A PRELIMINARY ASSESSMENT OF INDUSTRIALIZED HOUSING UTILIZING REGIONAL RESOURCES

(SETTING PRECEDENTS FOR A NEW INDUSTRIALIZATION PROCESS)

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This paper begins with the premise that regionalism will substantially influence 21st century industrialized housing. It is based on the realization that each region is endowed with systems of resource use and potential use that need to be adapted to in order for sustained industrialized building to occur. However, the effectiveness of this adaptive process hinges on state of the art technology and managerial procedures similar to those that have influenced U.S. industrialization in the last decade. In essence, this new industrialization discards the linear production dinosaurs and replaces them with organic flexible production micro-systems and by-product reuse approaches. This new dynamics in industrial manufacturing at the community/regional level, gleaning existing agriculture, mining, manufacturing, and waste treatment processes, among others, is waiting to be let loose within a total ecological framework of regionalized human activity and natural processes. By the very nature of the adoption of this new paradigm of industrial production, numerous issues confronting environmental quality, economic development, and housing demand are simultaneously met.

ASSUMPTIONS

This approach assumes that the audience reading this paper has familiarity with the upheavals in U.S. industrialization including significant changes in the socio-managerial arena and the replacement of linear mechanistic methods of production with more holistic, organic processes.[1] The assumption is important as this model goes beyond the boundaries normally suggested in these approaches in order for regionally based industrialized housing to take place. Four criteria are suggested:

1. That entire regions including the production processes therein of many different types are considered as potentially continuous industrial sequences;

2. That small, somewhat isolated businesses representing a broad spectrum of processing and production can communicate and work with one another;

3. That it may be necessary to upgrade existing facilities to accomodate more flexible end uses modeled after the various sized industries within flexible manufacturing networks;

4. That there are bounds within which each region must work in order to preserve the natural ecology upon which life support needs are ultimately met.

Accompanying these criteria is the assumption that obtaining affordable energy, water, and other overexploited resources needed to operate human-dominated systems will be increasingly difficult in future years. Finally, it is assumed that the reader can conceptually move beyond the concept of a Third World trash reuse syndrome, to pragmatically conjecture the future of the industrialized world by regarding an ever-widening spectrum of resources--whether finite, virgin, renewable, or secondary--as resources.

In order to keep the paper within a manageable length I concentrate on a brief description of trends that support this direction. These trends involve new scientific methods, new methods in industrial management and processing, and new approaches to energy and material use. The accompanying slide presentation shows examples of how these trends can be put to work to address the estimated 19 million low-income homes needed in the U.S. by 2003, and to provide a conceptual framework to begin reformulating strategies to address the estimated 800 million dwelling units needed around the world.[2]

TRENDS & PRECEDENTS

This approach to industrialized housing stems from the recognition of several global trends and precedents established in related fields:

- changes in the philosophy of science and scientific method, with specific implications in planning and design, emphasizing a ground-up process vs. the persistent and out-moded top-down approach to production and planning;

- the philosophy and practice of industrial development, with the latter affecting how future manufacturing processes will be integrated with other processes to minimize environmental impacts through continual reuse, thus establishing more symbiotic relationships between industry and regional ecology;

- the structuring of economic development and financing programs to establish continued fiscal health through the financial support of micro-businesses, thus creating a new order of regional stability: working models on both these areas could become bases for the continual upgrade and retrofitting of community enterprises;

- a re-analysis of the respective roles of energy and material use: in this case, we find that material systems will assume the dominant role currently held by energy systems, and that integration among and between energy types and systems into ever-expanding open systems, instead of closed, incremental systems heralded by conservation, will become strong trends in the future;

- materials will become the hallmark of how regionally-based building systems will evolve with mateial flows becoming the apex of integrated regional systems.

The following brief statements will address the trends cited above and elaborate on the elements necessary to realize the proposed approach.

NEW SCIENCE

Implicit in the scientific method is the belief that problems have solutions; as concerns the built environment, therefore, one assumes that there exist meaningful and solvable solutions to its myriad problems, and that seemingly unsolvable problems are simply those that have not yet been solved through a method of breaking things down into smaller and smaller parts. New scientific theory, however, implies first that "no sub-atomic event is independent of another", and that "no sequence of such events is strictly predictable."[3] This "new science" readily admits, therefore, that no action by the observer, nor the act of observing itself, is independent of the system as it evolves. A logical outgrowth of this realization is that understanding a system admits to and "requires engagement"[4] from within.

The implications of this to the industrialized systems approach is to become part of the economic, social, physical, technological, environmental, human system within which the built environment is embedded. Since the overall system is in a constant state of chaos, nothing is assured a place in the future. Chaos is a naturally occurring phenomenon and can cause either disaster or evolution. "The choice of where we position ourselves in this reality will determine whether we create disaster or evolution."[5] This bottom-up methodology implies a totally different view of how we approach industrialized housing. It implies the development of regionally-based industrialized systems whose every component admits to the same quantum to which physics and many other sciences are now admitting.

THE ADVENT OF INDUSTRIAL ECOSYSTEMS

Industrial processing, although not admitting to be part of or even connected to the thinking described above, is beginning to operate in somewhat parallel ways. The September 1989 Scientific American, " Managing the Planet," included a significant article, "Strategies for Manufacturing" by Frosch and Gallopoulos putting forth "industrial ecosystems as analogues of biological ecosystems."[6] In describing this concept, they state simply that "wastes from one industrial process can serve as the raw materials for another, thereby reducing the impact of industry on the environment."[7] The implications, however, are great! The approach concedes that human systems might be considered simply as meta systems of their biological counterparts, of which people are the guiding stewards. As in biology, this living system continually adjusts and learns more and more efficient methods of utilizing its resource base compared with what it produces and eventually becomes, as in nature, a mature ecosystem with maximum diversity, maximum stored information, minimal energy loss, and continual material cycling. Furthermore, it implies that businesses in general become metabolic analogues of endless biological hierarchies of chains of producers and consumers. New entries into these chains must adapt and work with the evolutionary balance already established or they will be expelled from the system, or never become an effectively working part of it. So, ideally, industrialized building systems, in order to become long term successes, must become regional partners in a continually evolving necklace. They must become "gap fillers" or, in a more evolved state, "trigger industries." The total ecology of a region can ultimately be realized by using previously unrecognized natural resources that set the capacity to fulfill local live support, needs at a new level. The result could be the evolution of indigenous resource utilizing systems that fulfill a spectrum of human needs in sophisticated micro-industrial production processes.[8]

NEW FORMS OF ECONOMIC DEVELOPMENT AND FINANCE

In recent years, economic development has taken some exciting turns. Not only has the financing of micro-enterprises greatly increased, but so have the returns on these investments. On a global scale, the phenomenon has been most successful in financing the poorest of the poor and using innovative collateral methods such as peer or family groups and micro-loans structured to have quick turn over.[9] In the U.S., community development loan funds have been among the most successful of these programs. Begun in 1985 with the incorporation of the National Association of Community Development Loan Funds, CDLF's now comprise 24 active regional and local funds with assets of $31.4 million and a 40% per year growth rate[10] with many actively supplying jobs through low-cost housing construction programs.

Another form of community economic development which looks at addressing regional needs with regional resources is based on the conventional input/output analysis. The approach basically demonstrates and then puts into action through the local business community a process to support local buying and selling. The method can take many forms, including a personalized "getting together" of local businesses in order to develop more cooperative approaches (which are often better suited to rural areas) and computer banks and bulletin boards showing available products and commercial and industrial by-products. At least four U.S. firms engaged in this type of service exist, serving about 12 urban areas and several small towns.[11,12,13]

The importance of these approaches to the conceptual model being developed here are the regional monetary and material linkages able to be achieved. But perhaps the most exciting concept to emerge is the flexible manufacturing network.[14] In a mode similar to micro enterprise financing, success of the FMN lies partially in the personal roles people play in their small, often family-owned and -operated businesses. Beyond this, however, an entirely new set of possibilities arises.

Within flexible manufacturing networks, enterprise is viewed specifically as part of a chain of production along with many other areas of network cooperation, including financing, by using each other as collateral. Other cooperative efforts include the exchange of strategic information and joint ventures for product development. A network may involve a few or many firms, small or large. But the networks function best when their organizations and activities are not static, but are flexible and responsive to changing market conditions.[15]

In the United States, there are presently 130,000 small manufacturing firms. Together they employ more than half of the nation's blue collar work force and supply 60-70% of the parts used by large firms. In Italy, considered to be the birthplace of flexible manufacturing, thousands of small- to medium-size businesses are linked and, together, produce major commodities including automobiles, clothing, machinery, and food. Nine U.S. states are currently operating flexible manufacturing network initiatives and, as has been demonstrated in Italy and Denmark, there is great promise for increasing incomes and job opportunities beyond the *modus operandi* of unconnected business development.[16]

ENERGY

I join the school of thought, that believes in a natural tendency towards organization among living and non-living things.[17] Contemporary energy policies, however, have defied this natural tendency as a result of their manipulation of pricing, bringing about artificially low energy costs which do not begin to reflect their actual costs. Because of an over-dependence on a single energy source, there has been a disincentive to organize or integrate it, but, instead, to simply plug the holes or engage in what is generally referred to as energy conservation. This, despite the obvious options posed by a number of renewable and non-renewable fuel types. Some renewable energy sources have a relatively high capacity to supply with relatively low environmental impact and are, today, as cost effective as non-renewable sources.[18,19] However, more important than energy availability is the energy cost of energy in equipment manufacturing, construction, transfer and storage, as summarized in the chart below.[20]

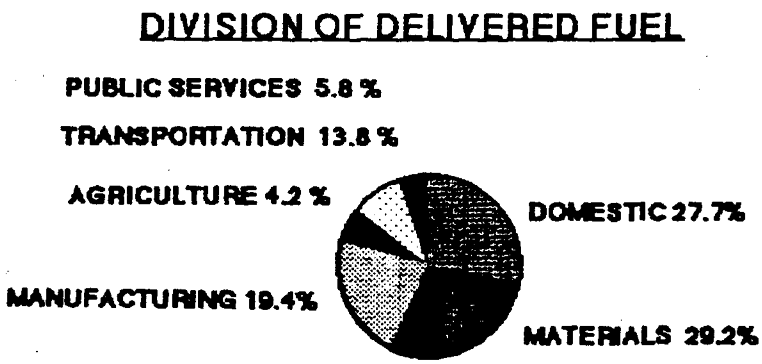
ENERGY SOURCE	ENERGY INPUT	ENERGY OUTPUT
PETROLEUM (-35 YRS)	1	50
PETROLEUM (NOW)	1	6
METHANOL (PETROL BASED)	1	5
NUCLEAR	1	2.5
ETHANOL	1	1.1
PHOTOVOLTAICS	1	-.5

Obviously, if one were to analyze why renewable energy sources are energy losers, we would find it to reflect our paradigm of social and physical infrastructural frameworks. Generally, values relating to renewable appraoches such as ethanal and photovoltaics are negative because they are designed to mimic the enormous centralized power plants characteristic of the petroleum age. Their energetic efficiency could be enhanced several fold through decentralized methods of production and use and through a closer proximity between home and work.[21]

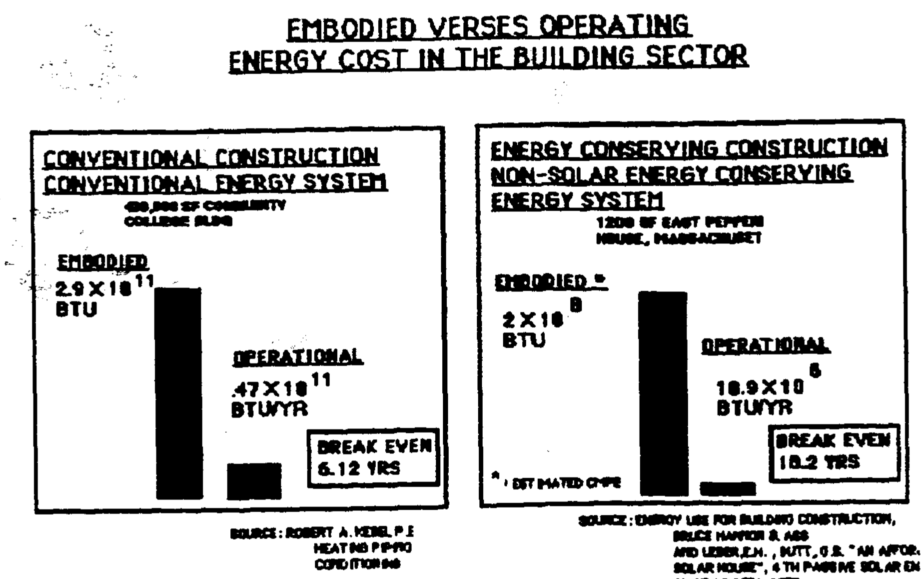
Integrating vs. conserving energy use, and load sharing between different energy types are proven to be cost effective and efficient. For example, energy-conserving refrigeration vs. **utilizing** a refrigerator's waste heat have relative energy efficiencies of 75% vs. 94%.[22] These figures also relate to the fact that the systems discussed are co-generation, total energy systems, are usually micro-scale, and are well coordinated. This begins to hint at rarely addressed issues concerning energy derived from an overall systems approach as in community energy planning: a recognition of the **total** by-products-- not just heat. We know them but we seem not to have thought too much about using them.

As in the industrial ecosystem, scenario above, there is an enormous potential to put these untapped energy sources to use, as well for the myriad derivatives resulting from scores of non-related energy industries, by-products--gaseous, liquid, and solid--that represent untold quantities of items seldom, if ever, used.

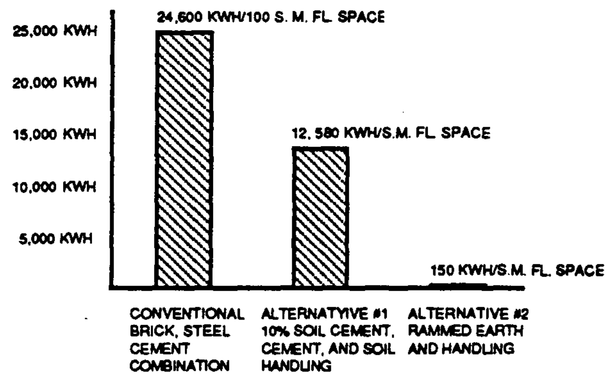
o finally we come around the long way to something usually thought of as industrialized housing--materials. Despite the volumes of texts and treatises analysing the various facets of energy dependencies, diversification, conservation, and on, there is rarely a mention of the fact that, in general, materials in the built environment are the largest energy user among industrialized nations. This is simply a reflection of the bias presented in the structure of the dominant pie charts. The one below, however, illustrates this relationship and is the only one of its type of which I am aware.[23]



The relationship between a building's operating energy cost and the energy cost of the materials in the construction of the building is well known. As a building receives a modicum of energy conservation enhancement, the relationship of its operating and embodied energy becomes more disparate until one finds some building types to have operating energy that may never reach its embodied energy. This particularly applies to short-lived large buildings which become unusable due to physical facility obsolescence, yet have high-efficiency HVAC and other energy systems. The bar chart[24] below describes some of these relationships; it is a modest statement that begs a tremendous amount more study.



To better synchronize embodied and operating costs could take some drastic actions uncommon in the industrialized building industry. As described in the chart below,[25] the earthen building material scenario is an easy leader.



THE PURPOSE OF THIS GRAPH IS NOT TO SUPPORT THIS P. TECHNOLOGY AS MUCH AS TO POINT OUT THE DIFFERENCE

The problem with the above example is that our minds are closed to looking at this in any way related to the manufacturing of housing. Yet, if we change our context and are willing to expand our information playing field, we find sophisticated technologies working with these same elements. Japan with a sophisticated building system based on sand,[26] Germany with a total (floors, walls, roof) building system based on oat and wheat straw,[27] France building public housing now (in the 1980's and 90's) using a wide range of indigenous soil building technologies.[28] While I look at this as encouraging, I also look at this as linear and not purposely integrated in a regional dynamic model that hybridized these many raw material options with the plethora of by-products that could make them even better.

In 1980, the fly ash resulting from coal burning totaled 40 million tons per year in the U.S..[29] With proper analysis, fly ash can be used directly as cement--totally or in part depending on the coal type replacing the energy- and water-intensive portland cement. Yet, in 1980, less than 10% of the available fly ash was used in the U.S. In Texas, approximately two-thirds of the portland cement produced could be replaced by fly ash cement.[30]

Similarly, there are 1.1 billion tons of mine waste produced each year,[31] 390 million tons of agricultural waste,[32] 160 million tons per year of solid waste,[33] of which 38% by volume is paper,[34] 2.8 billion cubic feet of sawdust.[35] Yet, while 90-100% of these items go to wasteburied in landfills or burned in incinerators-- many of them have proven uses in the building industry. Moreover, we face catastrophic consequences of depleted forest and soil resources. Not only are there approximately one million acres of virgin forest used yearly, thus reducing our carbon dioxide absorption potential, but the quality of marketed lumber is seriously deteriorating.[36] In western Montana alone, the average sawn tree diameter has decreased from 14 inches to 7 inches in the last 10 years.[37]

The hybridization potential which is proposed to address some of these dissynchronisities is endless. For example, among the research programs at the Center for Maximum Potential Building Systems, fly ash cement has been foamed using low-energy methods and a foaming agent based on renewable resources derived from the animal husbandry and forest products industries to create lightweight insulative products. Other examples: ox blood mixed in proper proportions produces identical bubble size in cement, thus doubling the cement's strength; sulfur from the precipitator stack of a coal plant, when surfaced with gypsum for fireproofing (recycled or raw) becomes a low-energy, high strength material; and so on.[38] The irony resulting from not looking at regional material flow as an integrated job producing system is that we have a sulfur glut from overmining while, simultaneously, we are creating environmental havoc resulting from the release of sulfur into the air from various combustion processes. The fact that industry cannot substantiate the use of preciptators that could catch the sulfur, thus eliminating sulfur pollution and providing a valuable industrial resource, is preposterous. A brief patent search comes up with hundreds of such examples not only of sophisticated high strength or low conductivity and eminently industrializable building products, but many are low in embodied energy resulting from their by-product derivation.

Just as impressive is the job multiplier effect. Not only is there a strengthening of job producing opportunities and creation of **permanent** jobs resulting from working with other businesses, that ultimately are flexible, thus able to adapt to new demands. Due to the fact of heightened awareness of a business's inputs and outputs, there is an opportunity to fill gaps in the local economy, thus adding jobs by creating more input/output connections. In many cases, new regionalized industries are created, which in turn " trigger"[39] a region's self-actualization beyond capacities already known.

In his important work, Environment Power and Society, Howard Odum shows that, from the standpoint of separate roles, species diversification in the urban environment is high compared to any natural ecosystem. This diversity, however, is biased from the standpoint of consumers, not producers, in the way natural ecosystem species diversity occurs. It is reasonable to believe that tapping the urban/rural potential through industrialized housing and other human needs could witness the development of one of this world's richest ecosystems.

FOOTNOTES

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