dis-couraged in order to encourage group design processes. Over subsequent days, specific requirements for the buildings became clear and designs developed. Community representatives outlined expectations of the students' participation. Council officers clarified safety and maintenance issues and a consulting engineer worked the students through structural implications and helped refine the two designs. With 20 highly motivated students working on each design, it was inevitable that tense moments occurred on occasions even though staff helped guide the groups through problems. Some students consciously withdrew from discussions at times, realising that the others would resolve the cause of the friction and then they could re-engage to contribute further. Stream 1 professionals joined the process and spent half a day working on joint and assembly details, providing a change of perspective.

During all this, the refinement of the working models grew. On the fifth day of the workshop, the two designs were presented to the client group and were accepted. At this time, conditions on site threatened to disrupt the completion of at least one of the buildings. The Pizza Hut site was clear and the slab had been laid, ready to receive its building. However, the Chickenfeed site, had unexpected services running under the existing pavement. This, plus limited access space for construction, complicated excavation and extended the footing completion. After consultation, it was decided the Chickenfeed group would complete their building as scheduled and the building would be handed over to the contractor on the last day of the workshop. It was then the contractor's responsibility to install the building when the slab was in position and set.

On the final day of the workshop, both buildings were ready to install. The students carried the Pizza Hut building outside the workshop, and then lifted it onto a small flat-bed truck. The building was driven carefully 1 km to its site. With assistance from council workers, the following five hours saw the Pizza Hut shelter fully installed and in use. Installation was simply careful positioning and fixing down with masonry anchors. The Chickenfeed building was moved outside the workshop to be photographed and await collection by the contractor.

With the workshop over, the 40 students participating in Stream 2 of the workshop returned home to continue their education at other institutions. In response to surveys completed before they left, all thought the learning experiences of the workshop would assist them in future design work while 93 per cent thought the experiences would assist in furthering their understanding of building construction (Wallace, 2001). Sixty-seven per cent identified improvements in communication skills, understanding of the capacity and structure of materials, and development of construction skills as key outcomes. On the day the workshop ended, one of the two buildings, the Pizza Hut shelter, was in place and serving the local community. The Chickenfeed building sat a little sadly behind the architecture workshop. While disappointed about not seeing it installed, the Chickenfeed group's work was rewarded when the contractor eventually completed the support slab two weeks later. He was able to install the building without problem or delay.

After the buildings had been in use for two months they were undamaged and had not been defaced, a fate that has befallen the adjacent standard steel shelter. Though established artefacts in a public context and very well received by the City Council and the shopping precinct community, they remain both transportable and temporary structures. The City Council has since expressed keen interest in working with the School of Architecture on future small building projects. As the buildings are considered temporary, and therefore disposable if problems occur, the City Council is now willing to help more students realise their first small public building.

Conclusions

In the last nine years, students of the School of Architecture at the University of Tasmania have built about 28 structures. Their functions have ranged from storage

10.6 The Pizza Hut building is lifted into place

sheds, seats and shelters to play-grounds, bus stops and circus trapezes. In each case, the objects are made primarily to give the student experience of the process of conceiving, designing, documenting and constructing a three-dimensional structure. Often the buildings are delivered as a gift to the community, for while the nominal client may contribute to the cost of the materials, they do not pay the real cost of design and construction. As the students build their own design, they accept this and the other limitations imposed in return for the educational benefit they know they will receive. To ensure the correct circumstances for an educational process, the staff guide the scale of the project and its progress, A major strategy in this is prefabricating the building and making them portable.

Outside of one mud brick dome, all the structures have been significantly prefabricated, with the major elements constructed in the architecture workshop. The only elements regularly fabricated on site have used concrete footings. In the last three years, as the experience and skill of the teaching staff has increased, the extent of prefabrication has extended further so that the structures are now more likely to be transportable buildings, rather than just prefabricated ones. Generally, they can be moved and fixed on site in one operation. Two of the buildings have been truly portable structures. One is a circus trapeze that is used by local performers and the other a portable stage at a local school used annually by 50 dancers.

While all the buildings have been designated as 'temporary' structures, only three of the buildings have been removed or demolished. In addition to the Tamar Island structures, a group of seats and installations in one of the state's national parks were taken out of service after a dispute about develop-ment in World Heritage areas and one structure on the university's campus was removed when a water pipe under it burst. This 'success' rate does not alter the educational approach, as the concept of the buildings being temporary greatly encourages both experimentation and student ownership. Rather it demonstrates the care and dedication the students place on constructing something of their own design that will remain, for at least some time, in the public domain.

10.7 Positioning the Chickenfeed shelter

Like performers, architects must leave behind the buildings that they design and move onto the next project. This is at the core of a practising profession.

With these studio buildings, most students experience this for the first time. They design and build a structure with their peers, in a process carefully weighted so that they succeed. They take the experience, repertoire and positive solutions with them onto the next project. The buildings, prefabricated, portable and temporary, have served their purpose and are given to the community to use as they will.

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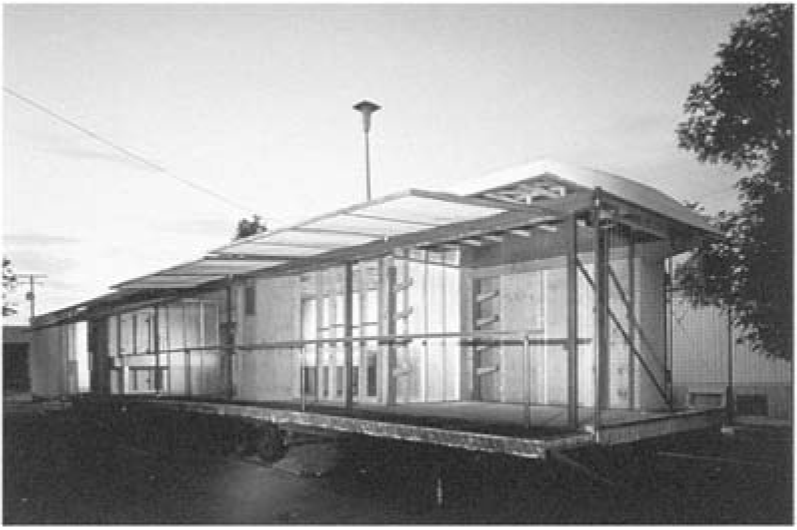


The Portable Construction Training Centre, Office of Mobile Design

Design

11.1 Paper Church, Kobe (1995)

Beyond Paper and Curtain: Works and Humanitarian Activities

Shigeru Ban

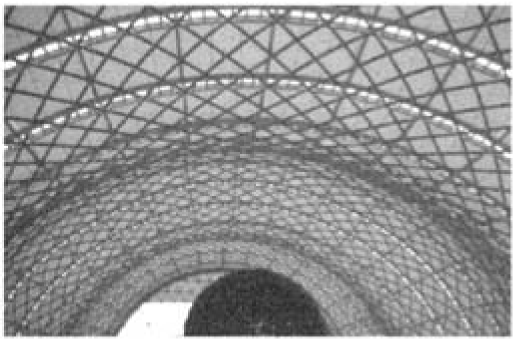
Shigeru Ban Architects

In Japan, the apprenticeship of an architect upon graduation determines the architectural style he or she pursues and the type of architect he or she eventually becomes. In retrospect, I believe my fate was decided earlier, in secondary school. I was at the Ochanomizu School of Fine Arts trying to gain admittance to the architecture school at the Tokyo University of Fine Arts and Music. There, while neglecting to prepare for my entrance examinations, I was absorbed in solving design problems. Each week, students were asked to create a structural frame out of different materials—wood, paper and bamboo. I would always produce two solutions for each assignment. An interest in materials, structures and methods of construction was already evident in my work and approach at this early stage of my career. One of my teachers from Ochanomizu, Mr Tomoharu Makabe remarked recently, 'You're still doing what you did in high school.'

It was my good fortune to be classmates with Konomi Ikebe, the daughter of Professor Kiyoshi Ikebe. Ignorant of his reputation as an architect in Japan, I would often drop in on him at home for informal critiques of my design work. Rereading his book *Dezain no kagi (The Key to Design)*, I realised that we shared a similar approach to the materials and methods used in design. It was at Mr Makabe's home and on reading the issue of *Architecture and Urbanism* on the Whites and the Greys and the work of John Hejduk that I decided on my future. Even though I knew nothing about architecture, I was instantly attracted to the work of the New York Five. Although Hejduk's houses existed only on paper (for example the Diamond Series, the Fraction Series, or any of his Wall Series houses), the work completely captured my imagination. I decided I wanted to study in the United States at the Cooper Union where three of the New York Five (Hejduk, Peter Eisenman and Richard Meier) had graduated.

Upon graduation from the Cooper Union, I returned to Japan and immediately began working on my own. I designed and organised exhibits for architect Emilio Ambasz (1985) and for the architectural photographer Judith Turner (1986). At the same time, I was beginning to design buildings. I learned mainly by watching other people. I relied primarily on my university education and experiences without the benefit of an apprenticeship and more practical experience. My design method involved the geometric manipulations found in the work of the New York

11.2 Paper Loghouse, temporary housing, Kobe



11.3 Japan Pavilion, Hanover (2000)

Five and the use of walls to create domains in Hejduk's style. In addition, my experience as a student in Cooper Union's Foundation Building shaped the landscape of my imagination. Constructed in 1859 and renovated by Hejduk in 1974, it was his only built work at the time. A cylindrical elevator core penetrated each floor of the main building and endowed the space with a sense of order. I was also influenced by these environmental experiences to organise my designed spaces with walls and cores as exhibited in the early Three Wall Houses, Villa TCG, Villa K, and the Muramatsu Residence.

In the Villa Torii I deliberately avoided geometrical manipulation in my design process by using two parallel walls to create a space that was open in the axial direction. This was the first in a series of houses involving the same theme. The task in each case was to make the parallel (or non-intersecting) walls freestanding. Various structural solutions were adopted. In the Villa Torii and the I House, lateral forces were dealt with by using steel bars to pull the tops of the wooden walls towards the ground. At Shakujii Park, non-intersecting, reinforced concrete walls were arranged like dominoes in an S-shape. Although the walls in each unit favoured one direction, they were arranged on a plan to stabilise the building as a whole. In the Factory at Hamura, steel frames replaced parallel walls. In the

House for a Dentist, laminated beams pin-jointed to parallel, cantilevered walls of reinforced concrete supported the floor construction.

In my very first project, the Emilio Ambasz exhibition in Tokyo, I designed partitions from fabric screens. The fabric was delivered on cylindrical paper tubes.! thought it was wasteful to throw the tubes away and kept them in my office for later use. In the installation for the Alvar Aalto exhibit in 1986, I wanted to create a space that suggested the master's building techniques. However, the budget did not allow for the lavish use of wood that would have been an ideal representation of his work. In addition to financial restrictions, any wood used would have to be discarded after the exhibition's run of only three weeks, which again struck me as wasteful. While looking for alternatives to wood—it finally occurred to me to use the paper tubes I had collected. I visited a paper tube factory where I learned that the recycled paper tubes were inexpensive and could be made in almost any length, diameter and thickness. I created the ceiling of the exhibit from tubes of varying dimensions and I found that the tubes were much stronger than I anticipated, and I wondered if they could, in the future, be used as a structural material. A couple of years later, I submitted a design for the Asia Club Pavilion to be built for the 1989 Hiroshima Exposition. I proposed a low-tech, Asian alternative using paper tubes to contrast with the pseudo high-tech solutions often seen in expo design. Unfortunately, because of the untested nature of paper tubes as a building material, the proposal was rejected. However, one of the exposition's designers saw potential in the tubes and commissioned me to design the small Paper Arbour for the 1989 Nagoya Design Exposition.

The following year, I began to design a multi-purpose hall for an event celebrating the fiftieth anniversary of the city of Odawara. I finally had the opportunity to design a true piece of paper architecture, albeit a temporary one. I consulted Professor Gengo Matsui on the design of the structure. Although he was only a few years from retiring, he eagerly accepted this new challenge (including the structural design of wood and bamboo buildings by Shoei Yoh). Since there was no precedent for a paper structure of the projected size, we began experimenting with paper tubes of different dimensions. My collaboration with Professor Matsui eventually led to three more projects as well as the Odawara Pavilion and the East Gate; the Library of a Poet; the Paper Gallery; and the Paper House. The paper tube structure developed for the Paper House was eventually approved by the Minister of Construction and added to the Building Standard Law.

Whereas CADCAM processes do not make every stage of the design process accessible to the designer (especially critical ones) Professor Matsui's method of using only a slide rule was very transparent to me and I was able to identify and control the design parameters I felt crucial to the design. Until this point, I had been under the impression that some things were simply impossible to build regardless of how logical their structural designs seemed. Subsequently, I learned that anything is possible if the design is credible and one has the will.

11.4 Paper arch designed by Shigeru Ban and built in 2001 at the Vitra design workshops run at Domain de Boisbuchet, Lessac, France

The House with a Double Roof was a result of my experience with Matsui. The size of a corrugated steel roof was usually specified from a catalogue based on load conditions and span length.

However, I calculated it as a beam and chose accordingly. Usually, if the steel sheet is usable from the stress calculations but the deflection point exceeds the norm, then one selects the next larger size. But deflection is not an issue if the ceiling is an independent structure separate from the corrugated roof. In this way, one can use a sheet of minimal size for the roof element. Various structural ideas were developed in the process of designing the House with a Double Roof, and the double wall structures mentioned earlier. However, we chose not to make the details of the structure part of the stylistic vocabulary as is often seen in high-tech designs; the structure was never 'visible'. I use a structural idea to create a certain space, transform an unfavourable site or poor weather conditions into something positive. The structural ideas are often concealed in the finished work as 'invisible structure'. While developing paper architecture, I have also discovered new ways to utilise a number of other materials, for example pre-cast concrete piles. Ordinarily placed out of sight underground, I decided to unearth these columns and use them in a residential/retail project. In the Complex by Railroad, I used inexpensive pre-cast concrete piles instead of reinforced concrete columns as a structural force to create a colonnade that would allow light to pour through the intervening gaps. In the PC Pile House, I used six 1-metre high piles to support the roof of the 'floating' intermediate floor. A colonnade of these pre-cast piles supported the large roof of Tazawako Station. As in the House with a Double Roof, this disperses the load and obviates the need for piling. In the Library of a Poet, gate-shaped trusses were made with freestanding bookshelves in between the trusses. After the insulation was installed, the floor joists fixed, and the exterior wall material attached, I realised that the bookshelves were just as capable of supporting the roof as the paper tube frames. This experiment led to the development of the Furniture House in which, having confirmed the strength of the bookshelves through calculations and trials, I substituted various factory-produced pieces of furniture for columns and walls. The idea evolved into the 9 Square Grid House that was a steel furniture house. Furniture was created using the steel studs of an American steel house prototype. The furniture units were consequently made lighter and stronger and labour costs were reduced by giving each unit more than one function. Curtain Wall House, 2/5 House, and Wall-less House are works based on spatial instead of structural themes.

One of my favourite buildings is Mies van der Rohe's Farnsworth House. This was a revolutionary work that liberated the spaces previously enclosed by masonry walls in Western architecture and allowed for continuity between the interior and exterior of the house. However, in the Farnsworth House there is no physical continuity as in traditional Japanese homes, where spaces can be exposed or enclosed by the use of screens, which I have reinterpreted as 'curtain wall'. Mies' fixed glass wall is currently becoming heavier and heavier with the adoption of double glazing, the introduction of blinds between glass panes, and recent trends in using two sets of double glazing. The Curtain Wall House was formed with an exterior wall that is actually a curtain. The idea was to create a contemporary interpretation of traditional Japanese spaces with current materials. 2/5 House and Wall-less House were responses to Mies' 'universal space'—the idea of a fluid space beneath a large continuous roof supported by furni-ture-like cores and shaped by partitions. 'Universal space' may seem quite amorphous or uncontrolled at first glance, but in fact it is composed with carefully positioned cores, partitions and perfectly arranged furniture to create precise yet invisible spatial domains, By contrast, the size, continuity and quality of traditional Japanese space can be changed by means of the *fusuma*, *shoji,* or reed blinds depending on the season or occasion. With or without a roof, the interior and exterior spaces are continuous and the intermediate domain shifts. I call this arrangement the 'universal floor', and the 2/5 House, Wall-less House, and 9 Square Grid House were attempts to realise this arrangement with contemporary materials and methods for everyday life. In the Hanegi Forest apartments, I chose to interpret the circumstances and context of a particular site with an appropriate geometry in order to derive structure and space. This new approach is also evident in the context of my current projects. Up until now, I have used paper tubes and columns or framed trusses, but in the Paper Dome I designed a large frame with arches which spanned 28 m using paper tubes carrying axial compression forces.

I have had doubts for some time about the contributions architects make to society. In recent years the public perception of the architect's work has been that it is either egocentric or profit motivated. I cannot deny that it is part of the architect's role to create monuments that throughout history have played an important role in cultural development. In this century, however, the urbanisation that began with the Industrial Revolution accelerated when large numbers of low-cost housing units became necessary. Architects addressed the issues of collective or industrialised housing and produced not only a large quantity of buildings but also created a number of masterpieces that marked the important technical and stylistic aspects of modernism. In short, architects in this century began to work in the service of the masses.

Although the Cold War is now over, ethnic and regional conflicts abound worldwide, creating an unprecedented number of refugees and homeless people in their homelands. In addition, natural disasters that leave people with homes and livelihoods destroyed still occur. The way architects serve society, particularly minority groups, may be an important factor in determining the profession's character in this era. Until recently, the United Nations High Commissioner for Refugees (UNHCR) provided only plastic tents as shelter for disaster victims. To mount the tents the UNHCR would provide aluminium poles, but refugees would sell them and then cut down trees and use large branches to assemble the shelters, which led to massive deforestation. The UNHCR commissioned me to design a new type of shelter for disaster victims, using paper tubes. After the 1995 Kobe earthquake, I served as a volunteer and constructed, along with a group of student volunteers from all over the country, a community centre, Paper Church, on the site of a destroyed church and a cluster of temporary shelters on parks.

Even in the disaster context, I am motivated as an architect to create beautiful buildings in order to move people emotionally and to improve their lives. If I did not feel this way, it would be impossible to create meaningful architecture and to make a contribution to society at the same time.

A Deployable Lightweight Medical System for Use in Disaster Areas

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12.1 Red Cross tents

12.2 German army containers

Background

Floods in Mozambique, famine in Ethiopia, earth-quakes in Turkey, civil war in Kosovo; these recent events all exemplify that despite the advancement of modem technology, the number of severe natural disasters and armed social conflicts is not decreasing. In these types of circumstances the lack of sufficient aid, including food, shelter and medical care exposes many victims, especially the poor in developing countries, to hunger, disease and often death. International humanitarian organisations strive to provide disaster relief in the affected regions by employing mobile hospitals that offer medical services ranging from first aid, outpatient treatment to complex surgery. Armed forces brought in to aid in relief missions set up field hospitals to provide medical care for both their staff and the people affected by disaster and war. Precedent analysis of mobile hospitals revealed two basic systems currently in use: the tent solution utilised by humanitarian organisations, and the container-based solution typical of military forces. Interviews with users of both systems, the German Red Cross Disaster Relief Unit in Berlin and the German Army Crisis Reaction Forces in Ulm, gave valuable insight into these relief approaches and medical care concepts.

The tent concept is a cost efficient option for the Red Cross, which usually operates on a very tight budget. It is a highly mobile system, and its low-tech construction allows for easy assembly by unskilled workers. However, tents offer only minimal protection from the environment and rarely allow for inter ior climate control. An additional concern by the Red Cross is the fact that tents lack the ability to offer the highly sanitary conditions preferred in the medical field. Research is presently being conducted to address this drawback of the system. Regarding the medical operation of relief missions, the International Red Cross generally works closely with local Red Cross and Red Crescent organisations in order to optimise medical standards and treatment procedures typical for that region. Strong emphasis is placed on balancing medical care so that all parts of the population in the affected region receive equal treatment, which could otherwise lead to additional social tensions.

In contrast to the tent concept, the container system, as used by the German army, offers a developed interior with all the benefits of a sanitary environment, climate control and protection from the elements. However, disadvantages in the system's transportability are evident. Although containers are indisputably mobile, their weight and size place great restrictions on the means and efficiency by which they can be transported. The average treatment container has a total weight of 8 tons and requires heavy equipment for assembly, which naturally imposes limitations on the system's mobility. The transport logistics and a rather conventional energy concept reveal little incorporation of environmental factors into the system. In contrast to the Red Cross approach to medicine, effort is made to provide the same quality of medical care abroad as a member of staff would receive at home. More often than not, these treatment procedures exceed the local medical standards, creating potential for additional social tension in the disaster area if this policy were pursued.

Based on this background information, the need for one system that integrates the ideals inherent in mobile structures, as demonstrated by the tent concept, with the desirable spatial qualities of the container system, is apparent. This translates into a system that is efficient in all facets of its design with regard to its transportation, assembly, energy consumption and cost, while offering a sanitary environment that is conducive to medical treatment. Lightweight construction principles are employed to create high-quality environments that are transported and erected in an effective manner. A systematic approach allows individual modules to be linked together to establish a network of spaces similar to the container complexes, while maintaining the flexibility of the tent concept, The networks can be arranged in a variety of configurations, offering options that may be operated independently or coordinated with local disaster relief and health care organisations in order to stabilise social conditions,

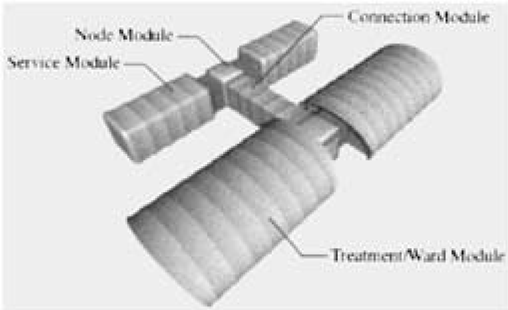
The system proposed here, developed as a design thesis project, incorporates information gathered through the previously described interviews, in addition to analysis of other precedents such as air-supported structures and even outdoor clothing and camping gear. During the design development of this prototype system, computer and physical models were used to explore its large-scale organisation as well as specific construction detailing, both of which are discussed and illustrated in the following section.

The system

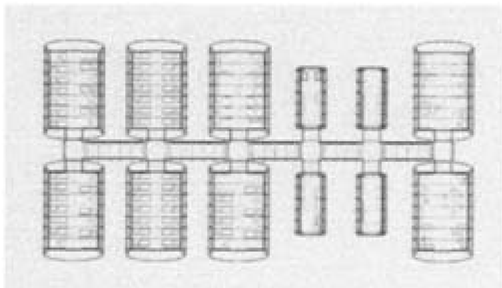
Organisational strategy

The deployable lightweight medical system is designed as a kit-of-parts consisting of four basic modules: Treatment/Ward Module, Service Module, Connection Module, and Node Module. Serving as the main element of the system, the Treatment/ Ward Module houses the medical spaces of the hospital, which range from patient wards and laboratories to operating rooms. Next, the Service Module contains climate control facilities in addition to equipment that provides the system's supply of electricity, water, oxygen and compressed air. Finally, the Connection and Node Modules form a continuous link between all modules creating a network of interior spaces that are protected from the external environment.

There are numerous ways to combine these basic modules to form medical units; however, three standard configurations have been established. These arrangements are based on those proven by current mobile hospitals to be effective in most situations. These include the Basic Health Care Unit, the Referral Hospital Unit, and the Surgical Hospital Unit. The most fundamental of these configurations is the Basic Health Care Unit. Due to its relatively small size, it is a highly mobile unit that provides medical first aid for approximately 20,000 people. Its ease of transportation makes it ideal for supplying aid to refugees since it easily adapts to their migrant nature. Next, the Referral Hospital Unit is a fully equipped mobile hospital that can either be integrated into an existing health care facility or operate independently.



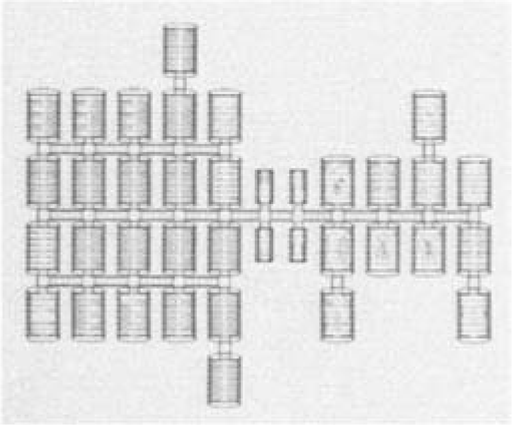
12.3 Modules of the system



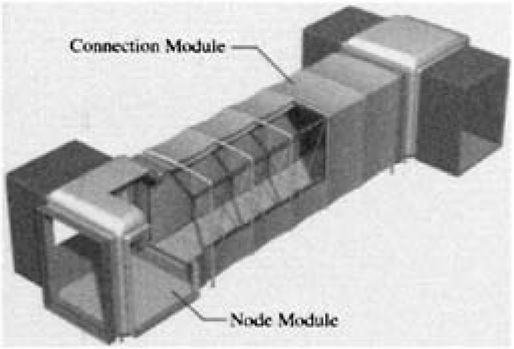
12.4 Basic Health Care Unit

In most circumstances though, it functions in conjunction with several Basic Health Care Units to provide extensive aid to a larger area and approximately 150, 000 people. Last, the Surgical Hospital Unit is an expansion of the Referral Hospital Unit that is equipped with additional surgical and prosthetic components. It is conceived to operate in areas affected by civil wars or armed conflicts and therefore specialises in the treatment of war-related injuries.

The erection phase, regardless of the unit type, begins with the set-up of the Service Modules followed by the remaining modules according to the configuration required. This layout of a central service zone and peripheral treatment areas allows for a high degree of spatial flexibility during the life-span of each application of the medical facility, because additional modules can be attached easily while unnecessary modules can be removed. Patients can enter the system at various points leading them directly into the general Treatment Modules. Out-patients can leave the system after treatment through the internal circulation corridors, while patients requiring further in-patient care are referred to the internally located Ward Modules. The main circulation and service spine connects the Ward Modules to centrally located, specialised Treatment Modules that contain operating rooms, laboratories, X-ray facilities, and other specialised care units. Additionally, the main supply lines for energy, water and air are routed along the main spine of the system, with secondary lines branching off into the individual



12.5 Referral Hospital Unit



12.6 Node and Connection Modules

modules. Storage and waste management areas are located at the perimeter of the system, allowing for easy supply and disposal of goods and waste products.

Medical services

The three different system configurations provide an array of medical services, although the equipment is adapted to the needs and requirements of the specific circumstance and location. It is assumed that effort is made to cooperate with local disaster relief and health care organisations to obtain the best possible treatment concept for the affected population. Of utmost importance is the equal medical treatment of all, which otherwise could result in social tensions within the population. Additionally, training of local medical personnel is encouraged as part of a self-help programme to enable the affected region to become less dependent on outside medical assistance. Listed below are the standard services and equipment provided by each unit type.

Basic Health Care Unit (out-patient care only)

- 28 beds for medical observation
- emergency treatment
- obstetrics
- vaccination programmes and epidemic treatment
- health education and nutrition consultation
- health and nutrition population screening
- local medical personnel training

Referral Hospital Unit, Surgical Hospital Unit (out-patient and in-patient care)

- 182 beds for in-patient care
- emergency treatment
- surgery
- internal medicine
- obstetrics and gynaecology (Referral Hospital Unit only)
- paediatrics (Referral Hospital Unit only)
- prosthetics (Surgical Hospital Unit only)
- pharmaceutical services
- lab work
- blood bank (Surgical Hospital Unit only)
- vaccination programmes and epidemic treatment
- health education and nutrition consultation
- health and nutrition population screening
- local medical personnel training

The modules

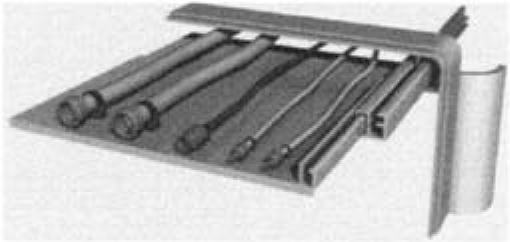
The design of the modules is based on lightweight construction principles that utilise highly engineered materials such as honeycomb-sandwich platforms and fibre-glass structural supports. The skin varies according to the specific use of the module and can range from a solid shell to an inflated textile membrane. These skin variations provide protection from the elements in addition to insulating and conditioning the interior environment of the modules. The Node Module is used to connect modules and is constructed of lightweight fibre-glass elements, which allow for easy transport and assembly. The roof element contains extendible tracks that hold all necessary supply line couplings for convenient con nection to water and electricity. Bellows are used at the connecting interfaces to adjust to tolerances between the modules. The Connection Module is used to establish a network of enclosed walkways between the modules, providing all circulation with protection from the elements. The collapsible design of this module consists of a honeycomb-sandwich platform and fibre-glass tubing for structural support. The skin is constructed of a double-layered, PVC-coated Polyester-membrane that creates an enclosed air layer used to insulate the module interior. Supply lines are connected to the couplings provided by the Node Module and are routed in tracks suspended from the ceiling.

The Service Module measures 2.40 m by 6 m and contains all necessary equipment to ensure that the system is supplied with water and energy. This module also consists of a honeycomb-sandwich platform with fibre-glass supports. The ends of the module, though, are capped with fibre-glass shells with one of the shells containing integrated couplings and control panels required for water and energy supply. The skin that stretches between the shells is also double-layered with an outer layer constructed of a PVC-coated Polyester-membrane. Contrasting from the skin of the Connection Module, the inner layer is made of an inflatable Silicone-coated Polyester-membrane used for even greater insulation.

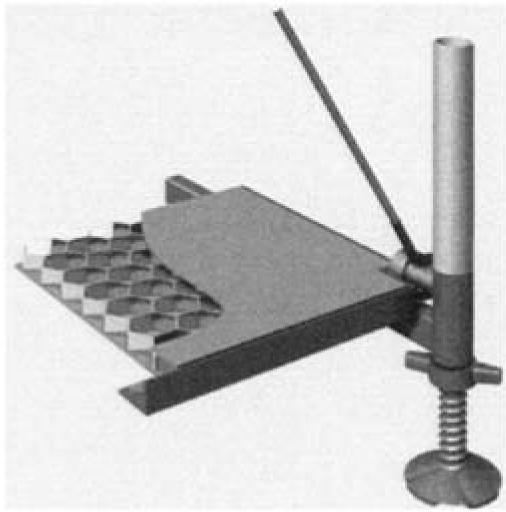
The Treatment/Ward Module measures 6m by 8.40m and is the main element of the medical system. It houses both general and specific medical areas such as wards, treatment units, laboratories, X-ray units and operating rooms. Similar to the previously described modules, a honeycomb-sandwich platform holds fibre-glass structural supports that are covered by a double-layered membrane skin. The skin, like that of the Service Module, also has an outer PVC-coated Polyester-membrane layer and an inflatable inner Silicone-coated Polyester-membrane layer. It not only serves as insulation, but it also aids in conditioning the interior space of the module. Small pores in the membrane provide the interior environment with a constant supply of fresh air, while air valves extract the relief air. A low-emission coating on the inside of the inflatable skin helps prevent radiant heat from entering the module, and an additional ventilation layer between the inner and outer membrane layers prevents over-heating. Furthermore, the outer skin has a translucence of 20 per cent, while the two layers of the inner skin possess a translucence of 40 per cent each. This results in an overall translucence of 3.2 per cent, which allows the interior to utilise natural day lighting when available and only minimal electric lighting for tasks and night-time use.

Energy and water supply

The energy and water concept of the system enables its use in a wide range of environmental site conditions. It employs a combination of conventional fossil fuels and solar energy to power the modules. Photovoltaic cells are the primary power source, while back-up generators using fossil fuels ensure a constant energy supply. Additionally, solar energy can be stored for future use via hydrogen electrolysis. This process converts excess solar electricity into hydrogen that is easily stored in light-weight composite tanks. When energy is needed, fuel cells



12.7 Extendible tracks

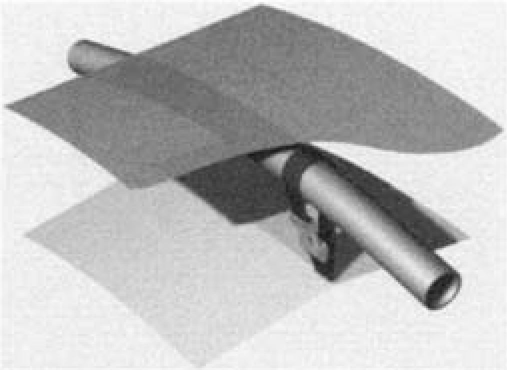


12.8 Honeycomb-sandwich platform

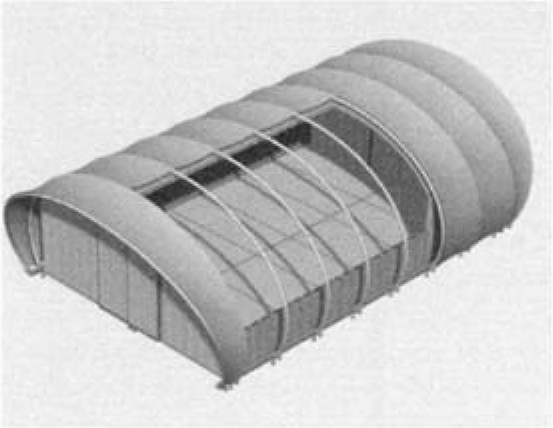
use oxygen to convert the hydrogen back into electricity. The use of varying types of energy sources allows the system to be used in practically any part of the world, even the most remote regions. Water from rivers, lakes or wells is chemically treated and thoroughly filtered to provide clean water. It is then stored in large foldable tanks for a long-term supply of safe water.

Transport and assembly

Requiring minimal space, the system's modules are stored on palettes in collapsed condition and can easily be transported by land, air or water. Shipment and assembly can take place within 48 hours to provide immediate aid. In the country of origin, forklift trucks load the system onto a cargo plane, which then proceeds towards the destination. On arrival, the system is loaded onto trucks for further transport or, depending on the topography, it may also be transported by helicopters. Designed to be light-weight and moderate in size, each individual element of the kit-of-parts system can be carried by one to four people, requiring



12.9 Double-layered membrane skin

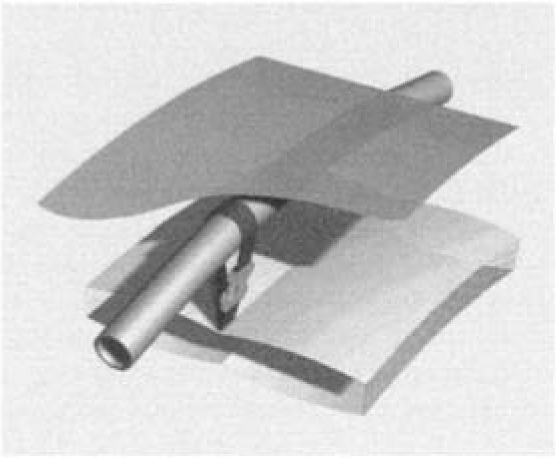


12.10 Service Module

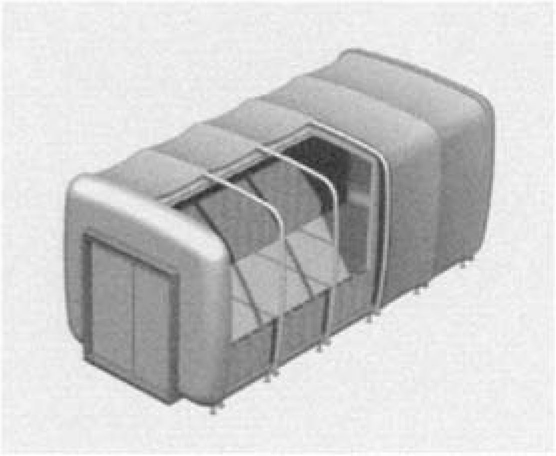
no special equipment for loading or assembly. Last, unskilled workers under minimal supervision can complete the system's assembly.

Outlook

The proposed deployable lightweight medical system builds on the existing knowledge of mobile medical facilities and serves as a prototype system that further defines the important aspects of such structures. It combines simple construction techniques with advanced technology and highly engineered materials, resulting in a more efficient system with a higher performance level than other similar systems. With subsequent development, it could establish a new direction for future medical applications.



12.11 Inflatable double-layered membrane skin



12.12 Treatment/Ward Module

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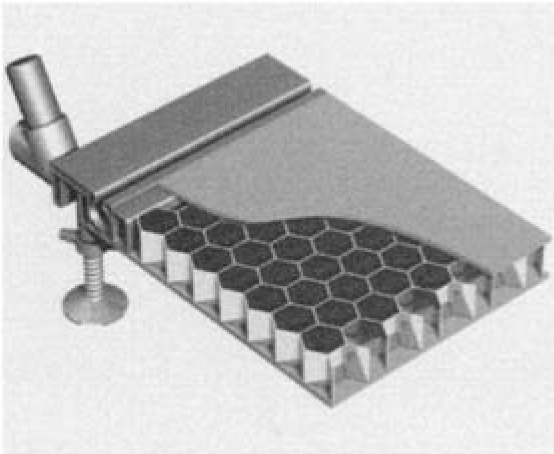
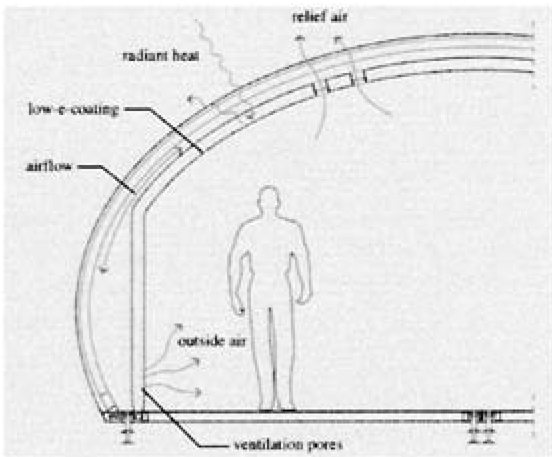


12.13 Honeycomb-sandwich platform



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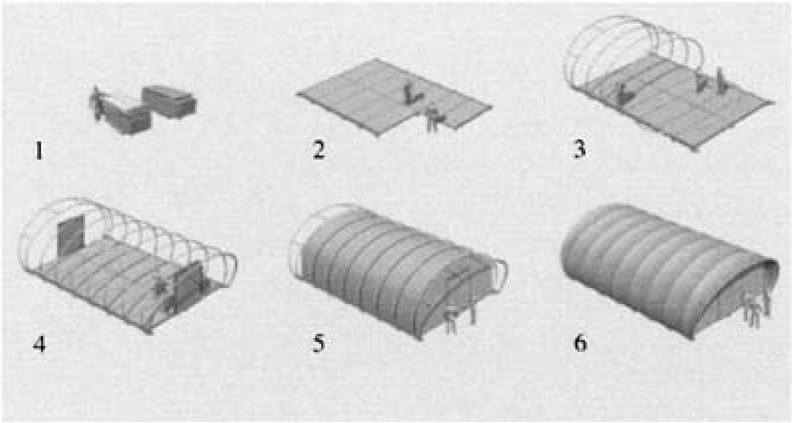
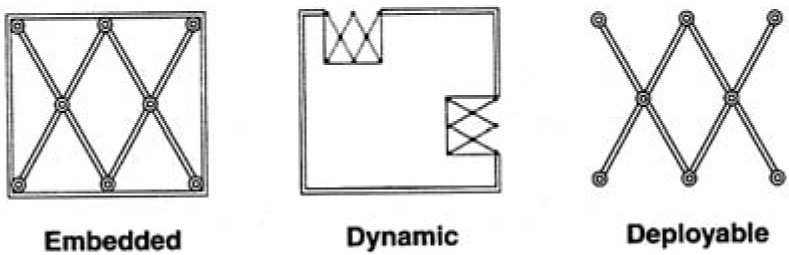


12.15 Assembly sequence of Treatment/Ward Module



13.1 General kinetic typologies

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Kinetic Architectural Systems Design

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Part I: beyond kinetic

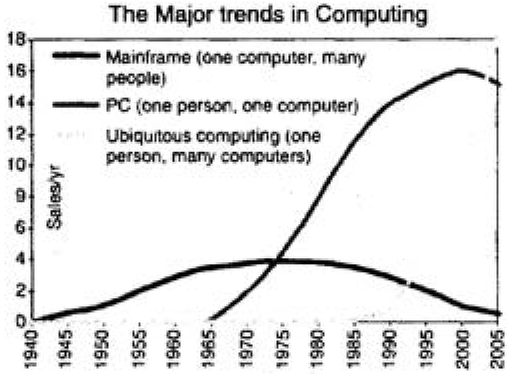
Our capabilities of utilising kinetics in architecture today can be extended far beyond what has previously been possible. Advancement will only be accomplished when kinetic structures are addressed, not independently, but as an integral component of larger systems and take advantage of today's constantly expanding and far-reaching technology. In order to achieve this the use of advanced computational design tools, materials development and embedded computation will be required: developments that are grounded in science fact, not science fiction. The irony is that from an architectural standpoint this field is in its infancy. Although in terms of general technological advance, this field is not based on revolution but on evolution, its end cannot be predicted outside the parameters of political and economical entanglement.

The motivation for advanced kinetic architectural systems lies in creating spaces and objects that can physically reconfigure themselves to meet changing needs with an emphasis on the dynamics of architectural space. Such systems arise from the isomorphic convergence of three key elements: structural engineering, embedded computation and adaptable architecture, which are all situated within the contextual framework of architecture.

Kinetic architecture: a definition

Kinetic architecture is defined generally as buildings and/or building components with variable mobility, location and/or geometry. The general implications of utilising such systems in architecture include, but are not limited to: space efficiency, shelter, security, transportation, safety, economics and aesthetics. The specific applications are enormously varied and include novel applications that arise out of the changing patterns of human interaction with the built environment. Structural solutions in kinetic architecture must consider both the *ways and means* for operation in parallel. *The ways* in which a kinetic structural solution performs may include among others, folding, sliding, expanding and transforming in both

13.2 Intersection of embedded computation and kinetic architecture



13.3 The major trends in computing

size and shape. *The means* by which a kinetic structural solution performs may be, among others, pneumatic, chemical, magnetic, natural or mechanical.

Kinetic structures in architecture are classified here into three general categorical areas. *Embedded kinetic* structures are systems that exist within a larger architectural whole in a fixed location. The primary function is to control the larger architectural system or building, in response to changing factors. *Deployable kinetic* structures typically exist in a temporary location and are easily transportable. Such systems possess the inherent capability to be constructed and deconstructed in reverse. *Dynamic kinetic* structures also exist within a larger architec-tural whole but act independently with respect to control of the larger context. These structures can be further subcategorised as mobile, transformable and incremental kinetic systems (see Figure 13.1).

Controlling kinetic function

The way that kinetic function operates can be described diagrammatically as mechanical motions. Contemporary innovators such as Chuck Hoberman and Santiago Calatrava continue to demonstrate the possibilities of novel kinetic implementation at an architectural scale. For this reason, interested designers ought to focus their attention upon the vast wealth of resources that have been accumulated over numerous centuries of engineering practice. One can argue that many great scientists of 1,000 years ago would have had no difficulty under-standing an automobile or an engine or a helicopter and certainly not the most advanced contemporary architectural system. The craftsmanship would have been astonishing but the principles straightforward with respect to an understanding of the novel material properties. Materiality is the one great promise for advancement in this area, primarily as a result of technology providing an unprecedented vision into microscopic natural mechanisms and advanced manufacturing of high quality kinetic parts with new materials such as ceramics, polymers and gels, fabrics, metal compounds and composites of unprecedented structural properties. The integrated use of such materials in kinetic structures facilitates creative solutions in membrane, tensegrity, thermal and acoustic systems.

Embedded computation

Television, computers or radar would have appeared magical to scientists from the distant past. The difficulty would not have been the complexity of the system, but rather because they lacked the experiential framework required to conceptualise such non-mechanistic devices. Today it does not take much effort to extrapolate existing computation as a means for kinetic actuation. The integration of embedded computation and kinetic function is rapidly approaching a practical and feasible reality (see Figure 13.2).

The major trends in computation show a clear transition between the three general human-computer relationships. Initially there was the use of one computer (mainframe) by many people. This evolved to a one-on-one relationship with computers (personal computer). The present trend is towards one person using many computers. This relationship was coined 'ubiquitous computing' by Mark Weisner of Xerox PARC in 1988. 'Ubiquitous computing' forces the computer to live out in the world with people but, at the same time, will recede into the background of our lives. The concept of 'ubiquitous computing' integrates human factors, computer science, engineering, and social sciences. It now appears that Metcalfe's Law (which states that the network benefit increases as a square of the number of connected devices) is starting to replace Moore's Law (which states that CPU performance doubles every 18 months) as the driving force behind the development of computational devices (see Figure 13.3).

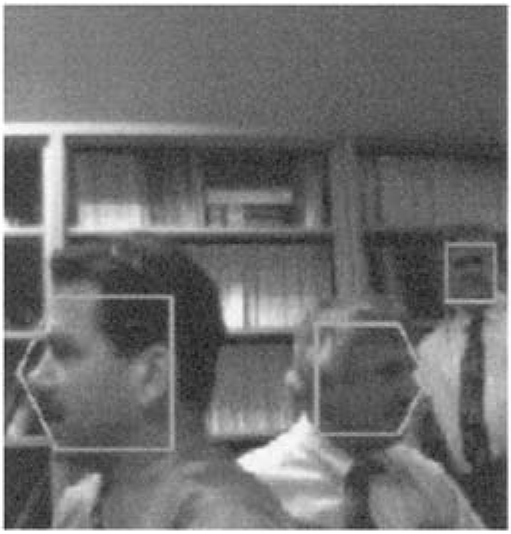
Extrapolating precedent in embedded computation

What then, are the implications of ubiquitous computing to built form? From an architectural standpoint, embedded computation has taken an interesting foothold. Work in embedded computation has arisen primarily out of the field of computer science, reaching into the sub-disciplines of both artificial intelligence and robotics. The research has emerged from both academia and the corporate world and there are currently numerous examples of embedded computation that have begun to define the field now known as Intelligent Environments (IE). The projects cover a diverse range of scales; from the Biosphere2 project, which is arguably the most sophisticated building constructed by man, to the Adaptive or 'Neural Network' house in Colorado. Ironically the most sophisticated intelligent environments built to date have been constructed for space travel where the environmental conditions are extreme yet relatively constant. On the other hand, a residential house in, for example, Phoenix, Arizona could not be identified as typically different from one in Anchorage, Alaska. The primary goal of intelligent kinetic systems should be to act as a moderator responding to changes between human needs and environmental conditions. The primary target clientele for research in Intelligent Environments has been the military, the elderly and the handicapped, typically in that order. Not surprisingly, the vast majority of the work has been both highly tectonic in dealing with recognition tasks such as speech, gesture, motion, and the environment whilst focused on managing human interactions and other novel applications of Internet technology (see Figure 13.4).

The motivation for such research lies in embedding computers in ordinary environments so that people can interact with them the way they do with other people; in other words, it is aimed at enhancing everyday activities. The major problem in what has been accomplished outside the field of architecture is the myopic nature of the ambition of simply enhancing everyday activities. When embedded computation is employed to control physical built form the most obvious application is to foster an extension of manual capabilities. With due respect to the advantages such systems can provide to the elderly and handicapped they are at best equalising the current advantages of built form, and not extending them. Architects need to design with an understanding of the current capabilities of embedded computation that have attained sufficient maturity to act as independent sub-systems with the potential to be beneficially incorporated into kinetic design. A consequence of this motivation could be to create a seamless integration of computation into the built environment. It transcends a question of aesthetics to ask if embedded computation should be hidden from the users that inhabit an intelligent space, or if there should be an honest expression of form that communicates its existence.

Another relevant area emerging from the field of computer science is research into the development of robots. Unfortunately, whilst highly sophisticated, contemporary robots are typically autonomous with respect to the built form in which they operate and tend to be fixed function devices. Not only should robots become mutating, multi-function machines but also they should be developed with regard to the architectural built form they occupy. If the architecture itself were embedded with the intelligence of a robot and with the capability of completely controlling the built form, then the development of single-task autonomous robots might not be required at all.

Perhaps the most relevant resource to draw upon in designing intelligent kinetic systems lies in active control research that focuses upon the design of structures that control the movements of a building. These operate through a system of tendons or moving masses linked to a feedback loop with sensors in the building. Changes are brought about by both environmental and human factors and may include axial, torsion, flexural, instability and vibration and sound. Such systems have been successfully employed in numerous large buildings situated in high-



13.4a Specialised tasks in embedded computation research

wind or earthquake-prone locations to minimise the structural damage caused by natural forces.

Controlling kinetic function by computational means

Precedents in embedded computation serve as a foundation for the explicit means of controlling kinetic motion. Such means can be described diagrammatically as the controlled source of actuation. Embedded computation is considered specifically as a control mechanism for kinetic function to accommodate and respond to changing needs. Such systems will be utilised to interpret functional circumstances and direct physical movements adaptively to better suit changing human needs. The issue of controlling kinetic motion is central to issues of design and construction techniques, kinetic operability and maintenance, as well as issues of human and environmental interaction.

There are the six general types of control, which can possess both centralised and decentralised case-specific advantages. *Internal* control systems have inherent constructional rotational and sliding constraints inherent. Within this category is architecture that is deployable and transportable. Such systems possess the potential for mechanical movement in a constructional sense, yet they do not have any direct control device or mechanism. *Direct* control systems actuate movement directly by any one of numerous energy sources including electrical motors, human energy or biomechanical change in response to environmental conditions. *In-direct* control systems actuate movement indirectly via a sensor feedback system. The basic system for control begins with an outside input to a sensor. The sensor must then relay a message to a control device. The control device relays

13.4b Specialised tasks in embedded computation research Georgia Tech: Future Computing Environments (FEC) Group

an on/off operating instruction to an energy source for the actuation of movement. In-direct control is defined here as a singular, self-controlled response to a singular stimulus. *Responsive* in-direct control systems operate in the same way as in-direct control systems; however, the control device may make decisions based on input from numerous sensors and then make an optimised decision to instruct the energy source to actuate the movement. *Ubiquitous responsive* in-direct control results in many autonomous sensor/motor (actuator) pairs acting together as a networked whole. The control system necessitates a 'feedback' control algorithm that is predictive and auto-adaptive. *Heuristic responsive* in-direct control builds upon either singularly responsive or ubiquitously responsive self-adjusting movement. Such systems integrate a heuristic or learning capacity into the control mechanism. The systems learn through successful experiential adaptation to optimise a system in an environment in response to change.

Novel applications for kinetic adaptability

There are many reasons for employing kinetic solutions in architecture as a means to facilitate adaptability. Adaptability is taken in the broadest sense to include issues such as spatial efficiency, shelter, security and transportability. Such systems that are inherently deployable, connectable and producible are ideally suited to accommodate and respond to changing needs. An adaptable space flexibly responds to the requirements of any human activity from habitation, leisure, education, medicine, commerce and industry. Novel applications arise through addressing how transformable objects can dynamically occupy predefined physical space as well as how moving physical objects can share a common physical space to create adaptable spatial configurations. Applications may range from multiuse interior reorganisation, to complete structure transformability, to response to unexpected site and programme issues. Specific applications may include intelligent shading and acoustic devices, automobile-parking solutions, auditoriums, police box stations, teleconference stations, devices for ticketing and advertising, schools and pavilions, as well as flexible spaces such as sporting, convention and banquet facilities. Other spaces for consideration are those with necessary fixed exterior configurations, such as airplanes, boats, transport vehicles and automobiles. Through the application of intelligent kinetic systems, we can also explore how objects in the built environment might physically exist only when required and disappear or transform when they are not functionally necessary.

Kinetic adaptability also reflects the rapidly changing patterns of human interaction with the built environment. New architectural types are emerging and evolving in response to today's technologically developing society. These new programmes present practical architectural situations for unique and wholly unexplored applications that address today's dynamic, flexible and constantly changing activities.

Future human interaction with the built environment is extremely difficult to predict even as science-fact extrapolations because it is ensnared with contradictions. In the example set forth by Arthur C. Clarke, a really perfect system of communication would have an extremely inhibiting effect on transportation. Less obvious is the fact that if travel became nearly instantaneous, would anyone bother to communicate? Our cities are the result of our mastery over neither. A topic of great interest today is the effect of our current mastery of communication on urban built form. What would be the effect if our mastery over travel had preceded that of communications? More relevant to applications of intelligent kinetic systems is the still science fiction issue of planetary engineering or climate control. If climate control at an urban scale were localised by architectural means, would there be any desire to investigate planetary engineering, given the potentially adverse effects on terrestrial equilibrium?

Projects by the MIT Kinetic Design Group

The Kinetic Design Group at MIT is an inter-disciplinary research group focused on the design and application of responsive kinetic design in architecture. The motivation for such an agenda lies in extending current trends in intelligent environments to affect physical architectural spaces. Intelligent kinetic systems in architecture are cantered on the issues of embedded computational infrastructures, human and environmental interaction, physical control mechanisms and the processes of architects designing such systems.

The Secret Garden designed by architects roart inc. and artist Yasmin Gur is a reading and contemplative place for the children of a New York public school. It is a place to read in an environment filled with nature, science and art. It is a garden inspired by the imagination of children and the dreams of their parents and friends. Among the giant, wood, sculpted flower pots which serve as seating areas roart/KDG designed and installed interactive robotic flowers which gently move to track the sun and turn to bend and follow the motions of the children playing in the garden.

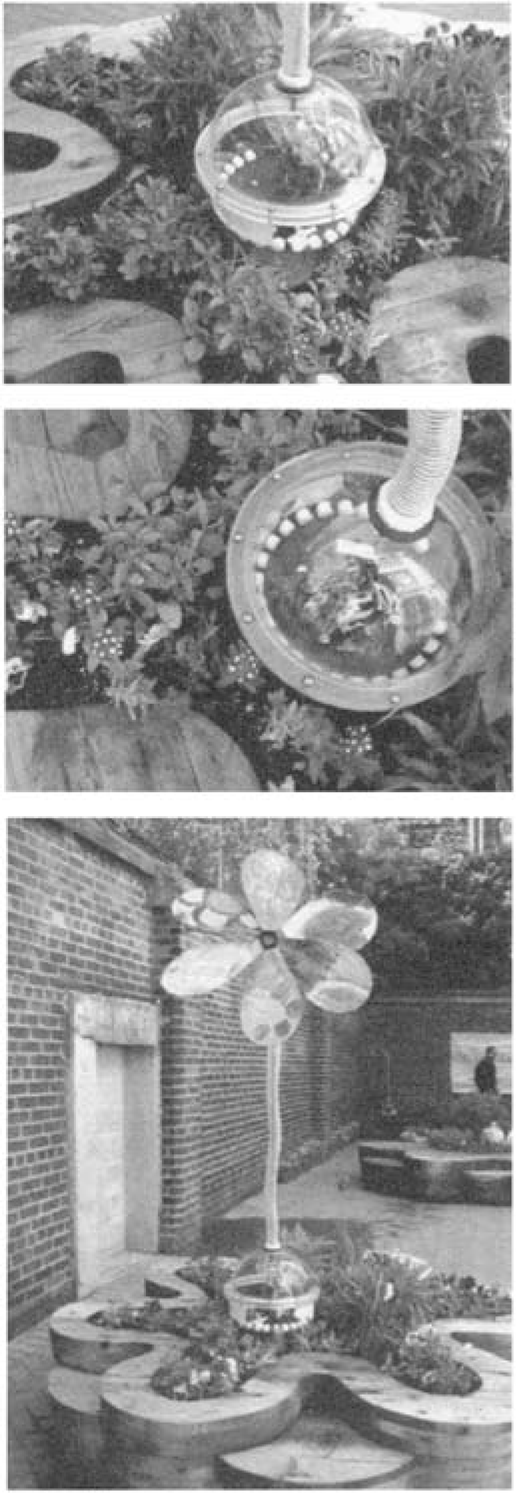
The interactive Kinetic Façade project, a collaboration with roart inc., fosters direct interaction between an architectural-scale installation and pedestrian activity on the street. The 160 ft (48 m) long band of responsive 'whiskers' that will wrap around a building in New York allow pedestrians to walk up and interact with the installation through their presence. The bars move in wave-like rhythm driven by sensors mounted beneath each row that monitor the presence of a moving person. If motion is detected, the poles gradually point towards the target, creating a ripple through the field. Each element moves in a simple fashion but together more complex patterns evolve. The project at once engages individual interactivity and at the same time actively mirrors the unengaged pedestrian activity as a whole.

The Deployable Teleconference Station houses a computer exhibit and teleconferencing station. During the 'off' hours the object is closed into a simple, secure (theft-proof) pyramid. While functioning, the structure transforms into a framed shell for communication. The structure was designed for the 1996 Lyon Biennale, to express the conceptual aspects of the project in reference to language and communication as constantly transforming systems with multiple encapsulated meanings.

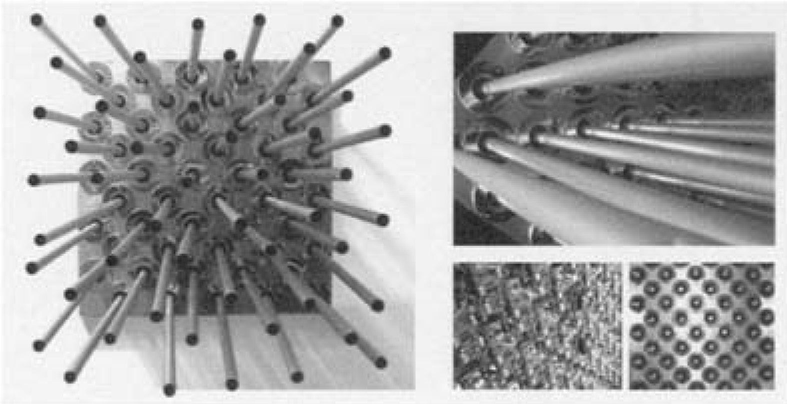
The Responsive Wall with integrated membrane project is a large-scale kinetic wall with a fully integrated servo-controlled sensor feedback system. The wall can respond to any number of human and environment generated variables including sun, wind, shade, light, whim, desire or impulse. The system is mobile and can be controlled by either an active computer control system or by direct response to human movement.

The motivation for the Boeing Business Jet Interior project was to create an interior design solution that is flexible and adaptive and, when required, is responsive and intelligently active in response to changing individual, social and climatic contexts. Accordingly, the goal was to provide a responsive interior space that could be configured by the users prior to a specific flight as well as partially reconfigured in-flight. Such adaptability aims to meet the changing needs of the users and their activities/environment for comfort and optimum spatial efficiency. The interior has three basic kinetic components or sectors, which display variable location (mobility) and variable geometry (transformabil-ity). The sectors can technically operate independently—as a complete system, they divide and define the programme zones in the interior. Each is equipped with the technical and the physical/spatial apparatus necessary for various parts of the programme.

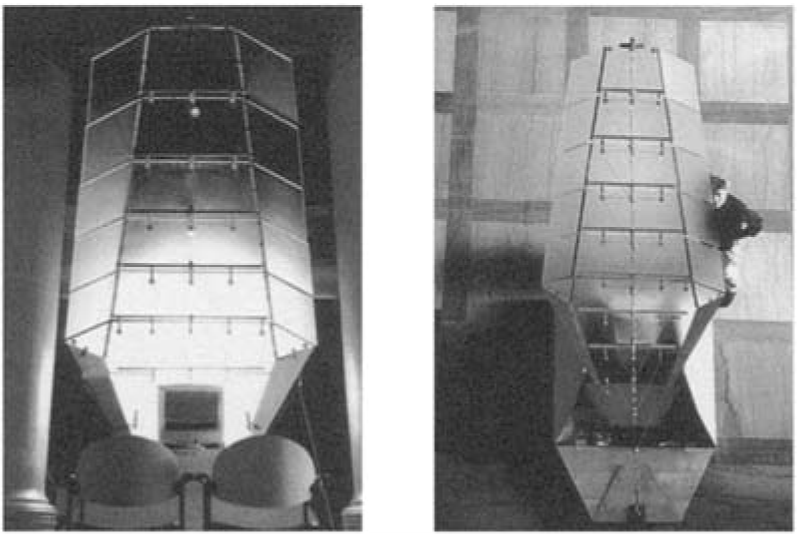
Elevator Choreography is a fully automated hydraulic folding door system for an interior, large-scale, vehicle elevator that connects several floors of a private dwelling that also houses a collection of automobiles. The servo-controlled doors operate through a dynamic sequence of choreographed motions to enable the movement of cars for display within the central living space of the dwelling.



13.5 Interactive robotic flowers in the Secret Garden (roart. roart/KDG and Yasmin Gur)



13.6 Full-scale working prototype of Interactive Kinetic Façade (roart, roart/KDG)



13.7 Deployable Teleconference Station (Kinetic Design Group)

The future of kinetic architectural systems

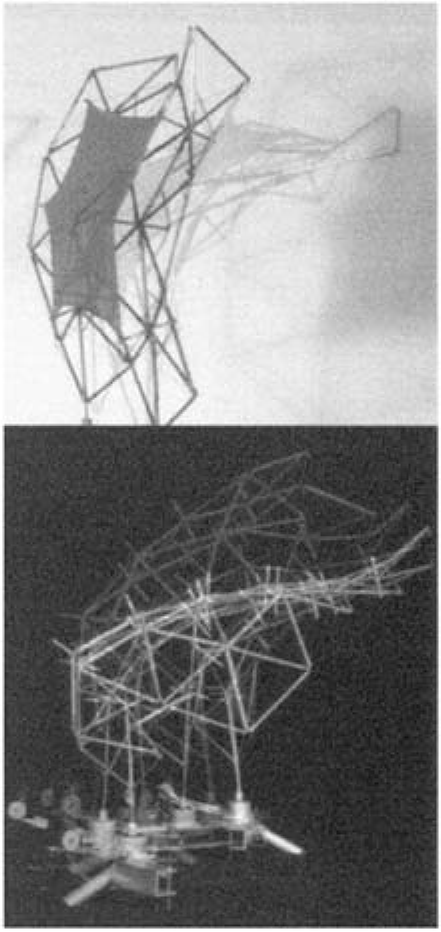
It is difficult to see if advanced kinetic architectural systems are far away on the horizon or an inevitable part of the very near future. To extrapolate the existing into a future vision for architecture is a conundrum resting in the hands of architects directing the future of their profession. Adaptive response to change must intelligently moderate human activity and the environment and build upon the task of enhancing everyday activities by creating architecture that extends human capabilities. Such systems introduce a new approach to architectural design where previously objects have been conventionally static, where use is often singular, and responsive adaptability is unexplored. Designing such systems is not inventing, but appreciating and marshalling the technology that exists and extrapolating it to suit a revised architectural vision.

Architects will inevitably hear that 'it cannot be done', and to this they might respond that commercialised electric light was until recently thought impossible, that it was thought a man would suffocate on a locomotive if he were to travel at a speed exceeding 30 miles an hour, and, of course, that heavier than air flight was impossible. Architects need to grasp a vision that will harness technology transfer from 'outside' fields in order to prevent contradictions in human interaction with the built environment. To a great extent the success of creating intelligent kinetic systems in architecture will be predicated upon the real-world test-bed. Applications must consider the capability for such systems to yield realisable, practical benefits. Actual construction and operation will allow architects to develop realistic considerations of human and environmental conditions, and to overcome simplified assumptions about the costs of manufacture and operations. The result will be an architecture of unique and wholly unexplored applications that address the dynamic, flexible and constantly changing activities of both today and tomorrow.

Part II: sustainable applications of intelligent kinetic systems

The general motivation for intelligent kinetic systems (IKS) research arises out of a growing interest in the benefits of hi-tech sustainable strategies for architecture. The topic of sustainability is inclusive of many factors and is defined by a holistic approach to responsible building construction and use. IKS builds upon existing strategies rather than defines a new definitive approach. Sustainable strategies that increase the resource efficiency of the operation of buildings are an increasingly important way in which high-level technologies may play a role in responsible architecture. Furthermore, it is necessary that technology and design issues be treated equally within the evolution of the architectural design process.

Form and material configuration have traditionally been the focus of design investigations as a catalyst for architectural invention; thus, the implementation and integration of computational devices within architectural components as an environmental moderating system pose a new level of developmental opportunities. With the current increase in the computational power of extremely small devices and the ability to embed, deploy and interconnect these elements, the possibilities for a large range of architectural elements has become a sensible and practical reality. There is a critical need to focus such novel technologies towards an important architectural responsibility; namely, sustainable strategies in buildings. In addition, these technologies, as applied to the definition of variable micro-environments that suit the particular needs of individual users, are an important way in which a combination of computational devices and innovative materials may provide for a wide range of environmental conditions. This

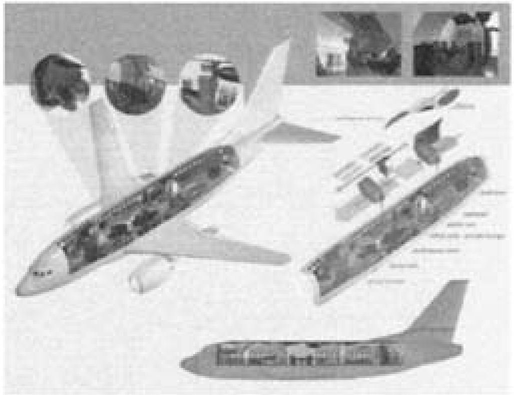


13.8 Responsive Wall (Kinetic Design Group and Bryant Yeh)

approach defines a need for the development of creative forms and technological innovations to serve as moderating adaptive control mechanisms for the improvement and satisfaction of basic human needs.

Living pattern trends

Developments in the fields of information and communication technologies could potentially have profound impacts on urban form. As more and more workers telecommute through the use of interactive communication via a multimedia environment, regular urban building use becomes sporadic, fostering new patterns with wide-ranging impacts on urban form and ways of living. Kinetic systems with embedded intelligence could potentially expose new programmes and forms

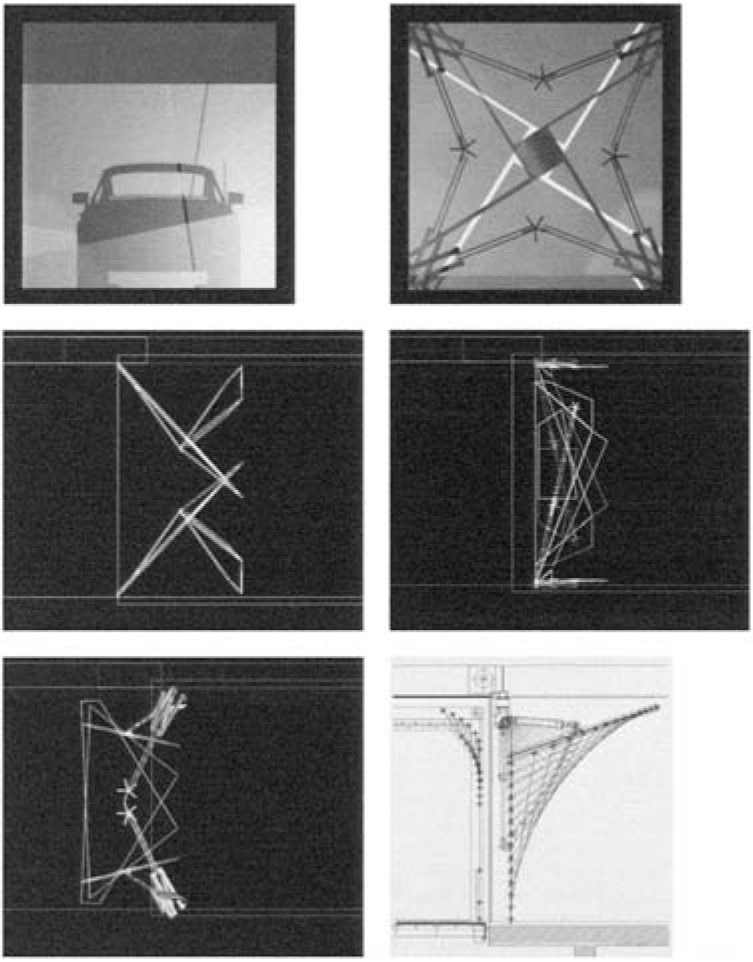


13.9 Boeing Business Jet Interior (Kinetic Design Group)

as this technology is incorporated into our everyday lives. Possible applications will arise relative to such rapidly changing patterns of human interaction with the built environment. New architectural typologies are emerging and evolving within today's technologically developing society. These new programmes may present practical architectural situations where intelligently responsive kinetic solutions can be considered for their ability to foster novel applications. For example, it is conceivable that only 25 workers use an office space on any particular work day that was designed to accommodate 40 employees. Could the physical space be optimised by kinetic means to utilise only what physical resources are necessary at any given time?

Physical adaptability and material reduction

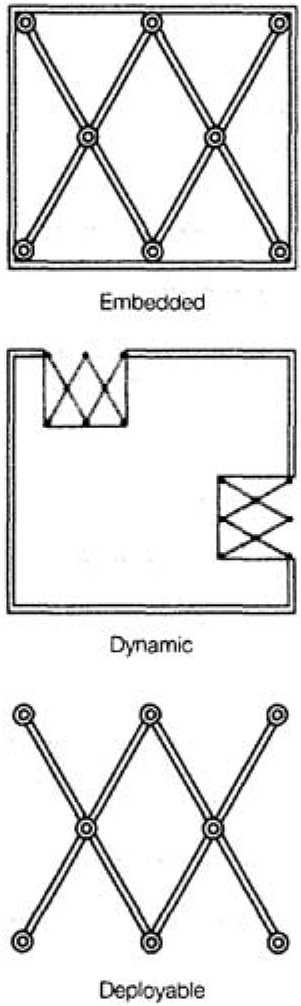
Sustainable strategies should integrate adaptability both in terms of physical transformations and in terms of computer control mechanisms used to optimise resources to dynamically suit user needs. When we look at the higher levels of computer-controlled behaviours, an interesting phenomenon can be observed in regard to actual physical built form with respect to kinetic structures. What we are describing is a structure as a mechanistic machine that is controlled by a separate non-mechanistic machine: the computer. Guy Nordenson describes the phenomenon as creating a building like a body: a system of bones and muscles and tendons and a brain that knows how to respond. In a building such as a skyscraper where the majority of the structural material is there to control the building during wind storms, a great deal of the structure would be rendered unnecessary under an intelligent static kinetic system. In other systems besides structure, much of the construction could be reduced through the ability of a singular system to facilitate multi-uses via transformative adaptability. Buckminster Fuller first envisaged this concept of material reduction, naming it 'ephemeralisation'.



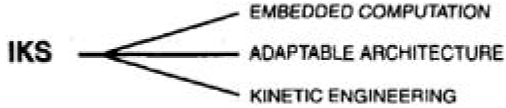
13.10 Servo-controlled choreographed elevator doors (roart inc., Derek Larsen and Kinetic Design Group)

Adaptive control

Adaptive control is computer-controlled automation whereby the system actually programmes itself through observing the user needs and changing environmental conditions. Such systems have been proven to learn in just three or four actual user examples, what are the lowest acceptable energy settings, Numerous precedents already exist in the area of 'home automation' where adaptive control has been demonstrated to yield economic benefits under realistic operating conditions. Timed programmes can be scheduled to perform certain actions at regular intervals on selected days of the week; for example switching the heating or air conditioning on and off, controlling the thermostat, or operating the garden sprinklers. Integrating temperature detectors or thermostats, a system can



13.11 Diagram of kinetic typologies in architecture



13.12 Diagram of intelligent kinetic systems

independently respond to various environmental conditions. On cold days the heating could switch on to prevent water pipes in the loft or garage from freezing and on hot days motorised windows could open for ventilation. Using motion detectors within rooms, it can further be ensured that the lights will switch off once the room has become unoccupied. This can be made dependent upon whether the system is set or not so that the heating will only override in the absence of the occupant and the windows will only open when the occupant is at home.

How are such systems both extended and optimised with the integration of kinetic function? Simple applications such as closing dampers and doors in empty rooms or opening windows for optimised thermal conditions can potentially extend the precedent areas of 'home automation'. With a fully integrated system, the windows and thermostat understand each other's actions and operate cooperatively to optimise conditions.

Intelligent kinetic systems

Intelligent kinetic systems are architectural spaces and objects that can physically reconfigure themselves to meet changing needs. In these systems, computers will interpret functional circumstances and direct the motor-controlled movements to change responsively and adaptively to optimise usage needs. Intelligent kinetic systems arise from the isomorphic convergence of three key elements: *structural engineering, embedded computation* and *adaptable architecture* (see Figures 13.11 and 13.12).

Concerns in structural engineering focus upon extending the possibilities of kinetic design. Kinetic function addresses a technological design strategy for building types that are efficient in form, light-weight and inherently flexible with respect to various contexts and a diversity of purposes, Facilitating adaptability, transportability, deployability, connectability and producibility, they are ideally suited to accommodate and respond to changing needs.

Embedded computation addresses sensor technology as a computational control mechanism to accommodate and respond to changing needs. Systems will specifically be utilised to interpret functional circumstances and direct motor-controlled movements to operate adaptively to better suit changing human needs. Many research areas in this field have achieved sufficient maturity to act as independent sub-systems that can beneficially be incorporated into kinetic design. Our motivation lies in sensor technology as a means to actively control kinetic objects in the built environment in response to change.

Adaptable architecture is adaptable space that responds flexibly to the requirements of any human activity—habitation, leisure, education, medicine, commerce and industry. Adaptability may range from multi-use interior reorganisation to complete structure transformability to difficult site and programmatic response. Buildings that use fewer resources and that adapt efficiently to complex site and programmatic requirements are particularly relevant to an industry increasingly aware of its environmental responsibilities (Kronenburg, 1996).

An architectural approach to product

identification

Another important area in defining sustainable strategies in architecture is product identification as a means of adequately addressing the physical properties of the materials related to their application in architecture. The goal of product identification and classification is to make explicit the design possibilities and design principles of kinetic building types for future designers in the field. Although specific properties are very often relative to the application for which they are applied in an architectural environment, each material also has specific properties that are crucial to the performance and application usage. Some have acceptable folding and deformation factors although they also have either a high production or assembly labour cost (in time of assembly and production). Others may meet our targets for R-values and moisture penetration, but have a high cost.

There are many standardised material qualities that a product is required to possess in order to fulfil its intended function. Typically, these qualities relate to permanence and are thus left to the discretion of the manufacturer. Various manufacturers, however, can fabricate materials to custom specifications, thus opening up the design limitations set by a consumer product line. To a large extent, the design motivation is to advocate unprecedented and unconventional use of materials. It is hoped that by encouraging exploratory use of sustainable products, they will play a more significant role in the determination of distribution, end-user demands and consequently covering the costs of such products.

Material life-cycle matching

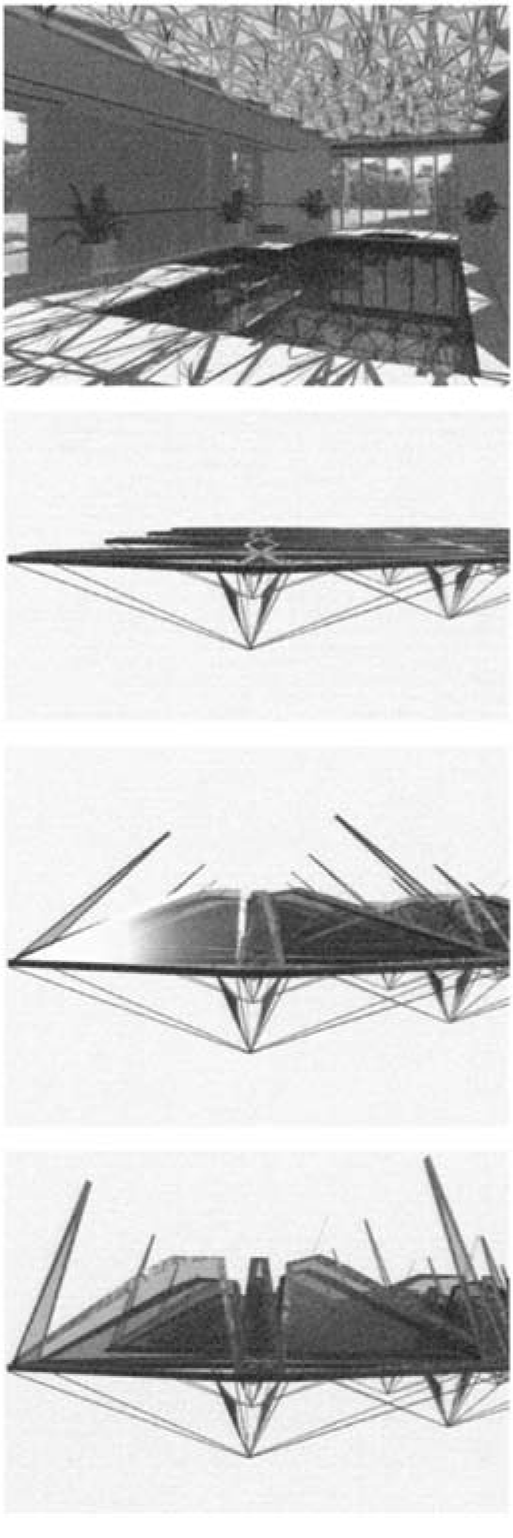
A building represents a large amount of resources and energy, not only in its construction, renovation and demolition, but also in the manufacture of the building materials used. All phases of a building's life-span (including demolition) come at considerable cost to the sustainability of the environment as a whole. If we were to include the additional cost to the environment of its contents: furniture, chairs, desks, consumer items, electronics and the numerous daily-use objects, we would be looking at a system that has immense and shortsighted waste.

The IKS approach to 'life-cycle matching' is to design objects and building components using materials that have a lifespan relative to that which has been designed. In addition to the architectural building components, including sofas, desks, tables, televisions, radios, computers, everything within a building typically has one determinate lifespan for the users, and another lifespan as objects in our environment. Consumers generally throw away and do not directly recycle a large amount of the constructed environment. Thus, there is a need to consider more inclusively the application of sustainable products to replace heavier, bulkier products made from glass, metal, wood and other materials. The strategy is then not to look at a small percentage of applications and how they could be environmentally ideal, but to look at the broad range of applications and how they could be improved (even if partially). In the simplest terms, when building components and objects are meant to last for a short time, their materials should be easily recycled. An additional advantage of such a recyclable product base is that when the parts of a building or object become worn, they can be easily and inexpensively exchanged with a new recyclable product. In this way the lifespan of the environment can go on as long as required. The IKS approach to design is from this environmental perspective and includes the concepts of dematerialisation and design for disassembly.

Table 13.1 Material use: modified version of *Environmental Design Guidelines*, created by the Design for Environment Research Group at Manchester University

Guideline	Reason
Optimise lifetime of product by increasing reliability and durability	Decrease need for new products, hence decrease material and energy use for production
Avoid designs with a technical lifespan which outdates the aesthetic lifespan	Decrease disposal of operational products because of outdated aesthetic design
Design in modular product structure	Enable upgrading, hence prolonging lifetime, of products at a later date
Design for easier maintenance and repair by: Indicating instructions for cleaning and/or repair Indicating parts for maintaining by colour codes Making vulnerable parts easy to dismantle and replace	Increase lifespan of a product by easier repair and maintenance
Minimise energy consumption during use by: Using lowest energy consuming components, e.g. clips, fasteners, supports	Decrease energy consumption during life
Minimise amount of consumables used during the use stage by: Product design that stimulates sustainable behaviour, e.g. only reusable material employment as opposed to disposable	Decrease the amount of consumables used by a product during its life
Design product to meet possible future needs of users	Extend possible lifespan of products

The IKS philosophy advocates some form of producer responsibility legislation or regulation that makes producers liable for taking back products at the end of their life cycle. The goal is that eventually the majority of countries will introduce some form of voluntary or legislated producer responsibility for their products, There is also the need to develop methods for separation of materials designed in products; to seek possible new uses for these materials and, above all, to learn how to design so that they can be efficiently recycled. Life-cycle thinking is a broad and inclusive way of looking at design issues, including the design process and all aspects that influence design requirements, such as environmental aspects, performance, cost, cultural aspects and legal aspects.



13.13 Moderating skylights

The *Environmental Design Guidelines*, created by the Design for Environment Research Group at Manchester University, UK, was created to assist in reducing the impact of product design upon the environment. An inclusive list of guidelines includes the following five groups:

1 Materials—extraction
2 Production
3 Transport/distribution/packaging
4 Use
5 End of life/design for disassembly/design for re-cycling

The IKS has adapted this list of guidelines to focus specifically on architectural applications. It therefore

Table 13.2 End of life/design for disassembly/design for recycling: modified version of *Environmental Design Guidelines,* created by the Design for Environment Research Group at Manchester University

Guideline	Reason
Stimulate possible re-use of the product by: Sound constructions that do not become prematurely obsolete technically	Extend possible lifetime of a product, therefore decreasing need for new products
Stimulate possible remanufacturing/ refurbishing by: Hierarchical and modular structure Use of detachable points Use of standardised joints Position joints to minimise necessary movement of product during disassembly Indicate opening instructions for non-destructive disassembly	Extend possible lifetime of part and components and therefore decrease need for new products
Stimulate possible recycling of part and materials by: Using recyclable materials with an existing market Avoiding polluting elements that interfere with the recycling process Mark any part made from synthetic materials with standardised material codes Avoid or minimise painting and fillers	Decrease need for virgin materials
Stimulate safer incineration by concentrating toxic materials and providing easy removal	Decrease hazardous emissions from incineration process

concentrates on the ‘Use’ and the ‘End of life/design for disassembly/design for recycling’ groups, without focusing upon an Input-output, Life-cycle assessment (EIO-LCA) for each specific material.

Life-cycle assessment (LCA)

Life-cycle assessment involves the evaluation of the relevant environmental, economic and technological implications of an object or process throughout its lifetime from creation to waste. A full life-cycle assessment involves identification of environmental impacts and assessment of any hazards and improvement.

The *eiolca.net* software is one approach to help life-cycle assessment (see *http://www.eiolca.net/*). It defines a way of examining the total environmental impact of a product through production. Environmental impacts include energy use, air pollutants, hazardous wastes, toxics emissions and cost estimates of external air pollution. An inclusive Inputoutput Life-cycle assessment (EIO-LCA) through production may include, but is not necessarily limited to: economic purchases, electricity used, energy used, conventional pollutants released, OSHA safety, greenhouse gases released, fertilisers used, fuels used, ores used, hazardous waste generated, external costs incurred, toxic releases and transfers, weighted toxic releases and transfers and water used. An even more inclusive LCA would include an analysis of the product for every step of its life, from obtaining raw materials (for example, through mining or logging) all the way through to making it in a factory, selling it in a store, using it in the home, and disposing of it. Disposal options include incineration, burial in a landfill, or recycling.

A second common approach is to detail the most important processes associated with a product during its entire supply chain and life, though this approach also requires considerable attention and time. Perhaps the main drawback with using LCA to compare products is that of incomparability: it is like comparing apples to oranges. For example, which is worse: a product that pollutes the air by consuming energy from coal-fired power plants or one that disrupts ecosystems by consuming energy from massive hydroelectric dam projects? Both types of pollution should be minimised if possible. A life-cycle assessment can be a valuable tool for companies to look at all aspects of their operations and integrate them into their overall decision-making process. Perhaps more relevant in this discussion are the designer and consumer aspects. In the latter, it is necessary to develop education methods to help the public understand the sustainability characteristics associated with products, processes and activities. In the former, it is design curricula for training those involved in product, process and activity design that are needed. Furthermore, designers and consumers should be able to understand that the choice of the product's end-of-life management method should be subordinate to the more general material/product choice, which is based upon a life-cycle assessment of its environmental impact.

Responsive Skylights: a model for IKS design

The Kinetic Design Group's design project, Responsive Skylights, exploits simplified prototypical attributes that are relative to kinetic function, human interaction, adaptive control and realistic operating conditions. The project is a specific application scenario that actually affects the nature of the architectural construct. The intent is to provide an example for further speculations in the area as well as real world applications. Specifically, the design project is a networked system of individually responsive skylights that function together to optimise thermal and day lighting conditions. Primary design considerations are to utilise natural daylight in the space, to take advantage of natural ventilation and ultimately to reduce energy costs (see Figure 13.13).

Mechanical control system

The prototype system contains six units. Each unit contains eight individual panels that slide along four straight lines towards the centre of the panel to create an open position. The system maintains structural stability throughout all stages of deployment of the individual units. One of the corner joints of a single unit contains an individual cable attached to a servomotor that deploys the unit by sliding that joint towards the centre of the unit. Integrated computer control is achieved with a system of positional sensor devices attached to each panel.

Product identification including material life-cycle matching and assessment

This product would be identified as having a material life-cycle matching and assessment that would affect its use in a particular architectural environment. The Kinetic Design Group's approach to 'life-cycle matching' is to design objects and building components using materials that have a lifespan relative to that which has been designed. While an extensive LCA can often be an arduous and even at times subjective task, it is important to look to manufacturers to understand resource use and realise the characteristics associated with products, processes and activities. Designers should understand that the choice of product end-of-life man agement method should be subordinate to the general conclusion of material product choice based upon a LCA of environmental impact. Further, although the initial costs of fabrication and installation may be higher for an intelligent kinetic system, it is important to understand the long-term benefits of such a system in the total architectural environment.

Construction system

Each panel consists of photovoltaic cell panelling under which lies a layer of film that is both for shading and a moisture barrier of variable self-adjusting opacity. This skin is fixed to a ribbed Plexiglas panel that is then fixed to a structural aluminium frame.

Embedded computation

The component's systems learn through successful experiential adaptation to optimise their operation in their environment in response to change. Optimum thermal and natural day lighting conditions can be achieved through the algorithmic balance between the individual deployment of the panel units and the individual opacity variances. As a user adjusts an individual skylight unit, for instance to provide shading, the system learns through observation to automate such needs.

Conclusion

The IKS under consideration builds upon existing strategies rather than defining a totally new approach. The concept demonstrates ways of increasing the resource efficiency of the operation of buildings by integrating high-level technologies into the physical built form in order to control kinetic functions. There is a need to integrate computational devices within architectural components as environmental moderating systems, to focus novel technologies on the important architectural design responsibility of sustainable strategies in buildings. The Responsive Skylight application example indicates how the combination of computational devices and innovative materials provided for a wide range of automated and efficient environmental conditions might work, This approach defines a muchneeded means by which issues of energy efficiency and the environmental quality of buildings could be technologically enhanced to be more efficient, affordable and reach a broader implementation.

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Office of Mobile Design

Jennifer Siegal

Office of Mobile Design

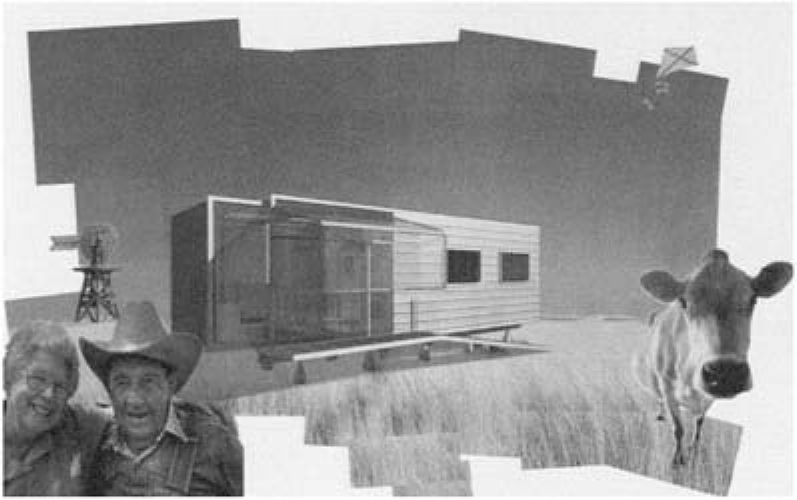
Introduction

Since 1998, Office of Mobile Design has focused on developing 'mobile' architecture, designing and constructing portable, demountable and mobile structures. OMD specialises in finding non-standard solutions to unconventional and unique problems, with dynamic rather than static and permanent structures. A majority of OMD's work involves providing services to public agencies, non-profit agencies, schools, commercial businesses and private interests. Research and education-based projects have yielded a number of models that serve as templates for subsequent projects.

By designing non-permanently sited structures that move across and rest lightly upon the land, OMD is rethinking and re-establishing methods of building that contrast the generic clutter that increasingly crowds the landscape. Inspired by Sant' Elia's Futurist manifesto, OMD shares the philosophy that 'we no longer believe in the monumental, the heavy and static, and have enriched our sensibilities with a taste for lightness, transience and practicality' (Kronenburg, 1995, p. 49). This desire for the 'active, mobile, and everywhere dynamic' that provoked the Italian Futuristic machine aesthetic infuses OMD's work. Like machines in a metropolis, however, OMD's built projects bring innovative community-based programmes to their users. Vision melds with a desire for user-based, programme-inspired machines accessible through their mobility.

Education-based projects that have served as OMD's laboratory case studies include: the Portable Construction Training Centre (PCTC), used by the Venice Community Housing Corporation in their job training programme to teach various construction methods; and the Mobile ECO LAB, created for the Hollywood Beautification Team, and used throughout Los Angeles County to inform K-12 school-aged children about the importance of environmental issues.

Additional work that OMD has produced includes the PuppetMobile, a travelling theatre and teaching facility for Cal Arts' Cotner Center for Puppetry and the Arts; and the prototype series iMobile, an online roving port for accessing the global communications networks and announcing the latest computer systems, peripherals, hardware and software. The Portable House, a prefabricated 3.6 m×18



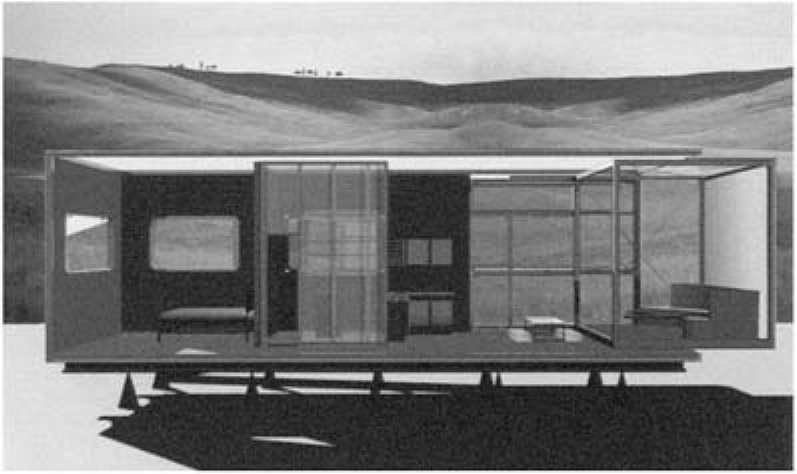
14.1 The Portable House's expandable/contractible spaces render it uniquely flexible and adaptable

m (12 ftx60 ft) modern dwelling built with eco-friendly and sustainable materials; and the deployable ZEVO Kiosk, a flexible 'store within a store' offering a retail and service hub for the Electro Bike Company. Most recently OMD has been commissioned to design a new Mobile Event City for Pallotta TeamWorks, the creator of Tanqueray's American AIDS Rides. The project includes overall campsite master planning for Pallotta's multiple-day events, as well as mobile structures to accommodate the events' service, transport, housing and vending needs.

Portable House

Referring back to original prehistoric models of shelter and dwelling, the Portable House adapts, relocates and reorients itself to accommodate an ever-changing environment. It offers an eco-sensitive and economical alternative to the increasingly expensive permanent structures that constitute most of today's housing options. At the same time, the Portable House questions preconceived notions of the trailer home and trailer park, creating an entirely new option for those with some disposable income but insufficient resources for entering the conventional housing market.

The Portable House's expandable/contractible spaces, the varying degrees of translucency of its materials, and its very portability render it uniquely flexible and adaptable. Its central kitchen/bath core divides and separates the sleeping space from the eating/living space in a compact assemblage of form and function. When additional space is required, the living room structure can be extended outwards to increase square footage. By design, the house can be manoeuvred and



14.2 Section through the Portable House

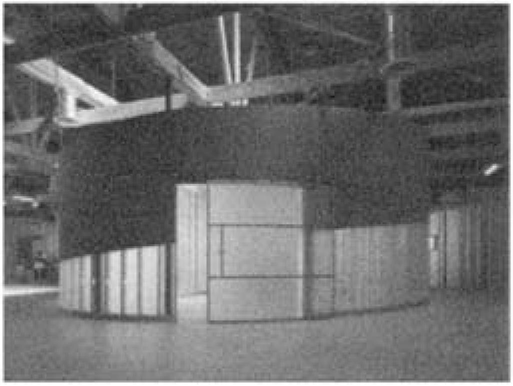
reoriented to take advantage of natural light and airflow. The Portable House also adapts to or creates new social dynamics wherever it goes.

The Portable House's mobility, the way it moves across and rests lightly upon the landscape, pro vides a provocative counterpoint to the status quo housing model. It recalls a time when the elements that constituted shelter were easily manipulated to accommodate innumerable variables and conditions. Whether momentarily located in the open landscape, briefly situated in an urban space, or positioned for a longer stay, the Portable House accommodates a wide range of needs and functions.

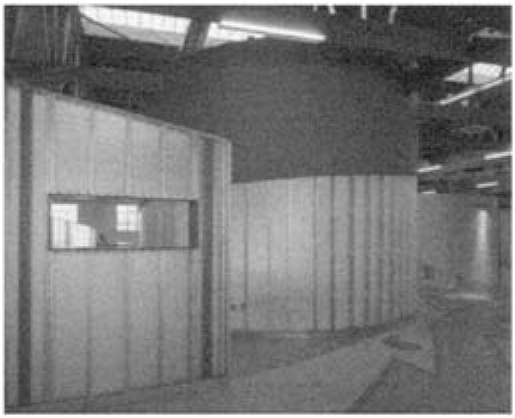
PIE.com

For its corporate headquarters, the extreme sports-oriented web site, PIE.com, chose a bow truss loft space in Hollywood. The open plan of the 1000 sq metre (10,000 sq ft) space houses the various functions of the business under one roof, and allows for dynamic and free flow (of ideas, information, views, light, bodies) within. The programme includes reception lobby, conference room, work stations, executive offices, kitchen/dining, storage/copy room and brainstorming 'base camp' space. To distinguish work areas, a series of light, almost delicate structures appears throughout, curvaceous and translucent, snaking here and there to delineate places for meeting, sitting, eating and working, Dotting this interior work-scape are clusters of bilevel, amoeba-like desks gathered in threes around slender electrical supply columns; the locations of these work stations are determined by the overhead cable suspension track that winds sinuously around the entire office. A large swirling drum of a conference room dominates the space, rising up to the sky like a wave in a great swell of vibrant blue and green. It is entered along the sweeping path of a grey-on-grey floor mural, by the Los Angeles pop artist, André Miripolsky, that leads from the elevator doors, through the entry lobby, right into the eye of the drum.

PIE.com's business focuses on dynamic, competitive, and high-intensity extreme sports, such as snowboarding, surfing, skateboarding and mountain biking. Though the design of PIE.com's offices includes moving parts (rolling doors and wheeled desks), it avoids being a literal manifestation of such activities. Instead, the space achieves its sense of dynamism and action through a dramatic manipulation of architectural elements. As natural light pours in from large skylights and plentiful east- and westfacing windows, it skips across exposed beams and free-standing walls, backlights translucent partitions, silhouettes the sometimes frenetic motions of workaday goings-on, and sets various areas aglow with the reflected colours of nearby walls. This complex interplay of materials, colours, forms and light makes for an animated environment that fosters productivity, creativity and fruitful collaboration.



14.3a PIE.com—view towards conference room

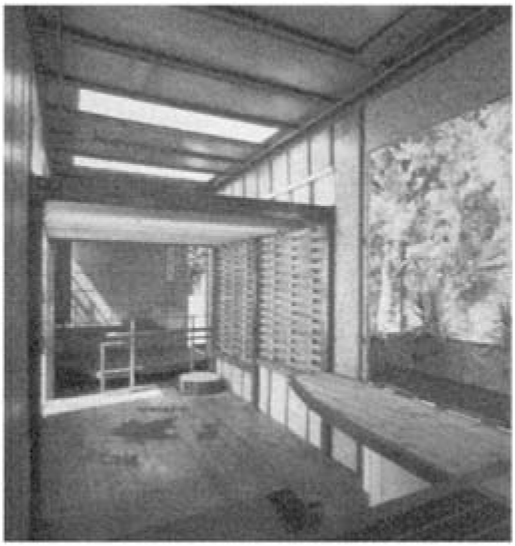


14.3b View from reception towards conference room entry

Mobile Eco Lab

The Mobile Eco Lab was built in collaboration with the Hollywood Beautification Team, a grassroots group founded with the mission to restore beauty and integrity to Los Angeles' Hollywood community. Verbal and visual exchanges took place using computer-animated drawings, traditional drafting and large-scale modelling techniques. Full-scale work was performed with a defined material palette, specifically that of a donated cargo trailer and cast-off from film sets. The 2.4 m×10.5 m (8 ft×35 ft) trailer now travels throughout Los Angeles County to inform K-12 school-aged children about the importance of saving and protecting our planet. Like a circus tent, this mobile icon arrives at the school-yard, where the lab's elevated walkways fold down and slide out of the trailer's body. It is immediately recognisable as a place for interaction, discovery and fun.

14.3c View towards main space from base camp area



14.4 Interior view towards media area

As a working mobile classroom, the Eco Lab provides a base for a range of exhibitions—all of which focus on ecology. Arriving at the threshold of the trailer, a child climbs up a set of folding stairs that has been lowered by a nautical winch. When the stairway meets the ground, the attached springs and wheels swivel into place, absorb the compression and provide access. Ascending the recycled expanded steel treads, the child enters a multimedia antechamber. This begins a programme explaining the 'life of a tree', creating a path for discovery that weaves in and out of the expandable Eco Lab.

The multimedia chamber facilitates learning by providing a computer for surfing the Internet on topics focusing on ecology. The young visitors watch a video describing a tree's growth cycle. Each child is then given a small container

14.5 Exterior view at night

and a tree sapling to be cared for along the path. Moving single file, the visitors emerge from the trailer onto a fold-down, tiered catwalk. Advancing along, they move back into the body of the trailer, and re-emerge outside on a stage-like platform that rolls out of the wheel wells. Here the children water their saplings and the teacher uses this space to discuss each child's role in the importance of planting trees and maintaining a sustainable environment. Progressing to the core of the Eco Lab, visitors gather in the dappled light streaming through the woven wooden wall. The floor, engraved with a giant California oak leaf encircled by the words 'you are ecology', provides the space for discussion and questions.

Zevos Kiosk

ZVO is a rising star in the rapidly expanding field of zero emissions vehicle (ZEV) design and manufacture. Its designs for electric bicycles have garnered praise from ecological groups and industrial designers alike.

Designed in collaboration with ZVO, the Zevos Kiosk is a lifestyle-driven apparel and merchandising centre. This portable, flexible 'store within a store' offers a retail and service hub ideal for placement in university student centres, shopping malls and airports—or anywhere else people gather for commerce and socialising. The nature of the Zevos Kiosk allows for wide-ranging flexibility of use. It moves about easily on its wheeled base, which doubles as a securable ZVO bicycle repair and service station. The wings of its main structure can pivot open to reveal a simple and interchangeable display system for ZVO bicycle accessories — portable palm-held computer units, saddlebags for laptop computers, alternative coloured battery cartridges and cyclometers. Computer monitors mounted on its hinged support posts swivel about, offering views from varying directions. Whether the kiosk is open for business with its wings spread wide, or closed securely during off-hours, these monitors run educational, informational or promotional consumer programming.

The dramatic profile of the Zevos Kiosk evokes a sailboat at full mast, or a graceful butterfly. With its striking form and originality, it is an instant attention grabber. Further, its iconographic, folding screen-like structure, made of lightweight materials, doubles as a billboard. With a clear display of product and logo, the Zevos Kiosk proclaims its purpose and wares wherever it travels—a unique, compact, all-purpose combination of marketing tool, product display, retail, technology access and consumer information.

Portable Construction Training Center

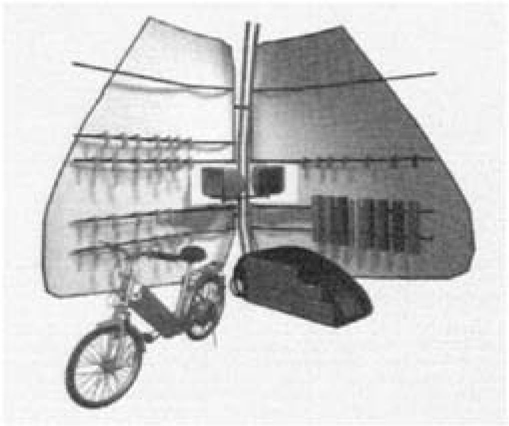
The Portable Construction Training Center (PCTC) was developed for the Venice Community Housing Corporation, an organisation founded with the mission to develop and maintain permanently affordable housing for disadvantaged and low-income individuals. This non-profit organisation affords an opportunity for its student trainees to learn construction skills and in turn apply their skills to needed projects.

The 4.2 m×19.3 m (14 ft×65 ft) PCTC is a handson classroom used as the focal point in this construction training process. Divided into four sections, each area allows for instructional activities specific to one of four basic construction trades: painting and plastering, plumbing, electricity and carpentry. One entire length of the trailer unfolds bisectionally, providing both an overhead shading device, and a catwalk to facilitate instructor supervision and inter-action among the four workspaces. The portable, flexible and easily operable PCTC provides unskilled labourers with an alternative method for acquiring the practical, applicable and transferable skill sets required for advancing in the construction trades.

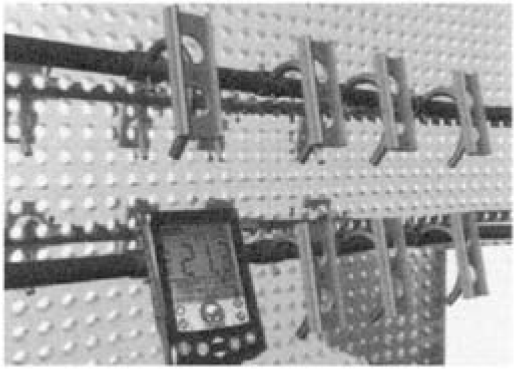
Mobile Event City Architecture (MECA)

The Mobile Event City Architecture provides an overall upgrade of event facilities for a socially con scious event-planning firm that creates multi-day outdoor charity events in support of AIDS, breast cancer, world hunger and like causes. The goal is to provide structures for their nightly encampments, that are easily relocatable, adaptable to varying site conditions, climate controlled, clean, well-lit, and visually striking—and that help engender intimate social interaction.

Four possible master plan schemes assemble the campsite components into a four-tiered hierarchy, which can then be organised either around a central gathering space ('Town Square'), along a linear corridor ('Main Street'), or in a combination thereof. Individual campsite elements, such as Medical Services, Outreach (marketing), Vending Kiosks and the 'Remembrance Place', use existing truck types as points of departure, then hybridise them with tensile fabric structures. These compact, self-contained mobile structures are weather resistant, hygienic and easy to deploy and relocate. As they unfold, slide open, pivot and pull apart to expand their floor areas, their fabric components take shape to form



14.6a Zevos Kiosk in operational position

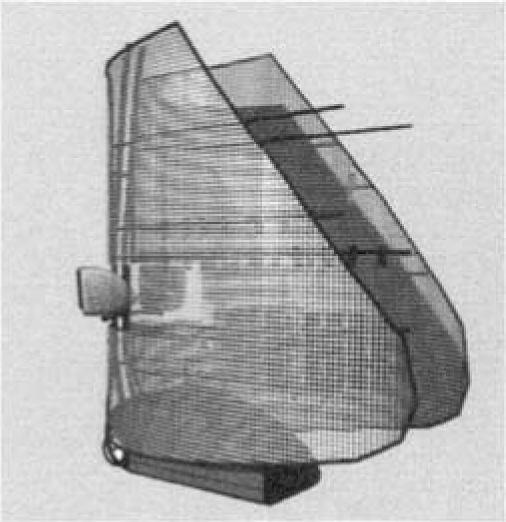


14.6b Flexible racks for detachable bicycle accessories

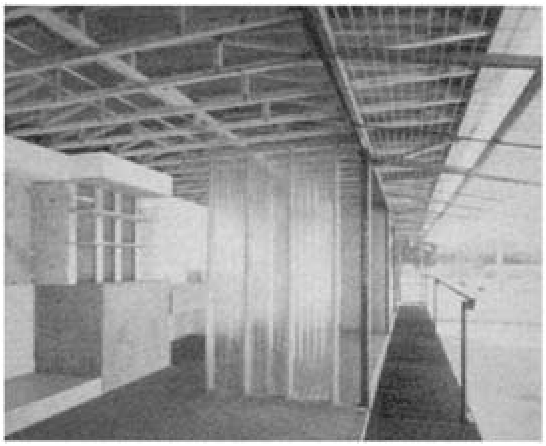
roofs, walls and overhangs, transforming their host vehicles into unique, wondrous building/machines.

The master plans call for the primary structures to be situated along an elevated boardwalk that either extends linearly along 'Main Street,' or circumscribes the 'Town Square'. This raised thoroughfare, composed of sections that slide out of each vehicle and interlock, unifies the disparate elements to the Mobile City, providing identifiable and accessible circulation that is also a level alternative to an often uneven ground plane. This streamlines the organisation of campsite operations and augments the overall level of comfort and care afforded to event participants.

To facilitate intimate social interaction, the diminutive Vending Kiosks locate/relocate throughout the campsite, offering a variety of 'comfort foods'. Two wing-like structures envelop food preparation and storage equipment on the truck bed. When open for business, these wings spread out, unfolding a fabric canopy that instantly creates sheltered gathering space and becomes a recognisable



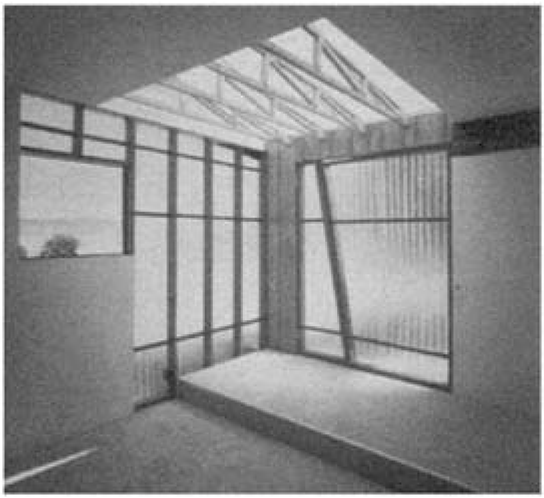
14.6c Zevos Kiosk en route



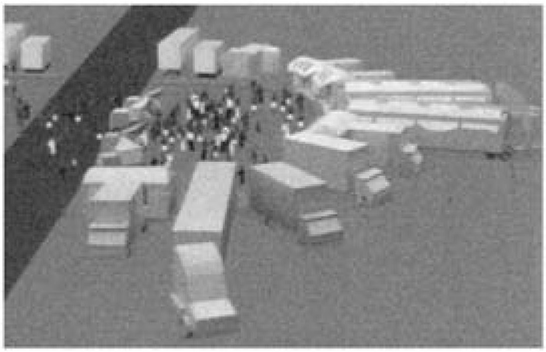
14.7 PCTC interior view

iconographic presence in the camp landscape. Condiments, utensils or products for sale are displayed on shelves along the wings' interiors.

The Remembrance Place's under-scaled entry vestibule gives onto a more ample main chamber, which has translucent curved fabric walls that suffuse the contemplative space with a serene, muted light. In the Medical Services facility, three umbrella-like columns give shape to the vaulted fabric roof, simultaneously housing skylight, plumbing, electrical and lighting elements. The Outreach facility doubles its area by sliding and pivoting into a T-shaped structure, creating three distinct areas (staff office, customer service, video screening) that can be closed



14.8 Interior view of meeting and exhibition space

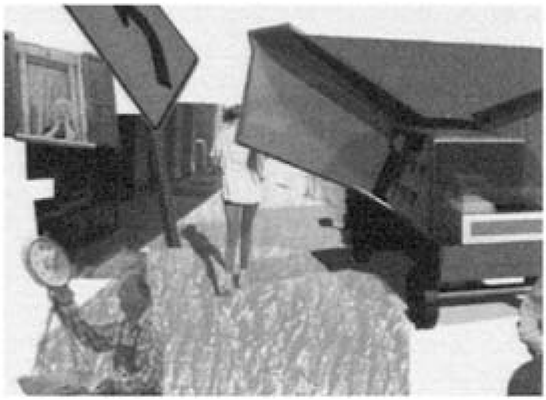


14.9 One possible masterplan scheme turns MECA into a 'town square' configuration, promoting social interaction and providing central accessibility to programmatic facilities

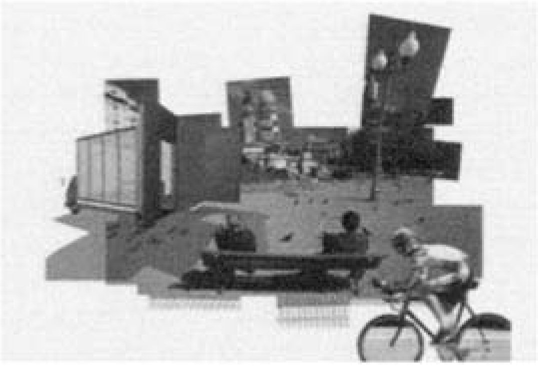
off from, or opened up to, one another. Its fabric roof extends out to provide additional exterior covered space, transforming the entry into a welcoming, sheltered front porch.

iMobile

Fold-out, plug-in, boot-up: the iMobile brings the World Wide Web right to you —literally. As a roving access portal to global communication networks, it announces with its very arrival the latest computer systems, peripherals, hardware and software—and then unfolds to invite you in for a surf. Marvel at the remarkable efficiency of a dynamic mobile enterprise. It is here that the workplace effortlessly evolves, enabling businesses to respond to the need for augmentation, contraction



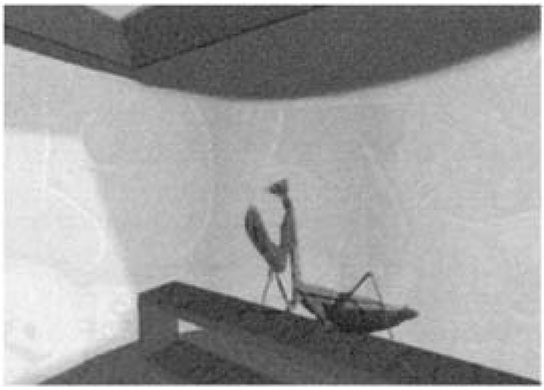
14.10 The Vending Kiosk spreads its wings, serving food and supplies to members of the MECA community



14.11a The Remembrance Place achieves a contemplative space by use of light and materials

and metamorphosis. The iMobile offers building solutions to the mobile entrepreneur, acting as a portable R&D facility, focus group laboratory and consumer Outreach centre. Based on an economy of movement, where form follows necessity, this adaptable and flexible structure is always responsive to its immediate and shifting environment. It is self-sufficient and relocatable, composed and durably constructed of high-quality, light and affordable materials. The iMobile gives shape to the metropolis of the future.

While Office of Mobile Design draws inspiration from Le Corbusier and Buckminster Fuller and the spirited dreamers of Archigram, the 1960s British futurists, it rejects the notion of generic solutions. Office of Mobile Design is dedicated to design, which has a distinct identity, adoption of irregular forms and sculptural details where appropriate. It seeks mobility and embraces mass-customisation, consequently creating mobile structures for a new modem age.



14.11b The Remembrance Place achieves a contemplative space by use of light and materials

14.12 A visually uplifting design combined with professional medical services makes this a welcome haven to those in need, both mentally and physically

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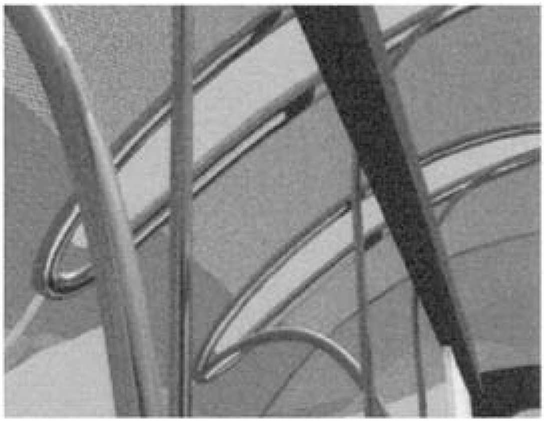

14.13a Shade screen detail

14.13b Interior view of Outreach space

14.14 Front view of iMobile

14.15a Interior view from rear

14.15b iMobile on location

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