

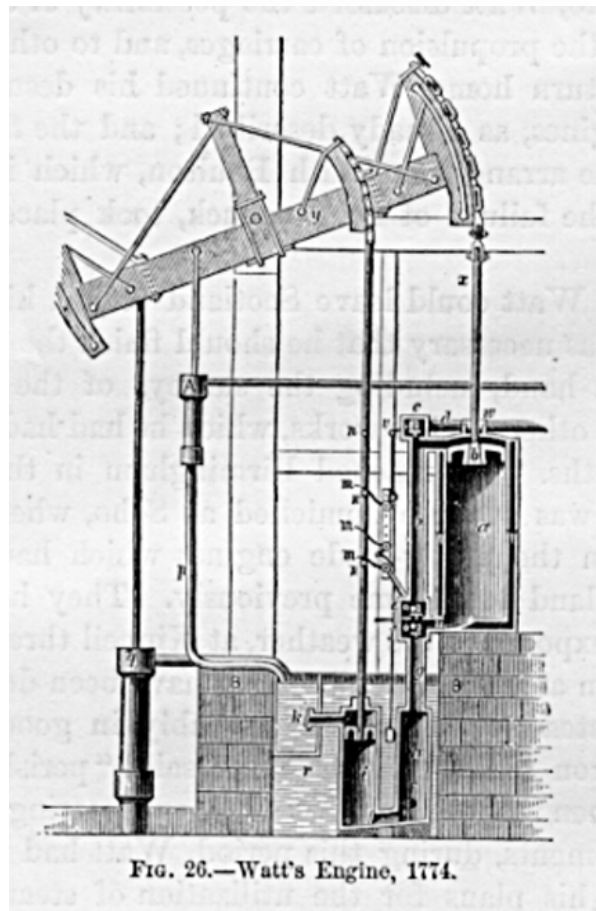


prefab+armature

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$$746 \times \text{[Portrait of James Watt]} = \text{[Illustration of a Horse]}$$



From a macro perspective, ‘civilization’ can be viewed as a recent 10,000 year socio-cultural construct of a ‘habitat builder’ species called Homo-Sapiens. All species, and especially the habitat builders, create an impact on the environment. No species lives in perfect harmony with the environment, but is merely a part of the biosphere ecosystem with its interconnected relationships of cause and effect. The price of ‘civilization’ in ecological terms is (and always has been) to change the environment in which we live. In terms of human civilization as a component of the biosphere ecosystem, two epochs can be identified: the carbohydrate age and the hydrocarbon age. The carbohydrate age is characterized by energy used for useful work derived from plant and animal matter locked into the specific limits of growth of their own ecosystems. The impacts on the environment were limited by mans physical strength, the strength of his domesticated animals and on some wind and water power. The limits to growth were capped by society’s ability to manage nature’s carbohydrate based technology. The manageable energy man could derive from nature, the productivity of his daily work, was limited. Around 1850, what is commonly called the Industrial Revolution, civilizations ceiling to limits to growth was raised by human technology by employing hydrocarbon based energy to perform useful work. Since the invention of the ‘machine’, daily productivity to relocate and transform material and energy flows has increased anywhere from fifty to fifty-thousand fold. This transition in civilization from a carbohydrate energy age to a hydrocarbon energy age marks the beginning of a trend where humanity has been able to avoid most of the traditional checks and balances that nature uses to balance the interconnected relationships of the biosphere ecosystem. Machines have increased the human capacity for initiating material and energy flows so dramatically that global scale consequences are the new reality. (1)

At its core, the notion of sustainability is centered on the fact that humanity is still an integral part of the biosphere ecosystem despite its success in exceeding the traditional checks and balances. We can not live apart from the biosphere but only as part of it. The biosphere is a planet bound closed system and at some point a rebalance will occur. There are no exceptions made for us. Ancient history is filled with examples of civilizations that that grew and exceeded the checks and balance of nature. In his book Collapse, Jared Diamond, a geographer, graphically details the history of rebalance of Easter Island after it's forest were denuded by its inhabitants. (2) While it is materially impossible for us to destroy the planet Earth, we now have the capacity to engage in material and energy relocations that are so disruptive to the biosphere that a new rebalance point could emerge that is drastically different from the status-quo of the last 10,000 years which has nurtured civilization. (3)



Since the Industrial Age, the socio-cultural vantage point has been closely linked to advances in human technology. Civilization's vantage point has shifted from an eye-level view of the horizon from trains, to a bird's eye view from planes, to a planet wide view from space. On December 22, 1968, an iconic photograph was taken by the Apollo 8 space mission that showed, for the first time, the planet Earth rising over the moon. That photo is considered by many to be the tipping point for the birth of the environmental populist movement. (4) This new planet wide perspective brought on by Space Age technology has established the cultural reference frame that is mainstreaming the new Global Perspective. This large, holistic point of view is radically redefining the underpinnings of progress. Bountiful and unlimited resources are now finite resources to be managed. Environmental cause and effect can not be neatly contained by political borders. The planet Earth is now the fragile planet Earth. This socio-cultural perspective is reflected in pop culture and the mass media with such films as 'The day After Tomorrow' and, of course, 'an Inconvenient Truth' as well as 'special green additions' of magazines such as Harpers.

Starting with the Industrial Revolution western society went from a carbohydrate energy base to a fossil fuel energy base. Our current Western society can be labeled the cheap oil energy base. Since fossil fuels are a finite resource, their continuous use is unsustainable. In addition, the huge rate of use is a material flow change that is considered by many as so large that the planet can not adjust to it without a major rebalancing event we are calling “global warming”. Cheap oil providing cheap energy is the underpinning of the socio-economic/socio-cultural/socio-technological (5) framework of our current society. A buildup of pressures on this resource is forcing a rebalance that will impact across all spectrums of society.

This new socio-cultural awareness of sustainability has jump-started a re-examination of many issues including housing. It has been estimated that up to 40% of the energy and material resources consumed by Western Society is used in the building industry and 80% of the building industry is housing construction. (6) It is clear that sustainable development in housing would have a large impact in improving the sustainable prospects for society as a whole.

In North American modern society, plentiful and cheap resources, especially cheap oil coupled with the personal car, has, starting after WWII, reshaped the urban landscape into what is commonly now called urban sprawl. The concept of a house in a garden has almost universal appeal. The Iconic flagship of this landscape is the detached single family dwelling which is now recognized for many reasons, by many disciplines, as an unsustainable urban habitation pattern. Despite the clear ‘unsustainable’ character of this housing type, it remains the choice of most in our society as the ‘Dream Home’. Inevitably, any real model of sustainable urban housing development involves stacked dwellings – all the while, everyone fully acknowledging that the ‘Dream Home’ is never a vision of an apartment in a high-rise in the city.

And that is the prototypical urban housing problem.



Levittown NJ



The beautiful illusion of the ‘dream home’ country retreat conceals many problems. The reality of subdivision homes on small lots has been debunked as individual isolation in a boring environment that offers neither spatial qualities nor urbanity. In reality the modest distance between detached houses becomes inhospitable and labor intensive nuisances. Acoustic privacy is marginal and can be much better achieved through technical means. The current offerings of ‘density-carriers’ as housing in the city presents its own problems. Few building types disconnect people from nature and each other as effectively. Dense urban housing designed by architects that looked laudable in architectural journals turned, in most part, into socially engineered ghettos. (7) The decision to opt for the suburbs could be viewed not as a rejection of the city as a place to live but as a response to insufficient housing options. We have inherited a legacy of housing stock of detached homes and high-rise apartments more than sufficient in quantity to meet the socio-cultural/socio-economic/socio-technological demands of the future. Sustainable urban housing that will meet the new rebalance of the above stated Triple Bottom Line occupies the range between the two current extremes. Future sustainable urban housing will have to be a form of stacked dwelling for intensification while providing the perceived values of the detached home.

As previously stated, the physical amenities of a detached house can readily be achieved in a denser form through technology (ie: sound control, cross ventilation, visual privacy etc.). Even the fact that a detached house is inherently ground related with direct access to garden and backyard can be addressed in a denser form with patios, terraces and courtyards. The distinguishing socio-cultural factor that sets the detached house apart from other housing types is the image of unencumbered ownership and control. This direct control allows the home owners to personalize their environment. This was the historical basis of vernacular housing – direct control of the individual dwelling by the occupant within a larger societal framework of communal support. (8)

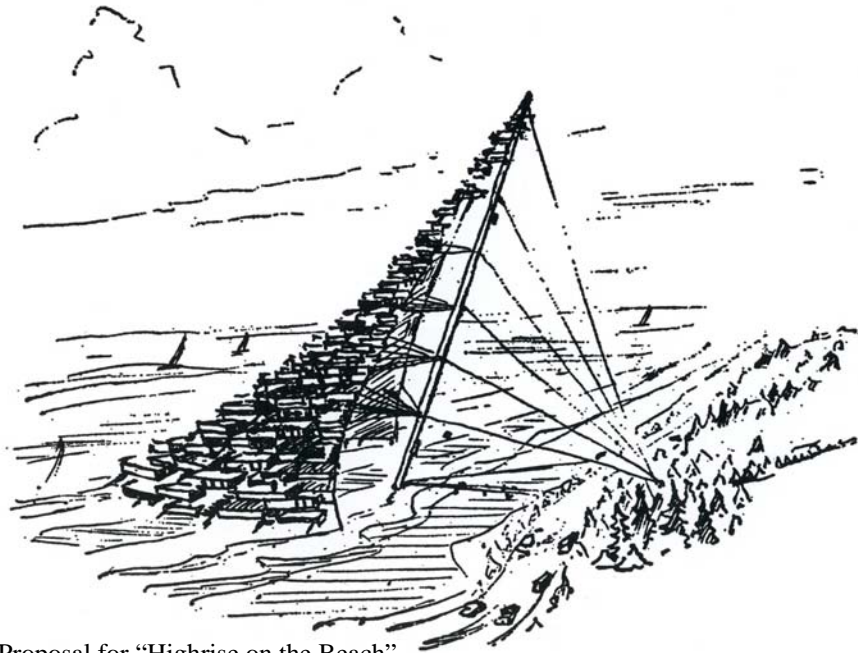
The speculation proposed for this competition posits that only when individuals can exert their own decisions and exercise direct control over their dwelling can that dwelling form be the preferred choice. The speculation acknowledges that dwellings are the result of the dynamics of two spheres of control: Individual + Communal. It is proposed to unbundle support + infill which in modern urban housing has been provided together and provide a form that has discrete communal infrastructural support + flexible individual dwellings. By separating the two spheres of control, it is possible to create a detached house environment in a sustainable urban intensified environment by fostering an active dweller as a recognizable participant in the housing process. (9)

This is a radical change from the current working model for stacked dwellings where a designer exercises authorship (10) over the entire project. The actual dwelling end user is totally excluded. The design is simplified to match the ‘most probable’ user reflected in a basic floor plan that is always a compromise. The floor plan becomes an exercise in finding a good enough solution to justify continuous repetition. Then, as soon as the unit dweller establishes control, invariably and universally, he/she begins making changes. The potential serviceability of the originally constructed assemblies with its ecological rucksack of energy and material flows (11) is lost while additional material and energy flows are needed to make the changes.

By separating support and infill, the renewal of dwellings can be flexibly undertaken in response to changes in lifestyle, individuality and technology. A robust support system can be used as a social asset for long periods of time providing a permanence in the urban fabric. (12)



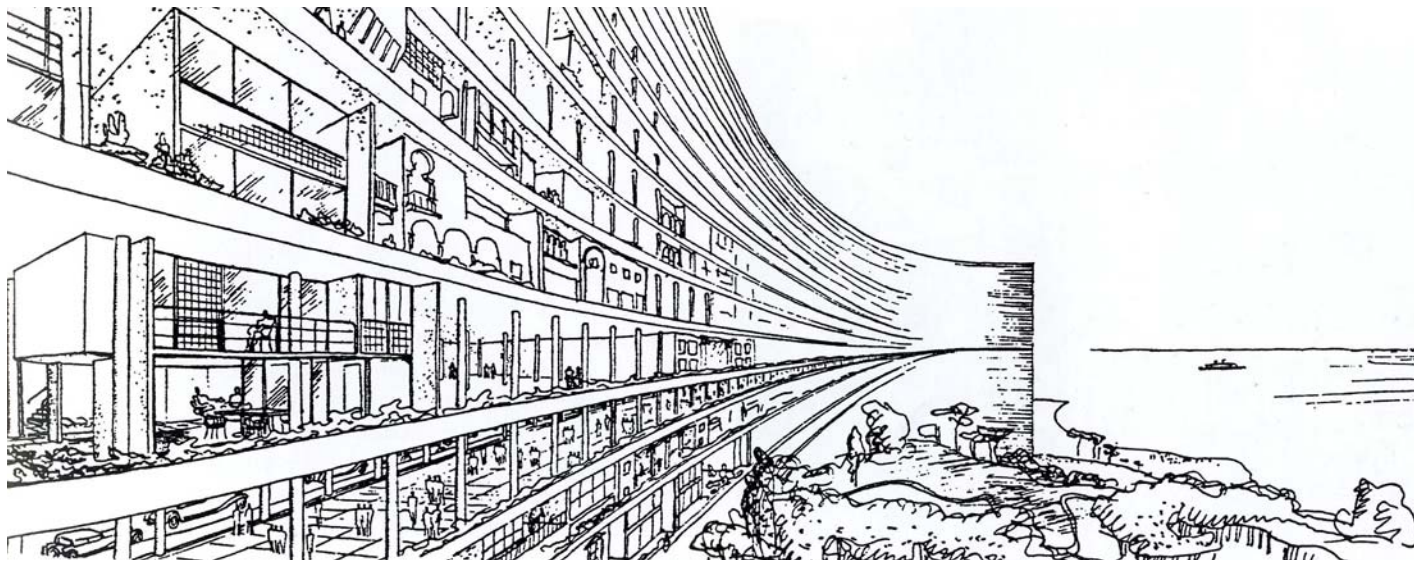
Housing project “highrise of homes”
S.I.T.E. 1981



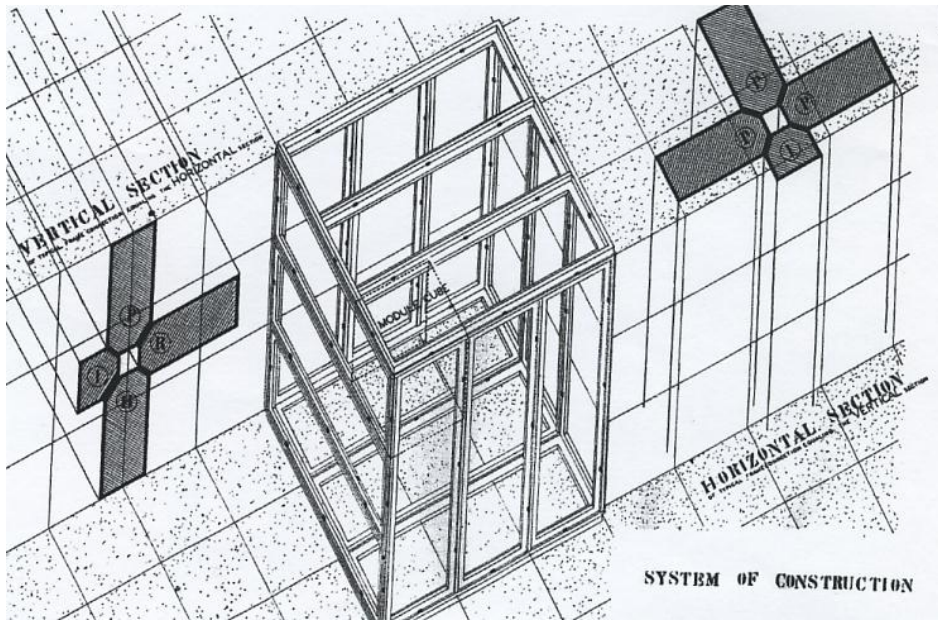
Proposal for “Highrise on the Beach”
Frie Otto circa 1960

A support is more than a structural grid. It is a framework of communal services and infrastructure. (13) The support armature form and construction would be regionally based responding to site specific parameters. The structural components would be a durable and robust design culturally acceptable as ‘ground’ with an expected life span in excess of 99 years, fire proof, waterproof, hurricane proof. It will become a social asset, a permanence, that will be usable by different users with differing wants throughout its lifespan.

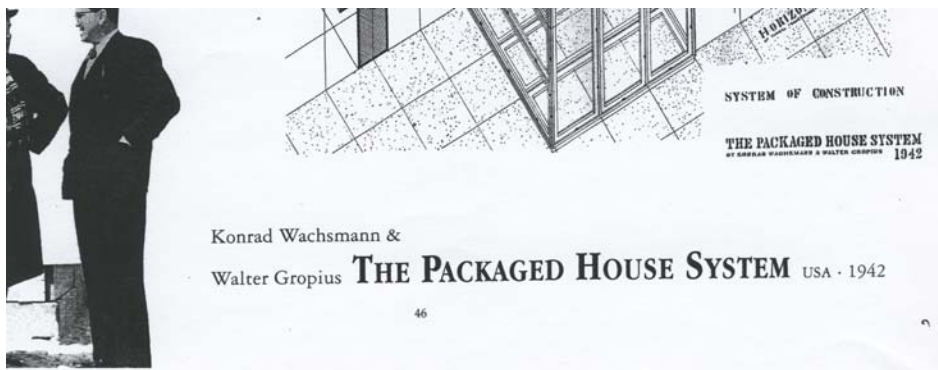
An infill is more than dwelling units. It is an intricate interweaving of spaces and functions directly responding to the unit dwellers vision of ‘home’. The authorship by designers of the support armature would not extend to the dwelling unit. An individualized dwelling unit could be viewed as a consumer durable assembly truly reflecting personal aspirations. In contrast to a support which must be built in a specific place, infill would be much more flexible and adaptive. The expressions of individuality would be the raw material for the growth of real communities; communities that grow out of mix, risk, and identity.



“plan Obus” vertical garden city
Le Corbusier 1931



By adopting a highly flexible infill systems, different forms of adaptive reuse over varying timelines become practical. The partibility and seperability of systems can dramatically improve sustainability by allowing the maximum service life of each component to be independently realized. Current construction practices interweave components and the net effect is that the component with the shortest useful service life determines the useful life of the assembly. Manufacturing learned long ago to decouple components as free standing armatures to yield greater efficiencies. The building industry is a well-known late comer to the resource efficiencies offered by digital technology. The Stanford University's Center for Integrated Facility Engineering (CIFE) has studied the productivity of US construction relative to all non-farm industries over a period of thirty-four years and found that construction productivity has slightly declined while all other industries have almost doubled. Thus, construction has not only lagged other industries but has actually deteriorated. The housing construction industry has calcified into inefficient delivery practices that are unnecessarily resource and energy wasteful. (14)



Many modernist architects have been intrigued by this inefficiency and have asked the question – “why can’t we build houses like we build cars?” (15) Early in the twentieth century the new architecture was conceptually linked to the reductive nature of new assembly methods. Le Corbusier predicted that in 20 years a rational transformation in the methods of construction would come to pass. Walter Gropius developed The Package House after WWII with support from the US government but it also only lived on as a concept. Increases in manufacturing efficiencies were tied to standardization which in turn did not support individuality. This lack of the ability to customize is contrary to the socio-cultural need in housing to be under the control of the unit dweller. Gropius’s need for ‘aesthetic unity’ and authorship over the dwelling ran contrary to personal choice.



Automated welding machine



Automated concrete floor finishing machine



Automated concrete placement machine

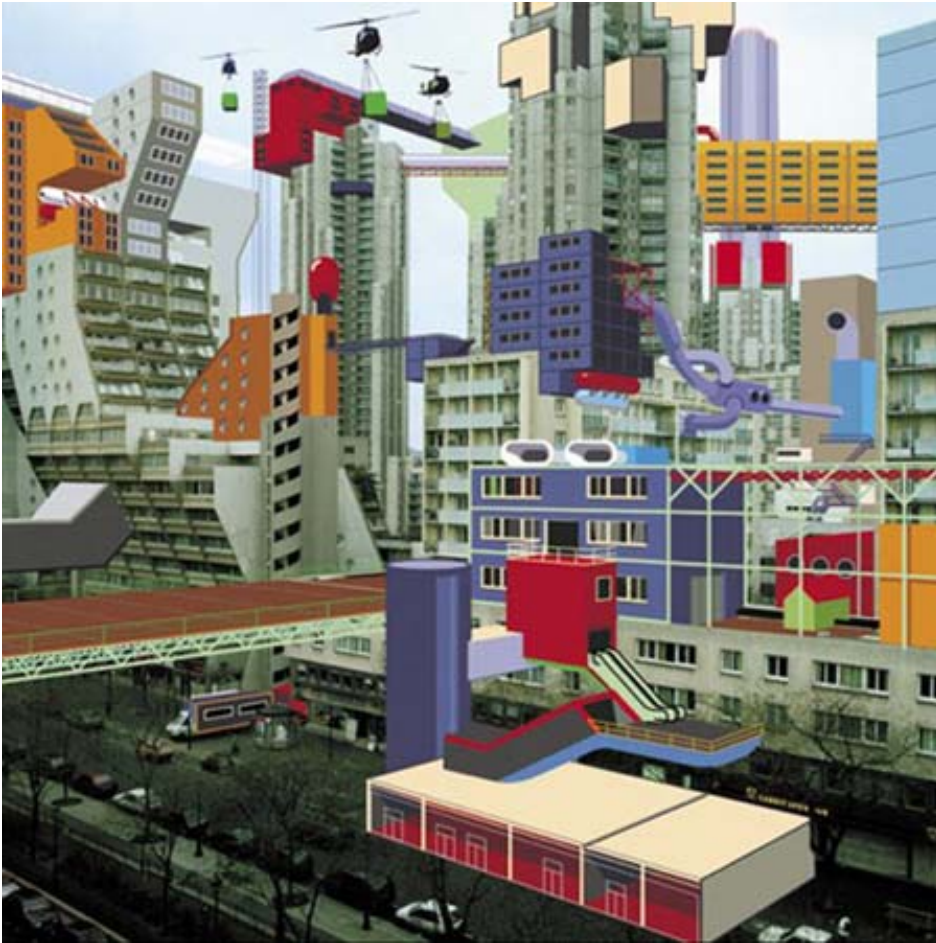
The Fordist model of mass production with standardization for prefabrication is only now being challenged. In 1952 the first numerically machine tool was made for the US Air Force in a research lab at MIT. It was the start of an infiltration of digital technology into manufacturing that would culminate in whole factories controlled by computers. The most important advancement from a designers point of view is CAM (Computer aided Manufacturing). It dispensed once and for all with standardization. A computer controlled fabrication can make different components in the same time as identical components. Mass production is now being replaced with lean production responding to specific demand. The socio-technical application of digital control to blocks, chunks and modules is reducing waste while increasing variety and choice. Digital control has dispensed with the necessity for standardization. The logical outcome of efficient digital production is variety of form and individual choice through mass customization. Digital prefabrication has the potential to re-introduce personal choice into housing while at the same time dramatically increase resource efficiencies by cutting onsite construction waste.



Prefabrication has the potential to facilitate the design and construction of large housing projects without necessarily imposing uniformity and rigidity. It can be the basis for how big scale housing projects do justice to the small scale where variety and adaptability over time are desirable. If neither the dwelling user nor technical means are dictating uniformity and rigidity of the built form, then it is designers, architects, that are imposing dwelling plans that they feel need to be the same for reasons of efficiency. Designers and architects and their need for authorship, by virtue of the fact that designing urban housing is profession protected, could be the weak link in the chain to the introduction of new sustainable urban housing typologies that are prefabrication based. In the non-profession protected housing industry of the detached single family house (only 5% of all housing projects involve a designer), a high (and increasing) percentage of manufactured components are used. According to research done by the Movement for Innovation (www.m4i.org) approximately 75% of the 'content' of a building is identical and often replicated from project to project.



The architectural profession has always struggled with prefabrication. There is a general social prejudice associating prefabrication with the 'mobile home'. Even though prefabrication clearly made mobile homes the most efficient shelter industry in the world, it didn't count because the shelters in question were not 'real houses'. The size and quality were not the issue – it was where they came from and how they got where they were. The lack of authorship relegated mobile homes as an area to study, to learn lessons from, so that the concept can be applied elsewhere, in the real housing industry



Archigram plug in city



. One of the dominant lessons inspired directly by mobile homes and prefabrication was plugging living pods into multistory megastructures. Factory produced became a distinct architectural style. The best known project was 'Plug-in-City' by Archigram. Words like 'Pods' and 'Capsule' appeared in the architectural lexicon rather than 'house' or 'home'. Prefabrication has made some inroads in terms of architectural acceptance. The British High Tech style of Norman Foster uses factory production as an important theme. (16) Architectural authorship has been extended to factory made building components designed by architects in close consultation with manufacturers in such landmark projects as the Hong Kong and Shanghai Bank building. This marked a radical extension of architectural authorship into the factory. Versions of most of the components were already available in semi-standardized form by the manufacturers but by being redesigned under architectural authorship, they became architecture. This new found legitimacy of prefabrication is causing a recent resurgence in interest. The potential for prefabrication to alter the means of delivery for housing in a more sustainable direction can not be ignored. Hopefully, this competition entry adequately conveys the potential.

1. In a paper titled “The Factor Ten/MIPS-Concept: bridging ecological, economic, and social dimensions with sustainability indicators”, the author F. Schmidt-Bleek estimates that 80 tons of non-renewable resources are devoted every year to maintain the material wealth of Americans and Europeans. As these resources are put into an economy, what comes out of it are emissions, effluents and wastes. Currently, CO2 emissions are highlighted in our society by its link to global climate change. The scale of anthropogenic materials flows could be causing environmental stresses on a global scale that simply have not been measured yet.
2. Jared Diamond recites how troubling the story of Easter Island was to his students. He was always asked the same question: “what was the islander who cut down the last tree thinking?”. How could a society make such a disastrous decision? Will the people of the next century be as astonished about decisions today as we are about the Easter Islanders decisions back then?
3. In the book “the Fossil Makers” the author F. Schmidt-Bleek states that in the Pre-Industrial age, nature—the result of millions of years of evolution—had a balanced state of affairs between material flows and environmental reservoirs. Industrial and economic forces have dramatically disturbed these material flows and the environmental reservoirs are rapidly changing their composition. At some future date a new equilibria may establish itself. But these new conditions will not be advantageous to humans because they will be divergences from the conditions under which humans first evolved.
4. In the movie “An inconvenient Truth” Al Gore clearly identifies this picture as the milestone to the start of the environmental movement.
5. John Elkington, co-founder of the business consultancy SustainAbility in his 1998 book *Cannibals with Forks: The Triple Bottom Line of 21st Century Business* first coined the phrase “the Triple Bottom Line” as the new metric to assess criteria for measuring organizational (and societal) success - economic, environmental and social.
6. Statistics cited from the book “the Prefabricated Home” by Colin Davies
7. In 1956, 2870 apartments rose skyward in St. Louis. It was hailed as an incredibly forward-thinking model of public housing, and was Minoru Yamasaki's first big design before he moved on to create the WTC. Few could have guessed that the complex would become a dystopia that would result in its demolition 16 years later.
8. In his book “House Form and Culture”, Amos Rapoport posits that in primitive societies there is diffuse knowledge of everything by all and in terms of building this implies that everyone is capable of building his own dwelling. In most cases, for social or technical reasons, buildings which the group needs is done cooperatively by a larger group.
9. In his landmark book “Supports: an alternative to mass housing” N.J. Habraken outlines the conceptual framework of separating support from dwelling as a response to modernist mass housing. He posits that current mass housing failures are attributable to the elimination of the individual as a means to ensure uniformity. He was a proponent of a more direct relationship between man and dwelling.
10. Colin Davis in his book “ the prefabricated Home” argues that architecture seems to need the concept of authorship as a means to distinguish architecture from mere building. If the designer of a building can not be identified, then that buildings status as architecture is somewhat called into question.
11. F. Schmidt-Bleek proposed a new metric be established as an indicator for sustainability that takes into account the full environmental cost of a given product over its useful service life. The unit of measure would account for the resource extraction, manufacturing, transport, packaging, operating, re-use, re-cycling, and re-manufacturing and final disposal. The unit of measure is MIPS—Material (including energy) Intensity Per Unit of Service (utility or function). The ‘ecological rucksack’ is defined as the total quantity (in Kg) of natural material (M) that is disturbed in its natural setting and thus considered the total input (I) in order to generate a product—counted from the cradle to the point when the product is ready for use—minus the weight (in Kg) of the product itself. The disturbed material is analyzed for its impact on five categories of ‘ecological rucksacks’ which correspond to the five environmental spheres that have been traditionally distinguished in environmental sciences and policies: water, air, soil, and renewable biomass, non-renewable (abiotic) material. On average, industrial products carry non-renewable rucksacks that are 30 times their own weight. By this measure, a gold wedding band carries 3.5 tons of rucksack mainly caused by the material movement of overburden in the mining operation.
12. Since the support structure will receive the benefit of architectural authorship, it has the potential to be the landmarks in architecture that become durable markers in the urban fabric.
13. Le Corbusier, an architect with considerable authorship clout, in 1935 published a ‘revolutionary idea’ for living in ones own home in the city. In his book “La ville radieuse” he states: “Here are ‘artificial sites’, vertical garden cities. Everything has been gathered here: space, sun, view; means of immediate communication, both vertically and horizontal; (.....). The architectural aspect is stunning! The most absolute diversity, within unity. Every architect will build his villa as he likes; what does it matter to the whole if a Moorish-style villa flanks another in Louis XVIth or in Italian Renaissance? (.....) The artificial lots are created first: highway+floorings of the structure. And these sites are put up for sale as villas with garden and limitless view. “
14. In a CMHC report titled “Sustainability in Practice: reducing construction waste

in the Ontario residential construction market” it is noted that an 1800 sqft house generates 3.6 tons of construction waste during the construction process.

15. In his book “The Evolving House” Alfred Farwell Bemis directly compared the production of a house to the production of a car. His concept was based on modular co-ordination. By making all housing components to fit a 4” module, he felt that building components could be mass produced and stockpiled ready for assembly knowing that all the components would fit.
16. The process of architects working in close consultation with manufacturers is called ‘Design Development’ in Foster’s office. ‘Design development’ as a process is really only feasible on a big project with a big budget where the components can be designed from scratch as a completely new product line requiring large investments in mock-ups, prototypes, testing and custom manufacturing.

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