UNIVERSITY OF NEW MEXICO

FUSED HORIZONS: BROADENING THE CONTEXT

TWO LONGER-TERM APPLICATIONS IN YUNNAN PROVINCE, PEOPLE'S REPUBLIC OF CHINA

PROGRAM: THESIS PROJECT FOR THE MASTER'S IN ARCHITECTURE

SCHOOL OF ARCHITECTURE

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CONTENTS

Purpose 1
SUVs and the ANWR 2
Mexican Timber and New Mexican Housing Development 3
Approach 4
Applications 6
A Privy for Ang Wen Kai Zhu
A Vertical Village at Dian Chi
Essential Reading 9
Cited
History/Culture
Technical
Appendices
A – CEPP Twin Bin Net Composter
B – Micro Wetlands as Logical Landscape Elements
C – Chinese Rural Architecture
D – Staggered Truss Design
E – Slotted bolt Connections
F – Straw Bale Construction
G – Photovoltaics
H – Consumption Growth
I – The Timber Industry in Northern Mexico

A NOTE ON INTELLECTUAL PROPERTY

The legal construct of Intellectual Property is inimical to the dissemination of ideas and techniques promoting longer-term solutions for a shrinking world. By a similar token, the best designs are collaborative, the very best rid of ego. Accordingly, no copyright is expressed or implied. Borrow at will — most important, steal these ideas and improve on them.

Common title to the future and the fusion of horizons depends on the wholesale poaching of territory, mind, and spirit.

PURPOSE

Catch only what you've thrown yourself, all is
mere skill and little gain;
but when you're suddenly the catcher of a ball
thrown by an eternal partner
with accurate and measured swing
towards you, to your centre, in an arch
from the great bridgebuilding of God:
why catching then becomes a power –
not yours, a world's.

Rainer Maria Rilke

As is so often the case with coined expressions, the meaning of *sustainability* was, at incept, and remains, idiomatic to the cultural and economic context. In the U.S. it is often defined as the employment of resources such to guarantee the status quo well-being of future generations. Elsewhere it is synonymous with *subsistence*, a goal incompatible with the ambitions of post-industrial societies or with those of societies aspiring to that mythical state. In some circumstances it means *renovation* of damaged cultural and physical landscapes. The definition of *sustain* is clear enough: *to give support or relief to: to supply with sustenance: nourish: to keep up: prolong*[1] — it is made problematic by the absence of a shared vision of a commonly held future, by the willful and short-sighted partitioning of discreet horizons.

The move toward sustainable development in the U.S. is rooted in Western mid-twentieth century anxieties regarding the impact of Third World poverty and population growth on First World culture. During the 1970s that concern matured to embrace issues associated with the resource consumption and depletion which characterize urbanized societies, particularly that of the U.S. In the 1980s the true dimensions of the population explosion became apparent, Western societies exported their heavy industry to the less-developed world, and the global migration from rural to urban environments began in earnest. Simultaneously, populations across the globe embraced Western consumer culture without regard for it's economic or environmental efficacy. In the 1990s these threats to a secure future assumed the cast of intractability; and skepticism regarding the developed world's motives in promoting sustainability gained political weight throughout the Third World. The questions then became, "How many futures can there be.?" and "Whose is at stake?"

Although our understanding of natural systems, so called, now features deeper awareness of the finite dimensions of resources and of the essential values of diversity and integration, government policy and corporate strategies continue to promote a consumer's life style at the expense of any genuine attempts to realign Western culture to the status of one component in a collective future. Indeed, the imposition of the consumer ethos in the developing world continues apace with an enduring faith in both stopgap technological fixes and the global suitability of a narrowly conceived monoculture. Today, in the U.S., 4% of world population

[1] *Webster's New Collegiate Dictionary*, (1975), s.v. "sustain."

consumes 40% of world resources and generates 60% of the world's waste.[2] Moreover, the production and occupation of architecture here accounts for 75% of that resource exploitation and 20% of water usage[3] — patently unsustainable levels of consumption. Yet the U.S. model persists as the ideal.

The purpose here is not served by a litany of resource consumption facts and figures, those having been made innocuous by repetition. It is, however, illuminated by the brief examination of two recent American phenomena: SUVs vis-à-vis the Arctic National Wildlife Refuge, and the relationship of Mexican timber to North American housing development.

SUVS AND THE ANWR

Although some industry historians date the suburban utility vehicle to the introduction of the Chevrolet *Suburban* of the 1930s (an enclosed van developed for the commercial market), its true incept came with the introduction of the Ford *Bronco* during the 1983/84 model season and matured to its present form with the introduction of the Ford *Explorer* in the early 1990s.[4] These products aimed to satisfy the sensibilities of middle-class motorists who perceived their driving environment and their personas to be increasingly "urban" and rough-edged. Ford, followed by the rest of the automotive industry as Ford's sales surged, calculated the SUV to qualify under the Corporate Average Fuel Economy (CAFE) standards as a "light truck" and, therefore, exempt from the stricter goals for passenger automobiles. The first dilemma emerges — Congress passed the CAFE standards in reaction to the energy crises of the early 1970s. It was intended as a means to reduce U.S. dependency on *foreign* oil. With its emphasis on conservation, it was, by any reasoning, a conscientious attempt to do so. Cynics might say that conservation was the only means available given the depleted state of domestic resources but Congress' logic was, and remains, sound: *when faced with scarcity, use less* —particularly when that scarcity reveals the absolute dimensions of the resource. As timid as the CAFE standards are considered to be outside the automotive industry, they resulted in appreciably lower volumes of oil consumption totaling some three million barrels less each day than might have been the case otherwise.[5] This despite the industry's recalcitrance. So, faced with logic and, by 1990, empirical evidence that conservation succeeds, the auto manufacturers, in league, if not collaboration, with their cohorts in the oil industry, introduce a product designed specifically to circumvent the standards and, presumably, to undermine that progress. Half the story.

The more dispiriting half is told in the exuberant acceptance of the product by the American driving public. Sales have climbed steadily to reach 50% of new vehicles sold despite low fuel efficiency and vehicle safety records (SUV design employs the older cab application to truck ladder frame technology as opposed to the lighter and safer monocoque auto design.)[6] The net result is an overall decline in fuel efficiency, current daily consumption rising to 18 million barrels, half of that imported, that half equivalent to the quantity consumed in light

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[2] http://www.wri.org/wri/index.html, World Resources Institute.
[3] Ibid.
[4] *Roll Over: The Hidden History of the SUV* (Washington, D.C.: Public Broadcasting System, 2002) videotape.
[5] Nedra Pickler, "SUV Sales Soar, Gas Mileage Hits 20-year Low," Associated Press, December 19, 2000.
[6] Ibid.

trucks and autos, and a society more dependent on oil imports than in 1973 (55% today v. 35% then.)[7]

The Arctic National Wildlife Refuge coastal plain has been targeted for exploitation periodically by the oil industry and its allies in Congress since its establishment by Congress in 1960, notwithstanding ongoing resource extraction in the remaining 95% of the Refuge. The rationale for extracting resources from the coastal plain never varies. It centers around "energy security" and U.S. dependency on imported oil, this despite uncontested projections by the U.S. Geological Survey that production would amount to no more than six months' supply at present rates of consumption.[8] The fact that the *export* of Alaskan crude is permitted usually dodges the equation altogether. The argument here is not in favor of wilderness, habitat, or diversity (although no apology for such argument is expressed or implied), but, rather, is intended to draw attention to the circular illogic underlying the actions and deeds of American corporations and consumers in their pursuit of — what, exactly? — the enjoyment of a purely conceived (and received) consumptive product of little use beyond its value as a elevated mobile perch and as a rationale for additional consumption?

MEXICAN TIMBER AND NEW MEXICAN HOUSING DEVELOPMENT

The import of timber originating in the region of Mexico centered on the Sierra Madre in the State of Chihuahua through the U.S. Customs port of Santa Theresa, New Mexico, increased from 22,000 board feet in 1995 to over 36 million board feet in 1997.[9] This astronomical increase coincides with reduced harvesting in the U.S. resulting from declining timber resources and the legal gains made by environmental organizations questioning forestry management, such questions increasing in importance as degradation of the resource becomes more apparent. As the value of Mexican timber rises, harvesting that timber attracts U.S. corporations intent on satisfying the unabated demand for lumber-based residential construction. It has also piqued the interest of Drug Cartel capital in its search for laundering. No conspiracy theory directly tying the corporations to drug interests is necessary in the presence of the fact that harvesting by both ultimately funnels through to the housing industry here. Abuses of the resource in the Sierra Madre extends to those *ejiditarios* who dare to protest expedient, often unauthorized, harvesting of communal forests.

The import and crime statistics testify to the spiral effect created when resources diminish in a region without a concomitant decrease of appetite. Comparing consumption in the form of housing in the U.S. with that of other societies is meaningless since no basis exists for the comparison. Each comparison results in yet another multiple of the statistic from the society compared — 21 times that of one, 50 times that of another — and lends itself to the rationale that we enjoy the fruits of our labor and ingenuity. Looking at that consumption as an indicator internal to the U.S. of the direction and consciousness of the housing industry and its

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[7] *NRDC Slams Senate Plan to Drill in the Arctic Refuge, Says GOP's Omnibus Energy Bill Unresponsive to Nation's Needs* (Washington, D.C.: Natural Resources Defense Council, February 26, 2001) press release.
[8] Ibid.
[9] Kent Patterson, "Timber Trade," http://commongroundradio.org/transcpt/98/9816.html, Common Ground Radio, April 21, 1998.

consumers reveals more. Alternatives to Growth Oregon (AGO) has collected and published the following figures:

> From 1970 to 1996, the average house size in the US went from 1,385 to 2,060 square feet, an increase of 29%. At the same time, occupancy of the average house has dropped 16%.
>
> From 1970 to 1979 in the Pacific Northwest, population increased about 65% while households increased 110%. A significant portion of this increase is due to divorce.
>
> In 1993, 9,400,000 Americans owned second or more homes. 1998, on any given night, 600,000 Americans were homeless.[10]

These statistics describe the single most important economic indicator used to gauge the health of the U.S. economy, which is to say the *consumer* market for housing as distinguished from the *need* for housing. Like any market, the interests dependent on it will seek satisfaction even in the face of declining resources with little or no consideration extended to conditions beyond its narrowly defined horizon.

All of the indications that Albuquerque is living beyond its natural resource means aside, housing starts here continue to number in the thousands each year. All of these new "homes" meet the statistical norms described by AGO. All of these new "homes" symbolize the health of the local economy in the minds of the consumers and those assigned the task of worrying about such matters. Though timber imports through Santa Theresa are destined for points throughout the Western U.S., all of these new "homes" contain some Sierra Madre content. One might say they contain the blood, sweat, and tears of Mexican peasants, as well.

These two examples of the power of the relationship between capital and consumer to limit the horizons of each to the immediate context in terms of both space and time reveal the impediment to a sustainable future; namely a structural, cultural inability to perceive interests beyond our own, beyond today. Accordingly, any definition of "sustainable" cannot be as specific as those currently in use. But a new definition may be found in the collective variety offered in the context of a commonly held future that spans political and economic borders. Hans-Georg Gadamer, in *Truth and Method*, tell us "Understanding…is always the fusion of these horizons which we imagine to exist by themselves."[11] *Sustainable* needs to be tied to the idea of *legacy* in the minds of those doing the defining, which is to say, everyone, to spawn that kind of understanding. And Paulina Aguilera-Harwood reminds us that the only lasting legacy is cultural. Designers are doomed to working in the physical, but their product, thoughtful or not, for good and ill, directly impacts the culture. The purpose here is to uncover pieces of the physical that might promote a broader appreciation of long-term solutions in that culture most in need, the U.S.

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[10]Alternatives to Growth Oregon, "Consumption Growth," http://www.agoregon.org/growth/consumption.asp, March 15, 2001.

[11] Hans Georg Gadamer, *Truth and Method* (New York: Seabury Press, 1975 [1960]) p.273.

APPROACH

If we don't change our direction, we'll wind up where we are headed.

Chinese Proverb

The straightest path to a broader understanding of the challenges we all face is to "adopt" another context with the conviction that there are lessons to be learned and brought to bear at home. That much is obvious in the same way that travel broadens outlook. And practically any alternate context serves the purpose. This project looks at conditions in the Peoples' Republic of China in the belief that meeting those specific challenges tells us important things about the direction we might take here in the U.S. — about solutions for challenges we will inevitably face here. China's most important lesson is that we will face that future much sooner than we think.

There are three views of China: multinationals see a market that never ends; consumers see that market as a threat to their quality of life; and the less pessimistic see her as an experienced co-conspirator in the move toward sustainable systems. None of these views is all right or all wrong. The first two seem certain. The third is nuanced and requires time and effort. We know now that the rewards of the first will be short-lived and the depredations of the second eventually forgotten. It is the third view that holds one of the keys to the future. China's long experience with maximized landscapes and her long view of history complement the brash immediacy of Western environmental activism. China is a waking giant, but in ways that are much more subtle and powerful than those reflected in corporate balance sheets or consumer indexes. Her potential for tripling or quadrupling the global rate of consumption is limited only by the finite quantities of the resources available. All indications are that development in China currently exceeds that of the West: eighty million square feet of new housing in the coming decade, housing necessary to accommodate a population that is expected to peak at 1.6 billion by mid-century; large, unprecedented shifts of population from rural locales to urban complicate the picture. And the question of resource redeployment after mid-century complicates it yet further. The emergence of the Socialist Free Market, with its burgeoning urban middle class, shifts the consumption balance both inside China and throughout the world.

The applications proposed here assume the well established efficacy of renewable and recyclable resources as building systems as well as that of smaller, site-specific constructed wetlands for wastewater treatment. In combination with sound passive design (solar heat capture and avoidance), crop residues (baled straw) offer the greatest potential in the form of infill walls within box building frames (larger framing components). With bales smaller than those produced by Western mechanized equipment, such systems are appropriate for multistory applications. The benefits come in the form of reduced carbon dioxide generation (the avoidance of burn-off in the field, the cutting of timber, and energy intensive manufacturing) and in the creation of a windfall agricultural commodity. Likewise, pozzolan catalysts (coal ash, rice hull ash) used to supplant the Portland cement content in concrete further reduce greenhouse gases and also create commodity from waste (the manufacture of Portland cement accounts for 8% of carbon dioxide generated worldwide). Constructed wetlands (engineered versions of natural wetland filters), particularly at the site-specific scale, renovate downstream water quality and mitigate against erosion and aquifer fragmentation. Applying these systems and principles in the extreme circumstances represented by China's heated urban development

and fractionated agricultural landscape will further substantiate their efficacy. Demonstrating that those extreme conditions still offer an abundance of materials and the possibility for cultural and natural renovation may prove to be a source for optimism and action. Given the global context, such designs are directly applicable here in the U.S. The potential for landscape and resource renovation here in New Mexico is, perhaps, more important.

CHALLENGES *(problems)*

Overburden of incoherent western design
Widespread adoption of high-embodied-energy/throwaway building systems and materials
Degradation of water resources
Gas emissions resulting from the burning of crop residues & manufacturing
Wasteful centralized power generation
Meeting immediate need for exurban housing with an eye toward adaptation beyond mid-century

OPPORTUNITIES *(solutions)*

Reframing the design context for a common future
Redefining building capital in terms of natural systems and processes
Simpler designs supplanting mechanical energy with human
Recycling agricultural and industrial residues into building materials

SPECIFICALLY

Adapted CEPP design for composting toilets combined with wastewater wetland technology
Baled straw on lighter weight braced steel frames; reduced co2 emissions; windfall agricultural product
Smaller bales better suited for manual labor and a fractionated agricultural landscape
Reduced Portland cement content; reduced building mass; reduced co2 emissions
Recycled coal ash pellets for earth plasters and pozzolan content
Active & passive solar design
Grid-tied photovoltaic power generation
Kit-of-parts combined with local materials and manual labor

APPLICATIONS

Though the problems of the world are increasingly more complex, the solutions remain embarrassingly simple....
Bill Mollison

A PRIVY FOR ANG WEN KAI ZHU

Human waste and wastewater treatment are central to the experience in China. Public facilities are utterly rudimentary and devoid of delight. They are, when convenient, associated with a stream or river for direct disposal. In the absence of surface water, the product is washed into an open pit. The collection of raw night soil by members of the underclass is still practiced throughout the country. Residential urban systems have adopted Western style fixtures and chemical-based municipal treatment facilities. The net results: no potable surface

water—anywhere[12]; colossal waste of water in conveying waste and in treatment facilities; squandered human and soil nourishment resources

The opportunity here is to design detached toilet and shower facilities for a bed and breakfast in Zhong Dian (10,500 ft., 28° N) owned and operated by one of the local incarnate lamas and his wife.

Ang Wen Kai Zhu and Dawazhuoma, his wife, live in a traditional Tibetan house on the outskirts of Zhong Dian along the route to Songzanlin Lamasery. The house is 20 years old and was constructed as a part of the Lama's rehabilitation following the Cultural Revolution. They operate the site as a bed-and-breakfast which enjoys considerable popularity stemming from the gracious and accommodating attitude extended to visitors from within China and around the world.

Their higher water consciousness is evidenced by formal petitions to local and provincial officials protesting the degradation of ground and surface water resources throughout Zhong Dian caused by deep wells servicing new hotels in the city and the profligate consumption and waste generation resulting from government promoted tourism. They are also skeptical of claims made in promoting the new wastewater treatment plant designed by engineers from Qing Hua University, Beijing, which is scheduled to go online in 2003.

Although the bath and toilet facilities at their site are inadequate, those facilities do represent an improvement over those generally available by virtue of frequent maintenance. General practice in the region is to use open-pit latrines which are occasionally mucked out, the contents then spread on gardens or across adjacent meadows. The occupied terrain is the product of natural meadow building with the concomitant meandering streams and shallow water table.

The Lama and his wife agreed that the existing privy was not adequate in both aesthetic and practical terms. They also expressed a need for the increased energy to operate a computer and the desire to expand the courtyard wall to the farthest extent possible to the east. The courtyard garden is well maintained with ornamentals and herbs. They aspire to a seasonal truck garden producing quantities sufficient to meet the need of guests.

A VERTICAL VILLAGE AT DIAN CHI

The great rift valley lake immediately south of and contiguous to Kunming suffers every environmental and social malady imaginable: choked with vegetation fed by agricultural runoff; direct industrial and wastewater effluents; and, the relocation of the farming population and the poaching of arable land as the city sprawls in the only direction available (mountains to the north and west block expansion, indigenous reserves to the east.) All of the familiar urban challenges compounded by the expected pre-peak 30% population increase by mid-century (400 million people) and a wholesale abandonment of the farm for the city by those present (130 million in the last 10 years.)[13]

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[12] Caroline Blunden and Mark Elvin, *Cultural Atlas of China.* (New York: Chekmark Books, 1998) p.44-45.
[13] Robert Benewick and Stephanie Donald, *The State of China Atlas* (London: Penguin Putnam, 1999) p.14-15.

If the object is to keep people on the farm, producing for an inexorably (for now) expanding population, and accommodate the concomitant population increase on the farm, then the only way to go is up. This application borrows directly from the previous in technical terms and more clearly embraces the architectural issues of community and future.

The eastern shore of Dian Chi is a classic example of fault geology with minimal gradients facing sharply rising escarpments across the narrow ±400 square kilometer lake. The city of Kunming has always been contiguous with the lake and dredging and filling at the northern extremity dates to the Ming period (400 years). Despite official policy proscribing the poaching of arable land, modern Kunming encroaches increasingly with official approval to accommodate the new middle class desire for low-rise dwellings.

Industrial pollution point sources exist at the southern end of the lake. Generalized fertilizer runoff from the perennial cultivation of ornamentals for the world's markets along the eastern shore exacerbates algal and hyacinth proliferation. And direct disposal of raw or inadequately treated sewage from Kunming and other communities within the basin completes this picture of habitat degradation. [14]

Conversations with the people now providing rowing services to tourists visiting the formal gardens across the Da Guan inlet confirm the officially sanctioned displacement of farmers evidenced by the two story townhouse developments visible from those gardens. The complaints range from those associated with degraded lifestyle and employment to inadequate compensation for their land. Net results are centralized ownership of cash-crop monocultural agriculture and an increasingly displaced, dispirited population.

[14] *Yunnan Environmental Project: Environmental Assessment Report* (World Bank Overseas Development Administration, February 3, 1996) p.1.6-1.10.

ESSENTIAL READING

CITED

Benewick, Robert, and Stephanie Donald. *The State of China Atlas*. London: Penguin Putnam, 1999.

Blunden, Caroline, and Mark Elvin. *Cultural Atlas of China*. New York: Chekmark Books, 1998.

Gadamer, Hans Georg. *Truth and Method*. New York: Seabury Press, 1975 [1960].

Natural Resources Defense Council. "NRDC Slams Senate Plan to Drill in the Arctic Refuge, Says GOP's Omnibus Energy Bill Unresponsive to Nation's Needs," Washington, D.C.:, February 26, 2001, press release.

Patterson, Kent. "Timber Trade," http://commongroundradio.org/transcpt/98/9816.html, Common Ground Radio, April 21, 1998.

Pickler, Nedra. "SUV Sales Soar, Gas Mileage Hits 20-year Low," Associated Press, December 19, 2000.

Alternatives to Growth Oregon, "Consumption Growth," http://www.agoregon.org/growth/consumption.asp, March 15, 2001.

Public Broadcasting System. *Roll Over: The Hidden History of the SUV*, Washington, D.C., 2002, videotape.

Webster's New Collegiate Dictionary, 1975 ed., s.v. "sustain."

World Resources Institute. http://www.wri.org/wri/index.html,

Yunnan Environmental Project: Environmental Assessment Report. World Bank Overseas Development Administration, February 3, 1996.

HISTORY/CULTURE

Benewick, Robert, and Stephanie Donald. *The State of China Atlas*. London: Penguin Putnam, 1999.

Blunden, Caroline, and Mark Elvin. *Cultural Atlas of China*. New York: Chekmark Books, 1998.

Information about the current state of Chinese Society becomes increasingly available in the West. However, the introduction of opinion often shades the facts. These two atlases provide the latest information without bias or opinion.

Butterfield, Fox. *China: Alive in the Bitter Sea*. New York: Times Books, 1982.

Although Butterfield's world view is as quaint as that prevailing at the time of publication, his account of personal stories recorded in the immediate aftermath of the Cultural Revolution offers insight into an important influence on the modern Chinese character.

Debo, Angie. *Prairie City*. Tulsa, Council Oaks Books, Ltd., 1985.

This 1944 work by a grossly neglected author is the fictionalized account of the history of Marshall, Oklahoma. It describes the "adventitious…development that put the American farmer alone on his land."

Fairbank, John King. *China: A New History*. Cambridge: Harvard University Press, 1992.

The final book by the classic American historian of Chinese history and politics.

Gadamer, Hans Georg. *Truth and Method*. New York: Seabury Press, 1975 [1960].

The author's dense but ultimately understandable seminal work on the hermeneutics of art and literature. Perhaps not essential reading in toto, but helpful in explaining the private experience of "fused horizons."

Goldstein, Melvyn C. *A History of Modern Tibet, 1913—1951: The Demise of the Lamaist State*. Berkeley: University of California Press, 1989.

Thorough, frank appraisal of the interaction between those forces internal and external to Tibet leading to her forced occupation by the Peoples' Republic. Goldstein demystifies the myth of Tibet at no expense to a deeper appreciation for the intimate interplay of temporal and spiritual interests in the Buddhist state.

Jackson, Wes. *Becoming Native to this Place*. Lexington, The University Press of Kentucky, 1994.

The lectures on the future of American culture/agriculture delivered at the University of Kentucky as the 1991 Blazer Lectures by Wes Jackson, recipient of a MacArthur Fellowship for his seminal work researching the prairie grass biome and landscape renovation. Anyone with an interest in the potential future of agriculture in America should avail themselves of Jackson's wisdom and the work being done at his Land Institute in Salina, Kansas.

Kaplan, Robert D. *An Empire Wilderness: Travels into America's Future*. New York: Vintage Books, 1997.

An uncompromising look at the current state of American culture and where it is certain (in Kaplan's mind) to lead.

_____. *The Ends of the Earth: A Journey to the Frontiers of Anarchy*. New York: Vintage Books, 1999.

Kaplan's equally frank and frightening account of modern societies in crises leavened with an optimism best summed up by Krishnamurti's axiom: "Whatever can be solved locally will be."

Shakya, Tsering. *The Dragon in the Land of Snows: A History of Modern Tibet Since 1947*. New York: Penguin Compass, 1999.

Dry, but exhaustive account of that period in Tibetan history, the first written by a Tibetan.

Starr, John Bryan. *Understanding China*. New York: Hill and Wang, 2001.

Politically biased but informative comparison of Chinese and U.S. societies.

TECHNICAL

Campbell, Craig S. and Michael H. Ogden. *Constructed Wetlands in the Sustainable Landscape*. New York, John Wiley and Sons, 1999.

The first work on the subject to place constructed wetlands in the non-industrial landscape. An excellent source book for both technical and aesthetic design issues, readable even.

Del Porto, David and Carol Steinfeld. *The Composting Toilet System Book*. Concord: The Center for Ecological Pollution Prevention, 1998.

Complete guide to most, if not all, options for dry toilet technologies and designs.

Marsh, George Perkins. *Man and Nature or, Physical Geography as Modified by Human Action*. Cambridge, The Belknap Press of the Harvard University Press, 1965.

Originally published in 1864, this is the seminal American work chronicling the degradation of habitat. Consider it the technical companion to Thoreau's *Walden Pond.*

Outwater, Alice. *Water, A Natural History*. New York, Basic Books, 1996.

The first natural history of water in North America, Outwater's account of the dismantling of the continental filter gives one a keen sense of the intricate, irreplaceable relationships that made clean water possible.

Van der Ryn, Sim. *The Toilet Papers: Recycling Waste and Conserving Water*. New Sausalito: Ecological Design Press, 1995.

Reissue of the classic pocket design guide and polemic on the history and future of toilets and wastewater management.

CEPP TWIN-BIN NET COMPOSTER

Although David Del Porto's design for the Center for Ecological Pollution Prevention is successful across societies and terrains, the challenge here is to accommodate bathing facilities in combination with toilet. Moreover, one goal is to ensure lowest odor levels and "self-cleaning" waste chambers with enough ammonia and minor solids finding their way to the wetland rock/reed filters to support the micro-biological community, plant growth, and, thereby, thorough treatment of wastewater before the effluent is exposed to the surroundings as irrigation water.

It is important to understand the difference between light-water (sometimes called gray) filters in which physical filtering only occurs and constructed wetland cells in which biological filtering akin to natural wetlands is the process at work.

The combination of oxic (aerobic) composting for solids and wetland oxic/anoxic combined cleaning of liquid wastes is the optimum.

The Systems

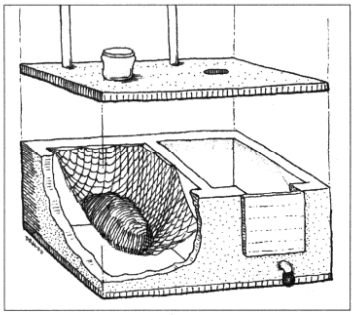
The following are sources for plans for two-vault systems. Each features a different aeration assist, from a metal cage to a hanging net.

• CEPP Twin-Bin Net Composter

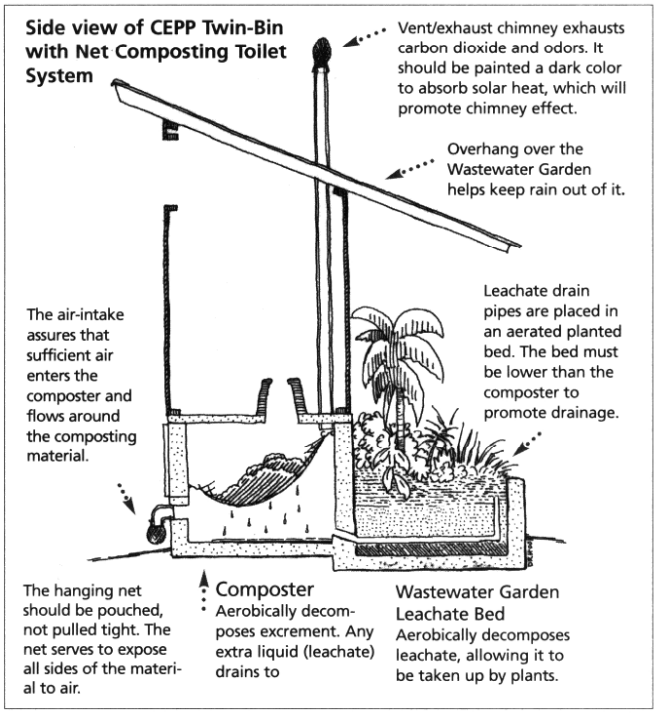
David Del Porto, one of the authors, designed a system for a Greenpeace initiative in the Pacific islands that uses a heavy-gauge fishing net suspended by hooks from the sides of each vault. The net is inexpensive, non-biodegradable and flexes as the mass changes shape, creating more surface area to improve diffusion of oxygen through the composting material. In projects sponsored by Greenpeace and island medical schools and government agencies, this system has been successfully introduced in the Micronesian islands and Fiji. In Pohnpei, the design has been duplicated by islanders, and the public utility assists in some installations. Some of these system have been coupled with evapotranspiration beds to handle leachate and graywater from washing facilities. Visited years after their installation, these systems were working well.

Plans and manual for the Twin-Bin Net Composter are $30.

Center for Ecological Pollution Prevention (CEPP)
P.O. Box 1330
Concord, MA 01742-1330
978/318-7033
EcoP2@hotmail.com



Clockwise from top: A strawbale structure is being constructed around a twin-bin system in Pennsylvania (Photo: David Cervenka); a side view diagram of a CEPP Twin-Bin with Net system; inside the vault before it is sealed for use, palm fronds or a degradeable mat are placed on the net; a front view. (illustrations: CEPP/Dan Harper)



ETPA = Excrement, Toilet Paper and Additive

APPENDIX A
CEPP TWIN-BIN NET COMPOSTER

MICRO WETLANDS AS LOGICAL LANDSCAPE ELEMENTS

A brief compilation of information and rationale for smaller, widely dispersed site-specific constructed wetlands. Much of the information is gleaned from Campbell and Ogden (see Essential Reading) which is the first (and only, so far) source placing the technology within the non-industrial environment.

Campbell and Ogden promote the use of rock/reed filter cells which are appropriate for households and clients with an established interest in gardening and plant maintenance. Bill Coleman has developed designs (unpublished) for rock (only) filters supporting the same oxic/anoxic processes with the same quality of effluent that are appropriate in those situations where no such interest exists or in situations where site forces preclude plantings in the filter.

Rock/reed filters are incorporated into the designs here because interest in agricultural and gardening endeavors is high and appropriate.

MICRO WETLANDS AS LOGICAL LANDSCAPE ELEMENTS

Constructed wetlands for wastewater treatment replicate the natural (former) systems for attenuating and utilizing metabolic by-products, filtering water, and recharging aquifers. Early returns indicate that constructed wetlands are capable of doing so, even at modern levels of human population concentration.

The latest innovation in constructed wetland "technology" is the micro-wetland, scaled to meet the on-site waste treatment need down to the level of individual homes, conceivably on conventional urban-size lots.

Within the last twenty years the processes of natural wetlands have become well enough understood to make constructed versions more effective alternatives to the sequential, high-tech systems typically employed in large scale municipal waste treatment facilities The move to constructed wetlands technology is also fueled by a clearer understanding of local and regional water cycles and the efficacy of wastewater recycling and ground water recharge. Accordingly, site-specific micro wetlands are now seen as the best approximation of natural systems for wastewater treatment and aquifer replenishment.

GOOD NEWS AND BAD

THE FILTER EFFECT The hydrology and chemistry of wetlands is not entirely understood. We do know that in any wetlands, natural or constructed, water quality is improved by the breakdown of organic solids, the conversion of nitrogen (in the form of ammonia) to its gaseous (atmospheric) state, the sedimentation of dissolved metals, and the consumption of coliform and other harmful bacteria. They differ from conventional wastewater treatment by providing an environment that supports both aerobic and anaerobic bacteria in tandem rather than in sequence. In natural and constructed wetlands the sediment within which the plants root is largely anaerobic and the zone immediately surrounding the roots is oxygenated by the action of the plants.

THE RECHARGE EFFECT We are only beginning to understand the contribution to life on the surface of the planet made by aquifers. Beyond our ability to exploit them for irrigation and potable water, it appears that aquifers support ecologies, all their own, which relate to life at the surface and that water tables contribute to tectonic forces, at least locally. Naturally occurring wetlands slow the flow of runoff from the land to faster moving streams and rivers. The result is obvious: water is filtered and then allowed to percolate through the strata underlying the wetlands thereby recharging the aquifer which, in turn, supports the underground ecology and returns even cleaner water to the surface much later and much farther downslope. Constructed wetlands perform the same service commensurate with their surface area.

THE EDGE EFFECT Naturally occurring wetlands and riparian environments provide a boundary between open water and dry land that supports an extraordinarily diverse ecology. This system supports life ranging from several forms of plankton all the way to the largest land animals at the top of the food chain, and, in North America, some 5,000 species and varieties of plants. It is generally agreed among natural scientists that this ecological phenomenon is unique among natural systems in its ability to promote and support life.

THE DIRGE EFFECT Both the good news and the bad news is that the Clean Water Act of 1972 worked. Point source discharges from municipalities and industries have been brought up to standards regarded as highest. Yet 30% to 40% of the surface water in the U.S. (streams,

rivers, ponds, and lakes) is unsafe to swim in, let alone to drink. “How is that possible?” one might ask. While point sources of pollution were, and will continue to be, a critical factor in water quality, our water will never reach pristine (pre Columbian) quality in the absence of the natural filtering system we’ve spent so much time and effort dismantling. Outwater’s book (see Sources) delineates the components of that system and their demise. The net results:

50% of America’s wetlands gone (95% in California)

Aquifers depleted (and polluted) by as much as 25% within the last 30 years

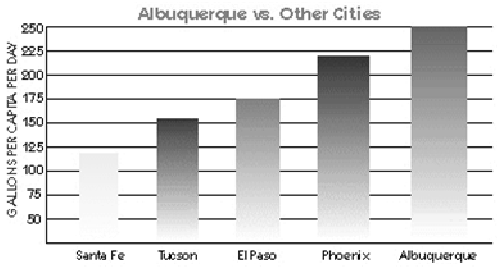
90% of New Mexico’s riparian environment destroyed by cattle grazing

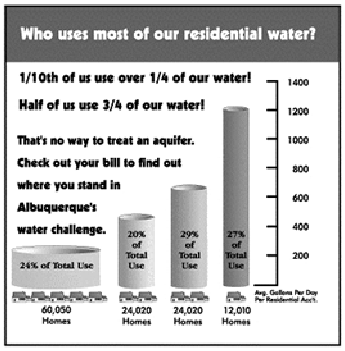
Populations of migratory birds and waterfowl down by 95% since 1950

The Colorado and Rio Grande polluted, then oversubscribed beyond the point where they no longer flow to the sea

Locally, development and sprawl continue to outstrip water supplies. Moreover, Albuquerque residents are particularly profligate in their use of water.

Figures from Albuquerque Water:



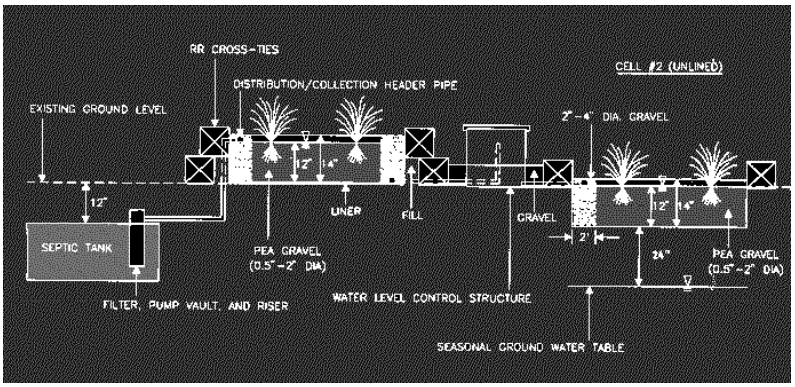


A more complete picture of local aquifer depletion and water use is available at:

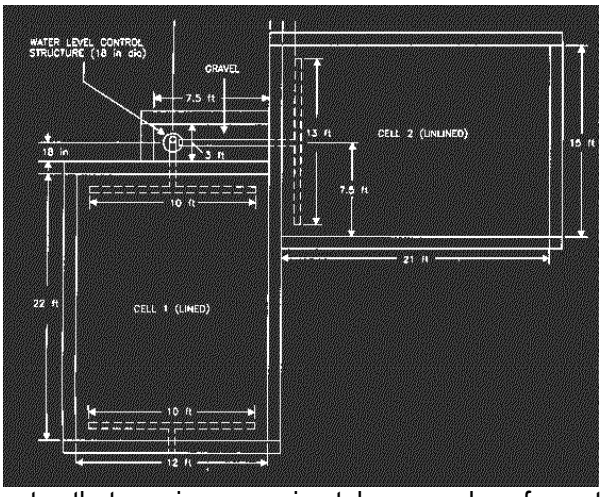
http://water.usgs.gov/ and http://www.nmcjnet.org/resources/insert.html#citydo

WETLANDS DESIGN Applied constructed wetlands science dates from the early 1970s and government funding for wastewater research slumped shortly thereafter (the imperative of the Clean Water Act was expected to solve the problem). That means that data on results and sizing is still building. But the news is all good. Constructed wetlands are becoming the treatment of choice for renovating stormwater and wastewater as data is produced supporting the practice as superior in effect both for water quality and cost. Constructed wetlands of any size generally cost one half to one third of conventional facilities to establish and operate. For on-site wetlands, the cost comparison can be much more favorable. Moreover, theory favoring decentralized systems is enjoying increasing popularity in wastewater treatment circles. Simple principles based on natural systems and thoughtful planning always result in clean effluent.

BASIC DESIGN



From: http://www.usouthal.edu/usa/civileng/wetlands.htm



The design shown is a subsurface flow wetland with the water level in the two treatment cells at two inches below the top of the gravel medium. Effluent from the second cell may be allowed to leach directly from the cell. In locations with impermeable soil, effluent may be directed to an evaporative pool or recycled to irrigate the surrounding landscape. In any event, each and every element of the wetlands is susceptible to landscape design principles.

Any wetland should be designed for flow rates that require approximately seven days for water to move through the system. The type of plants and media used affect flow rates.

Sizing the wetland to the likely flow of wastewater is critical. One calculation for cold climates suggests 1.3 square feet per gallon of waste per day. That translates to 300 to 400 square feet of working wetland for a two-bedroom house. Experience indicates that larger is better depending on climate and personal habits. Typical rates of consumption range between 120 and 150 gallons per day per occupant. That figure diminishes in arid climates populated by water conscious folks. The point here is that these systems need to be based on local conditions. Utility half-lives for constructed wetlands are not yet established. Extrapolations range from 30 years on up. The issue in regards to longevity is sedimentation, an issue not clearly understood as yet in either natural or constructed wetlands.

THE PLANTS Individual plant types and associations vary with climate and altitude. The following list includes species that are generally considered effective. It is important to remember that wetlands occur naturally throughout the landscape. That means that almost any location will suggest varieties of the following, or alternatives.

HARD-STEMMED PLANTS	SOFT-STEMMED PLANTS
Blue Flag Iris *Iris versicolor*	Arrow arrum *Peltandra virginica*
Horsetail *Equisetum hyemale*	Elephant Ear/Taro *Colocasia esculenta*
Dwarf Palm *Cyperus alternifolius*	Canna Lily *Canna spp.*
Soft Rush *Juncus effusus*	Pickerel Rush *Pondetaria cordata*
Dwarf Papyrus *Cyperus papyrus*	Duck Potato *Sagittaria spp.*
Thalia *Thalia dealbata*	Sweet Flag *Acorus calamus*
Graceful Cattail *Typha laxmanii*	Dwarf Canna Lily *Canna variegata*
Yellow Flag Iris *Iris pseudocorus*	Woolgrass *Scirpus cyperinus*

SOURCES

Outwater, Alice. *Water, A Natural History*. New York, Basic Books. 1996.

The first natural history of water in North America, Outwater's account of the dismantling of the continental filter gives one a keen sense of the importance of water in our lives and how its quality affects us.

Campbell, Craig S. and Michael H. Ogden. *Constructed Wetlands in the Sustainable Landscape.* New York, John Wiley and Sons. 1999.

The first work on the subject to place constructed wetlands in the designed landscape. An excellent source book for both technical and aesthetic design issues, readable even.

Constructed Wetlands for On-Site Septic Treatment: A Guide to Selecting Plants for Low-Maintenance Micro-Wetlands; a joint project of: East Texas Plant Materials Center, Pineywoods Resource Conservation & Development, The Forest Resources Institute, and Arthur Temple College of Forestry, SFASU.

A well executed, comprehensive, and concise brochure specifically devoted to this issue. Available in .pdf format at: http://plant-materials.nrcs.usda.gov:90/pmc/ETPMC/etbrconwet.html

Comprehensive, up-to-date information: search for "constructed wetlands" at Environmental Building News: http://www.ebuild.com/

The Texas On-Site Wastewater Treatment Research Council at: http://towtrc.tamu.edu/.

The Sustainable Building source Book at: http://www.greenbuilder.com/sourcebook/contents.html

The University of South Alabama at: http://www.usouthal.edu/usa/civileng/wetlands.htm

CHINESE RURAL ARCHITECTURE

Despite the authors claims, the Hakka round house designs of Fujian Province in the southeast of China are not the sole examples of multifamily agricultural dwellings. The most obvious exceptions to the claim are the many examples of Puebloan villages, many still occupied. Beyond that are the Dogon villages of Mali, West Africa and Shaker towns of 19th-century Northeast America.

The object here is not to suggest that apartment living for farmers is something new so much as it is something forgotten in the sense that farmers traditionally clustered their dwellings and cultivated either communal lands and herds or individually owned plots or a combination of the two. See Angie Debo and Wes Jackson in Essential Reading.

CHINESE RURAL ARCHITECTURE

Photography by Olivier Laude
Text by Ronald G. Knapp

The richly diverse vernacular architectural traditions of China are unrivaled in the world. No nation has as long an unbroken tradition and, with the dissolution of the former Soviet Union, none is as ethnically diverse. China, a nation of 56 nationalities living in disparate natural landscapes with widely varying climatic conditions, is certainly more varied in its housing patterns than is the case in single nations such as the United States or even in comparison with multi-national Europe. China's folk architectural forms, even as they portray common elements, clearly reveal the broad range of solutions that humans are capable of in providing basic shelter and creating homes for their families. The soaring silhouette of a Hakka fortress, the subdued grandeur of a Huizhou merchant's manse, the graceful "swallow's tail" ridgeline of a Taiwan farmer's house, the compact and utilitarian shape of a Mongol yurt, and the stark functionality of an underground dwelling in the loessial uplands are but a few of the notable examples of China's vernacular architecture that can still be seen today. Each emerged out of specific environmental and social conditions characteristic of China at different times in the past and in the different regions of the country's vast space.

Ronald G. Knapp is the author of books and articles on Chinese folk architecture including CHINA'S LIVING HOUSES: Folk Beliefs, Symbols, and Household Ornamentation that will be published by University of Hawaii Press in Fall 1998.

A large communal dwelling in Hekeng, a Hakka village in Fujian. Called Tu Lou, buildings like these - very likely the only communal rural apartment buildings in the world - can measure up to 100 yards in diameter and house up to 700 people under the same roof. There are three main building forms: round (Yuan Lou), square and 'Phoenix' Tu Lou.

Interior courtyard of a Tu Lou. Each family lives in a triplex accessible by communal staircases throughout the building.

A Tu Lou which houses only seven families. This is a highly unusual version of the Tu Lou. A small ancestral worship altar (marked by a red banner) is to the right.

Ground-floor dining room, Hongcun village.

Hakka kitchen with altar to the kitchen god, lowest of all in the pantheon of Chinese deities who is believed to report to the Jade emperor every new year on a household's deeds and misdeeds.

Interior courtyard of a large Tu Lou. Pigs and other farm animals are often kept within these courtyards. The surrounding buildings were originally designed to be self-sustaining and easy to defend from aggressors.

Staircase inside a square Tu Lou.

Hong cun village.

Hekeng Village

Paved courtyard of a square Tu Lou.

APPENDIX D

STAGGERED TRUSS DESIGN

One example of steel braced-frame construction. As is related in this article, braced frames are gaining popularity among architects, builders, and owners for their suitability in seismically active locations and for the systematic reduction in building weight. The combined result is a structure that responds well to eccentric forces, goes up in a shorter period of time, and exacts a much lighter (30% reduction, or more) toll on the environment in terms of emissions generated during manufacture and erection.

The system also lends itself to adaptation and reconstitution thereby prolonging the utility half-life of the materials.

The Staggered Truss Steel Framing System

"The engineers decided to ignore everything that was known about typical residential construction in New York City in favor of the staggered truss system."

Aine M. Brazil, P.E.
Managing Principal
Thornton-Tomasetti Engineers
New York, NY

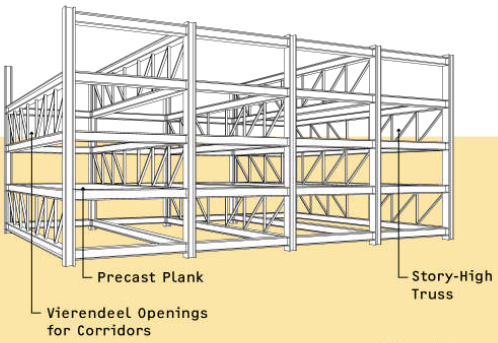
The 14-story Embassy Suites Hotel was part of an extensive mixed-use project in New York City. It originally was conceived as a cast-in-place concrete system—a design that proved to be excessively expensive. The innovative Staggered Truss Steel Framing System was chosen because it offers virtually all the advantages of flat-slab concrete construction at a significantly lower cost. Also, it allowed the hotel to meet its 8'-9" floor-to-floor height requirements. The lighter weight steel frame also contributed to significant cost savings on the pile foundation system.

Increasing Speed and Reducing Costs

The decision to use a staggered truss system on the Embassy Suites project was partly a financial one. Steel's 20% weight advantage over heavier concrete systems resulted in lower foundation costs, reduced seismic loads, and overall savings of $2.5 million. The low floor-to-floor dimensions further reduced costs by reducing the overall building height and lowering its heating and cooling costs.

Improving Quality and Enhancing Occupant Satisfaction

The staggered truss system dramatically improved the hotel's layout by eliminating interior columns to create more clear open space. This open space provided more aesthetic design options for lobby, ballroom, restaurant and retail activities, and added to the inviting ambiance of the space as well. In the portion of the structure designated for retail, steel framing provided the ultimate in flexibility. It permitted easy modification of the main shopping areas and simplified the process of changing individual tenant spaces.



The staggered truss system consists of a story-high truss that spans the entire width of the building. The trusses alternate from floor to floor with the long axis of one truss mid-span between the trusses on the floors immediately above and below. The system works in harmony with precast plank that provides a smooth floor and ceiling while achieving the desired low floor-to-floor height. The composite truss and plank system provides a safe and efficient structural system that resists both gravity and lateral loads.

APPENDIX E

SLOTTED BOLT CONNECTIONS

The poor man's alternative to expensive, manufactured "un-bonded" connections for braced-frame construction, this technique for seismic design also lends itself to site-assembled trusses suitable for circumstances offering surpluses of manual labor.

REPORT NO.
UCB/EERC-92/10
JULY 1992

EARTHQUAKE ENGINEERING RESEARCH CENTER

SLOTTED BOLTED CONNECTION ENERGY DISSIPATERS

(WITH AN APRIL, 1993 ADDENDUM OF SOME RECENT RESULTS)

by

CARL E. GRIGORIAN
TZONG-SHUOH YANG
EGOR P. POPOV

Report to the National Science Foundation

COLLEGE OF ENGINEERING
UNIVERSITY OF CALIFORNIA AT BERKELEY

Abstract

Slotted Bolted Connections (SBCs) are modified bolted connections designed to dissipate energy through friction during rectilinear tension and compression loading cycles. Experimental results on two types of SBCs are reported. In one type, friction occurs between clean mill scale steel surfaces; in the other, friction is between clean mill scale steel and brass surfaces. The behavior of connections with brass on steel frictional surfaces is found to be more uniform and simpler to model analytically than that with steel on steel surfaces. These connections maintain essentially constant slip force, and unlike those with steel on steel surfaces, require minimal overstrength of the system in design. The frictional mechanisms giving rise to the observed behavior are explained. As an example of application a one story diagonally braced frame was designed and its behavior determined for four different earthquakes. Experimental results are presented for the fabricated SBC for this frame subjected consecutively to the four displacement histories derived from these earthquakes. The agreement between the analytical and experimental results is found to be excellent. Because of the intrinsic simplicity of the SBCs and their very low cost, their use in seismic design and retrofit applications appears to be very promising.

This *Tips* publication is a re-print of a Univ. of California, Berkeley, Earthquake Engineering Research Center Report No. UCB/EERC-92/10 and includes an April 1993 addendum.

Introduction

Various types of energy dissipating devices, utilizing friction as means of energy dissipation, have been tested and studied by researchers [4, 6, 7]. Two of the common features of these devices have been that their manufacture requires precision work or exotic materials and that their installation demands specialized training. Consequently, the additional expense in using such devices has prevented their wide acceptance in engineering practice. The development of the Slotted Bolted Connections (SBCs) as energy dissipators represents an attempt to overcome the abovementioned shortcomings of these systems. SBCs, as presented in this paper, require only slight modification of standard construction practice, and require materials that are widely available commercially.

In this paper a Slotted Bolted Connection (SBC), see Figure 1, refers to a bolted connection where the elongated holes or slots in the main connecting plate, in which the bolts are seated, are parallel to the line of loading. In addition a Belleville washer [8] is placed under the nut. Two types of SBC specimen are discussed in this paper, one with brass insert plates and one without. Upon tightening of the bolts, the main plate is "sandwiched" directly between either the brass insert plates or the outer steel plates. The holes in the brass insert plates and in the steel outer plates are of standard size. When the tensile or compressive force applied to the connection exceeds the frictional forces developed between the frictional surfaces, the main plate slips relative to either the brass insert plates in the case of the first type specimen or the outer steel plates in the case of the second. This process is repeated with slip in the opposite direction upon reversal of the direction of force application. Energy is dissipated by means of friction between the sliding surfaces. Application of cyclic loads of magnitude greater than the slip force results in approximately rectangular hysteresis loops. The earliest investigations of SBCs as energy dissipators date back to 1976 when a series of experiments were carried out at San Jose State University (SJSU) [1] on specimens similar in concept to those presented here. The term SBC used here is adopted from the report by T. F. Fitzgerald, et al. [3]. A number of other researchers have also investigated similar devices [2, 5].

Specimens and Experimental Results

To date, over forty SBC specimens of various bolt sizes, configurations and surface conditions have been tested at the University of California at Berkeley (UCB). Experimental results for specimens presented in this paper are representative of the salient SBC characteristics encountered throughout testing. Presented here are two specimens which are identical in every aspect with the exception that one includes shim like brass insert plates with a hole pattern matching that of the outer steel plates. Figures 1 and 2 show, respectively, the details of an SBC connection and the overall view of a typical assembled test specimen.

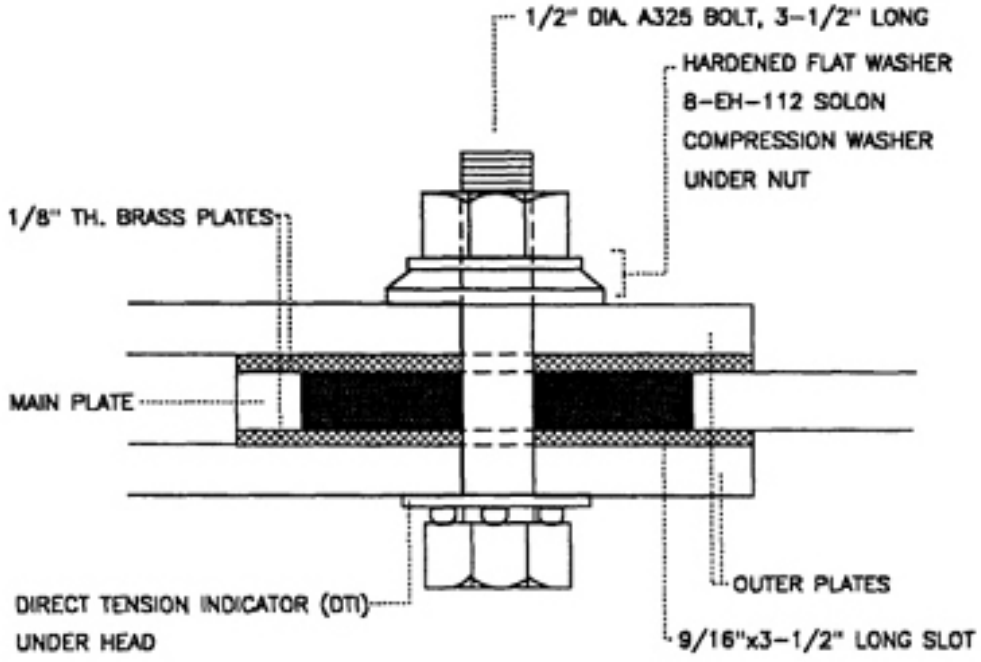


Figure 1

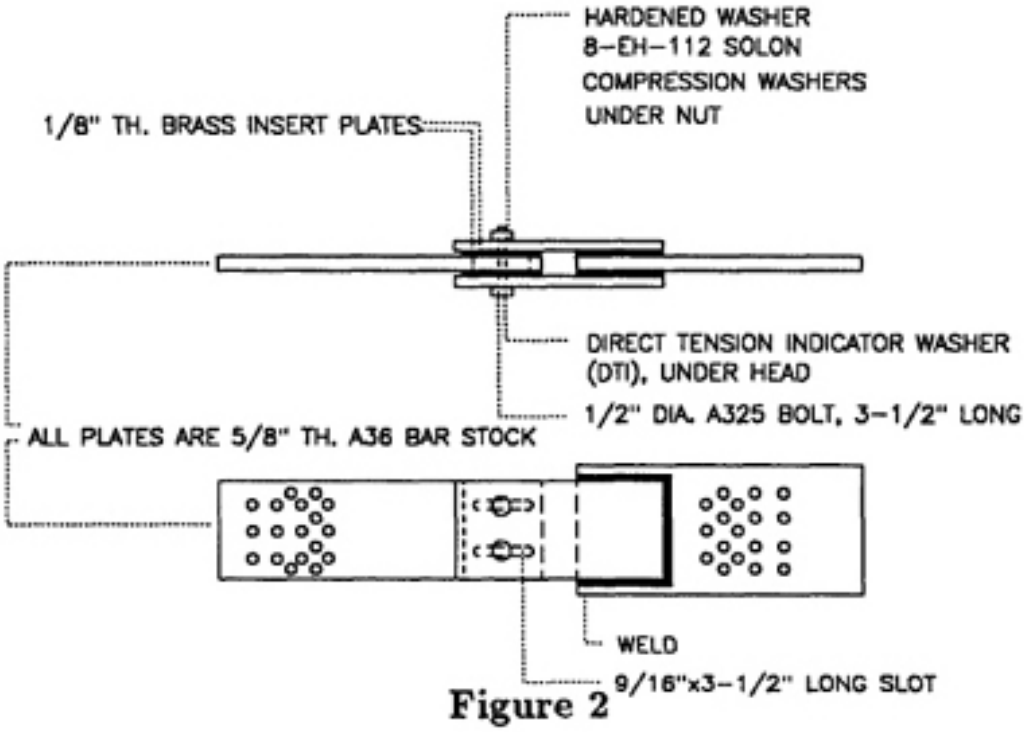


Figure 2

Both specimens are of A36 steel. The steel surfaces were cleaned to clean mill scale condition. The brass plates were of the widely available half hard cartridge brass variety (UNS-260). The test specimens were prepared by a local structural steel fabricator so as to simulate industry standards. Holes and slots in the steel plates were punched, and the edges were deburred. The two specimens described in this section are two bolt specimens. The bolts used were a inch diameter, 32 inches long A325 bolts. The Belleville washers used were 8-EH-112 Solon compression washers. One such washer with a hardened washer on top was placed under each nut. Belleville washers are initially cone shaped annular disk springs which flatten when compressed. Earlier studies of SBCs [1] have shown that without the use of Belleville washers, and under large cyclic displacements, there is an almost immediate loss of bolt tension resulting in quick degeneration of the slip force. With the inclusion of Belleville washers, both turn of the nut and torque wrench methods of developing minimum bolt tension (70% of minimum tensile strength [111) become inapplicable. To achieve the desired initial bolt tension, Direct Tension Indicator (DTI) washers were placed under each bolt head. DTIs are specially produced washers with protrusions pressed out of the flat surface. As the bolt is tightened, the compressive force exerted on the DTI flattens the protrusions and reduces the gaps between the flat portions of the DTI and the head of the bolt. The gaps can easily be measured with a supplied feeler gage. When the feeler gage fails to enter a specified number of gaps, the desired load in the bolt has been reached. DTIs used here were designed to indicate a bolt tension in the range of 12 to 14 kips.

The specimens, described above, were placed within an MTS loading frame as shown in Figure 3. The ram was capable of applying forces of 300 kips statically and 250 kips dynamically, with a maximum displacement stroke of 6 inches. Both displacement and force control were possible through a controller unit, and a function generator enabled the servoram to produce preprogrammed load or displacement histories. All testing was done under displacement control. Axial load and displacements in the specimen were measured through a load cell built into the MTS loading frame and a Linearly Variable Displacement Transducer (LVDT) built into the servoram. Axial force and displacement were monitored and recorded using a Data Acquisition System in conjunction with an IBM PC-AT computer. In addition, an X-Y plotter recorded load-displacement curves on paper for immediate visual observation of results.

Figures 4 and 5 show the applied displacement histories, force responses and the resulting hysteresis loops for the two selected tests. Figure 4, representing the case of friction between like clean mill scale steel surfaces, shows the main shortcoming of SBCs with friction between steel surfaces. As seen in the force response diagram, there is an almost immediate increase in the slip force followed by a quick drop to a magnitude several times less than the peak slip force. Although this behavior has not been observed in all tests of SBCs with friction between like steel surfaces, it has been present, to various extents, in the majority of cases. In tests with specimens where the mill scale steel surfaces were polished by wire brushing and those in which the surfaces were roughened and the mill scale removed by sand blasting,

this behavior not only did not disappear but was actually intensified. The occurrence of this behavior in SBCs where friction occurs between steel surfaces renders such SBCs inefficient, at best, and impractical, at worst, as energy dissipators. Figure 5 represents the case of a SBC test with friction between clean mill scale steel and brass surfaces. As seen in Figure 5, the use of brass insert plates significantly reduces the variations in slip force magnitude observed in SBCs where friction occurs between steel plates, almost completely eliminating this undesirable behavior.

Discussion of Experimental Results

A discussion of experimental results involving friction must necessarily involve concepts of Tribology. Tribology is the body of science dealing specifically with friction, wear and lubrication. Terminology is a matter controversy in this field. The Tribological terminology used here is adopted from E. Rabinowicz's classic book "Friction and Wear of Materials" [9]. Friction is defined as "resistance to motion which exists when a solid object is moved tangentially with respect to the surface of another which it touches." Wear is defined as the "removal of material from solid surfaces as a result of mechanical action." Of the several types of wear discussed in Tribology literature, the two most relevant to the present discussion are adhesive wear and abrasive wear. Adhesive wear occurs when "two smooth bodies are slid over each other, and fragments are pulled off one surface to the other." These fragments may later return to the original surface or form into loose wear particles. Abrasive wear occurs when "a rough hard surface, or a soft surface containing hard particles, slides on a softer surface and ploughs a series of grooves in it." The material from the grooves generally forms into loose wear particles. Adhesive wear is almost universally present in all frictional phenomena, and it is the authors' belief that it, in conjunction with some abrasive wear, is the main mechanism of wear in the SBCs tested. In general, no one explanation can satisfactorily account for observed frictional behavior as many different mechanisms are involved in friction and wear processes, some simultaneous, some sequential and often interacting with each other. Presented here is a qualitative explanation of the experimentally observed SBC behavior based on the above mentioned Tribological notions and experimental observations. The explanation given here applies to both SBCs where friction occurs between like steels and where friction occurs between steel and brass. It is believed that as sliding is begun, wear particles are formed due to adhesive wear between the sliding surfaces. This results in outward displacement of the outer plates in the direction of the bolt axes. This in turn results in an increase in the bolt tension force and therefore an increase in the normal force between the sliding surfaces. As frictional force is directly proportional to normal force, this increase in the normal force is observed as an increase in the slip force. With continued sliding, a portion of the loose wear particles fall out of the connection, as observed experimentally, while the rest are either reabsorbed or act as abrasive particles contributing

to abrasive wear. In Tribological terminology, the phenomenon that occurs here can be, simplistically, described as adhesive wear giving rise to wear particles which then cause additional abrasive wear. That abrasive wear occurs despite the smoothness of the original surfaces is evidenced by the appearance of sliding surfaces observed after the completion of experiments and upon the dismantling of the specimens. In the case of friction between like clean mill scale steel surfaces, both surfaces can be described as severely scratched. While in the case of friction between clean mill scale steel on brass, only the brass surface appears as scratched while the steel surface appears undamaged but with smears of brass. Scratched surfaces are a typical consequence of abrasive wear. The fall out and reabsorption of wear particles has the effect of reducing the bolt tension force as the outer plates now displace inward. This results in a reduction of normal force and is observed as a drop in the slip force. That the outer plates displace outward and then inward simultaneous with rise and drop in the slip force has been confirmed by measurements of the displacements of the outer plates along the axes of the bolts.

The above mentioned behavior, i.e. initial increase in slip force followed by a drop, observed in both Figures 4 and 5, although clearly far more poignantly evident in Figure 4, is directly attributed to the wear mechanisms mentioned above. The difference in behavior between the two types of specimens is solely due to the choice of the use of brass as a frictional surface, as the other two parameters known to influence adhesive wear, namely initial normal force and total travel distance, were identical for the two presented specimens. This choice was made precisely with the reduction of wear in mind. Brass is a common choice as a material frictionally compatible with low and medium carbon steels, and is often used in moderate cost applications where it is desired to reduce adhesive wear [9].

Application and Verification of Assumptions

As an illustration of the utility of SBCs as energy dissipators, consider the example structure shown in Figure 6. A SBC with a slip force of 60 kips connects the diagonal brace to the main structure. Analysis of the structure was performed using the DANS [10] computer program. Newmark's step-by-step integration method was used. The structure was assumed to behave as a shear structure, and the SBC was assumed to behave as an elastic-perfectly-plastic connection. Viscous damping was assumed to be 2%. Responses due to four acceleration histories were calculated. The acceleration histories were as follows: the 1971 Pacoima Dam earthquake S16E, the 1952 Taft earthquake N21E with magnification factor of 5, the 1940 El Centro earthquake SOOE with magnification factor of 2 and the 1987 Whittier earthquake NOOE, at Sylmar, with magnification factor of 40. Figures 7, 8, 9 and 10 show ground acceleration histories, structure displacement responses and energy diagrams for each applied history. The columns remain elastic at all times and the SBC prevents the buckling or yielding of the diagonal brace. An examination of the energy diagrams reveals that on the average close to 85% of the total input energy is dissipated by the SBC.

To verify the validity of the assumption of elastic-perfectly-plastic behavior for SBCs with brass insert plates and to observe the response of such an SBC to displacement histories more realistically representing response to actual earthquakes, an SBC specimen was designed to slip at 60 kips. Based on previous results from tests of specimens with two z inch diameter A325 bolts, a test specimen with eight inch A325 bolts was fabricated. The specimen was subjected to SBC slip displacement responses derived from the above mentioned analyses. The four SBC slip displacement response histories were applied consecutively, in the order of acceleration histories mentioned above, to this specimen. Figures 11, 12, 13 and 14 show SBC slip displacement response histories and analytical and experimental hysteresis diagrams for each acceleration history. It is seen that the target slip force of 60 kips is attained almost perfectly in response to the first displacement history. As expected, the slip force drops, although not significantly, for the next three applied displacement histories. The rectangular shape of the hysteresis loops, coupled with the reasonably constant slip force, indicates that the assumption of elastic-perfectly-plastic behavior for SBCs with brass insert plates is a valid one.

Concluding Remarks

Both SBC types have been shown capable of dissipating significant quantities of energy as judged by the areas enclosed by the experimentally arrived at hysteresis loops. Slip force in SBCs where friction occurs between like steel plates has been shown to vary significantly. The peak slip force for such SBCs occurs almost immediately and may be several times the magnitude of the mean slip force. As such, for this type of SBC to dissipate energy throughout the course of ground excitation, either the members supporting the SBC must be designed with excessively large safety factors or the SBC itself must be under-designed. On the other hand, in SBCs where because of the brass insert plates friction occurs between brass and steel, slip force has been shown to remain relatively constant over the range of interest. It has also been shown that such SBCs behave in nearly perfect elastic-perfectlyplastic manner. In view of these results, it is evident that SBCs with steel on brass frictional surfaces possess significant advantages in terms of efficiency as energy dissipators and ease of modelling. As such, and with low material and fabrication cost, these SBCs exhibit great potential as an alternative choice for energy dissipation in seismic design and retrofit of structures.

Acknowledgements

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The opinions expressed in this paper are those of the writers and do not necessarily reflect the views of the sponsor.

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BALED STRAW CONSTRUCTION

An internet treatise on the efficacy of baled-straw building systems.

Much has been written and claimed about baled-straw systems, but most of that has centered around the industrial-scaled bale. This thesis proposes the employment of smaller bales harvested form the barley, wheat, and rice crops common to the regions in which the sites are situated. The smaller bales are more appropriate to the fractionated agricultural landscape of China, reduce the high tare square footage associated with the industrial-scale bales, and are more appropriate to placement in multistory structures. See the Practicum images for the Tab Tape/Braced Frame innovation for placement and securing.

1

Straw Bale Construction:
How environmentally friendly IS it?

Ann Edminster
design AVEnues

My presentation is not on multi-story, as advertised; that is what I was working on when I met John Swearingen. However, assumptions about the need to work toward using SBC for multi-story construction underlie my research:

- responsible land use demands it
- production building (i.e., subdivisions) dictates it

The most prevalent reason given for building with s.b. is environmental concern. However, obvious differences of approach suggest a closer look--without careful design, for example, massive amounts of concrete can go into foundations (concrete very high in embodied energy, etc.).

2

Environmental Benefits of Straw

Reduces timber demand
Diminishes pollution associated with disposal
Conserves energy in building operation

3

Reducing Timber Demand

Housing consumes >1/3 of all lumber
Average house uses 5,820 CUBIC FEET of lumber
Straw bale walls, slab floor could save 2,000 ft 3 /house (twenty 100-foot trees, 13.5" diameter)

Lumber figure includes plywood, OSB, dimension lumber.
Size of average house in 1988: 2,000 ft 2.

4

Diminishing Pollution From Straw Disposal

:99% of CA rice straw burned in the fields
56,000 T carbon monoxide
3,400 T particulates
3,000 T oxides of nitrogen
CO CO2 2, CH , CH4 4, methyl bromide
environmental illnesses
traffic hazards

1.3 million tons of rice straw alone; over 2 million tons for all field crops (barley, corn, cotton, sorghum, wheat, and rice).
Carbon dioxide (CO2) and methane (CH4) are the two most significant greenhouse gases.
A 24-car accident in OR in 8/88 killed 7, injured 38.

5

Diminishing Pollution From Straw Disposal

:Rice straw left in fields to decompose increases methane production 12x
methane is 30x more effective greenhouse gas than CO2
flooded rice fields produce 10% of all atmospheric methane

6

Conserving Operating Energy

Estimated savings: 9%
281 MBtu over 40 years
47 barrels of oil
Over $15,000/house
Experience suggests even greater savings potential
More savings from reduction in system needs

Paul Fritz estimated heating and cooling energy savings using DOE-2 computer simulation model. Savings estimated are versus standard frame construction (R19 walls, R38 ceiling), without other design changes. Tree of Life seed storage building monitoring shows temperature range of 58 to 64 degrees F with 40 degree diurnal temperature swings; when temperature climbs over 100 for a few days, the interior temperature climbs to 68.

HVAC system may be downsized, simplified, or eliminated entirely through proper climatic design, in conjunction with the high insulation, moderate mass that SBC provides.

7

How Much Straw Can We Use?

California's waste straw enough for 65,000 houses/year (rice yields 88% of CA straw)
106,000 new houses/yr
Five percent of CA housing market = 5,300 houses/yr

1991 is reference year for 106,000 new housing starts in CA.

8

Environmental Benefits—5% of new CA housing

5,300 affordable, high quality homes
More than 10 million ft 3 of lumber saved
CO production reduced by 6,400 T

9

ENVIRONMENTAL IMPACTS: THE WHOLE HOUSE

Identify the design decisions & available choices
Define environmental impact indices
Establish a regional "measuring stick"
Quantify the impacts for each decision
Rate the options
Evaluate the whole-house impacts

The Straw Bale House (thank you, DE, et al.) provided a starting point for looking at the different design approaches.

10

THE DECISIONS

Wall system & openings
Foundation
Waterproofing
Vermin proofing
Roof covering & insulation
Roof framing
Bale assembly & pinning
Wall stabilization
Bale wall finish
Floors
Interior wall

11

The Wall System: modified post-and-beam
Nebraska-style limitations
Traditional post-and-beam inefficiency
Tillman house–Tree of Life comparison
Production building labor costs
Multi-story for responsible land use

Threshold decision: what's the structural system?

- demanding loads (snow, wind, seismic) & building permit approval dictate more structure
- heavy timber is a scarce, precious resource and a highly inefficient way to use wood
- the modified post-and-beam version (Tillman) saved 41 board feet of lumber and nearly 500 pounds of steel; saved labor and money, too
- professional building requires efficient use of labor-- Shenoa ref: (thanks, John) 44% labor, 6% contractor, 19% subs (assume half labor); yields 60% labor-related costs (and that's with a lot of volunteer labor . . . which may or may not, in the long run, save $)
- we need to use land as efficiently as possible: infill, reclaiming damaged lands, densifying developed areas

12

ENVIRONMENTAL IMPACT INDICES

Manufacturing emissions
Renewability/sustainability of resource
Embodied energy/energy intensity
Water used in manufacturing
Reclaimability (salvage, recycle/compost, waste)

The “long list” includes:
• global warming
• ozone depletion
• resource depletion
• energy consumption
• air pollution
• habitat/ecosystem damage
• waste disposal
• ground pollution
• water pollution
• health issues

I wanted to use these five, but found: CO2/CO2 equivalent--little data, linked directly to energy consumption (99%) no good, objective measure of sustainability; even more problematic looking at wall assemblies comprising several materials embodied energy: energy consumed in the production of materials and their associated transportation during processing; plus energy consumed in the construction of buildings; expressed in unit terms (Btu per __). energy intensity: same as above, minus construction energy water use: CA drought-prone, supply is an important issue; also related to water pollution (though not necessarily so) waste: based on current practice

13

REGIONAL “MEASURING STICK”

Energy: 540 MBtu/house
Water: 82,000 gallons/house
Waste: n/a

Qualify: these are not true indicators, because they are derived from building materials mining and manufacturing in California, correlated with construction activity in California; these cannot in reality be correlated, because all the materials created here are not used here, nor do CA building projects use exclusively CA-made materials.

14

QUANTIFYING THE IMPACTS

Typical house design
Calculate areas, etc.
Identify all materials used
Find energy, water, waste data/material
Takeoff of materials
Multiply material qty x impact factors
Total for each design option; rank

Find a typical house design, redesign for s.b. (2,085 sq.ft.)
Average house size in 1990 was 2,080 sq.ft., in 1992 and 1993, 2,095 sq.ft.

Takeoff step typically involved calculating the materials that occurred in a detail or cross-section, then multiplying by the number of times this occurred in the house (e.g., lineal feet of foundation, or square feet of wall surface).

15

LOW-IMPACT HOUSE

rammed earth foundation, bamboo reinforced
plastic film waterproofing
silica sand termite barrier
thatch roof; straw insulation
bamboo roof trusses
3-wire bales, laid flat; bamboo pins; plastic strapping
adobe plaster bale wall finish
“no-header” openings
adobe floors
straw-clay interior walls

Foundation: asphalt-stabilized rammed earth.
Roof insulation: straw in attic, loose or burlap-bagged.

16

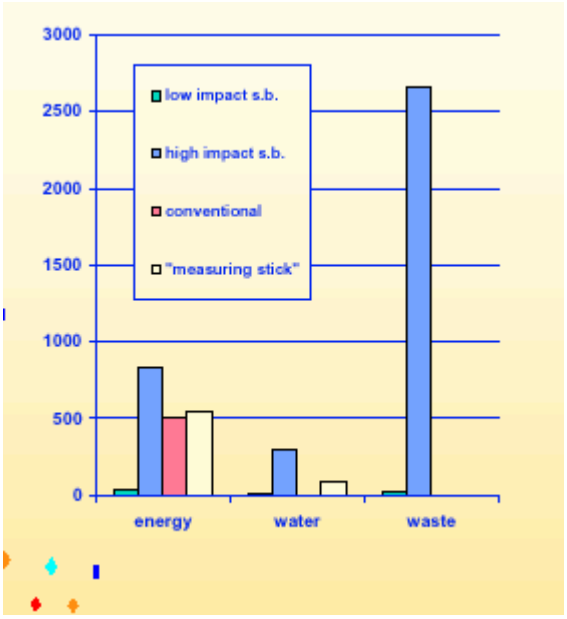
HIGH-IMPACT HOUSE

concrete foundation, steel reinf.
roofing felt waterproofing
sheet metal termite barrier
steel roofing; fiberglass insul.
dimensional lumber rafters
3-wire bales, laid on edge; rebar pins; plywd shear panels
cement stucco bale wall finish
steel headers, 2x8 frames
concrete floor, steel reinforced
concrete block interior walls, lime plaster finish

Bale walls: cement stucco over chicken wire reinforcing mesh.

17

COMPARISON OF IMPACTS



18

LIMITATIONS OF ANALYSIS

Data reliability
Durability/lifespan
Availability, transportation impacts
Cost/feasibility
Interdependency of choices
Ecosystem impacts

Data reliability: currency of data, boundaries, omissions , variation from mfr. to mfr.
Transportation impact limitation includes huge potential deviation from averages assumed by embodied energy studies; also transportation post-manufacturing, to arrive at job site.
Interdependency: example is living roof--higher loads necessitate more roof framing, more foundation, etc.
Ecosystem impacts: arrow bamboo is principal food for the Chinese giant panda, now threatened with extinction--just because a material is natural and locally available doesn't necessarily mean it can be used without adverse impact. Just heard yesterday from one of the workshop participants about a case involving Saltillo tile . . .

19

OBSERVATIONS

LOW TECH = LOW IMPACT
Straw Bales MAY = low impact
Embodied energy will increase in significance with more efficient building envelopes

Low tech = low impact AS A GENERAL RULE
The Canadian r2000 houses are setting the example for building envelope efficiency. Once standards such as these become more widely adopted, embodied energy will become the next energy conservation frontier.

20

NEEDS

Testing
Code support
Education: low tech, low quality
MATERIALS IMPACT RESEARCH

Close the reuse loop/simplify materials
Strive for longevity and/or minimum impact
Weigh lifestyle choices first

Testing is vital (by the way, full copies are available for advance purchase for $15; $5 for every copy sold will be donated to BRAN to support SBC research and testing).

Materials impact research: ways to adequately assess renewability/sustainability; ways to evaluate levels of toxicity; and more and better information about energy, water, waste, as well as specific pollution impacts.

Redrawn and reformatted from the original.

PHOTOVOLTAICS

Significant advances have been made within the last five years in the productivity of photovoltaic panels as well as in manufacturing processes. Conversion of sunlight reaching the panels surpasses 15% and the energy embodied during manufacture has been reduced to such that it is recouped through three to five years' power generation leaving as many as forty years' productive half-life on the plus side of the cost-benefit equation. Thin-film panels laser etched to pass 5% sunlight are specified in each of the applications here thereby offering some solar gain and day-lighting in addition to power generation.

Generally speaking the rationale for PVs is rooted in the efficacy of dispersed production. Large-scale centralized production, whether hydroelectric or coal-fired, lays the system open to significant energy losses through transmission and energy squandered (as much as 70%) in the form of heat. The efficiencies of co-generation are compromised by transmission losses. And the wholesale degradation or destruction of habitat associated with hydroelectric generation is a cost calculable only on an imponderable level.

The grid-tied aspect of this component has as much to do with community issues as it does with environmental. Stand-alone PV installations require large arrays of batteries that easily eclipse the environmental efficacy of the PV panels with increased tare square footage, maintenance, and the dissemination of toxic pollutants. Stand-alone systems usually lead to imbalances between production and consumption with resulting hardship or waste. Moreover, the idea of stand alone systems is inimical to that of a commonly held future. Our ability to survive *alone* is not the issue. Our ability to survive *together* is.

Both applications here have electrical power available on site.

The Highest Efficiency Terrestrial Silicon Solar Cell You Can Buy

By John Perlin

Ever since the first silicon cells were developed, the biggest problem has been grabbing the energy from the cell and getting it to the electrical load. This has been the stumbling block since the beginning of solar cell research and development. The buried contact cell is providing the best solution yet.

Contacts

Without electrical contacts somehow adhered to a solar cell, the cell is useless, no matter how well it's put together. The contacts extract the electricity generated by the sun, and wires connected to the contacts carry it to the electrical loads. In the 1970s, solar pioneer Bill Yerkes and colleagues streamlined production of solar modules. They began screen printing contacts onto the front surface of cells to cut costs. Ever since then, most manufacturers of photovoltaic (PV) cells have followed suit. The process resembles the method used to put designs on T-shirts.

Arthur Rudin, Director of Product Marketing at Siemens Solar, explains the procedure: "You have a screen, you put your shirt under it, the screen has a pattern, and you move a squeegee with paint across the screen. With solar cells, the paint happens to be a mix of silver paste with glass. The concoction is a good conductorand bonds well with cells."

The rest of the industry seemed quite satisfied with the screen-printing approach, and adopted the process. It readily lends itself to assembly line production, and definitely proved more economically sound than earlier methods. But Dr. Martin Green and colleagues at the University of New South Wales in Sydney, Australia, took a different position. In the early 1980s, Green and his co-workers were also focusing their attention on improving the efficiency of single-crystalline solar cells.

They had witnessed the failure of cell developers to lower the price of solar cells. The attempts had centered on developing a new PV material that would circumvent the very expensive slicing step necessary for making crystalline cells. The Australians decided instead to look at ways to

substantially raise the efficiency of cells after the cutting process, without increasing manufacturing costs. This would provide more watts per dollar, achieving the same goal.

Cutting Edge

It was no accident that Australia fostered such cutting-edge research in terrestrial photovoltaics so early in the history of the technology. By the mid 1970s, Australia had become a hotbed of activity in PV research and development. The national Australian telecommunications provider, Telecom Australia (now Telstra) had decided to power much of their remote equipment-including rural telephones and microwave networks-with solar cells.

In fact, in the early 1980s, Solarex cited Telecom Australia's mass use of PV as primary " to the development of solar power as a practical energy source." Green applauds them for their commercial commitment to solar cells, and for helping him and his colleagues develop one of the premier PV research centers in the world. "It obviously stimulated our work because we had a target audience. There was a real interest by the Telecom people in actually using these things."

Green and his colleagues meticulously examined the solar cells that were being used in the 1970s and early 80s. They came to the conclusion that the performance of commercial crystalline silicon modules "hinged on how metal contacts were formed to the cell." That became their focus.

Green's group discovered that although screen printing lowered production costs, it was the chief obstacle to better cell performance. The Australians found that the additives in the silver paste that make screen printing possible are less conductive than pure silver. They significantly reduce the contacts' ability to effectively capture the electricity generated by the cell.

One might suggest an increase in the number of contacts on the cell to compensate for the loss in efficiency. But more of the relatively wide contact lines produced by screen printing would shade too much of the cell from the sun. The only way to get a sufficient amount of electricity out of the cell to the silver-paste contacts has been to flood the surface of the cell with phosphorous. Unfortunately, this creates a dead layer on the cell's surface. Light absorbed in this inactive region is wasted since it cannot generate electricity.

Laser Grooves

The Australians hunted for another way to lay the contacts in order to avoid the pitfalls inherent in screen printing. In their search, Green and his colleague, Dr. Stuart Wenham, "hit upon the idea of using a laser to form grooves on the surface of the cell and filling the grooves with copper. The copper contacts have three times the conductivity of silver paste, and since they are partially buried inside the grooves, they obscure less of the cell's surface.
This allows more sunlight to reach the cell, and also permits the cell builder to place more contacts on the cell without worrying about shading. Enough contacts can be added to eliminate the need for all that phosphorous, allowing the entire piece of PV material to respond to light. Green and his colleagues named their invention the "buried contact cell." Cells made this way have consistently outperformed all others in the world.

The Australians' ultra-efficient cells got their first test in the 1990 World Solar Challenge, where PV-powered
vehicles raced across the Australian continent. The Japanese contender-the clear favorite-was a Honda powered by modules rated as the best in the world. However, a Swiss car, which ran on the Australians' buried contact cells, unexpectedly won by a wide margin, proving its achievement was no fluke. The lopsided victory attracted worldwide attention to the work done by Green and his colleagues.

Buried Contacts

As one of the fruits of the Australians' triumph, British Petroleum (BP) purchased the rights to manufacture the buried contact cell. Currently, BP makes modules in Spain using the buried contact concept. The company takes a crystalline wafer 300 microns thick and digs V-shaped grooves 20 microns wide and 40 microns deep into each cell. Then technicians plate the copper contact into this groove.

The laser-grooved cells now on the market convert between 16 and 17 percent of the incoming sunlight into electricity under peak conditions-full sunlight with the rays falling perpendicular to the module. Under similar conditions, screen-printed cells change between 13 and 14 percent of the sun's energy into electricity. Laser-grooved cells improve peak performance by about 20 percent.

Low Light Performance

In less than ideal conditions during early morning, late afternoon, and on cloudy days, the efficiency of the laser-grooved product drops by only 13 percent. Its screen-printed rivals fall 35 percent off peak efficiency.

In other words, under less than ideal conditions, the buried-contact cell is better than the screen-printed cell by nearly 30 percent. People living in the Pacific Northwest, Northern Europe, and other places prone to low solar insolation levels should take note !

The significant difference in the two technologies' generation of electricity under less than perfect solar conditions has led to a change in how a cell's energy efficiency is measured. The goal is to more accurately rate a module's performance for a specific location. For many years, cells have been ranked by their peak watt efficiency. It now seems preferable to examine the cells' true energy output, letting people know how much energy they will really get.

Thin Film

BP has been commercializing the buried contact cell for crystalline wafers. Meanwhile, Martin Green and his colleagues have taken laser grooving one step further to pioneer a thin-film crystalline silicon cell that may someday lower the price of solar cells dramatically.

Actually, the Australians had always yearned to work on thin-film cells. But money constraints forced them to concentrate their efforts on thick, conventional crystalline silicon. Their financial situation improved dramatically after the solar car race victory and BP's purchase of the rights to manufacture the buried contact cell. These two significant achievements led the

Australian government to award Green and his colleagues a research center with generous funding.

Now they can concentrate on their dream: building a highly efficient thin-film crystalline silicon photo-voltaic device that will be cheap enough to provide a large fraction of the world's power. A thin-film cell would lower production costs considerably because it would avoid the wasteful process of cutting large pieces of crystalline silicon into wafers, and would use much less silicon.

Laser grooving is the key to the design of this new cell, now in pilot production, and planned to be commercialized by 2003. First, very thin alternating layers of positive and negative polycrystalline silicon are deposited onto glass. All potential electrical charges are near a p-n junction-the core of any solar cell, where the important photovoltaic activity occurs. Grooves that are laser-cut into each stratum and filled with metallic contacts collect the electricity generated in each layer of the cell when exposed to sunlight.

Time Will Tell

Pacific Power, the largest utility in Sydney, Australia, where Martin Green and his team are based, has generously funded their efforts. They have lured some of the best people in the crystalline silicon cell field to help move toward the commercialization of the laser-grooved buried-contact thin-film cell. Only time will tell if this bold application of the laser-grooved buried contact will bring about the ultimate solar generator-a low cost, highly efficient solar cell.

Access

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CONSUMPTION GROWTH

The complete text of the Alternatives to Growth Oregon treatise on the profligacy of consumption in the U.S.

Apropos of the claim made here that common title to the future is the only definition of "sustainable" that seems reasonable, let alone computes, one essential element to making that shift in the U.S. is an understanding that consumption here must assume levels in tune with the rest of the world. It is not enough to ensure the future of the child living in a suburban neighborhood of El Paso; the future of the child living across the Rio Grande in one of the *favelas* thrown up last week in Juarez must become a part of the equation. Otherwise the math continues to defy logic.

Consumption Growth

Is the Problem Population or Consumption?

Some argue that the absolute level of population is out of control and must be limited. Others argue that the real issue is consumption–especially in the overdeveloped United States. An average American consumes twenty-four times the resources of the average Bangladeshi.

The American consumes way too much and the Bangladeshi not enough.

Excessive population and consumption is a global problem *and* a local problem.

The average American now consumes at least 122 pounds of raw material every day.

Sustaining all of the current residents on Earth at the average American lifestyle whole require four more Earths. Eight more, if you want to leave room for nature.

The issue is partly–but not entirely–a matter of equity. If resource consumption and resultant pollution continues to rise, it won't make enough difference that population is stabilized. Similarly, if recycling doubles, nothing is gained if population also doubles.

The problem is not population *or* consumption. It is both.

Governor Kitzhaber is to be applauded for his executive order on sustainability. It is bold and, hopefully, precedent setting. However, one cannot reach sustainability just addressing per capita consumption. One also must address the absolute number of capitas.

No Linear Relationship Between Consumption and Happiness

"Grow for the sake of growth is the ideology of a cancer cell" said Edward Abbey. It is also the ideology of developers.

At some point growth will stop. Why not stop it now, before it's too late?

Most estimates project the global population leveling off at around 10 billion in the middle of this century. When population levels off, what happens to the growth economy then? And what happened to our environment and elbowroom?

What kind of an economy do we have that depends upon an ever-growing population and rate of consumption?

From 1970 to 1996, the average house size in the US went from 1,385 to 2,060 square feet, an increase of 29%. At the same time, occupancy of the average house has dropped 16%.

From 1970 to 1979 in the Pacific Northwest, population increased about 65% while households increased 110%. A significant portion of this increase is due to divorce.

In 1993, 9,400,000 Americans owned second or more homes. 1998, on any given night, 600,000 Americans were homeless.

In 1992, Americans were four and one-half times richer than our great-grandparents were at the beginning of the last century. Were we four and one-half times happier? Does that third television, that third garage make you three times happier than the first?

The practice of thrift by our grandparents has died out. The adage of "use it up, wear it out, make it do or do without" has been replaced with "Buy it up, toss it out, buy some more, don't do without."

Do you want more stuff or do you want more time? The average Oregonian is working 278 hours more each year–seven 40-hour weeks–than we did 20 years ago. American parents in 1991 spend 40% less time with their children than they did in 1965.

We have more shopping centers in America than high schools.

A result of global mass media is that we are no longer trying to keep up with the Jones' next door, but with the Gates'.

Sen. Avel Gordly asked, "At what point do we question the whole notion of creating wealth for the sake of having dollars and give that more value than creating community?"

When asked, Americans who reported being very happy were no more numerous in 1991 than in 1957.

The Gross Domestic Product is going up. How good is that? The GDP is merely a summing of financial transactions. Hurricanes, HIV-AIDS, and war all increase the GDP. (They also create jobs.) The GDP has nearly tripled since 1950.

Robert F. Kennedy, speaking in 1968 said:

> We will find neither national purpose nor personal satisfaction in a mere continuation of economic progress, in an endless amassing of worldly goods. We cannot measure national spirit by the Dow Jones Average, nor national achievement by the gross national product. For the gross national product includes air pollution and advertising for cigarettes, and ambulances to clear our highways of the carnage. It counts special locks for our doors, and jails for our people who break them. The gross national product includes the destruction of the redwoods, and the death of Lake Superior. It grows with the production of napalm and missiles and nuclear warheads.... It includes Whitman's rifle and Speck's knife, and the broadcasting of television programs which glorify violence to sell goods to our children.

And if the gross national product includes all of this, there is much that it does not comprehend. It does not allow for the health of our families, the quality of their education or the joy of their play. It is indifferent to the decency of our factories and the safety of our streets alike. It does not include the beauty of our poetry or the strength of our marriages, the intelligence of our public debate or the integrity of public officials.... The gross national product measures neither our wit nor our courage, neither our wisdom nor our learning, neither our compassion nor our devotion to our country. It measures everything, in short, except that which makes life worthwhile; and it can tell us everything about America–except whether we are proud to be Americans.

A think tank called Redefining Progress has developed The Genuine Progress Indicator–the "GPI"–that assigns dollar values to such things as crime, family breakdown, underemployment, and the

loss of species and farmland reveals that GPI increased from 1950 to 1970, along with GDP. However, GPI has had a steady decline since then.

So have other indices of social welfare. Oregon Well-Being Index tracked well with the state GDP from 1980 to1992. Since then the state GDP has risen dramatically, while the Well-Being of Oregonians Index has remained nearly flat. The projections are for an even larger disconnect.

Finally, the Fordham Index of Social Health gone down as GDP has risen.

GDP may have once been a good way to measure progress and well being, but it isn't any longer.

Sometimes One Has To Choose

As Americans, we are not used to having to choose. We want it all, and often have gotten it all. But if a city chooses to grow for the supposed benefits such population increase has, then that city will inevitably lose other values. You can't have small-town values in a big city.

Consider the effort to bring a major league baseball franchise to Portland. First, it is the nature of the industry to play off city against city to see which will give the franchise the most to come or stay. Free stadiums, other tax breaks, etc. Our taxes will have to go up if we want to go out to the old ball game. Second, a franchise needs a population base, larger than Portland has now, to have an adequate fan base to make the venture pay.

Name me a city with a major league baseball franchise that doesn't also have major league tax subsidies and major league congestion.

Sometimes you have to choose.

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APPENDIX I

THE TIMBER INDUSTRY IN NORTHERN MEXICO

An exhaustive examination of Mexican forestry practices and politics by María Teresa Guerrero, Cyrus Reed, and Brandon Vegter, with George Kourous prepared and published by de los Derechos Humanos, A.C., Chihuahua City, Chihuahua, México and the Texas Center for Policy Studies, Austin, Texas, July, 2000.

Excerpted transcriptions of a National Radio Project broadcast and a Common Ground Radio broadcast featuring Kent Patterson's reports on the predations of U.S. corporations and other unsavory elements in the forests held in common by the *edijos* of the Sierra Madre. This documents the very real implications of consumption in the U.S. Sustainability is no longer (probably never has been) a benign question of maintaining lifestyle, but rather is associated with immediate life and death issues that cast the debate into the realms of morality and economic, social, and criminal justice.

THE TIMBER INDUSTRY IN NORTHERN MEXICO:

SOCIAL, ECONOMIC, AND ENVIRONMENTAL IMPACTS

BY MARÍA TERESA GUERRERO (COSYDDHAC), CYRUS REED, AND BRANDON VEGTER (TCPS), WITH GEORGE KOUROUS (IRC)

Mexico has been ranked 7th in the world in terms of plant biodiversity in its intact forest ecosystems. It is also the world's second largest paper producer, and estimates indicate that well over half of Mexico's forests have been lost. According to some officials, there will be no forests left by 2050 if current trends continue. The northern state of Chihuahua has more hectares of trees than any other state in Mexico. Most of these trees can be found in the mountainous region known as the Sierra Tarahumara. As the pace of logging has accelerated in recent decades and international companies increasingly eye the area's rich forest resources, concern over both the environmental and social impacts of logging is mounting. This month, borderlines publishes a condensed version of a pending report on the situation by the Texas Center for Policy Studies (TCPS) and the Comisión de Solidaridad y Defensa de Derechos Humanos, A.C. (COSYDDHAC).

The Sierra Tarahumara's forests represent different things to different people. They are an important part of the larger hydrological cycle, capturing rain and maintaining nutrients in the soil while preventing erosion. The headwaters of six rivers--one of which eventually joins the Rio Grande--can be found in the Sierra Tarahumara. From a biological point of view, these mountains are a unique biodiverse area that provides key habitat for migratory birds and for plants and animals extinct in other parts of Mexico. From an economic viewpoint, the area's forests are a source of income for both local and national communities, and could potentially provide income to thousands of Mexicans. Finally, from a social perspective, the Sierra's forests are home to approximately 290,000 individuals, about 25% of whom are indigenous people with unique cultures. Of these, about 92% are Tarahumara, or Rarámuri, as they refer to themselves. As a result of increased outsider activity in the region, the Tarahumara people have had to struggle to maintain their traditional way of life, which is intimately related to the isolated and rugged land they occupy.

FORESTRY LAW IN MEXICO: FROM LIMITED OVERSIGHT TO FREE MARKETS

Mexico has had forestry legislation since 1884--most of it focused on regulating and establishing control of natural resources. For example, the agrarian reform of 1934 promoted occupation of forest lands, granting open access to those who could convert unused land to agricultural or livestock use. Attempts to conserve forest resources have often been surpassed by economic and agricultural development policies, land reform, or foreign trade. Mismanagement, corruption, and limited resources for enforcement of environmental standards have also played a role in the failure of measures to protect the forests. These factors have combined to favor commercial timber production over conservation.

Forestry law in Mexico is inextricably linked to government policy toward the country's large indigenous population. Nearly 50% of all land in Mexico is "social property," collectively owned by farming communities known as ejidos, created during the Mexican revolution and subsequent reforms. Because the most productive land was already in private hands at the time of land reform, most forests in Mexico ended up becoming social property contained within ejidos.

After decades of logging without regulation, the mid-1980s witnessed a general decrease in forestry production. The government responded with heavy regulation of the industry and assumed an active role in management. The 1986 Forestry Law introduced requirements for forest management plans and permits for the transport, sale, loading, and processing of timber. The 1986 law also clearly designated authority for enforcement of forestry rules, reforestation, and conservation to the federal government.

Declines in production continued, however, and changes to the Forestry Law in 1992 were a calculated step to reduce regulation in the hope of spurring increased production. The law completely deregulated timber felling and reduced the controls on quasi-governmental offices in charge of preparing forest management plans, known as Offices for Forest Conservation and Development (UCODEFOs). The new law also partially deregulated the transportation of forest goods, once highly controlled.

Despite these changes, the 1992 law upheld the cornerstone of national forest policy--the forest management plan (Programa de Manejo Forestal, PMF). Applicants seeking permission to log must hold either title to the land or a legal right to harvest timber and must submit a PMF written by qualified foresters. These documents must clearly describe the location of plots, the physical and biological characteristics of the forest ecosystem, the techniques to be used for extraction or reforestation, intended measures for habitat conservation, and plans for any necessary infrastructure. The law also gives Mexico's Secretariat of the Environment, Natural Resources, and Fisheries (SEMARNAP) only 30 days to act on most permit applications (60 days in more protected areas). Not surprisingly, inadequacy in the review process has been one of the more troubling aspects of the 1992 forestry law.

Constitutional reforms passed in 1992 as part of Mexico's neoliberal reform process also affected national forestry policy. Revisions of Article 27 of the Constitution introduced fundamental changes in land rights: land redistribution was eliminated, transfers of ejido lands were authorized, ejiditarios were granted the right to sell their land, and agrarian courts were created to solve land claim conflicts. The government intended these changes to encourage outside investment in ejido lands, leading to more productive use. Fundamental to this goal was the elimination of the size limit on privately held forests, at the time capped at 800 hectares maximum. By meeting certain requirements, private companies can now obtain up to 20,000 hectares of non-agricultural land for forest management. Despite these changes, however, most land in Chihuahua's forests remains social property. In fact, nationwide, some 80% of all Mexico's forests are contained by ejidos.

Changes begun in 1992 with the revised Forestry Law continued in 1994 with reforms to the General Law on Ecological Equilibrium and Environmental Protection (LGEEPA) and Mexico's participation in NAFTA, and they culminated in 1997 with further reforms to forestry laws. These changes reflect the ongoing shift in the government's economic paradigm toward liberalization, recruitment of foreign investment, and market-based mechanisms of environmental regulation.

Big business worked hard to influence the policy revisions. In 1995, for example, the Mexico City daily La Jornada published a letter from the International Paper Company to President Zedillo that set forth a series of conditions to be met before major foreign investment in the forestry sector would occur.

The main initiative of the 1997 law was the creation of two new programs designed to stimulate domestic production: PRODEFOR (Programa para el Desarrollo Forestal) and PRODEPLAN (Programa para Plantaciones Comerciales). PRODEFOR offers subsidies and grants through SEMARNAP for technical assistance; in 1997 it provided nearly 22 million pesos in direct subsidies and helped convert 316,000 hectares of forest to timber production.

PRODEPLAN provides direct subsidies and tax credits to companies, covering as much as 65% of the costs of establishing and maintaining commercial plantations for up to seven years. Not surprisingly, major companies such as Grupo Pulsar have announced plans to develop large plantations throughout Mexico. Although only 15,000 hectares of land were used for commercial plantations in 1970, SEMARNAP reports that in 1996 and 1997, fifty-seven projects involving approximately 54,000 hectares were established, most of them through PRODEPLAN. In 1998, SEMARNAP estimated that it would provide nearly 250 million pesos in direct subsidies to help establish 68,000 hectares of commercial plantations and to finance reforestation/ conservation of another 10,000 hectares with native vegetation.

To deal with the problem of illegal cutting, the law did reestablish some regulations on permitting, transporting, and processing, and it prohibited commercial plantations that replace natural vegetation. But oversight clearly gets

the short end of the stick: Mexico has just a few dozen inspectors charged with overseeing compliance with forestry regulations nationwide.

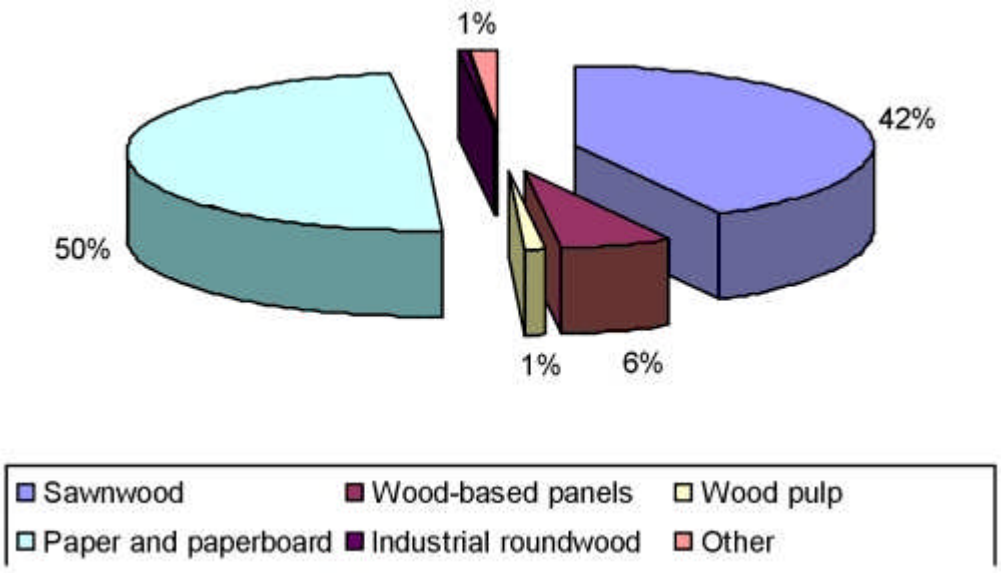
FORESTRY PRACTICES IN THE SIERRA TARAHUMARA

In 1997, there were more than 720 permits within Chihuahua to "manage" forested land, more than 680 of which were located in the Sierra Tarahumara. More than 90% of all the wood collected in Chihuahua comes from ejido land. Most of this activity involves straightforward cutting and collection rather than carefully managed and sustainable timber production.

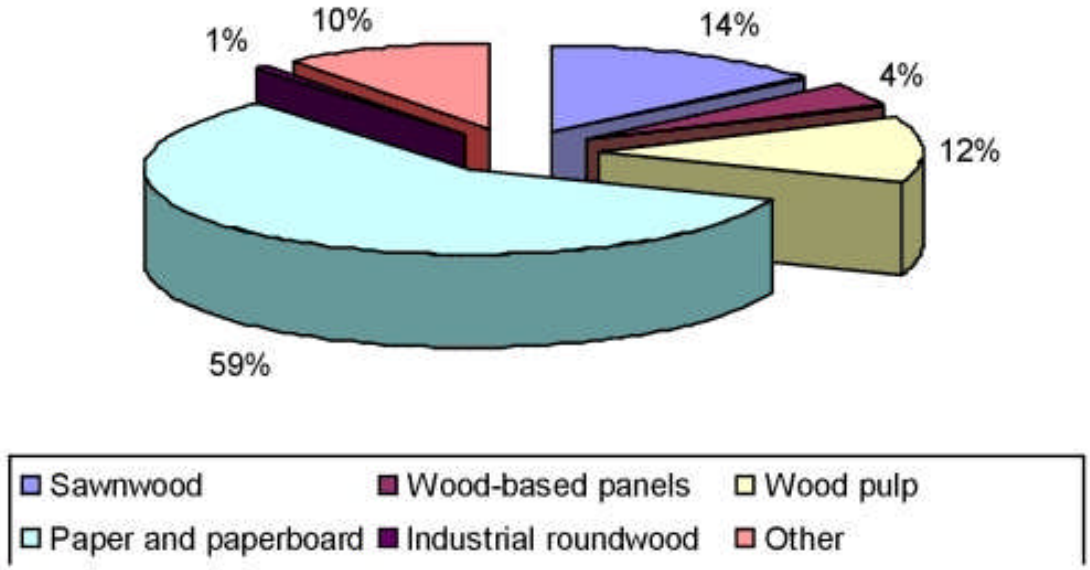
Harvesting in the mountains of Chihuahua generally conforms to what is known as the rentista model of production. An ejido negotiates a timber sale with a processing firm, which sets the price, and the timber is sold "standing" (pino parado). The harvesting firm works with government foresters to create the management plan and handles all logging, leaving local residents out of control of what happens to the ejido's timber resources. Frequently wood sales are rigged prior to voting in the ejido's governing council (Asamblea Ejidal). The financial return to the ejido is very low, unless high volumes are sold. In the meantime, the objective of government foresters and logging companies is to get the biggest return possible at the lowest cost, and environmental protection and the well-being of local communities are not priorities.

U.S.-MEXICO TRADE IN FOREST PRODUCTS, 1997

Value of Wood Exports to the U.S.
(total value: $444,232,000)



Value of Wood Imports from the U.S.
(total value: U.S.$1,468,470,000)



Source: UN Food and Agricultural Organization, FAOSTAT database (available at: http://www.fao.org/).

The strategy of using federally controlled UCODEFO forestry teams is based on the premise that ejiditarios are incapable of managing their natural resources and need external guidance. The local administrators of these programs have come to occupy important positions in community cacicazgo power structures. By law, the power to make decisions regarding the use of an ejido's natural resources belongs to a council of residents. In practice, however, cacicazgo can frequently allow out-side forces, whether the government or private enterprise, to influence and distort the process.

In some cases the ejido contracts to undertake the harvesting and transport of timber, but frequently their earnings barely cover costs. For example, in 1996 the ejido de San Alonso contracted to harvest a stand of pine and deliver the wood to the buyer's loading facility. The price of each ton of cut wood was set at 116 pesos. Of this, the ejido paid 84 pesos in transportation costs and 20 in labor costs, leaving 12 pesos per ton for the ejido itself. Meanwhile, companies that process the timber and sell it as pulp to the paper industry can expect to make a 240% return on their purchase price. The average income earned per resident on ejidos selling timber is 83 pesos--less than $9--a month.

The removal of control mechanisms under the 1992 Forestry Law has led to an increase in illegal extraction of timber, large numbers of questionable logging permits, and a rapid proliferation of lumber mills in the Sierra Tarahumara. The problem of illegal harvesting is so grave that in early 1999 SEMARNAP found itself obligated to reinstate the use of shipping manifests (guías forestales) that must accompany all timber shipments to prove that they correspond to a legally registered logging permit. But the guías forestales are hardly an adequate control mechanism. Penalties for violations are not only mild, they are rarely applied. According to Agustín Bravo, of the nonprofit Centro de Derecho Ambiental del Noreste de México, "in terms of environmental justice, in the Sierra Tarahumara the idea of rule by law is notably nonexistent. As for paying attention to charges filed by community members, allocating resources to enforcement and oversight, or fulfilling requests for environmental information,

there is a failure to follow through and meet legal deadlines and a lack of political will and administrative organization. Frequently, cases involving illegal logging are not reported to the district attorney (ministerio publico)." Indeed, in many cases activists and residents complain that some government officials themselves are complicit in illegal logging.

The PMFs required by current law are problematic as well. Once the permit is granted, the PMF is the last word in terms of what can and can't be done in the permit area; however, the focus of these plans is almost exclusively on timber extraction. For example, residents of the ejido de Caso Churo, in the municipality of Urique, have a number of complaints regarding a PMF recently developed by the government's UCODEFO advisory team: residents weren't given copies of the plan until eight months after it had been finished; the area earmarked for conservation is composed largely of bushes and scrub oak--in other words, an already degraded area; the plan's consideration of biodiversity issues is deficient and does not provide the basis for integral management; and harvesting is slated for hillside areas with a cut density of 26%, which will probably contribute to erosion.

Finally, conflict over resource use in the Sierra is a growing problem. Disputes are sparked when campesinos illegally fell trees for use in construction or to sell, or when disagreements over the use of resources break out within or between communities. The clearing of land for drug cultivation (in some cases as a result of violent threats from drug traffickers), the use of sawmills as money laundering operations, and the violence associated with the narcotics industry are also very real problems.

ENVIRONMENTAL IMPACTS

In Mexico as a whole, estimates of deforestation during the 1980s and 1990s vary widely, ranging from 1,500 hectares per year in one study to 329,000 hectares per year in another. Most government estimates of the causes of deforestation find that changes in land use, fires--many of them resulting from agricultural clearing that gets out of control--and disease are the principal culprits. One study found that agriculture and cattle grazing accounted for some 90% of total deforestation, with land dedicated to agriculture and cattle increasing by 39% and 15% respectively between 1970 and 1990 while forested land declined by 13%. Illegal logging and overcutting are relatively minor causes of deforestation overall, although in Chihuahua they represent serious concerns. In addition, intensive logging within the watersheds and along rivers as well as the construction of logging roads have caused serious problems with soil erosion and sediment loading in rivers.

There is little doubt that human activities in the Sierra Tarahumara have impacted the ecology of the region. Overgrazing by cattle is transforming natural ecosystems and allowing invasion by non-native species. Logging has resulted in habitat loss and fragmentation of the forest cover, impacting especially bird habitat. Studies estimate that throughout Mexico only 0.6%--571 square kilometers--of original old-growth pine-oak forest remains. Not surprisingly, species that rely upon old-growth forest habitat have declined in the Sierra. Meanwhile, the loss of ground cover results in soil erosion and reduces infiltration of rainwater into the water table, ultimately impacting both the volume and water quality of streams and rivers. In 1999, the Cascada de Basaseachic, a waterfall and protected area on the Río Mayo, actually dried up for the first time in recorded history, indicative of the poor drainage conditions and impacted flows of the region.

Human activity has also led to the extinction of numerous species, including the Tarahumara frog, the whooping crane, the Eskimo curlew, and the imperial woodpecker. In 14 localities in Chihuahua, more than 41% of fish species vanished between 1901 and 1975. Missing as well from the region are the wolf, grizzly bear, elk, bighorn sheep, and bison, and locals report that traditional medicinal plants have become scarce.

Yet the region remains largely unstudied. Only two large national parks--Cascada de Basaseachic and Cumbres de Majalca--are legally protected from development and logging, although there is a smattering of protected forested areas. Even these are not protected sufficiently and do not represent the most biologically important areas. No

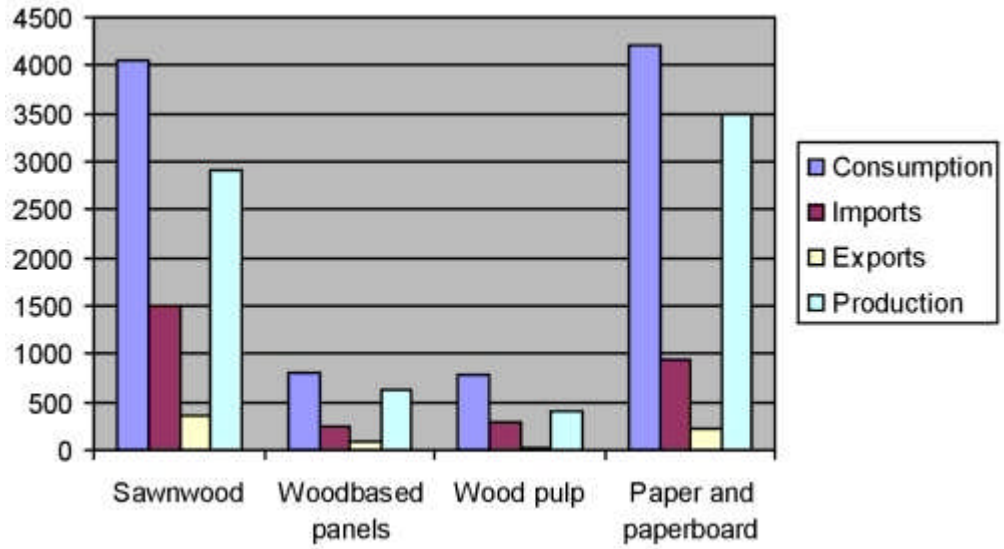
overall environmental analysis--including an examination of the impacts of logging, road construction and tourism--has been conducted, other than the inadequate environmental studies resulting from a defunct World Bank project in the early 1990s. Even rates of deforestation in the Sierra Tarahumara have not been documented.

FREE TRADE AND MEXICAN FORESTRY

Although NAFTA does not directly address forestry resources in any of its chapters, it eliminates "non-tariff" trade barriers such as quotas, permits, or bans, leaving only taxes and tariffs on imports as the sole mode to protect domestic producers. When NAFTA when into effect, it immediately reduced import tariffs on most forest products from the U.S. and Canada by 10-20%. Most of these tariffs have since been completely eliminated, leaving Mexico's domestic producers to compete directly with the largest timber and paper manufacturers in the world.

PRODUCTION, TRADE, AND CONSUMPTION OF MEXICAN FOREST PRODUCTS, 1997

(in thousands of cubic meters or metric tons)



Source: UN Food and Agricultural Organization, FAOSTAT database (available at: http://www.fao.org/).

Under Article 14 of the environmental side agreement to NAFTA, a citizen or private organization can submit a complaint to the North American Commission for Environmental Cooperation (CEC) against a government for failure to adequately enforce its environmental laws. Nonetheless, the agreement specifically excludes resource extraction and management laws--such as those related to fishing, mining, and forestry--from this complaint process.

Mexico is also a member of the World Trade Organization (WTO), which is currently discussing ways to increase free trade in forestry products. At the recent WTO summit in Seattle, members discussed a proposal that would

eliminate all tariff barriers on forest products. A recent report by the World Resources Institute and the Center for International Environmental Law found that the elimination of these barriers will likely have a relatively small impact on Mexico, because tariffs on forest products are already very low. More significant are proposals being discussed by the WTO that would eliminate non-tariff barriers. Currently, many voluntary and some obligatory government programs allow companies to label forest products that are harvested in a sustainable way. This allows consumers and importing countries to tell how the product was produced and to make informed choices when purchasing. Under one WTO proposal, the ability of a country to restrict--even by labeling--how a product is produced would be illegal.

Other WTO non-tariff barrier proposals would restrict an importing country's ability to require that certain environmental practices, such as sustainable logging or limited pesticide use, be employed in the production of trade goods. The removal of these types of barriers--especially in poorer countries with weak monitoring and lax enforcement of environmental laws, like Mexico--would further weaken forest protection worldwide. And without strong environmental and sustainability codes, free trade in forest products could promote further overdevelopment in enforcement-poor areas.

TOWARD SUSTAINABILITY

Wracked by recurring financial crises in recent years, Mexico is still suffering through the aftershocks of structural adjustment with large portions of its population ill-positioned to participate in its new, outwardly oriented economy. As a result, poverty there is widespread. Both government officials and community leaders in Mexico agree, to some extent, that economic development is a top priority. A more environmental approach to forestry that holds long-term sustainability as its objective is needed, certainly, but any strategy that does not factor in economic necessity will only have limited success.

In order to preserve the forest in the long term, ecosystem-wide strategies that manage for multiple resources, including biodiversity and ecosystemic integrity, are required. But Mexico's forest ejidos are economically dependent on the timber industry, and because timber is such a tangible source of income, ejiditarios can be averse to exploring alternative economic activities or new ways of managing their lands. For ecosystemic management to work in the Sierra Tarahumara, then, it will have to take economic factors into account and be able to deliver results in both the short and long terms.

Greater diversification in the types of wood products marketed by the ejidos is one starting point. The sale of value-added items, such as finished lumber, furniture, crates, and plywood would bring in more money than standing- and rough-cut timber. There is a demand for these types of products in Mexico, and U.S. exports of these items to Mexico have increased since the passage of NAFTA. In 1998 the value of U.S. exports of wood products to Mexico was $367 million, up 26% from 1997.

Competition with U.S. imports would be difficult, but ejidos could potentially produce finished-wood items at lower cost while still utilizing a labor-intensive approach that would provide much-needed employment for their communities. This is the strategy used by the Purepecha Indians at the New San Juan Cooperative in the highlands of Michoacán. Created during the "community forestry movement" of the 1980s, the San Juan Cooperative is designed to maximize both employment and profitability while preserving traditional leadership and culture structures. The cooperative doesn't just mill lumber, it also chips knotty trunks for sale to the papermaking industry, taps pines for resin in order to produce wax and turpentine, and sells furniture, molding, and prefabricated housing. The forest is divided into tracts that are harvested on a rotating basis and a 1,400-acre conservation area. Old-growth "father trees" are left standing in harvest areas to protect the soil, and new seedlings are planted to renew the resource once a tract is harvested. Community forestry enterprises have had a mixed history in Latin America, but San Juan shows that they are capable of both achieving economic success and doing better environmentally than current practices.

One obstacle to this sort of upgrade is the lack of investment capital in Mexico--especially on the ejidos. Without government or international support, communities would have to borrow money or form partnerships with outside investors. Recent changes to the agrarian code allow for this, but they also open the door to the possible loss of communal ownership of the forests.

Other options for economic diversification on the forest ejidos include the marketing of traditional, edible forest products like nuts, berries, and mushrooms, as well as ecotourism. Opportunities for fishing, camping, hiking, and other forms of outdoor recreation in the Sierra abound and have been suggested as potentially lucrative alternative economic activities for indigenous communities. But such activities raise important questions about local participation and environmental practices.

Most residents of the Sierra Tarahumara are not only well aware that the forest is their key economic resource, but also express a strong sense of being culturally and spiritually linked to the land. Opportunities to parlay this into a strong stewardship ethic--crucial in the implementation of any strategy of multiple resources management--abound. Additionally, education in holistic forestry practices, to build upon this ethic, is required. Management plans on the ejidos generally do take protection of the timber resource into account--addressing erosion and fire, for example--but they do not usually incorporate concerns such as biodiversity or ecosystemic integrity. Similarly, support for community leaders in business administration, record-keeping, and financial management is necessary. Elected ejido officials receive little if any training when they assume office, and implementing ecosystemic management practices would only add to the burden they face.

A more holistic management approach that takes different resources controlled by different authorities into account will require extensive cooperation among ejiditarios, government officials, and industry. Mexico's indigenous communities have extensive experience in just this sort of cooperative policymaking. Be that as it may, conflict is not uncommon among ejido members and especially between different ejido communities, and there is a need for arbitrated, transparent, and fair mechanisms of communication between the various players. Working partnerships among stakeholders and policymakers are essential to the effective implementation of integrated management plans.

Additionally, more land needs to be set aside for the protection of biodiversity, habitat, and watershed integrity than is currently the practice in the Sierra Tarahumara. There are relatively inexpensive and cost-effective ways to do this without asking the ejido to sacrifice potential income. For example, on the ejido de Cebadillas, residents, environmental NGOs, and two universities are currently involved in an attempt to preserve the breeding sites of the thick-billed parrot. This effort could potentially help preserve 4,000 hectares from logging by directly compensating the ejido for land set aside for conservation. In addition to efforts like this, however, the Mexican government should also consider creating federally-protected biospheres in key areas of the Sierra. Of course, area-wide environmental assessments and baseline studies, noticeably lacking for the Sierra Tarahumara, are a necessary step toward this goal.

Finally, the present system of relying almost exclusively on forestry management plans created by government forestry teams and private logging companies as the main control mechanism on logging, without proper buy-in and oversight by local communities, must change. In addition, considerations like biodiversity and watershed integrity need to be incorporated into the PMFs in a more thorough and meaningful way.