

ENVIRONMENTALLY APPROPRIATE PROCESSES -Global options and local applications

Sub theme: Practice and Pedagogy

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Abstract: Globalization has given us the freedom to adapt to newer possibilities. The information & technology available is overwhelming. While it offers so many options and solutions, we still find ourselves on the verge of a global environment catastrophe.

When it comes to the Global options of materials and techniques of Construction, we need to make our approach more scientific, respecting the laws of nature through its ecological context in this age of accelerated degradation. Increasingly one is realizing that architectural processes and planning practices have ecological consequences that significantly degrade the environment. The lack of ability to look beyond has led to unusual weather conditions worldwide posing a threat to Human existence

Most materials have high energy consumption during their manufacture and extraction process (**Embodied Energy**). Implicit in the measure of Embodied Energy of building materials are the associated environmental impacts. Large amount of ever increasing greenhouse gases are produced by these modern building materials which damage the urban air quality and are responsible for Climate change. Indeed, a recent report on greenhouse emissions for the residential building sector suggests that by 2010 emissions will have increased by 140% from 1990 levels and will continue to increase

The paper discusses the options and possibilities of exploring rational methodologies for choice and selection of Materials, Planning criteria and techniques of construction for a sustainable built environment

Key words: Building Materials, Globalization & Environment.

INTRODUCTION

Globalization has given us the freedom to adapt to newer possibilities. The information & technology available is overwhelming. While it offers so many options and solutions, we still find ourselves on the verge of a global environment catastrophe.

The concept of sustainability challenges Architects and urban planners to think and act in terms of long-term consequences of their decisions on the diminishing resources of the world. Increasingly one is realizing that Architectural and planning practices have ecological consequences that significantly degrade the environment

In a sustainable development perspective, we must address the quality and sustainability of our use of natural resources and ecosystems, threats of global change, quality of life in our cities, and the impact of the production and use of the energy, which is essential to our economies and to our way of life, and also centrally important in environmental problems.

When it comes to building designs, Architects seem to be more and more dependant on equipment and technology. Even with an overload of Global options we find the rational applications at the local level weak. The traditional architecture however always took advantage of the natural environment and searched for practical solutions for long term gains and better environmental adaptation. Unfortunately, Architecture today seems to be a mere play of fanciful borrowed global façade treatments. Knowing well that these models do not fit into our ground realities, we are still bent upon building Igloos in the deserts.

When it comes to the Global options of materials and techniques of Construction, we need to make our approach more scientific, respecting the laws of nature through its ecological context in this age of accelerated degradation.

With sustainable development as a necessary goal, are emergent countries reproducing the mistakes made by the developed countries?

A now classical example of Mies Van der Rohe's lack of awareness or perhaps rejection of the influence of the environmental physics parameters is the Farnsworth House at USA, which has been reported to be un-heatable in winters and intolerably hot in summers. The owner is said to have sued the Architect because the house was inhabitable. This glass house is so unsuitable in terms of the Architect's selection of material for the envelope, and yet this is still presented in authoritative terms as a masterpiece of the modern movement in most publications. Are these buildings by Mies designed with respect to solar radiations and the quality of Day lighting? According to me these perhaps are inordinate consumers of energy resources, a cost which has become the concern of the world community. His design vocabulary seems simple, and as Phillip Johnson has said, "Mies's works seem so easy to copy". The purpose of this review is not to denigrate the masters of the modern movement, but rather to illustrate the inappropriateness of copying their works in the context of today's value system, a value system which may even justify a greater capital cost in money terms with a view to minimizing recurrent costs in energy terms.

In the Seagram Building, New York city, the fenestration design is typically Miesian i.e. the Glass box, in which fenestration design of each façade has not been developed out of the careful study of orientation. It has identical fenestration treatment on each façade. Today we would expect a good student of Architecture to know that there is an inherent rationale in their being a different texture on each façade of the building- a texture that is the function of the relative position of the sun- the architect's carefully considered control of the solar heat load on the building, direct and reflected glare of direct sunlight penetration and optimal day light illumination of the interiors

To keep the profession's morale high the many glossy magazines, which we have in our countries, continue to publish the photographs of man made monsters on their cover pages.

Today, aware of the finiteness of the world's energy resources, the present generation of Architects will have a moral responsibility to design buildings that will house the occupants in comfort at a minimum of recurrent energy cost and better environmental adaptability.

Unfortunately, a vast majority of Architects are designing monuments where sober buildings will do. Modern day Taj Mahals, Twin towers and White houses are being raised with Italian Marbles, Belgium glass, Spanish tiles and other imported fittings. Happily or unhappily, the modern architect of the Third World, is unable to resist temptation, of the western concepts and accepts every facility offered to him by modern technology, with no thought of its effect on the complex web of his culture.

Technology devoid of humane values is meaningless; there are more technology disasters than natural disasters. . We seem to be playing football with cannon. If the purpose of the game is to score more goals, then assuredly we will score a goal with every shot. But the game itself will disappear killing the goalkeeper.

Rather than develop a new solution rooted in tradition, societies often opt for a modern answer. Unfortunately, in far too many cases, the traditional devices, methods, and systems have thus been supplanted by modern solutions that are inappropriate to and untried under the local conditions

Aggressive marketing strategies and foreign temptation have resulted in creation of the Westerly disturbances in form of large transparent building complexes most unsuitable to our climate. Are we not building Igloos in the deserts? Have we forgotten the fundamental form generating principles in Architecture? Even birds, when they build their nests are rational in their design approach. Designing to their own needs, they build their nests responding to the climatic conditions, selecting locally available materials. A Crow does not copy a nest of a Peacock.

Basic planning & architectural features planned with sufficient foresight do contribute effectively in generating indoor conditions conducive to reducing the energy demands.

In Orchid hotel, Mumbai, India, an effort has been made to minimize solar heat gain by proper planning and form generation. All functions are arranged around a central atrium that runs thru the entire height of the building. A skylight illuminates the entire space bringing in a calculated quantity and quality of natural lighting, minimizing the requirements of artificial lighting. A seventy feet tall fountain runs thru the atrium binding the roof to the lower levels like a water column, which also reflects light to augment the luminous intensity in the space. Seventy-two guest rooms face the atrium and since they are not exposed to outside conditions, the heat load of these rooms is much reduced lowering the air conditioning requirements. The swimming pool is located on the rooftop, which offers insulation to the atrium space below and also acts as a fire-fighting tank. Most of the wood used in interiors is a reused wood, Fly ash concrete blocks using 25 % waste fly ash has been used in superstructure reducing the total embodied energy and emissions into the atmosphere.

In the India Habitat Center at New Delhi Architect J.A.Stiens has demonstrated a rational use and placement of various court yards with canvass sun screens on space frames to generate an energy efficient form.

OURS NATURE, S EARTH... limited resources.

In a world so Beautiful and bountiful, we have underestimated the joys of co-existing with Nature. We are told in Genesis that at the close of the sixth day God saw everything that he had made, and behold, it was very good. Not merely good, but very good. Yet very few of us appreciate the beautiful world in which we live. The wise man's eyes are in his head but fools walketh in darkness. We are wandering perhaps like ghosts unaware of the joys of Nature's beauty and destroying every evidence of its resources, so vital for us to exist. We have eyes, but look not.... In our flight of fancy we just overlook and forget the ground realities.

The magnificent spectacle of boundless oceans, sometimes so grand in their peaceful tranquility and at other times so majestic in their mighty power, the glory of the rising and setting sun are so much a part of us.

It is a pity that some of us are unable to appreciate our rich wealth of resources- the wonders of nature, which are beyond the power of language. I do not know whether there will now be any more rainbows or just the milestones passing by in our journey of Life.

We are mercilessly hacking the trees to their death, and in the process digging our own Graveyards.

As a story goes, the Trees in the capital city, annoyed with the pollution levels decided to leave the city and look for an alternate location. A meeting was fixed for a Sunday at the Boat Club at 8 AM. A decision could not be taken because the quorum of the members was not complete. About 40% of the trees could not leave their locations because of severe concreting around their base, 25% could not travel because of poor health, 15% of the trees fainted on way because of pollution and about 10% were still held up in traffic jams.

We adopt meaningless measures like banning the use of Timber. This has encouraged the use of alternative materials like plastics, aluminum and other metals whose production processes throw much more pollutants in our environment.

Environment is being polluted by the high-energy intensive units of increased production levels and at times destroying every evidence of our resources so vital for us to exist. These are perhaps the weapons of Mass destruction: Neither Bush, Tony Blair or even we seem to be concerned. Albert Einstein had

once quoted, "I know not with what weapons World War III will be fought, but World War IV will be fought with sticks and stones." Let this not happen.

Today, unfortunately the practitioners and the academicians seem to have taken the back seat; the Market seems to be driven totally by the manufacturers. Unless there is cohesion between the three, we would be taken for a ride- in a direction most dreaded. We need to address the fast changing life styles and the aspirations of the people and local needs with innovation and rational.

GREEN ARCHITECTURE. Embodied energy

In recent years, the construction industry worldwide has witnessed a trend towards environmentally responsive facilities, called eco properties. These structures carry the environmental theme throughout, from the positioning of buildings to maximize the natural assets benefits, to the careful selection of construction materials.

A green properties uses resources wisely, incorporating energy, water recycling and waste reduction techniques into the daily operations. Emphasis is laid on energy efficiency, resource conservation and environmental commitment.

GREEN MATERIALS

Every materials used in a typical modern building is the product of energy intensive processing - all consuming vast quantity of power in their manufacture (**embodied energy**). These materials have to be dug out from the ground, cut from the forest or fields, or created by human technology. All these processes use energy.

- (i) For extraction of material
- (ii) Process & manufacture
- (iii) Transportation cost
- (iv) Energy for production of capital equipment
- (v) Disposal of waste
- (vi) Maintenance

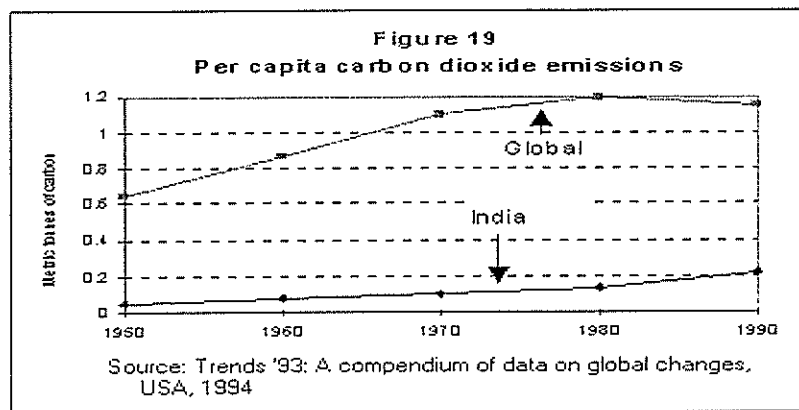
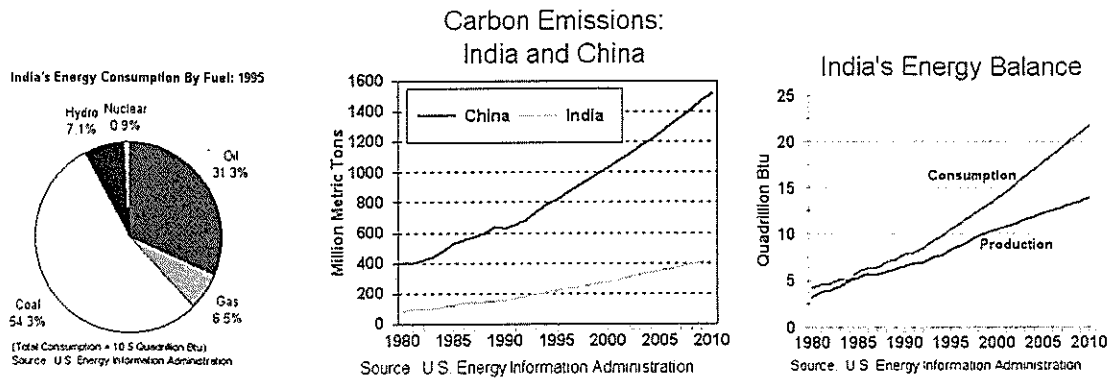
The manufacturing process also releases toxic affluent unto water and hazardous chemicals into the atmosphere. The manufacture of Portland cement for example is responsible for on estimated 4% of the green house gases.

CO₂ emissions are highly correlated with the energy consumed in manufacturing building materials. Furthermore, cement and aluminum are higher than average and glass is lower. On average, 0.098 tonnes of CO₂ are produced per gig joule of embodied energy

Indian energy consumption has grown very rapidly, particularly in the last ten years, from an aggregate consumption of roughly 8000 peta joules (PJ) in 1984, to over 12000 PJ in 1994. In only six years, between 1985 and 1991, per capita electricity consumption expanded by 50 percent. These statistics are closely tied to India's economic transition from agriculture to industry and to the general increase in standard of living and shift towards a more Western-style consumption ethic.

One impact of India's increasing demand for energy, both in the form of fossil fuels as well as biomass, is the emission of carbon dioxide, which, along with other gases like methane and chlorofluorocarbons, is feared to contribute to global warming. Although these other gases have a larger per unit global warming potential, carbon dioxide poses the greatest problem because of the sheer volume of production,

Choices of material and design principles have a significant, but previously unrecognized, impact on energy required to construct a building. Embodied energy is one measure of the environmental impact of construction, particularly CO₂ emissions



per capita carbon dioxide emissions: India and Global scenario

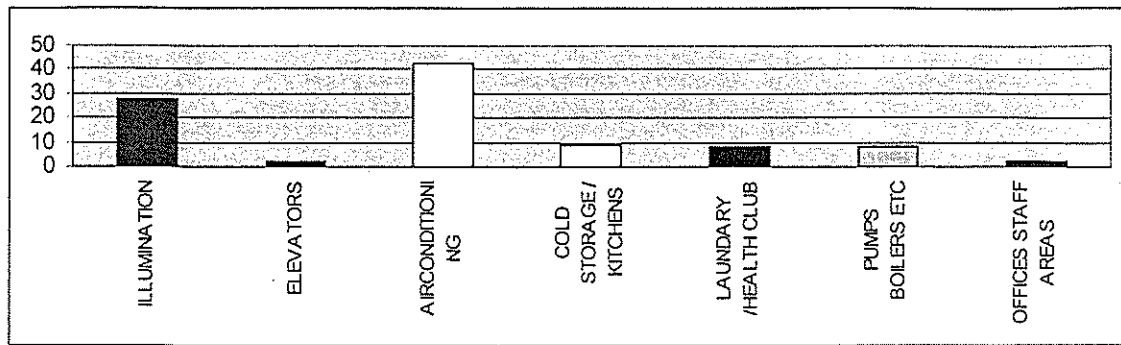
Of course it is impossible to build with no environmental impact, but it's our responsibility to minimize the damage.

Most material have high energy consumption during their manufacture and extraction process (Embodied Energy). Implicit in the measure Energy of building materials are the associated environmental impacts. Large amount of ever increasing greenhouse gases are produced by these modern building materials which damage the urban air quality and are responsible for climate change. Indeed, a recent report on greenhouse emissions for the residential building sector suggests that by 2010 emissions will have increased by 140% from 1990 levels and will continue to increase.

Chart below gives the embodied energy and emissions of some of the important building materials

Name	Embodied Energy	CO ₂ (g/kg)	CO	No.	So ₂	CH ₂	NMVO C	Dust
Primary Aluminium	204 MJ/Kg	11687	26.683	24.769	15.139	19.907	2.538	1.754
Secondary Aluminium	15.7 MJ/kg	860	0.834	1.496	625	2.063	0.127	0.096
Reinforce Steel	16.3 MJ/Kg	1500	1.15	2.9	8.15	6.6	0.21	0.5
Cotton	17.6 MJ/kg							
Concrete	0.7 MJ/kg	123	0.0037	0.318	0.084	0.104	0.011	0.011
Prefab. Concrete	2.3 MJ/Kg	242	0.147	0.457	0.744	0.677	0.036	0.055
Burnt lime	4.6 MJ/kg	1059	0.296	0.453	0.303	1	0.022	0.19
Roof tile	4.2 MJ/kg							
Roof tile	6.8 MJ/kg							

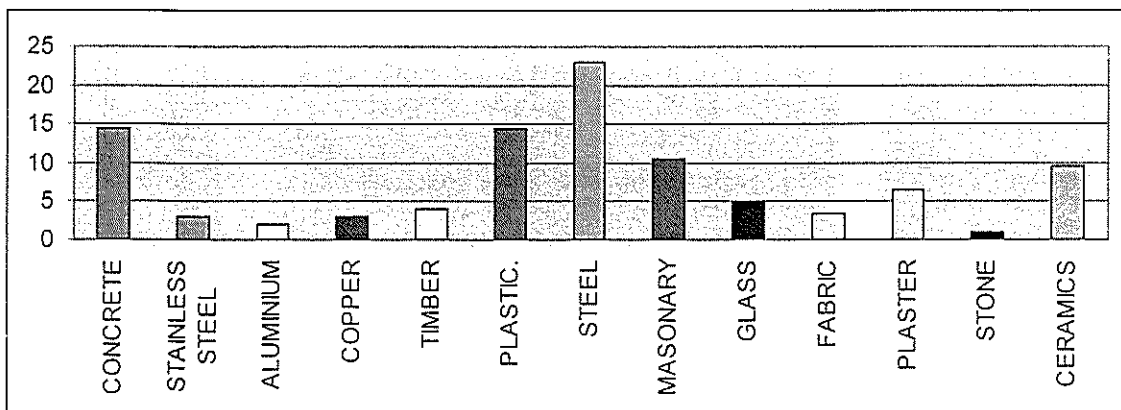
cement								
Insulating plate	9.5 MJ/kg	3836	2.074	15.064	18.304	15.074	11.67	2.461
Paint Cement	0.9 MJ/kg							
Foam concrete	3.6 MJ/kg							
Gypsum	1.5 MJ/kg	87	0.075	0.171	0.044	0.179	0.013	0.009
Gypsum plane	3.5 MJ/kg	155	0.141	0.24	0.051	0.373	0.017	0.013
Glass wall	16.5 MJ/kg	1011	0.705	12.77	1.135	2.599	0.09	0.112
Name	Embodied Energy	CO2(g/kg)	CO	No.	So2	CH2	NMVO C	Dust
Wood	12 MJ/kg	80						
Furniture	16 MJ/kg	372						
Wood board hard	23 MJ/kg	1180	1.104	2.412	0.861	1.168	0.343	0.132
Drainage pipe	125 MJ/kg	5200	2.9	12.9	11.9	16	11	1.7
Insulate pipe	95.6 MJ/kg	3005						
Cable	77 MJ/kg	2200						
Calcium hydrate	3.5 MJ/kg	804	0.225	0.344	0.231	0.762	0.017	0.144
Sand stone	1 MJ/kg	128	0.061	0.176	0.087	0.128	0.015	0.026
Cast iron	39.4 MJ/kg	446						
Pipe	66 MJ/kg	2.1	1.7	7.6	5.3	5.9	3.8	0.9
Gravel	0.044 MJ/kg	3	0.004	0.024	0.003	0.003	0.003	0.002
Hard burned brick	3.1 MJ/kg	175	0.171	0.42	0.53	0.421	0.019	0.04
Primary copper	44.2 MJ/kg	2749	3.549	9.656	4.723	5.984	1.07	0.71
Secondary copper	30.7 MJ/kg	1413	1.162	2.845	1.017	8.303	0.245	0.205
Mud brick	2.4 MJ/kg							
Light concrete	5 MJ/kg	567	0.299	1.045	1.604	0.996	0.068	0.106
Wall light concrete	1.7 MJ/kg	252	0.112	0.812	0.196	0.201	0.046	0.036
Wall Brick Tile	2.5 MJ/kg	292	0.114	0.42	0.107	0.237	0.014	0.04
Brass	105 MJ/kg							
Polypropylene	73.7 MJ/kg							
Polypropylene	72.5 MJ/kg							
Poly styrene	69.3 MJ/kg	2856	1.788	8.545	8.68	10.385	10	1.17
Pores concrete	4 MJ/kg							
PP Foil moisture barrier	73 MJ/kg							
PV foam plate	95 MJ/kg	4900	3.3	5.8	3	10.3	2.55	0.36
Insulating Paint	3.2 MJ/kg	527	0.16	1.2	0.4	0.5	0.033	0.045
Inner Paint	0.7 MJ/kg	91	0.046	0.14	0.035	0.1	0.013	0.02
Outer Paint	1.4 MJ/kg	250	0.07	0.6	0.17	0.23	0.017	0.022
Gun metal	83.1 MJ/kg	64						
Sand	0.044 MJ/kg	3	0.004	0.024	0.003	0.003	0.003	0.002
Scarf wool	16.4 MJ/kg							
Foam glass	23.5 MJ/kg							
RCC	2.4 MJ/kg	258	0.153	0.586	0.788	0.719	0.032	0.056
Stone wool	20.90 MJ/kg							
Cellulose Fibre	3.2 MJ/kg							
Cement high oven	1.7 MJ/kg	233	0.071	0.534	0.157	0.0238	0.019	0.019
Portland cement	4.3 MJ/kg	893	0.184	1.874	0.59	0.754	0.017	0.043



Operational Energy Pattern use in a typical five star hotel in Mumbai, India

The graph shows percentage usage

TOTAL ENERGY CONSUMPTION PER SQUARE METERS 350 KWH ANNUALLY



Embodied Energy Pattern use in a typical five star hotel in Mumbai, India

The graph shows percentage usage of materials.

TOTAL ENERGY CONSUMPTION PER SQUARE METERS 850 KWH .

It is interesting to note that the total energy consumed in building materials of a Luxury hotel is about three times the energy consumed by a running hotel annually. Of course it is impossible to build with no environmental impact, but it's our responsibility to minimize the damage

HEALTHY MATERIALS

The indoor air quality has deteriorated over recent times. The sick **building syndrome** (SBS) is not new. The fast track construction, sealed interiors with reduced ventilation air exchange and irrational use of synthetic building materials have lead to unhealthy indoor air. Since the indoor air quality can considerable effect human healthy, working efficiency, it is essential to choose building materials with minimum pollutant emissions.

Emissions from such materials can cause serious health problems ranging from skin irritation to breathing disorders, Leukemia, liver malfunctioning, genetic damage and cancers

Chart IV identifies major organic compounds in some of the products

Material/Product	Major organic compounds identified
latex caulk	Methyl ethyl ketone, butyl propionate 2-butoxyethanol, butanol, benzene, toluene
Floor adhesive (Water based)	Nonane, decane, undecane, dimethyloctane 2-methylnonane, dimethylbenzene
Moth crystals	Para-dichlorobenzene
Floor wax	Nonane, decane, undecane, methyloctane Trimethylcyclohexane, ethylmethylbenzene
Wood stain	Nonane, decane, undecane, methyloctane Dimethylnonane, trimethylbenzene
Latex paint	2-Propanol, butanone, ethylbenzene, propylbenzene, 11 oxybisbutane, butyl propionate, toluene
Furniture polish	Trimethylpentane, dimethylhexane, Trimethylhexane, trimethylheptane, Ethylbenzene limonene
Polyurthane Floor finish	Nonane, decane, undecane, butanone, Ethylbenzene, dimethylbenzene
Room freshener	Nonane, decane, undecane, ethylheptane, Limonene, substituted aromatics.

Chart V below gives information on some of the health hazardous chemicals in building products

Acetaldehyde An intermediary metabolite in the breakdown of some chemicals and brain hormones, also made by candida; highly toxic to the body it stays in this stage and does not get metabolized further into excretable and less toxic acid.

Aldehyde A general category of intermediate metabolites that are toxic to the body if some blockage occurs.

Aromatic Merely described the structure of hydrocarbon

Benzene A common chemical, it is known to initiate leukemia.

Carbon Monoxide A gas in the exhausts of industry, cars and furnaces; in the bloodstream it is a poison.

Carbon tetrachloride A common chemical solvent and also a highly potent liver toxin.

Chlorpyrifos Dursban, a commonly used toxic organophosphate (inhibits nerve transmission) pesticide used in schools, homes and offices.

Cyanide A poison found in some pesticides that can affect the white matter of the brain.

Epoxides Dangerous intermediates that cause cancer and environmental illness(EI), poison the immune system, and damage genetics.

Mercury A dangerously toxic metal that can permanently poison many body enzymes.

Methacrylate A chemical that outgasses from plastics and adhesives

Methylnaphthalene A potent hydrocarbon that outgasses from many household and building products and can cause cancer.

Methylenechloride Dichloromethane; a solvent in paints, paint strippers and aerosol propellant, and can rapidly metabolize in the body to a lethal level of carbon monoxide.

PCP Pentachlorophenol, a common and toxic wood preservative.

Phenol A toxic benzene derivative, the old carbolic acid. A known carcinogen.

TCE Trichlorethylene, a ubiquitous solvent and xenobiotic (foreign chemical); can effect human response mechanisms.

Toluenec Methyl benzene, a solvent that outgasses from many products such as paint. It gets bio-transformed to hippuric acid in urine.

Vinyl chloride Outgases from plastics, can cause toxic brain symptoms.

Source: Tired and Toxic _ A Blue print for Health- Dr Sherry.A.Rogers M.D. (USA)

One must constantly stress that many environment illness (the EI syndrome) are a result of a mixture of different unhealthy emission. Research in this field is very much at a beginner's stage.

CONCLUSIONS

Energy savings can be achieved by intelligent Architectural process, rational use of building materials & technology, conserving resources respecting the laws of nature, appropriate building automation system and educating the users and the specifiers for adaptability to the ethical design solutions.

Let no architect's studio be allowed to exist as a beauty parlor to make up the built environment through idiosyncrasies or predilections of the nouveau rich.

REFERENCES

1. *Healthy Buildings* by Bill Holdsworth & Antony Sealey -Longman
2. *Embodied Energy of Building Materials* by Bill Lawson
3. *The Energy Design Hand Book* Edited by Donald Watson – American Institute of Architects.