# GREENFORMS:
# An Open Building Approach to Affordable/Sustainable Housing

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## ABSTRACT

This paper reviews the 1994 GREEN FORMS affordable-sustainable housing submission of a Mexican affordable housing competition, as an example of open-building. It lays groundwork for this discussion by exploring regenerative planning and design as the relationship between resource-flow, planning and design intervention within this flow, open-building at the range of scales, and formal and informal processes for community-building.

This paper takes the position that to be affordable and sustainable, housing must optimize the flow of materials, energy, currency, and information. It presents GREEN FORMS as buildings and communities that optimize these flows, but more importantly as a way of thinking. It asserts that GREEN FORMS as houses and communities – and the thinking they embody – address resource flows in the hierarchical manner at which they operate. It introduces GREEN FORMS as a paradigm and as designed environments at the range of scales, beginning with residential scales, and then expanding the scope to address larger community, regional, and global dynamics and environments. This paper addresses GREEN FORM housing and communities as affordable home-site productive systems. It reviews GREEN FORM concepts, technologies, stages of growth, community aspects, and environmental benefits.

This paper (in the OB Mexico 2002, Topic 2 "theoretical approaches to the quality of housing" category) then reviews the diverse environments within which Mexican affordable housing occurs, and the Val Verde hypothetical case-study included in the

competition that demonstrates the potential of GREEN FORMS metabolic open-building approach to harvest the potential of these contexts. The case-study addresses housing and community design at increasing scales (building and site assemblies, house, residential site, cluster of residences, neighborhood, sector, biome, and globe). It addresses the impacts of GREEN FORMS verses conventional affordable housing. It presents GREEN FORMS as a method for understanding the interrelatedness of affordability, sustainability, productivity, and sustainable decisions concerning affordable housing.

The paper closes with conclusions based on the Mexican affordability-sustainable housing submission, and subsequent global projects of the Center for Maximum Potential Building Systems that build upon, and extend, these GREEN FORM concepts.

## REGENERATIVE PLANNING AND DESIGN

This section lays groundwork for understanding the regenerative GREEN FORMS open-buildings and open-communities approach to affordable-sustainable housing by exploring relationships among resource-flow, open-building, planning and design, and formal and informal processes for affordable housing delivery.

### Resource-Flow and Regeneration

"The nature of nature is change" (McHarg 1977). Natural systems sustain health and productivity through resource-flows and regenerative processes (such as succession) that promote order, diversity, complexity, and stability (McHarg 1969).

Operating within natural systems, people choose two approaches: mining resources and thereby reducing system capacity, and harvesting resources and sustaining capacity (Motloch 2001). Miners are Takers (Quinn1995) who violate natural laws (including limits of growth) and convert resource to waste. Harvesters are Leavers (Quinn 1995) who operate within natural laws, integrate with life-cycles, and balance harvesting and regeneration (Motloch 2001).

Recent global communities – built by Takers with rapidly expanding technologies -- have profoundly impacted local and global ecosystems and converted nature's self-managing local and global ecosystems into human dominated ecosystems no longer able to self-manage. Human survival now depends on managing ecosystems to regenerate system health and productivity. Growing awareness of this dependency produced a 1970s landscape architecture epistemological shift to *systems management* (managing health and productivity of systems), a 1980s physical planning and design professions shift to *sustainable development* (development that sustains system resources, health and productivity), and their 1990's shift to *regenerative planning and design* (solutions regenerate system health and productivity). (Motloch, 2001).

### Buildings and Communities

Growing awareness is changing the way we see buildings and communities.

Intervention in Complex Systems: Buildings and communities intervene in complex systems. Responsible interventions address three levels: object, system, and meta-system (Hatchuel, Agrell, & vanGigch 1987). *Object level* planning and design project decisions address immediate and local needs. *Systems level* management frameworks sustain system capacity, set limits, and provide guidance for object level decisions. *Meta level* decisions establish relationships, conditions and processes that promote appropriate decisions at the systems- and object- levels. (Motloch 2001; Turner 1976)

Historically, buildings and communities have been viewed primarily as objects. System considerations have been limited to building and community systems rather than the contextual systems (environmental, human) in which they intervene. Meta-level thinkinghave pursued short-term, narrowly-defined, human-serving goals.

Scales of Concern: Historically, building design has addressed local issues. *Spatial focus* was on site or immediate context. Distant impacts (resource extraction, transportation) were not considered. *Temporal focus* was on first-costs and perhaps operation and maintenance costs, rather than deeper life-cycle costs (environmental mitigation, jobs and income, impacts that cannot be mitigated). (Lyle 1994). *Clientele focus* was on people who commissioned or used the building, rather than people affected by externalities, or "nature" as client (Motloch 2001)

**Open-Buildings and Open-Communities**

The need to manage human dominated ecosystems is motivating design pioneers to an epistemological shift to open-building and open-communities, and in the case of GREEN FORMS, a synergy of ecosystem and open-building dynamics (Fisk, Motloch & Pacheco 1994; Motloch 2001). Among limited precedents for this synergy is the Boles Building kit (Henriksson 1997), developed to address Sweden's tree mining prohibition, Figure 1.

Interventions in Complex Systems: Open-building seeks to reduce impacts by embracing change. "Buildings – and the neighborhoods they occupy – are not static artifacts even during the most stable times, and during times of great social and technical upheaval are bound to need adjustment in some measure to remain attractive, safe and useful … the best buildings are those most able to provide capacity to changing functions, standards of use and life-style, and improved parts over time" (OBMexico2002).

Scales of Concern: Open-building's primary focus is at the *object-level*: facilitating building and community change. *Systems-level* considerations are on participant diversity and building-environment transactions. *Meta-level* considerations expand timeframes (Dekker 1998; Kendall 1997; Decker and Kendall 1996).

Open-building expands the *temporal scale* by facilitating change, expanding perceived *clientele* to include future people who commission or experience buildings, and nature as client impacted by decisions. This paper speaks to an expanded *spatial scale* that addresses externalities and temporal and the people affected by distant and future impacts.

**Development Processes**
"The principle tool used by those working in an open building way is the organization of the process of designing and building on environmental levels" (OBMexico2002). Since *shapers* (politicians, regulators, planners, designers) generally pursue formal processes, and *reshapers* (people who use, operate and maintain facilities) use informal processes (Motloch 1992; Hattingh 1990), open-building involves both formal and informal building and community processes, each with differing relationships to resource-flow.

Formal Building and Community Processes: Formal education encourages designers to intellectualize meanings, and pursue the 'Grand Tradition' of design (Rapoport 1969). It seldom encourages 'cooperative' (Jantsch 1975) or vernacular approaches that integrate design with physical and cultural dynamics (Motloch 1992). Architects are taught to design buildings to address statics, but not taught to address system dynamics. In addition, while buildings and communities must change with individual, community and contextual needs, formal mechanisms (ordinances, financing) promote "finished" products. As a result, formal communities struggle with change.

Informal Building and Community Processes: Progressive communities, created by informal processes, are very different from formal communities (Turner & Fichter 1972). They are characterized by incremental growth, diversity, and change. Rapoport (1977) addressed the importance and benefits of these communities including their spontaneity, flexibility, open-endedness, accommodation of individual expression, and ability to accommodate change.

## GREEN FORMS: BACKGROUND AND CONTEXT

Northern Mexico is growing rapidly due to Mexico's new decentralization policy, shift from import substitution to regional growth poles, NAFTA, and U.S.-Mexico Integrated Environmental Program. Unfortunately, Mexico does not have affordable housing that addresses demand while producing ecologically, socially and economically sustainable communities. Mexico urgently needs solutions that integrate local labor, traditional building techniques, and potential regional materials, to provide affordable-sustainable housing that facilitates "incremental" construction. productivity, job-generation, micro-industry, local economies, and resident participation in building their homes. To be affordable and sustainable, these solutions must address economics over the building life cycle, Figure 2, and environmental economics.

## GREEN FORMS: UNDERLYING CONCEPTS

The GREEN FORMS submission (Fisk, Motloch & Pacheco 1994) to Mexico's II National Technologies Contest for Social Interest Housing, Secretariat of Social Development, built on Fisk's Metabolic Planning and Design (MPD) approach that "sees the value of physical planning and design … and the professions that produce it, to be the value of the information that flows, as measured through improvement in ecological dynamics and life-cycle flows of material and energy." (Motloch 2001) The submission integrated MPD with Motloch's research in South African and Mexican informal communities and Pacheco's experiences facilitating informal Mexican communities. GREEN FORMS affordability, human use value, and environmental responsibility accrue to concepts produced by this integration.

**GREEN FORMS as Resource-Flow**

"To be affordable and sustainable, housing must optimize the flow of materials, energy, currency, and information. GREEN FORMS optimize these flows, as buildings and communities; but more importantly, as a way of thinking" (Fisk, Motloch, & Pacheco, 1994) To optimize flows, the submission integrated open-building with productive systems (agriculture, aquaculture, agroforestry) to produce built-sites that augment production, retain flexibility, harvest resources, recover wastes, and regenerate resources. It integrated life cycle flows, alternative technologies, flexible manufacturing, and open-building to develop affordable housing that optimized resource-flow.

**GREEN FORMS as Open-Building Technologies**

GREEN FORMS develop the potential of open-building at the object, systems, and meta-systems levels. They embrace local materials and labor, convert wastes to construction resources, integrate green technologies into local home building industries, and develop new production chains (byproducts become resources) to enhance productivity and quality of life. They promote ecological responsibility, economic viability, and resident empowerment by accommodating diverse local materials (earth-, fiber-, and waste-based) as construction resources, translating consumptive (wood, energy, water) cement-based technologies, and allowing construction to occur incrementally by residents.

**GREEN FORMS as Scales of Concern**

GREEN FORMS address resource-flows in the hierarchical levels they operate: global, biome, community, home, site, and assembly, Figure 3. (Fisk, Motloch, & Pacheco, 1994) They optimize flexibility at environmental levels: "housing and community design use GREEN FORMS structural systems in conjunction with premanufactured wall, floor, and roof components; or as structural systems that receive locally produced non-structural earth-, fiber- or industrial byproduct- based materials.

**Open-Building and Progressive Change**

GREEN FORMS integrate the flexibility of open-building environmental levels with the incremental development necessary in progressive communities, to enhance local housing, labor, and industry bases. They begin as labor-intense, low-tech, low-cost technologies, and "grow" through phases of increasing space, sophistication, complexity, and efficiency, Figure 4. GREEN FORMS facilitate growth from modest beginnings (8' X 8' informal business with open-air sleeping grows into multi-story home, Figure 5). Residents progressively build complexity and amenities into GREEN FORM homes, Figure 6. As the individual unit changes, non-structural infill walls and module sizes (8' X 8', 8' X 13'4", 13'4" X 13'4") provide opportunity for diversity in size and layout, figure 7.

**Resource Regeneration / Resource Balance**
GREEN FORMS integrate ecological, economic, and technological systems to increase productivity (with minimal embodied capital and energy) of natural, human, and industrial systems, improve quality of life, and promote resource-balance. They achieve these by accommodating diverse potential materials and technologies, and harvesting, managing, and regenerating resources.

**"Aesthetics of the Unfinished"**
Pleasing at all incremental construction phases, GREEN FORMS aesthetics express the unfinished nature of progressive communities. They provide visual continuity through consistency of base-building components (framing materials, structural modules, exo-skeletal veil) while accommodating change and individual expression via fit-out (infill) components. In initial phases (need for maximum area and minimum costs), exoskeletal shading provides a positive utilitarian aesthetic and thermal comfort. In later stages, GREEN FORMS continue to accommodate individual expression as the community aesthetic completes itself.

## GREEN FORM TECHNOLOGIES

GREEN FORM technologies include green architecture, integrative support systems, and base-building structures that accommodate diverse earth-, fiber-, and waste-based local and regional materials, Figure 8.

**Green Architecture**
GREEN FORMS harvest water, energy, and light, convert solid and liquid wastes to resources, and integrate building and plants to optimize nature's ability to produce foodstuffs, enhance building and site microclimates, increase comfort, and reduce costs.

**Integrative Systems**
GREEN FORMS' highly-integrated systems can evolve through phases of increasing sophistication, complexity, efficiency, and comfort. The *Water-Wastewater-Landscape-Energy System* (integrated heating, cooling, water, wastewater and landscape subsystems, Figures 9-12), harvests water and wastewater to sustain living fences, fruit trees, trellises (food production and shading of building and site use areas), and raised planters (herb, vegetable, cut-flower production). Plant evapotranspiration and saturated soil thermal mass enhance energy efficiency. The *exoskeleton system,* Figure 13, is a flexible wire grid on rebar frame that supports vines that process nutrients from building-generated human wastes into leaves that shade walls, roofs, and use areas to improve microclimates. The *structural frame system*, Figure 7, serves various roles in the life cycle of the *integrated water-wastewater-landscape-energy-structural system*.

**"Accommodating" Structures**
GREEN FORMS are "accommodating" structures of three modules (8' X 8', 8' X 13'4", 13'4" X 13'4"). In some cases, rebar (for concrete frames) first function as demountable frames for shade canopies and exoskeleton, providing flexibility and accommodating

change. Encasing these rebar in fly-ash concrete (in fly-ash ferro-cement folded-plate forms) incorporates them into the "base-building", Figure 14. This fly-ash technology adapts Mexico's consumptive (wood and energy) and polluting (Portland cement) housing technology into an environmentally benign one.

**Earth-, Fiber-, and Waste-based Infill**
The base-building structure accommodates diverse earth-, fiber-, and waste-based infill wall fit-out materials, Figure 7, allowing residents to use readily-available, cost effective local or site-based materials to modify their homes. The open-building modular urban fabric produced also allows residents to buy or sell modules to adjust residence to family life-cycle, Figure 15-16, multi-use conditions, and changes in workspace (GREEN FORMS integrate work and home environments for income-generation).

## STAGES OF GROWTH

GREEN FORMS embrace staged, incremental growth, and different levels of access to innovations over time, in response to diverse and changing conditions.

**Flexibility, Incremental Growth, and Phased Construction**
GREEN FORMS embrace the flexibility of environmental levels, the incremental nature of progressive communities, and phased growth. Initial technologies (labor-intense, low-tech, low-cost) evolve through environmental levels and phases of increasing sophistication, efficiency, comfort and integration (including water-wastewater-energy-landscape-support system).

**Ability to Access Different Levels of Innovation**
Each GREEN FORM subsystem (heating, cooling, water-wastewater, structure) is open-ended, flexible and able to be accessed at different levels. Residents can access the most sophisticated levels of innovation, or more commonly use basic levels to allow them to downsize conventional systems. Residents who initially access basic levels can progressively access more sophisticated levels.

## COMMUNITY ASPECTS OF GREEN FORMS

GREEN FORMS also grow in sophistication as physical and social communities.

**Natural Productivity** and **Limits to Growth**
GREEN FORM communities progressively integrate natural systems, resident needs, and community productive capacity (energy, protein, fiber, and food). In these communities, buildings harvest resources and augment site production, while site productive systems regenerate resources consumed or degraded. GREEN FORM homes are placed on marginal soils, while shade structures extend to augment highly productive systems, Figure 17.

**Development, Resource-Balancing, and Social Territory**
GREEN FORMS include community scale utilities and production systems. As families grow, waste generation exceeds the potential for home-site regeneration to balance home-site wastes. Community scale production systems help maintain resource-balance. Community scale systems also support the GREEN FORM hierarchy of urban open space. Resources harvested and wastes produced by the residence (beyond those needed or mitigated on-site) augment community productive systems. In GREEN FORMS' hierarchically structured production systems (portions supported by the individual residence, cluster of residences, neighborhood, or community) resource and wastewater contributions to productive systems promotes a hierarchy of social territory including private, cluster, neighborhood, and community open space, Figures 18-19.

**Place Specific Sense of Community**
By incorporating site-based, local and regional earth-, fiber-, and waste-based materials, and by creating "a reality in whose shaping . . . (he/she) is actively and creatively participating" (Jantsch 1975), GREEN FORMS connect people to place and promote a strong place-specific-sense-of-community (Vigo 1990).

## ENVIRONMENTAL ASPECTS OF GREEN FORMS

**Regeneration**
GREEN FORMS are open-buildings and open-communities that accommodate (and change with) nature's dynamic systems, and balance and regenerate resources.

**Community Autonomy**
Typical houses in Mexico depend on external support. "(M)ore than 90% of all wastewater treatment plants are nonfunctional. There are about 1 billion people in Mexico who do not have an adequate water supply and 1.7 billion people do not have adequate sanitation facilities" (J. Briscoe 1993). GREEN FORMS incorporate productive site-based systems as self-sufficient alternatives to conventional systems.

**System Overlaps**
GREEN FORMS arbitrate among short-term efficiency (affordability), long-term efficiency (sustainability), and open-endedness (incremental growth, high human use value, fine-tuned relationships of building, site conditions and family life-cycle). This arbitration produces overlaps and redundancy, analogous to redundancy in ecosystems (necessary for long-term survival). Redundancy is important because a high percentage of external supports in Mexico do not function". Open-building allows for overlaps, redundancy, response to changing conditions, and adjustment to non-functioning systems (Fisk, Motloch, and Pacheco 1994).

## VAL VERDE CASE-STUDY

Progressive communities in Mexico typically occur in contexts with diverse resource units. The Val Verde hypothetical case-study demonstrates the potential of GREEN FORMS' metabolic approach to realize the productive potential of these contexts.

### GREEN FORMS as Open-Community Response to Resource Units

In the Val Verde case-study, GREEN FORMS integrate with resource units, Figure 20, into diverse built-site productive systems, Figure 21. In each case, metabolic concepts integrate site conditions, dwellings, and production systems to accommodate diverse resource potential and production strategies.

<u>Areas Suitable for Grain Production</u>: This zone of well-drained sandy-loam grassland soils on flat land can support a diverse *grain production sector* using dryland techniques to produce proteins for animals and people, fiber-based building reinforcements, building material replacements (for plywood, building panels, insulation), and biofuels such as ethanol (Jackson 1991). Dryland farming would avoid water connections between houses and grain production. Since grain crops cannot be pipe-irrigated, and wastewater cannot be air-distributed, a portion of land should be used for growing spray-irrigated non-edible crops. Self-sufficient houses in the *grain-based community sector* can use grain from the production sector to insulate walls, and wheat and oats to produce wheat and straw for infill walls.

<u>Areas Suitable for Cattle Production</u>: This zone's *cattle production sector* regenerates temperate grassland soils as cattle hoofs work the soil while cattle fertilize with manure and urine. The sector includes conventional food and leather production, and alternative products including animal-waste fertilizer, oxblood-based air entrainment systems for concrete, and animal bone-marrow to mix with resins produced in the agro-forestry area to make lightweight concrete foaming agents. Animal-wastes can also augment vegetable and grain production areas. The *cattle-based community sector* can include self-sufficient white stucco homes (using caliche fired by biomass produced in the forest sector) with large roof areas and impervious streets that direct water to deep wet ponds (minimum evaporation) for pumping to animal areas. Animal hair can be used to reinforce lime stucco and as alternative for metal products such as lathe.

<u>Areas of Calcareous Soils</u>: This important aquifer recharge zone of limestone outcrops, near-surface limestone, and highly calcareous soils is unsuitable for agriculture, and poor for septic of soil-based wastewater systems. The *production sector* includes production of energy conserving concrete block (calcium cement supplemented by reduced amounts of Portland cement) and high-mass caliche-type stabilized-soil building blocks, rather than adobe blocks made from loam soils elsewhere (preserving prime-agricultural soils). The *calcareous soils community sector* can use these caliche-type and lime-concrete blocks to build walls, raised-plant beds and microbial rock bed filter systems. They can use crushed limestone for road and building bases.

Area Suitable For High-yield Farming: In this zone of agriculturally-suitable soil, the vegetable *production sector* is augmented with resources harvested and wastes generated by the community. High yield agriculture includes animal waste compost-augmented raised-bed agriculture (also allow soil to be imported) can produce crops with 1/4 the water, 1/4 the nitrogen, 1/31 the land, and 1/100 the energy per pound of food as conventional agriculture (Jearon 1979). Houses in the *agriculture community sector* should be self-sufficient with large roofs to harvest water beyond residential needs. Streets should be impervious water-harvesters. GREEN FORM structures should extend into raised-bed areas, providing shade (water-harvesting surfaces that change wavelength for ultimate plant growth). Surplus harvested water should be stored in deep wet ponds to minimize evaporation, and applied directly to plant roots in the morning and through fertilization-atomization of leaves underneath GREEN FORM shade structures during hot periods.

Area Subject To Flooding: This flat zone is subject to flooding and characterized by highly productive high-nutrient soils. The *production sector* includes aquatic plants and animals augmented with sewage water. Ponds and wetland systems offer wastewater treatment alternatives to microbial rock bed flower systems and cisterns. Here, a *Chinampas – aqua-culture/plant combined community sector* can use ancient central and south American methods of raised bed agriculture alternating with lower submerged fish production terraces, with each using the wastes produced by the other as resources to augment production, with this high crop production system ameliorating microclimates.

Area Suitable for Forests: This zone offers *production sector* opportunities for tree farming and agro-forestry (shade tolerant food production). Trees can be propagated (with crops between) in a symbiotic relationship of plant types (trees build soil, shade crops from intense heat, reduce water consumption, and provide wind protection; Crops provide detritus for tree roots). This zone provide alternative crop opportunities (proteins, carbohydrates, and oils for biomass; nuts, fruit, berries, grain, and vegetables for consumption), and long-term carbon sequestering in tree mass. An *agro-forestry community sector* with open-building dwelling units within this zone can integrate with agro-forestry systems into autonomous built-agro-forest production units that harvest resources and process wastes, while the forest supplies organic and nitrogenous materials for agriculture below.

## CONCLUSIONS

The first six conclusions extend beyond the competition, to update GREEN FORM development, and relate them to Habracken's ideas about making the environment (www.obmexico2002.com.mx/ob.html). The seventh addresses broader issues.

**GREEN FORMS as Levels of Intervention**
The competitition's grid structuring urban fabrics and supporting productive systems extend CMPBS precedents developed in the Blueprint Farm (Fisk 1989) and other projects. The competition, has likewise informed subsequent CMPBS GREEN FORM

project levels of intervention including the "Armature" concept, where the most permanent element or systems at any level of intervention serves as armature for less permanent elements. In the Longju Sustainable Village Project (Fisk 2001), Figure 22-25, the levee (most permanent environmental feature) serves as urban level Armature for less permanent infrastructure and building components.

GREEN FORMS integration of CMPBS's Biom-etric™ approach (wastes generated at one level -- biome, country, region, sector, neighborhood, cluster, building, assembly -- function as resource at that or other scales) with natural systems dynamics, and levels of intervention served as springboard for other CMPBS projects including the Kosovo Traditional Housing Competition (CMPBS 2000) that links businesses with resource-flows, integrates self-sufficient housing systems into resource-flows, and interconnects open-building with ecological footprinting as an innovative approach for community design, Figure 26-27.

**GREEN FORMS as Pathway for User/Inhabitant Decisions**

Sustainability depends upon synergy of *shapers* (politicians, regulators, planners, designers) who operate in formal arena and processes and *reshapers* (residents, facility operators and maintainers) who function in informal arena and processes (Motloch 1992, Hattingh 1990). Fortunately, *fourth generation design processes* (Motloch 1992) include innovation-intervention type methods (Van Gigch 1984) to manage dialogue, integrate expertise, and create decision environments that dissolve barriers between peoples= lives, formal planning, and design. These processes are effective in helping overcome designer reticence to relinquishing autonomy and control of design.

The subsequent Longju Sustainable Village Project, Figure 22-25, institutionalized GREEN FORMS as pathway for user decisions. Fameworks were industrialized; Infill was micro-industrialized. The State (centralized unit) funds the Armature as support system upon which the community can extend, and takes care of code issues. The local community (decentralized unit) takes care of the more personal grain.

**GREEN FORMS Inclusion of Multiple Participants and Professionals**

Fourth generation processes promote dialogue, dissolve barriers, and integrate diverse value systems, world views, and design consciousnesses -- to supplant narrow-window discipline-based thinking with interdisciplinary consciousness. They have potential to build understanding of open-building, local and remote environmental impact, and. regenerative solutions responsive to diverse perceptions. (Motloch 2001) The institutionalization of roles, as in the Longju Sustainable Village Project facilitates the creation of interdisciplinary teams at the different institutionalized levels, with key participants participating in multiple team, facilitating and integrating their work.

**GREEN FORMS: Technical System that Allow Fit-Out Changes**

Taking their cue from nature's overlapping niches, GREEN FORMS maximize the ability of open-buildings and open-communities to accommodate diverse earth-, fiber-, and waste-based materials to performing the same function. GREEN FORM structures accommodate a range of infill wall materials, intended to change over time. At diverse spatial and temporal scales, GREEN FORM buildings and communities change to fully integrate with changing environmental and social conditions and family life cycles. Initially as "accommodating" systems, and later as "Armatures", GREEN FORMS are evolving into even more effective facilitators of openness through environmental levels that promote fit-out.

**GREEN FORMS as Facilitator of Urban Transformation and Change**

GREEN FORMS marry nature's ecological dynamics (the nature of nature is change) with the physical dynamics of progressive communities (informal and incremental). They embrace, participate in, and celebrate change as the natural/human order of things. They are emergent, open, and evolutionary communities always in the state of becoming something else, and celebrating an aesthetic of the unfinished, or aesthetic of becoming.

**GREEN FORMS as Product of Regenerative Design Process**

GREEN FORMS buildings and communities, express (physically and aesthetically) the regenerative design processes through which they evolve. As products of ongoing, never ending processes that are regenerative in nature, they participate in and help choreograph, urban transformation.

**GREEN FORMS Addressing Externalities & Distant (Spatial & Temporal) Impacts**

Most open building initiatives focus on local building impacts. Seldom do they address externalities (such as the impacts to places and people in distant regions from which resources are mined). GREEN FORMS apply metabolic, biometric, and open-building approaches to address all of Lyle's five Levels of Costs (Motloch 2001) "including: 1) materials and labor, 2) operation, maintenance and management costs, 3) indirect costs or externalities like environmental mitigation, 4) larger marketplace issues such as jobs generated, and effects on income distribution, and *5)* immeasurable environmental and social costs outside the marketplace."

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