A G E N D A

600 NORTHEAST GRAND AVENUE | PORTLAND, OREGON 97232 2736
TEL 503 797 1700 | FAX 503 797 1797

METRO

Meeting: **FUTURE VISION COMMISSION**

Date: August 8, 1994

Day: Monday

Time: 4:00 p.m. - 6:30 p.m.

Place: Metro, Room 370

		Approximate Time
1.	CALL TO ORDER	10 minutes
2.	ROLL CALL	
3.	PUBLIC COMMENT	
4.	OTHER BUSINESS	
5.	Calendar and Scheduling Discussion	10 minutes
6.	Future Vision Element of the Preferred Alternative Publication	20 minutes
7.	Carrying Capacity Discussion	110 minutes

Members: please review the Carrying Capacity and No-Growth/Slow-Growth reports

Enclosures:
Transit Supportive Development in the United States supplied by Judy Davis
Carrying Capacity newsletter, "*Natural Resources...*" article and *Hormone Copycats* report supplied by Ron Weaver

To assure a quorum members please R.S.V.P. to Barbara Duncan at 797-1562 if you are unable to attend.

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M E M O R A N D U M

600 NORTHEAST GRAND AVENUE PORTLAND, OREGON 97232 2736
TEL 503 797 1700 FAX 503 797 1797

METRO

To: Metro Council
Future Vision Commission

From: Gail Ryder, Senior Council Analyst

Date: August 8, 1994

Re: Article on Home Businesses

Councilor Terry Moore asked that I forward to you this recent article from the Business Journal.

c: Andy Cotugno

FOCUS

Careers & Education

Home businesses: The future is now

Carpenters, computer consultants link arms to form a new kind of business lobby

By Julie Freeman

NOT TOO MANY YEARS ago, home-based businesses were seen by many harried commuters as something to look forward to in the far-off future—a distant dream with little relationship to current realities.

But for many, the future is now. Home-based businesses are evolving from the mom-and-pop fruit stands of yesterday to the telecommuter enterprises of tomorrow.

And along the way, this hodgepodge of businesses is gathering strength with its own associations, publications, on-line computer services and health insurance packages—all signs that they're here to stay. But even as the number of these businesses increases and as they become a more viable career option for small-business entrepreneurs, they often still struggle under the weight of mainstream misconceptions about their operation.

Part of the reason is the diversity of the businesses themselves and the independent nature of their owners. Like the so-called Generation X, these businesspeople are hard to characterize. Although they may share certain personality traits, demographic features and consumer buying habits, they resist easy stereotypes.

Take Ron Renner, the owner of Geppetto's Woodworks, as an example. Renner, who designs and makes furniture and repairs antiques at his Vancouver home, says he has a hard time identifying with the computer-savvy service providers and consultants who have come to symbolize the home-based business owner.

"I have a real hard time clicking with that group," says the fortysomething former Navy man who started his business 11 years ago and boasts that his 9-year-old son has never needed a babysitter. "I guess it's because my world is so hands-on. It's a place where you get your hands dirty."

Racial Fields, on the other hand, has no trouble seeing herself as part of the new workplace revolution. A bookkeeper and computer trainer, Fields, 43, founded Paperwork Unlimited six years ago. Before that, she worked at business sites as a contract employee. But as computer prices lowered and the availability of software programs increased, she took the opportunity to set up shop out of her Northwest Portland apartment. "When I first started doing this, I think it was a novelty," says Fields. "Now it's fairly commonplace. I know tons of people who do this kind of work out of their home."

Home businesses are gathering strength with their own associations, publications and on-line services.

Indeed, home-based businesses are a growing segment of the economy. A survey by LINK Resources, a New York City-based research and consulting firm, reports that the number of work-at-home households in the United States increased by 6.5 percent last year, raising the total figure to 36 million. This number—which includes full-time self-employed workers, part-time self-employed workers, after-hours corporate workers and telecommuters—is higher than the Bureau of Labor Statistics' current estimate of 20 million. But it still marks a trend that has made the business community take serious notice of the home-based business.

Locally, the total number is hard to calculate. A recent survey by Home-Based Business News, a bimonthly newspaper published in Portland, found that there were close to 17,000 licensed home businesses in the metro area. But John Knowlton, publisher and editor of the paper, estimates the total number of licensed and unlicensed home businesses is closer to 50,000.

"The way we do work has changed so much in recent years," says Knowlton, who believes that corporate downsizing, technological innovations and workers' desire for a more family-oriented lifestyle will cause local figures to increase by 10 to 15 percent in the next several years.

In fact, Portland may earn a national reputation for encouraging this trend when Home Office Computing magazine publishes in December a report on the "10 Best Cities for Home-Based Businesses." Although the list has not been finalized, several Portland-area sources have been interviewed for the annual article.

"Oregon still has a pioneering spirit," says Knowlton, explaining why Portland is a good location for home-based workers. "Sure, there are people out there who believe that if you work at home, you don't have a 'real' job. But you don't need a three-piece suit and an M.B.A. from Harvard to be an effective, influential member of the business community here."

As the number of home-based businesses has grown, owners say they have enjoyed a higher level of acceptance. And while conveying the proper image to outsiders is not always easy, most say having a home office does not present a problem.

"The fact that I work out of my home is not the first thing I tell people," says Neal Lubow, whose business, Ideas-By-The-Hour, provides marketing and design services. "But I don't hide it," he adds. "I think where you work is not as important as how you present yourself and the quality of the work you do."

Indeed, with computer modems, e-mail, fax machines, telephones and messenger services, many home-based business operators say clients never have to see where they work, making their location almost irrelevant.

"I've never had anyone react negatively to the fact that I work at home," says Marnie Tapscott, a graphic designer who started Tapscott Design five years ago. "I do most of my work on computer, but when I need to meet with someone I usually go to their office or suggest meeting in a cafe."

Despite the change in attitude toward home-based operations, some businesses do better than others in this setting, says Tom Boothe, the current president of Portland's Association of Home Businesses. "Some professions or businesses are able to gain credibility at all levels," says Boothe, an attorney who has worked out of his home since 1984. "But there are others who are still trying to find their niche."

To help these business owners and those contemplating a home-based operation, Boothe's association provides members with practical information on everything from marketing to taxes at its bimonthly meetings. It also offers an opportunity for networking and socializing, two things that its 75 full-time members often miss when working by themselves at home.

"Our group grew out of the perception that people in this type of business were spread out and didn't have a strong connection with others in the same situation," says Boothe. "One of our goals is to create a group that can help look out for our

CONTINUED ON PAGE 18

Ex-Navy man Ron Renner makes and repairs furniture out of his home. He proudly boasts that his 9-year-old son has never needed a babysitter.

Photo by John Klicker

Home business mecca

	Total No. of business licenses	No. of licensed home businesses	Estimated licensed and unlicensed home businesses
Beaverton	4,500	1,000	3,500
Forest Grove	450	50	175
Hillsboro	1,700	400	1,500
Oregon City	884	200	800
Tigard	2,171	279	560
Tualatin	943	167	580
Wilsonville	1,500	300	900
Lake Oswego	1,395	642	1,900
Gresham	2,500	625	1,850
West Linn	998	700	2,100
Milwaukie	1,264	420	850
Vancouver	5,000	1,333	5,000
Portland	26,290	10,516	21,000
Total	**49,595**	**16,632**	**40,715**

Survey conducted summer 1993 by Home-Based Business News and the Association of Home Businesses.
Source: City licensing departments

Home businesses struggle with image

CONTINUED FROM PAGE 15

common interests."

But even though the 2-year-old association has attracted the attention of such local leaders as Mayor Vera Katz, who will speak at an upcoming meeting, it hasn't succeeded at providing members with a voice in the community.

"The problem, or difficulty, with any organization like this is that we have a very disparate base of members," says Boothe, who notes that the group represents everyone from a marine engineer to herbal tea sellers. "We have people who have been in business for years and those just looking into it. We have people happy to make any money and those that make substantial incomes."

Nationally, home-based business owners face the same dilemma. Although many desire more clout to solve such common problems as taxes, zoning laws, lack of affordable health care and discrimination by banks and suppliers, they are reluctant to give up their singular identities or invest their time in such outside causes.

"These people are fully occupied in their business," says Paul Edwards, who, with his wife, Sarah, writes a monthly on-line newsletter for the Working From Home forum on CompuServe. "There isn't somebody on the payroll to act as a lobbyist," he adds. "Another factor is that these people tend to be independent. They are not joiners or interested in unions."

Still, Edwards says home-based business operators are not without influence. Office equipment manufacturers, phone and data services, and a host of other businesses are eager to tap into this active and growing market segment, which spends money on such items as personal computers and cellular phones. According to the LINK Resources survey, 60 percent of homeworkers own a personal computer, and cellular phone ownership among work-at-home households increased by more than 70 percent over the last year. The same survey also revealed that the average pretax income of homeworkers is $58,400.

Stay-at-home boomers

Not surprisingly, demographic reports indicate that baby boomers—or college-educated professionals in their 40s who are married with children—make up the greatest number of home-based workers. Many choose this direction because of the personal freedom and flexibility home business offers. But even those that fit the mold caution others not to make too many assumptions about them.

"There's as much variety in this area as in the regular work world," says Tapscott, 40, who started her home business after her son was born. "In most ways we are not that different than any small business."

In fact, as home-based businesses gain the respect and the patronage of more people, their owners must deal with the issue of growth. According to a recent survey in Home Office Computing, 50 percent of the magazine's readers would expand outside their home. "As these businesses take off, they have had to learn how to examine their options," says on-line newsletter author Edwards, who also writes a column for Home Office Computing. "Some have simply taken on employees or moved into a bigger house. Others have set up virtual organizations that consist of a network of home-based businesses. Still others have moved on completely."

But for those who have become partial to an easy commute, relaxed dress code, flexible hours and low overhead costs, the notion of expanding their operation into a traditional office or off-site location just doesn't appeal. "Years ago, I considered moving my business out of my home," says Lubow, who has worked on his own for 12 years. "But as changes in the world continue to favor this type of business, the less of a reason there is to work anywhere else. This just feels right to me."

Fields couldn't agree more. A few years ago she did move into an office. But after six months she was back at home. "I didn't like it," she says. "I guess I had gotten used to working at any hour I wanted and I didn't feel comfortable in an office late at night or enjoy lugging work home with me. Now I think my location is one of the best things about my business. I wouldn't think of making a change again." □

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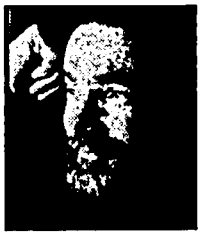
Home business author to speak at dinner Aug. 9



BERNER

Jeff Berner, author of "The Joy of Working From Home: Making a Living While Making a Life," will be the guest speaker at the Association of Home Businesses' monthly dinner meeting on Tuesday, Aug. 9.

Unlike other books for the home-based worker, which primarily focus on the technology and equipment required to set up home-based offices, "The Joy of Working From Home" is meant to provide realistic methods for striking a healthy balance between business and personal life.

The book includes profiles of successful home-based workers; creative marketing and networking techniques; strategies for self-discipline; practical advice about zoning, tax requirements and equipment purchases; and a resource listing. The Berrett-Koehler publication is due out in October.

The dinner meeting is open to the public and will be held at The Mallory Hotel, 729 S.W. 15th Ave., beginning at 6 p.m. Cost to attend is $20 for members, $25 for nonmembers. For further information call 223-1493. □

PEGGY LYNCH

(503) 646-4580
(503) 646-6286 fax

3840 SW 102nd Avenue
Beaverton, OR 97005-3244

July 26, 1994

To: Future Vision Commissioners (Barbara Duncan @ fax 797-1794; 1 page)

Received comments from one of my "just citizens" on June Draft Vision. I will relay her comments line by line:

1) Lines 82, 83 and 99: She wanted to know where the maps were--when this document is sent to others, we will need to have some kind of readable map to send along.

2) Line 139: Circling "our environment", she said "especially INSIDE the Urban Growth Boundary".

3) Lines 141-146: As we talk about "restoration or redevelopment of resources" and "the conversion of land to urban uses", she asks if we are talking about inside the UGB or just outside? Again, her concern is that we NOT give up on saving URBAN natural environment resources.

4) Line 237: "the integration of community institutions..." What does this mean? She wants clarification of our intent with that statement.

5) Lines 456-462: She wants to stress more flexibility in this area. As an urban dweller, she supports farmland retention--up to a point. Her issue is that urban dwellers should not be forced into small, cramped quarters to save farmland. A better view of her position would be that we need to be sensitive to the space needs of urban dwellers AS WELL AS farm owners/dwellers. Only an agressive urban open space/parkland/natural areas policy will appease her and allow her to support such a hard line position in the Vision. She also argues for a more scientific method of designating the EFU lands. And resents those "who now live on 5- and 10-acre lots and who are advocating that the rest of us live on 5,000 sq ft lots or less".

6) Line 564: ".... fixed urban growth boundary". She believes that the UGB should have SOME flexibility, to accommodate future generations of Oregonians.

7) Lastly, she recognizes the possible political implications of our eight- (or nine) county planning and asks for answers to the governance issue.

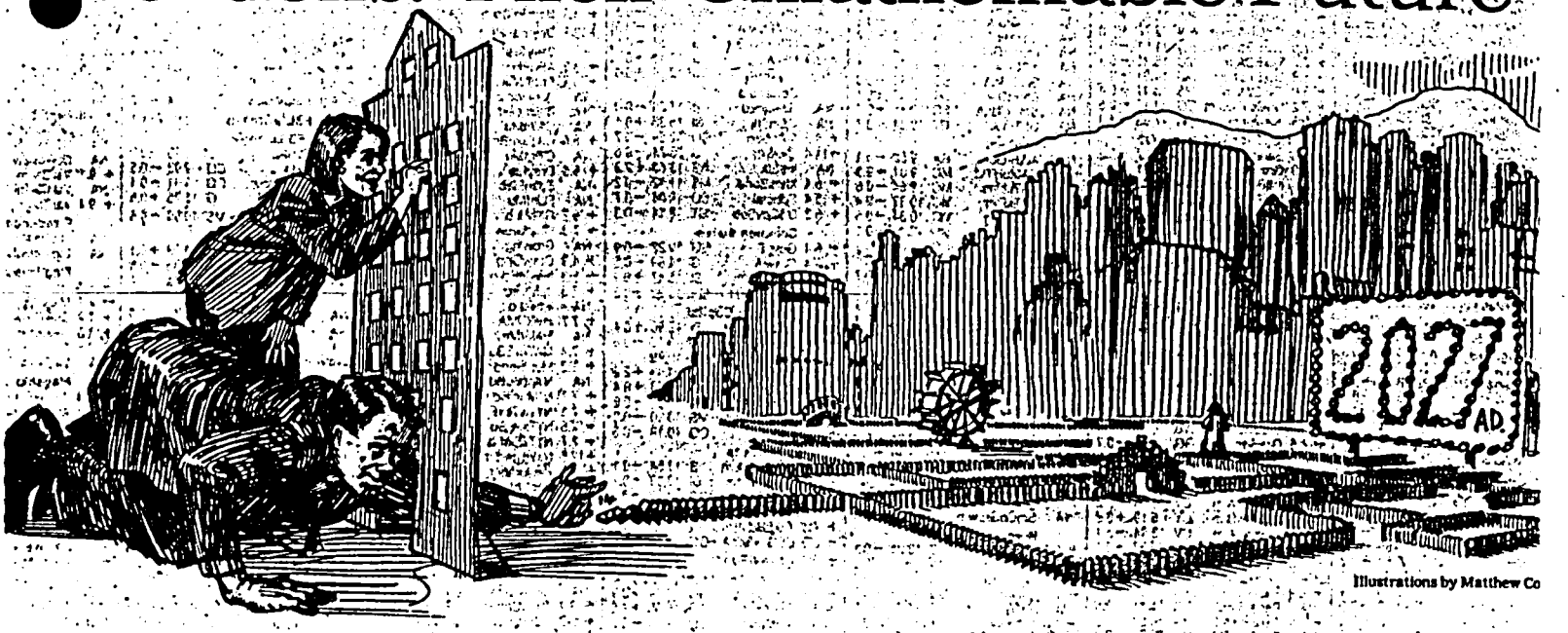
I received a more general response from another Washington County "citizen". He had two points:

1) He is concerned about Metro getting involved in education and would need to understand the positive effect of that involvement before supporting such a concept.

2) "What is important is making it happen." For many "just folks", the words are not nearly as important as the actions taken. He approved of the general direction of the Vision, but is keenly aware that lack of public will may make the document just another dust catcher.

Viewpoints

Inventions: Their Unfathomable Future



Illustrations by Matthew Co

By NATHAN ROSENBERG

WHAT will the information superhighway look like? If the electric vehicle becomes practical, how will things change?

M executives, investors and government offici hope they have answers to these questions, ınd they are spending billions of dollars in accordınce with their views. But they may want to stand ɔack a bit, and keep their options open. A review of nany important innovations, from the steam enɡine to the laser, shows an unsettling pattern: we ɛeldom can predict the full technological, economc and social impact of inventions, even long after heir commercial introduction.

Consider the laser, one of this century's most ɔowerful advances since its invention 30 years ıgo. Its versatility is breathtaking; lasers are ısed for navigation, precision measurement, hemical research and eye and gynecological surɛery. They are essential in making compact disks ınd in printing, too.

But the laser's most profound impact has been ı telecommunications, where, with fiber optics, it ɜ revolutionizing transmission. In 1966, the best rans-Atlantic telephone cable could simultaneous- carry only 138 conversations between Europe nd North America. The first fiber optic cable, ıstalled in 1988, could carry 40,000, and today's ables can transport nearly 1.5 million.

And yet, lawyers at Bell Labs, which invented ıe laser, initially hesitated to apply for a patent on . The laser had no possible relevance to telehones, they said.

The laser is not alone. Marconi invented the ıdio, but he thought it would be used primarily hen communication by wire was impossible, as ı ship-to-ship communication. (To this day the ritish call the radio the "wireless.") He saw the radio as a telephone substitute, a tool for private conversation, or narrowcasting; this was precisely opposite its eventual use for communicating with a large, public audience — broadcasting.

Such lack of foresight was common. When broadcasting was first proposed, wrote James Martin in "Future Developments in Telecommunications," one expert thought the only likely use was Sunday sermons.

Even I.B.M. saw no large potential market for the computer in 1949; world demand, the company thought, could be satisfied by just 10 or 15 computers. And when the invention of the transistor was made public in 1947, some saw the device as helpful for hearing aids, nothing more.

The list goes on and on. But we should not amuse ourselves too much, for the factors that blinded earlier generations to the impact of innovations are likely to persist.

One factor is that inventions are typically born in very primitive condition, and later uses become possible only after extensive improvement. I.B.M. was not far off the mark in its assessment of the computer as it stood in 1949. The first electronic digital computer, the Eniac, was notoriously unreliable and huge: it contained 18,000 vacuum tubes and was more than 100 feet long.

The tendency to define inventions in terms of existing technology also makes foresight difficult. In the 1830's and 1840's, for example, railroads were seen merely as feeders for the existing canal system, to be constructed in places where the terrain made canals impractical.

The problem increases when the technology is something entirely new. Who could have foreseen the effects of electricity or the laser, neither of which represented an obvious substitute for anything that then existed?

When the innovation comes from an effort to solve a single problem, forecasting is even harder. The steam engine, invented as a pump for flooded mines, was for a long time seen as nothing else.

Adding to the confusion are advances in old technologies spurred by competing inventions. For example, some of the greatest improvements in wooden sailing ships took place between 1850 a 1880 — just after the introduction of the iron l steamship and compound steam engines. Simil ly, great advances in gas lamps occurred shoı after the arrival of electric light.

A new technology may also turn out to b substitute rather than a complement for an ex ing one, thus drastically shortening the latter's expectancy. During the 1980's, the prospects communication satellites dimmed unexpecte with the arrival of fiber optics.

There are many other forces that make tech logical prediction difficult, and perhaps none greater than the elusiveness of imagination. M coni had no sense of how the radio might enla human experience. But David Sarnoff, an une cated Russian immigrant who headed RCA af World War I, had a lively vision of how it mi; transmit news and music into every househc and eventually into every automobile.

Similarly, Sony's Walkman takes existing te nology — batteries, magnetic tape, earphones and provides entertainment where it could not delivered before — indeed, where no one had ev thought of delivering it before.

What does all this mean? That innovation fo casting is hugely complex. Only the optimistic a the naïve would think some intellectual paradiɡ could put it all in order.

Given this inherent uncertainty, governm should ordinarily resist championing any parti lar technology and, instead, manage a deliberat diversified research effort, including private-s tor incentives. For example, a fair criticism of t Federal Government's postwar energy policy not that it made a major commitment to nucle power, but that it neglected alternative ener technologies that might have been invoked wh nuclear power turned out to be problematic.

We must not make the same mistake with t information superhighway or other emergi technologies. Government ought to open as ma windows as possible, so that the private sector c explore a technological landscape that can only faintly discerned from those windows.

Na n Rosenberg is a professor of economics Stanford University and director of the proram on technology and economics at its Center r Economic Policy Research.

ROBERT B. TEXTOR
3435 N.W. Luray Terrace
Portland OR 97210

Tel: 503/223-6370 Fax: 503/223-2521

Cellular: 503/936-0663
Internet: 73143.1570@compuserve.com

Wed Aug 3/94

To: Members of the Future Vision Commission
Ken Gervais
Ethan Seltzer

From: Bob Textor

Re: Ideas of Prof. William Boyer Re Population Growth, Carrying Capacity, Sustainability, and "Growth Versus True Development" Issues

Dear Colleagues:

I sent a copy of our draft Vision Statement to Prof. Bill Boyer, and he sent me the attached critique. It was done quickly, so forgive a few misspellings, etc.

Bill is a native Portlander who taught at the University of Hawaii for some years, retired early, and now lives in Sisters. He has published widely and well in the futures field. I value his colleagueship particularly because he helps keep me honest.

Cheers,

BR

Comments on Future Vision Draft

W. Boyer

The Charge (a. adoption) on P.1 is excellent, but the proprosals do not quite address the stated goal to"indicate population levels"..."that the region can accomodate within the carrying capacity of the land, water, and air resources of the region.". . .to "achieve the desired quality of life".

No attempt is made to stipulate population levels. And the "desired quality of life" should indicate desired by whom.? It should particularly include those who live in Portland. It is doubtful that merely mitigating growth out of control and supporting perpetual increases in population is in fact "desired" by the people living in Portland. If they knew the monetary and quality of life costs they might be even less supportive.

P.1--"to accomodate the population growth for the region while maintaining a desired quality of life" may be merely a way of ignoring incompatibles.
(I have evidence that population is a J curve while quality of life is an S curve that suggests points of no return when populations exceed a particular optimum. From there on mitigation, after the fact, may be a way of solving one problem and creating three, until the point of no return.)

Portland cannot plan its vision independent of considerations for the rest of Oregon. Possibly cities of about 100,000 located in various parts of Oregon would be a better alternative.

The vision seems to let the old forces of economics drive the change. This economic determinism is quite unworthy of people here in the later part of the 20th century. Planning then becomes "mop-up".

More specific points:

The term"balance" is deceptive because many times what it needed is "priorities." "Balance" usually permits the economically powerful to win against the contestant on the other side of the "balance" game.

Portland should not export garbage to poor cities. Consumption and recycling should be used which accomodate to each county, so that the county is responsible for its own garbage. Otherwise the rural poor make up for the excesses and lack of responsibility of the urban rich. (A form of exploitation.)

Give attention to the sewer problem and the river.

Give attention to the 19th century ugliness of the telphone poles in the old sections of the city. Here is where the 50 million might go if the labor would be local.

A vision statement needs to take accounts of the way employment occurs in the U.S. If local business were stimulated to put an employment rate in Portand at a level 2% higher than other cities, people would migrate in until the employment level was close to other cities. Growth would be stimulated, even though it is now excessive, and Portland would be back to where it was on an unemployment rate and worse off because of the community effects on excessive growth.

Throughout a vision statement the fundamental difference between "growth" and "development" must be driving distinctions. "Growth" presumes that quantiative expansion will produce qualitative trickle down advantages. Los Angeles belies this.

Portland is threatened by more "growth" but not by more "development" which means social and personal development targeted directly through land use planning, community organization, and public sector infrastructure connect to long run sustainability. Growth is categorically unsustainable, for carrying capacity is finite. You cannot make up in social development for growth that produces progress deterioration of natural ecological systems such as watersheds, forests, fisheriess, and wildlife.

The current model must take account of doubling time projections of population and corresponding impacts, or it becomes an unrealistic mitigative document.

Current Medical costs will crush any area that does learn to be healthy, especially with diet. And many current medical costs are unnecessary (bi-pass for example) and shift prioities away from social needs.

The document does not speak of trains, which could connect the Ashland--BC corridor and reduce the need for cars.

Tax structures that make cities parties to ecological destruction should be addressed, such as getting funds from the Forest Service. The endemic conflict of interest structure needs careful consideration. The recent 50 millior to the steel industry opens the political system to corruption. A few hundred thousand to the swing votes for use in the next election could be written off as a business expense and corrupt local politics.

A defining principle should be that in cities such as Portland, which have excessive growth, that public subsidy

through tax breaks and direct funding should be taboo. Also, the trade-off of funds from the public sector prevents social priorities from being realized. Funding a new steel mill while the library must close evenings from lack of funds is the kind of intolerable trade off to be avoided.

Also, funds to support new industries undermines existing competative industries. Current business needs an open field of competition, not the discriminating advantages of public sector subsidy of new business which current businesses do not enjoy. Issuance of "industrial revenue bonds" fits into this discrimination pattern and also drives up bond interest rates to schools and state projects, which in effect is one more subsidy for the private sector in a trade-off with the public sector.

****

Given the length of time (2040) designated, real suatainabiity can be achieved, but is not addressed.

1. What sustained energy base is proposed?
2. What sustained ecosystem base is proposed?
3. What reduced consumption levels are needed?
4. What sustained water level, compatible with sustained fisheries, is proposed.
5. How will transition costs avoid putting debt on future generations?
6. How will transition avoid leaving pollution for future generations?
7. How will transition avoid diminishing the natural heritage for future genertions?

Portland State University

P.O. Box 751, Portland, OR 97207-0751

MEMORANDUM

July 29, 1994

To: Members of the Future Vision Commission

From: Ethan Seltzer

Re: Next Steps Revisited

This memo is being sent as a means for focussing the work of the Commission in the next few months. First, I wanted to let you all know that I was very impressed with the way that the Commission presented its ideas at the joint meeting on July 27th. The draft that you've produced gives you the basis for commenting with some specificity. My overall impression is that your product is on the right track, and will serve as a useful measure for Region 2040 and subsequent regional planning efforts.

It's worth noting that the discussion you had on Monday, July 25th, in preparation for the joint meeting provided a relatively clear example of both the role for the vision and why it differs from other planning activities. The vision is not bound by current or short-range concerns, and can make statements that even Region 2040 cannot. For example, the discussion of the inclusion of EFU land in urban reserves looks quite different based on the vision, largely because the vision gives greater credence to our geological past and the needs of future generations than does Region 2040 despite the fact that they are both looking 50 years into the future. That's life, but it's also a sign of the importance of the contribution that you're making.

In addition, I was also struck by the breadth of the contract being outlined in the vision. The draft talks not only about our relationship to the place, but how we'll work together to make life for individuals and for communities as good or better than it currently is in this place. This notion used to be part of the comprehensive planning process. Too many communities have ignored the parts of their plans that required collective action, rather than regulation, for implementation. Consequently, too many folks erroneously believe that regulation is the core of the Oregon approach. Regulation is important, necessary, and effective. However, it cannot take the place of a methodical, perhaps inspired social contract. Although I haven't given it enough thought, we should probably figure out ways to make sure that the three segments of the vision have prominent and dynamic links between them. My hunch is that we should try to get folks to read the vision as a cohesive document, and not as a menu of choices. This vision should be seen as a full meal, not an ala carte experience.

With these thoughts in mind, you have a number of tasks that need to be completed prior to the submission of the vision to the Council after January 1:

a) Public Review and Comment - you need to get the vision out into the hands of citizens and others in order to simply get a reading on where you are. There are two primary activities for you towards that end:

- 2040 Newsletter - the next 2040 newsletter tabloid will be going out in early September. Staff has requested a 2-page summary of your draft and a map. There are two ways to produce this: you can spend the next several meetings attempting to write this as a group or you can spend a little time at you next meeting

School of Urban and Public Affairs Institute of Portland Metropolitan Studies
503/725-5170 FAX 725-5199

highlighting the ideas in the draft that need to be in there, and then delegate the writing to staff. I suggest you take the latter course of action.

• Your own tabloid - I think it's time for you to put together your own tabloid or other publication to get the draft out into the hands of 30,000 to 50,000 folks. If you are going to discuss publications at length in your next few meetings, then this should be the one. In addition to the outline and design, you should also discuss the mailing list. You should aim for a mailing date early in the fall, with a comment period extending to late November/early December.

You might also want to discuss now whether you want to hold hearings or other public events prior to sending the document to the Council. One thing you might consider is whether you might want to hold joint hearings with the new Council as a means for helping to transmit the document to a body that may not know much about you or the product. It would also give the new Council the option of asking the Commission to do more work prior to formally accepting the document from the Commission, but that work would be designed in partnership rather than in a vacuum.

b) Charter "Punch List" - as in any project, there are details that need to be attended to in order to finish the job. The following come to mind:

• Carrying Capacity - the Commission needs to have a focused discussion of this topic. There are two issues for you. First, what can we say about the carrying capacity of the metropolitan region. Second, what should the Future Vision include about carrying capacity. Ken and I met and felt that the most direct way to deal with this is for each member to read the Carrying Capacity and Growth/No Growth papers carefully. The Commission can then engage in a discussion oriented towards answering the following questions:

-- What would be required in terms of institutions, data, or other information to support a determination of whether our present and projected rate of growth should be greater or less than trend?

-- How should/must we use those resources to choose a growth "path" for this region? When should we make such a choice?

-- What can the Future Vision Commission do now and through the development of the vision to move this region along towards having the ability to meaningfully choose a path leading to a "desirable" rate of growth?

Please note that Wim's paper on Carrying Capacity gives you a conceptual framework for dealing with this issue. The No growth/growth paper from ECO Northwest gives you some insight as to how you'd implement the results of your carrying capacity analysis. Once the Commission hammers out answers to these questions, the next step will be to incorporate your findings in the draft vision statement.

• Have you included in your vision all that you want to say about:

-- settlement patterns

-- population levels
-- educational resources
-- quality of life
-- use, restoration, and preservation of land and natural resources
-- how and where to accommodate population growth
-- how to develop new communities and additions to the urban area

The Commission should determine whether it wants or needs to modify its draft to speak to these issues. In some cases, you might find that simply adding to the list of things to be done or monitored may adequately address your concerns. My sense is that a case can be made that all of these things are in the draft already, if the case is made persuasively that the vision should be acted on as a cohesive whole. Finally, the each subcommittee should take Bob Textor's suggestion regarding contextualizing forces to heart. The challenge is not to tell the world what, for example, telecommunications will do to the metropolitan area exactly. Rather, the document should note that telecommunications will likely have some kind of effect, and Metro should be on the look-out for it. Similarly, there are other issues that need to be flagged as forces that will likely provide some or all of the context for future revisions of the vision.

• Implementation - Beyond what you've included in the vision statement, how do you want to describe your view of how the Council should incorporate the vision in subsequent planning efforts? How can the vision become part of the common "culture" of our region?

• Final Product - What should the final product look like? You should anticipate working with a designer in the very near future.

To act on the items noted above, I'd like to propose the following schedule:

August 8	Full Commission meets to decide on approach to public review items noted above and to begin carrying capacity discussion
August 15	No meeting
August 22	Full Commission meets to continue carrying capacity discussion and receive progress report on writing for 2040 tabloid.
August 29	Subcommittees meet to discuss punch list items. Final draft of 2040 Tabloid material available for review and comment.
September 5	Labor Day - No Meeting.
September 12	Full Commission meets for carrying capacity discussion, to review punch list discussions and assign tasks, and to review plans for FVC tabloid.
September 19	Subcommittees meet to work on punch list issues.
September 26	Full Commission meets to review final tabloid copy, mailing list for tabloid, and to continue carrying capacity and punch list discussions.

October 3 Full Commission meets to discuss implementation and assign tasks to subcommittees.

On this schedule, the FVC tabloid would aim for an October 1 mail-out, and the Commission would discuss the design of the final product later in the fall after it has begun to receive public comment. Note that this schedule is predicated on the Commission carrying out the carrying capacity discussion within its own meetings. If the Commission decides to have the discussion with a larger group, or in other settings, this schedule will need to change to accommodate those arrangements. In any event, the Commission should, upon reviewing Wim's paper and beginning its discussion, identify those persons, if any, that it would like to invite to its meetings to comment on the carrying capacity issue, and the findings of the growth/no growth paper.

Ken will facilitate the discussion on August 8. I have not scheduled a meeting on August 15 as a result of our discussion on Monday and the request of at least one member for fewer meetings in August. Feel free to arrange and rearrange as necessary.

Thanks!

ES:ae

To: Future Vision Commission
From: Judy Davis

FYI

Please see pp. xiv and xv for some interesting conclusions about satilite cities and UMTA

Transit-Supportive Development in the United States:

Experiences and Prospects

Final Report
December 1993

Prepared by

Robert Cervero
National Transit Access Center
Institute of Urban and Regional Development
University of California, Berkeley
Berkeley, California 94720

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Washington, D.C. 20590

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Transit-Supportive Development in the United States: Experiences and Prospects

Executive Summary

Many American suburbs and exurbs are hostile environs to transit users and pedestrians. Campus-style office parks, walled-in residential subdivisions, and mega-malls are often designed so that it is difficult to access them or get around by any means other than the private automobile.

In recent years, there has been a chorus of calls to redesign America's suburbs so that they are less dependent on automobile access and more conducive to transit riding, walking, and bicycling. One prominent movement, neotraditionalism, borrows many of the successful elements from turn-of-the-century American communities, like gridiron streets, commercial cores, and prominent civic spaces. Another, transit-oriented development (TOD), focuses the entire community on a central transit facility. To date, relatively few such projects have broken ground. The handful that have are too new to carry out in-depth evaluations of their transportation impacts.

This report examines recent experiences in the U.S. with transit-supportive developments—projects which, by design, give attention to the particular needs of transit users and pedestrians. The study focuses mainly on experiences in the suburbs and exurbs of large U.S. metropolises, which in most cases are served only by bus transit. Assessments are carried out at three levels—individual sites, neighborhoods, and communities. Since in the course of the research we found fewer U.S. examples of transit-supportive developments in bus-only suburban-exurban environs than popular accounts might have us believe, the study gives particular emphasis to implementation issues—how recent market and regulatory factors have influenced the transit-supportive design movement.

Site-Level Analyses

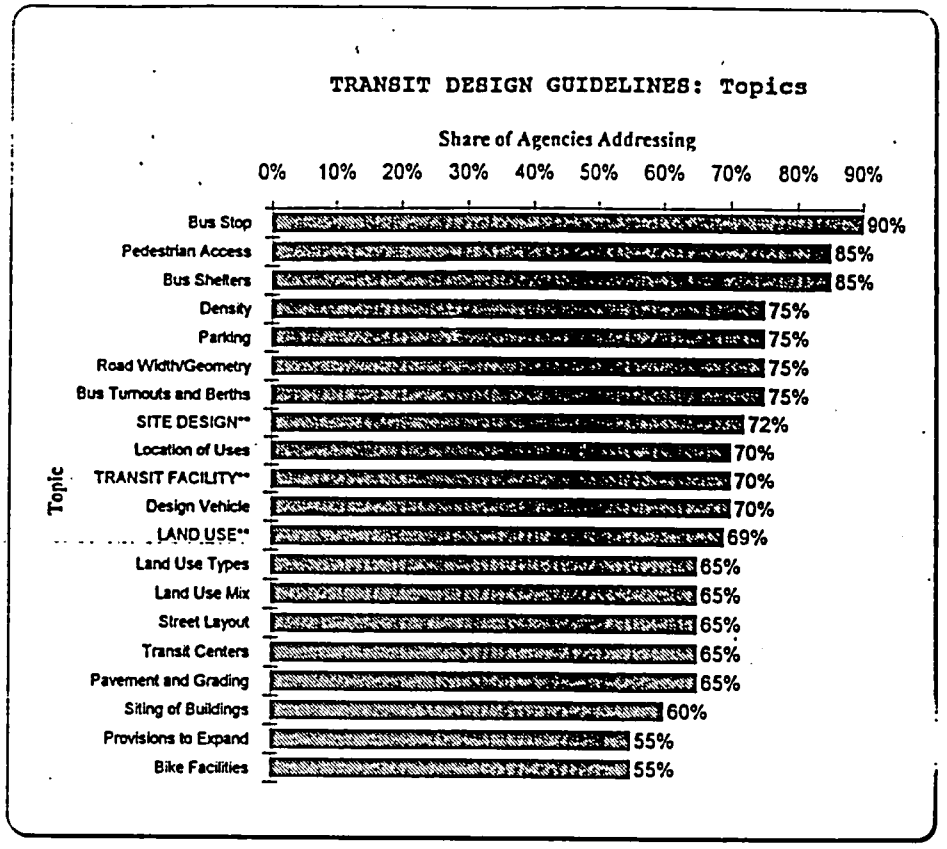
In order to study transit-supportive designs at the site level, a national survey was conducted that elicited information from U.S. transit agencies on local real estate projects that are friendly to transit users and pedestrians. The survey also gathered useful background information on transit-supportive guidelines themselves.

In all, around one-quarter of the surveyed U.S. transit agencies had guidelines, and around one-half of the guidelines have been approved or endorsed by a local policy body. Most guidelines are devoted to some combination of three topics: transit facilities design, site design, and land use (Figure E1). Around 70 percent of guidelines give at least some attention to all three topics. Levels of treatment varied greatly, however. Around 85 percent of guidelines contain illustrations and offer recommendations on the design and placement of bus stops and shelters, while only 65 percent suggest minimum densities for transit and only 40 percent address specific land-use programs that are

TRANSIT DESIGN GUIDELINES:

TOPICS

Topic	Share of Agencies Addressing
Bus Stop	90%
Pedestrian Access	85%
Bus Shelters	85%
Density	75%
Parking	75%
Road Width/Geometry	75%
Bus Turnouts and Berths	75%
SITE DESIGN**	**72%**
Location of Uses	70%
TRANSIT FACILITY**	**70%**
Design Vehicle	70%
LAND USE**	**69%**
Land Use Types	65%
Land Use Mix	65%
Street Layout	65%
Transit Centers	65%
Pavement and Grading	65%
Siting of Buildings	60%
Provisions to Expand	55%
Bike Facilities	55%



** Represents average percentage for each topical category.

Figure E1

Transit Design Guideline Topics

conducive to transit usage. Over 40 percent of guidelines set standards for transit facility designs, but only around 10 percent contain any standards for urban design or land-use planning.

From the survey, a surprisingly small number of specific real estate projects outside of rail corridors could be identified by transit officials that were genuinely transit supportive. While not a complete list, fewer than 30 transit-supportive sites were identified nationwide; most of these, moreover, incorporated micro-design features (e.g., on-site benches at bus stops and special staging areas for buses) rather than embracing macro-design elements aimed at shaping travel behavior (e.g., dense, mixed-use developments). Overall, the national survey provided few promising leads for finding "transit-friendly" sites that could be evaluated in terms of impacts on ridership and service delivery. It did, however, provide a compendium of good transit-supportive design practices as well as good examples of guidelines themselves. Based on criteria related to clarity of text, effective use of illustrations, quality of technical information, and integration of materials, eight areas had exemplary guide-

lines: Austin, Texas; Denver, Colorado; Montreal, Quebec; Reno, Nevada; Sacramento, California; Seattle, Washington; Snohomish County, Washington; and Portland, Oregon.

More in-depth analyses were carried out on the ridership characteristics of transit-supportive sites in five metropolitan areas: Chicago, San Diego, San Francisco, Seattle, and Washington-Baltimore. Besides the fact these areas have been at the forefront of promoting transit-sensitive site planning and designs, they were chosen also because travel data were available for the tenants of several transit-supportive projects. For the most part, differences in transit ridership rates were fairly modest across sites. Wherever transit-supportive projects were clearly outperforming other nearby similar projects, there were always extenuating circumstances. In suburban Chicago, for example, around one-third of workers at the new "transit-friendly" Sears headquarters in Hoffmann Estates commute by bus or vanpool/carpool, much higher than in any other outer suburban workplace in the region; however, these shares are due more to Sears' aggressive TDM program, the size of the company, and the carry-over of prior transit commuting habits among those who transfered from the Sears Tower in downtown Chicago. A number of offices and mixed-use centers in Bellevue, Washington, that have densities and site features supportive of transit average substantially higher shares of non-drive-alone commuting than in nearby campus-style developments; however, Bellevue's strict parking controls have as much to do with these outcomes as anything. Several transit-supportive retail and mixed-use projects in the Bay Area, San Diego, and greater Washington average ridership that is 8-15 percent higher than comparison sites, however in most of these instances the projects are near rail stations. Transit-supportive designs and rail service seem fairly compatible, in part because most rail-served areas are comparatively dense; for bus-only settings, however, the relationship between transit-supportive design and ridership is more tenuous.

To date, perhaps the biggest impact of the transit-supportive movement has been on local policy-making, such as the passage of Washington state's Growth Management Act and Baltimore's Access by Design program. Once such initiatives gain a momentum of their own and once sagging real estate estate markets begin to perk up, promotional campaigns like the marketing of transit-friendly guidelines will likely begin exerting stronger influences on development practices. The challenge will then rest with the public sector to mount good quality transit services which take advantage of transit-sensitive residential, office, and mixed-use developments.

Neighborhood-Level Analyses

The next level of analysis involved a comparison of commuting characteristics of transit-oriented versus auto-oriented neighborhoods in the San Francisco Bay Area and Southern California. Transit neighborhoods averaged higher densities and had more gridded street patterns compared to their nearby automobile counterparts. Efforts were made to match neighborhoods closely in terms of median household incomes and, to the extent possible, transit service levels to control for these effects.

For both metropolitan areas, pedestrian modal shares and trip generation rates tended to be considerably higher, in some cases well over 50 percent higher, in Transit than in Auto neighborhoods (Figures E2 and E3). Transit neighborhoods had decidely higher rates of bus commuting only

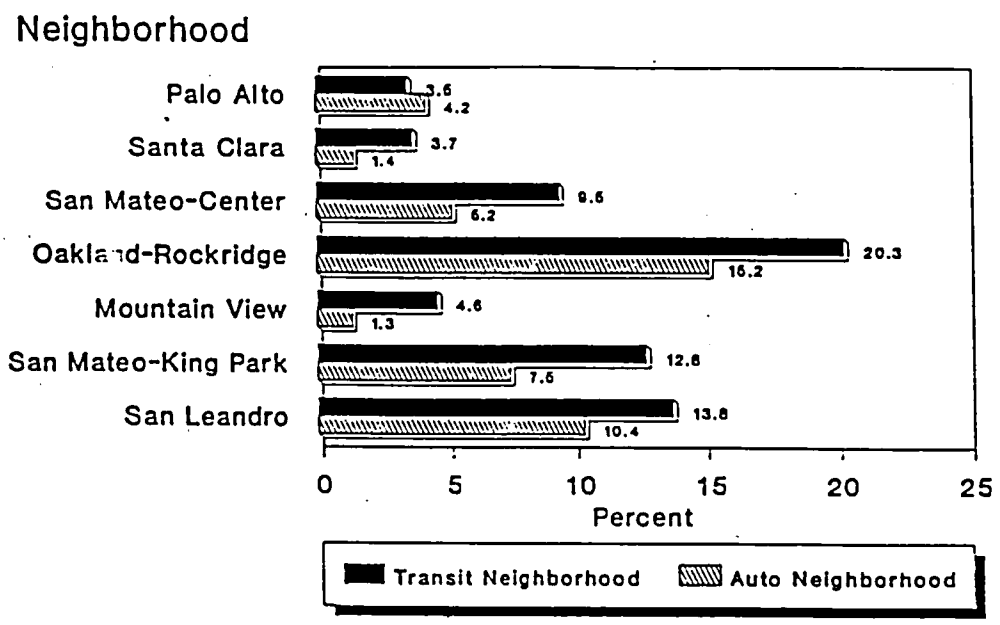


Figure E2

Neighborhood Comparisons of Transit Modal Splits, San Francisco Bay Area, 1990 Work Trips

in the Bay Area; in Southern California, both groups of neighborhoods had comparable transit modal splits and trip generation rates. On the whole, however, Transit neighborhoods won over larger shares of commuters to alternative modes than their Auto counterparts— for example, even in Los Angeles, Transit neighborhoods averaged around 50 more transit work trips per 1,000 households than Auto neighborhoods, controlling for household incomes and residential densities.

The general absence of strong and decisive relationships was no doubt due to several factors. One, finding true neighborhoods that met both differentiation and control criteria was problematic. Second, traditional transit-oriented neighborhoods probably have the biggest influence on non-work trips, particularly shop trips. Even if near-perfect matched pairs were obtained and shop travel data were available, it seems unlikely that bus transit modal splits will ever differ markedly among neighborhoods. However, when combined with pedestrian, bicycle, and carpool/vanpool travel, non-drive-alone shares are likely substantially higher in transit-oriented neighborhoods for many non-work trips.

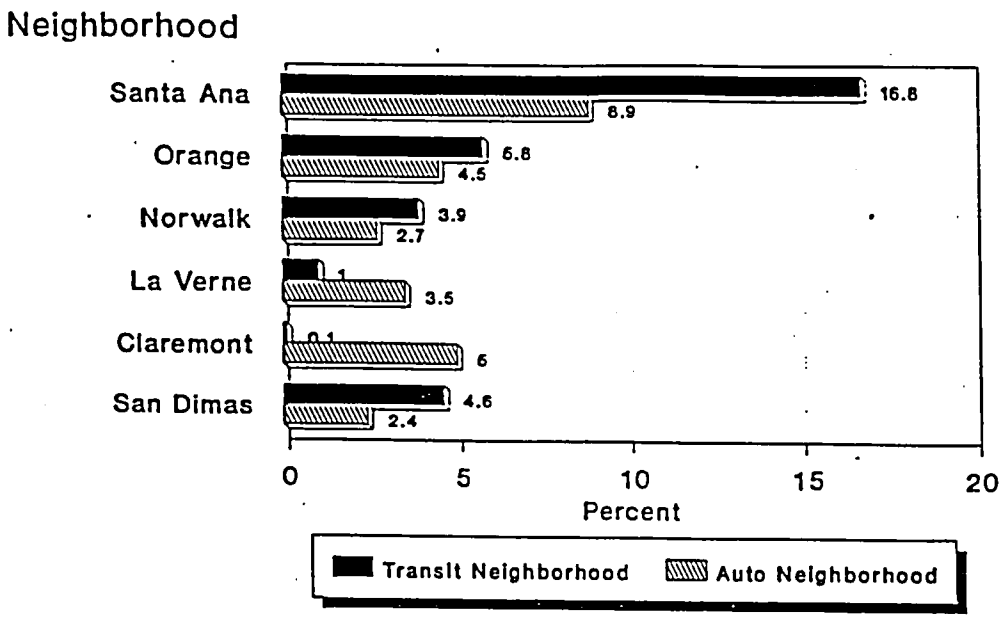


Figure E3

Neighborhood Comparisons of Transit Modal Splits, Los Angeles Region, 1990 Work Trips

Community-Level Analyses

At the community scale, the research focus shifted away from micro-design questions and more toward probing the ridership influences of structural elements of the built environment, like land-use compositions and levels of jobs-housing balance. One comparison was drawn between the commuting behavior of residents from ten traditional U.S. communities versus those of the metropolitan area at-large. Traditional communities averaged substantially higher shares of walk and bicycle travel as well as shorter trips. On average, larger shares of residents commuted by transit in traditional communities than did residents of the typical regional suburb, however not in all cases (Figure E4). The study of Edge Cities found that densities and mixed land-use compositions paid off only if Edge Cities are served by rail transit.

The bulk of the community-level analyses concentrated on planned communities. America's new towns were found to be fairly self-contained, averaging relatively large shares of residents working within the community. This produced shorter average commutes in new towns. Balanced new towns had slightly lower shares of transit and drive-alone commuting. In general, America's new communities seem to enjoy only modest mobility benefits.

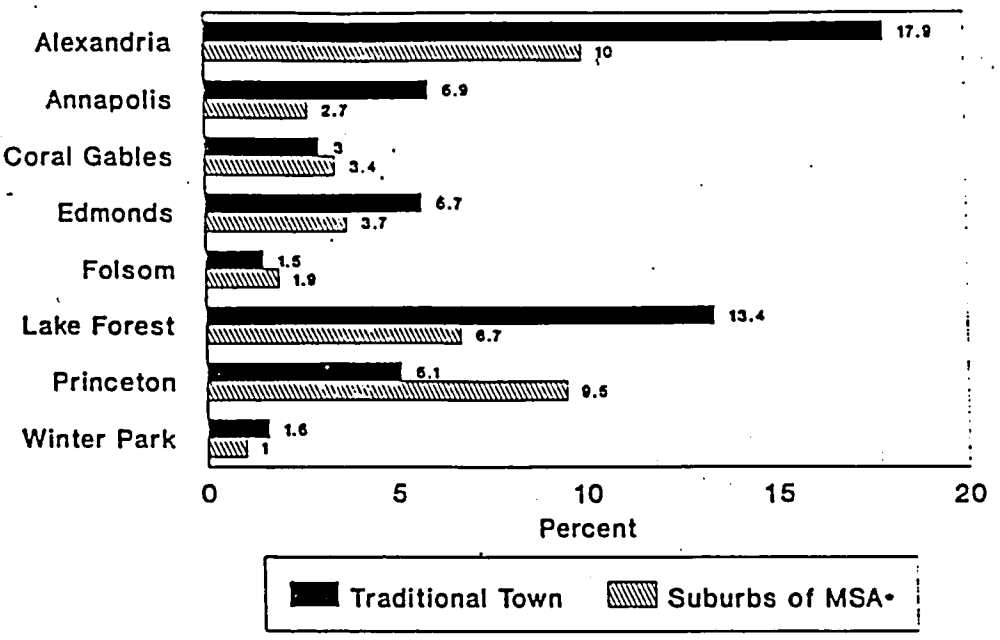


Figure E4

Transit Shares of Work Trips in Traditional Communities and Surrounding Suburbs, 1990

The best evidence on the link between community planning and commuting is from Europe. In general, an inverse relationship was found between how self-contained and balanced communities were and the share of work trips made by transit users. Britain's more recent new towns, epitomized by Milton Keynes, are highly balanced and theoretically self-contained, yet they are auto-dependent and average high levels of annual VMT per capita. In stark contrast are new towns outside of Paris and Stockholm. In both metropolises, satellite new towns are linked to the regional core by rail transit. While numerically balanced, new towns outside of Paris and Stockholm are not self-contained; rather, external commuting by residents and workers far exceeds internal commuting. Importantly, the external commuting that takes place is predominantly by rail transit, resulting in low annual vehicle-miles-traveled (VMT) per capita.

Experiences abroad suggest that having good quality rail or dedicated line-haul service is the key to luring new-town commuters out of their cars in substantial numbers, with such land-use considerations as density, neotraditional designs, jobs-housing balance, and self-containment of secondary significance. This is particularly so when regions have a built form similar to that of Paris or Stockholm —a strong, pre-eminent regional core orbitted by satellite centers that are radially linked to the core by fixed guideway services. In both instances, this regional form is the direct outcome of pro-active regional planning. Where regional planning is absent and development patterns are more diffuse

Notes: These European new towns are all separated from the central city by greenbelts. 'Balance' means "job-housing" balance.

and random-like, the opposite will result—commuting between communities will predominantly and almost unavoidably be by drive-alone automobile, even if rail services exist.

Conclusions

At the site level, there is little evidence that transit-friendly design features, like front-door bus staging areas and internal pathways, have much, if any, measurable impact on transit demand. Such micro-elements seem to be too "micro" to exert any meaningful influences on travel choices. More macro-factors, like densities and cost differentials of transit versus automobile commuting, are far more powerful determinants of how people travel. Once commuters have opted for a travel mode, micro-design features probably have some affect on secondary travel choices, such as during the midday. Thus someone commuting alone might be more inclined to walk to a restaurant several blocks away in a transit-and pedestrian-friendly setting than in a blatantly auto-oriented environment. However, the presence of micro-design features, in and of themselves, are too weak to shape the more fundamental decision of how to arrive at work.

The ability to evaluate the impacts of transit-supportive designs is confounded by the fact that all transit-friendly environments have transportation demand management (TDM) programs in place. Every office park or residential enclave with on-site transit shelters, front-door bus staging areas, and internal pathways also has an active, often ambitious, TDM program. Transit-supportive designs and TDM complement each other and no doubt mutually benefit. However, we believe that most of the differences in modal splits between transit-supportive sites and comparison sites are due to TDM programs rather than elements of the built environment. Overall, transit-supportive designs are helpful and well-intentioned, though fairly meaningless without good quality transit and rideshare services and pro-active measures that reduce auto-dependency.

To date, the transit-supportive design movement has had a bigger impact on the public than the private sector in many parts of the country. This has mainly been in the form of convincing local planners of the importance of considering the needs of transit vehicles and pedestrians in the review of development proposals. For the most part, the economic downturn of the late-1980s and early-1990s has slowed down the transit-oriented design movement since relatively few large-scale commercial projects are being built. However, when urban real estate markets begin warming up again, a number of jurisdictions will be well-positioned to see that whatever gets built is highly conducive to transit riding and walking. The burden will then shift to public transit agencies and private providers to ensure that good-quality transit services are delivered.

#156
RON WEAVER

Natural Resources and an Optimum Human Population

David Pimentel, Rebecca Harman, Matthew Pacenza, Jason Pecarsky, Marcia Pimentel
Cornell University

INTRODUCTION

The world's human population is currently more than 5.6 billion, and projected to reach nearly 8.4 billion by the year 2025 and possibly a disastrous 15 billion by 2100 (PCC, 1989). Presently a quarter million humans are added each day. Many leading scientists and public organizations are concerned about the rapid growth in population numbers and the deterioration of natural resources and the environment caused by human numbers and activities (CEQ, 1980; Keyfitz, 1984; Hardin, 1986; Demeny, 1986; Ehrlich & Ehrlich, 1990; Holdren, 1992). As populations and their consumerism increase, basic resources are depleted; this leads to environmental degradation while freedom of individual choice and quality of life decline (Durning, 1989; Durham, 1992). Worldwide at present from 1.2 billion (Durning, 1989) to 2 billion people (Abernethy, Vanderbilt University, personal communication, 1992) are living in poverty, malnourished, diseased, and experiencing short life-spans. In the United States 32 million now are living in poverty (USBC, 1991).

The natural resources required to sustain human life include ample supplies of fertile land, forests, water, energy, and diversity of natural biota. The interdependencies of these resources and their current and pro-

Please address correspondence to Dr. David Pimentel, Department of Entomology, Cornell University, Comstock Hall, Ithaca, NY 14853-0901.

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jected future status are analyzed in this paper. We propose an optimum population for the United States and the world based on a high standard of living while maintaining the sustainability of renewable resources and the environment. The goal is to determine the population size that will insure the possibility of individual prosperity for everyone while maintaining a quality environment. This information will assist the public and governments to make thoughtful decisions that lead to reducing population numbers and consumption levels while effectively managing natural resources and the environment to sustain future generations.

POPULATIONS AND CONSUMPTION OF RESOURCES

Human behavior demonstrates a strong will to survive, to reproduce, and to achieve some level of prosperity and quality of life. However, individuals as well as societies differ in their view of what they consider a satisfactory life. Contrasting some aspects of life in the United States, China, and world reveals disparities in lifestyles which most often are functions of the natural resources available per person (Tables 1 and 2). Furthermore most of these basic resources are finite and are not unlimited in

TABLE 1

Foods and Feed Grains Supplied per Capita (kg) per Year in the United States, China, and the World

Food/Feed	USA[a]	China[b]	World[c]
Food grain	77	265	201
Vegetables	129	180	139
Fruit	46	15	5
Meat & Fish	88	32	47
Dairy products	258	4	77
Eggs	14	6	6
Fats & oils	29	6	13
Sugar & sweeteners	70	7	25
Total food	711	515	552
Feed grains	663	70	166
Grand Total	1374	585	718
Kcal/person/day	3600	2500	2667

[a]Putnam and Allshouse (1991).
[b]All food item data, except vegetables, are from AMPRC (1989); the vegetable data are from D. Wen, Institute of Ecology, Shenyang, China, PC, 1991. Feed grains are from Ding Junsheng (1988).
[c]FAO (1991), except for feed grain data which is from FAO (1989).

TABLE 2

Resources Used per Capita per Year in the United States, China, and the World to Supply Basic Needs

Resources	USA	China	World
Land			
Cropland (ha)	0.52[a]	0.13[b]	0.28[a]
Pasture (ha)	1.3[a]	0.35[b]	0.58[a]
Forest (ha)	1.3[a]	0.15[b]	0.76[a]
Total (ha)	3.12	0.63	1.62
Water (liters × 10^4)	1.9[a]	0.43[c]	0.66[b]
Fossil Fuel			
Oil equivalents (liters)	10,000[e]	700[f]	1,500[f]
Forest Products (kg)	1,400[e]	40[d]	70[e]

[a]USDA (1990); [b]Shi Yulin (1991); [c]Sun Julin (1990), Water Use in China from Wen Dazhong, Inst. of Appl. Ecology, Shenyang, China, PC, 1992; [d]SSBPRC (1991); [e]USBC (1991); [f]SSBPRC (1990); [g]Buringh (1989); [h]WRI (1991); [i]UNEP (1985).

their supplies; as human populations continue to grow, prosperity and quality of life can be expected to decline (Fornos, 1987; UNFPA, 1991).

The present population of the United States is 258 million, and it is growing at a rate of 1.1% per year (USCB, 1992). If the number of immigrants are increased as proposed by the President and Congress, then the rate of U.S. population growth will increase at a greater rate. China already has a population of 1.2 billion, and despite the governmental policy of permitting only one child per couple, it is growing at a rate of 1.4% (PRB, 1991). The world population is now 5.6 billion and growing at a rate of 1.7%. Based on these data, the world population is expected to double in 41 years and the U.S. population to double in 63 years.

Each American consumes about 23 times more goods and services than the average third world citizen, and also each person in the United States consumes about 53 times more goods and services than a Chinese citizen (PRB, 1991). Achieving the U.S. standard of living is impossible for the rest of the world, based both on projections of future resource availability and population growth. The excessive consumption levels characteristic of Americans depend on the importation of natural resources from other countries of the world (USBC, 1991) and are reflected in the highest debt of any nation in the world.

Since the 1850s, Americans have relied increasingly on energy sources other than human power for their food and forest products. The relatively cheap and abundant supplies of fossil fuel have been substituted

for human and draft animal energy. Commercial fertilizers and pesticides as well as machinery have let U.S. farmers diminish the level of human energy they must expend to farm the land. Chinese farmers use as much fertilizer and pesticides per hectare as American farmers. But they al[illegible] depend on about 1,200 hrs/ha per year of human labor for grain produc[illegible] tion, compared with only 10 hrs/ha per year in the United States (Wen & Pimentel, 1984).

Industry, transportation, home heating, and food production account for most of the fossil energy consumed in the United States (DOE, 1991a). In China most fossil energy is used by industry and a lesser amount for food production (Kinzelbach, 1983; Smil, 1984). Per capita use of fossil energy in the United States is 10,000 liters of oil equivalents per year or almost 14 times the level in China (Table 2). U.S. per capita energy consumption is nearly 7 times that of the world average.

The relative affluence presently enjoyed by Americans has been made possible by our abundant supplies of fertile cropland, water, and fossil energy per capita. As our population continues to grow (Figure 1), we will inevitably experience resource shortages similar to those now being experienced by China and other nations (Tables 1 and 2).

STATUS OF WORLD ENVIRONMENTAL RESOURCES

What standard of living will be experienced by each person in the United States and the world in the future? We have already suggested that this depends on population numbers and the quality and quantity of land, water, and energy as well as of biological resources and the technologies employed to manage these resources. The U.S. population currently has 258 million consumers of these vital resources, many of which are b[illegible] depleted, with no hope of renewal after the next hundred years. Re[illegible] indicate that the average standard of living in the United States began to decline during the last decade (Fuchs & Reklis, 1992) and is projected to continue to decline if the U.S. population doubles its numbers during the next 63 years (USCB, 1992). The world population, as mentioned, is projected to double in just 41 years (PRB, 1991) and already shortages of fertile land, water, and fossil energy exist in many regions (WRI, 1991; Worldwatch, 1992).

Land Resources

More than 98% of world food comes from the terrestrial environment and the remaining small percentage comes from ocean, lake, and other

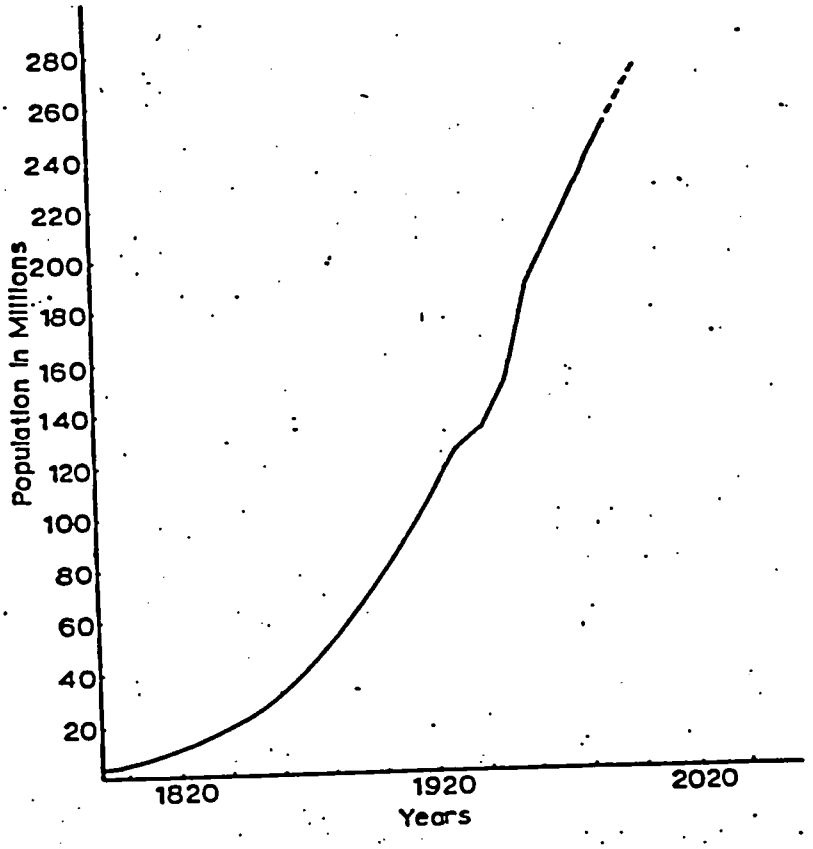

FIGURE 1. Rapid growth in the U.S. population from 1800 to date. At the current growth rate, the U.S. population is projected to double in 63 years (USCB, 1992).

aquatic ecosystems (Pimentel & Hall, 1989). Worldwide, food and fiber crops are grown on 12% of the earth's total land area (Buringh, 1989). Another 24% of the land is used as pasture to graze livestock that provide meat and milk products. Forests cover an additional 31% (Buringh, 1989). The small percentage of forestland and grassland set aside as protected national parks to conserve biological diversity amounts to only 3.2% of the total terrestrial ecosystem (Reid & Miller, 1989). The remaining portion of land area (34%) is mostly unsuitable for crops, pasture, and forests because it is too cold, too dry, steep, stony, or wet, or the soil is too shallow to support plant growth (Buringh, 1989) (Table 3).

To provide a diverse nutritious diet of plant and animal products,

TABLE 3

Land Area (Million ha) Uses in Major Regions of the World (WRI, 1991)

Region	Total Area	Cropland	Pasture	Forest	Other[a]
Africa	2,965	184	792	688	1,301
N. America	2,139	274	368	684	813
S. America	1,753	140	468	905	240
Asia	2,679	450	678	541	1,010
Europe	473	140	84	157	92
Total	10,009	1,188	2,390	2,975	3,456
	100%	12%	24%	30%	34%

[a]Land that is either too dry, too steep, or too cold to use for agriculture and forestry.

about 0.5 ha of cropland per capita is needed (Lal, 1989). The United States is at this level now, but the world average is only 0.28 ha of cropland available per capita, or nearly one-half this optimum value (Table 2). This shortage of productive cropland is in part the cause of the food shortages and poverty that many humans are experiencing today.

Currently, a total of 1,374 kg of agricultural products are produced annually to feed each American while the Chinese's supply averages only 585 kg/capita/yr (Table 1). Note that the world value is 718 kg/capita/yr. Based on available data (Tables 1 and 2) each person in China eats essentially a vegetarian diet. Further they have reached the carrying capacity of their agricultural system, even with huge inputs of fossil energy now used on Chinese farms (Wen & Pimentel, 1990).

Escalating land degradation threatens most crop and pasture land throughout the world (Lal & Pierce, 1991). The major types of degradation include water and wind erosion, salinization, and water-logging of [illegible] (Mabbutt, 1989). Indeed, more than 10 million hectares of productive [illegible]able land are severely degraded and abandoned each year (Pimentel et al., 1992). Moreover, each year an additional 5 million hectares of new land must be put into production to feed the 96 million humans added yearly to the world population. Most of this total of 15 million ha needed for replacement and expansion is coming from the world's forests. The urgent need for agricultural land accounts for 80% of the deforestation now occurring worldwide (Myers, 1990).

Soil erosion, the single most serious cause of soil loss and land degradation, is more intense than ever before in history (Pimentel & Hall, 1989; WRI, 1991; Pimentel, 1993). In Africa during the past 30 years, the rate of soil loss has increased 20 times (Tolba, 1989). Wind erosion is so serious

in China that Chinese soil is detected in the Hawaiian atmosphere when planting starts in China (Parrington et al., 1983). Similarly in 1992, soil eroded from Africa was detected in Florida and Brazil (Simons, 1992). Soil erosion on cropland ranges from about 16 t/ha/yr in the USA to 40 t/ha/yr in China (USDA, 1991; Wen, 1993; McLaughlin, 1993). Soil erosion worldwide is about 30 t/ha/yr (Pimentel, 1993). This magnitude of erosion is of particular concern because of the slow pace of soil formation; it takes approximately 500 years for 2.5 cm of topsoil to form under agricultural conditions (OTA, 1982; Elwell, 1985; Troeh et al., 1980). Thus, topsoil is being lost 20 to 40 times faster than it is being replaced.

Erosion adversely affects crop productivity by reducing water availability, water-holding capacity, soil nutrients, soil organic matter, and soil depth. Estimates are that agricultural land degradation can be expected to depress world food production between 15% and 30% during the next 25-year period (Buringh, 1989).

The arable land currently used for crop production includes some marginal land which is highly susceptible to degradation. When such changes occur crop production is depressed and the requirement for fossil energy inputs in form of fertilizers, pesticides, and irrigation is increased in an effort to offset some degradation (OTA, 1982; Follett & Stewart, 1985; Pimentel, 1993).

Water Resources

The present and future availability of adequate supplies of fresh water is frequently taken for granted. Distribution varies throughout the world and natural collectors of water such as rivers and lakes vary in distribution and frequently are shared by several countries. All water supplies, especially in arid regions, are diminished by evaporation. Reservoir water experiences an average yearly loss of about 24% (Meyers, 1962).

All vegetation requires and transpires massive amounts of water during the growing season. For example, a corn crop that produces about 7,000 kg/ha of grain will take up and transpire about 4.2 million liters/ha of water during the growing season (Leyton, 1983). To supply this much water to the crop, not only must 10 million liters (1,000 mm) of rain fall per hectare, but a significant portion must fall during the growing season.

The greatest threat to maintaining fresh water supplies is overdraft of surface and groundwater resources to supply the needs of the rapidly growing human population and of the agriculture which provides its food. Agricultural production "consumes" more fresh water than any other human activity (Falkenmark, 1989). Worldwide about 87% of the fresh water is

consumed (made nonrecoverable) by agriculture (Postel, 1989), while in the United States this figure is about 85% (NAS, 1989). An individual requires nearly 3 liters/day of fresh water for drinking, but needs a minimum of 90 liters/day for cooking, washing, and other domestic needs (Brewster, 1987). Each American uses about 400 liters/day for domestic needs (US[illegible] 1991).

As the world's population grows, so do its water needs. To provide the ever increasing amount of water required to meet human needs is resulting in increased demand for surface water and groundwater resources. For example, by the time the Colorado River enters Mexico it has literally disappeared because of the excessive removal of its water by the states of California, Arizona, and Colorado (Sheridan, 1983). Veltrop (1991) calculates that if the world's population increases about 20%, the demand for water will double..

Surface water and groundwater each supply half of the freshwater supply in the world (Wolman, 1986; Falkenmark, 1989). Groundwater resources are renewed at various rates, but usually at the extremely slow rate of about 1% per year (CEQ, 1980). Because of this slow recharge rate, groundwater resources must be carefully managed to prevent overdraft. Yet humans are not effectively conserving groundwater resources and overdraft is a serious problem worldwide. For example, in Tamil Nadu, India, groundwater levels declined 25 to 30 m during the 1970s because of pumping for irrigation (Postel, 1984; UNFPA, 1991). Beijing, China records a decline in its groundwater table of about 1 m/yr; and in Tianjin, China it drops 4.4 m/yr (Postel, 1984). In the United States overdraft averages 25% higher than replacement (USWRC, 1979). But in some locations, like the U.S. Ogallala aquifer, annual overdraft is 130% to 160% above replacement (Beaumont, 1985). If this continues, this vast aquifer is expected to become non-productive in about 40 years (Soule & Piper, 1992). Loss of available water limits the option of irrigation in arid regions[illegible] irrigation area worldwide is now declining per capita because of sali[illegible]tion, water-logging and population growth (Postel, 1989).

Another major threat to maintaining ample fresh water resources i pollution caused by people and industries. Considerable water pollution i documented in the United States (USBC, 1991) but is more serious in de veloping countries. For example, in Latin American countries, untreate urban sewage is often dumped into rivers and lakes (WRI, 1991), resultin in fecal-coliform bacterial counts higher than 100,000 per ml of wat (0.1/ml is the maximum acceptable level for U.S. drinking water Pesticides, fertilizers, and sediments pollute water resources as they a company eroded soil; industries dump toxic chemicals untreated in

rivers and lakes (WRI, 1991). Pollution by sewage, as well as various chemical wastes, makes water unsuitable for human drinking and for application to crops.

Biological Resources

In addition to land, water resources, and crop and livestock species, humans depend on the millions of other species that exist in agroecosystems and nature (Pimentel et al., 1992). Humans have no technologies that can substitute for the service provided by wild biota. In the United States there are approximately 500,000 species of plants, animals, and microbes that provide many essential functions for humans including: pollination of crop and wild plants; recycling manure and other organic wastes; degrading chemical pollutants; and purifying water and soil (Pimentel et al., 1992). These diverse species also serve as a vital reservoir of genetic material for future development of agriculture and forestry. Yet the world is losing about 150 species per day because of human activities of deforestation, pollution, applying pesticide application, urbanization, etc. (Reid & Miller, 1989).

Ecologists have reported that if sufficient natural biological diversity is to be maintained to ensure a quality environment, then about one-third of the terrestrial ecosystem should be preserved as natural vegetation (Odum, 1971). This biomass is essential to provide food, shelter, and protection for these valuable species and ensures their preservation (Pimentel et al., 1992).

Clearly humans need these organisms as well as their livestock and crop species. For example, honey bees and wild bees play an essential role in pollinating about $30 billion worth of U.S. crops annually in addition to pollinating natural plant species. It has been calculated that honey bees and wild bees in New York State on a bright, sunny day in July pollinate 10^{12} blossoms (Pimentel, 1994). Humans have no technology to substitute for this natural service supplied by wild biota.

Energy Resources

Some form of energy is expended to provide humans with all their needs. About 369 quads from all energy sources per year are used worldwide, the amount directly related to the rapid growth in the world population and the environmental degradation imposed by human activity (Pimentel & Pimentel, 1979) (Table 4). Although worldwide about 50% of all solar energy captured by photosynthesis is used by humans, it is inade-

TABLE 4

Fossil and Solar Energy Use in the USA and World

	USA[a]		World[b,c]	
	Quads	%	Quads	%
Total energy	85.1	100	368.9	100
Fossil energy	78.5	92.3	319.2	86.5
Solar energy	6.6	7.7	49.7	13.5
Hydropower	3.0	3.5	21.2	5.7
Biomass	3.6	4.2	28.5	7.8

[a]DOE, 1991a; [b]DOE, 1991b; [c]UNEP, 1985.

quate to meet their needs of food and forest products (Pimentel, 1989; Pimentel & Pimentel, 1991). To make up the addition, about 319 quads (10^{15} BTU or 337 × 10^{18} Joules) of fossil energy are utilized worldwide each year (UNEP, 1985; IEA, 1991), of which 79 quads are consumed in the United States (DOE, 1991a). These 79 quads represent nearly 3 times the 28 quads of solar energy harvested as crop and forest products, and about 40% more energy than is captured by U.S. vegetation. Fossil energy has also been used to fuel a wide array of human activities including industrial production, fuel for automobiles and trucks, highway construction, heating and cooling of buildings, and packaging of all goods.

Fossil energy is used to feed an increasing number of humans as well as improve the quality of life in many basic ways, such as protecting humans from numerous diseases. For example, delivering clean water has helped to eliminate a wide array of disease organisms that are transmitted in polluted water.

Developed nations annually consume about 80% of the fossil energy worldwide while the developing nations, which have about 75% of the world population, consume only 20% (UNEP, 1985; DOE, 1991a). The United States consumes about 25% of the world's fossil energy annually.

Several developing nations that have high rates of population growth are increasing the use of fossil fuels in their agricultural production. For example, since 1955 there has been a 100-fold increase in the use of fossil energy in Chinese agriculture (Wen & Pimentel, 1984). Similarly, fossil energy use in different U.S. economic sectors has increased 20- to 1,000-fold in the past 3 to 4 decades, attesting to our heavy reliance on this finite energy resource (Pimentel & Hall, 1989).

Projections of the availability of fossil energy resources are discourag

ing. A recent report published by the U.S. Department of Energy (DOE, 1991a) based on current oil-drilling data indicates that the estimated amount of national oil reserves has plummeted. This means that instead of the 35-year supply of U.S. oil reserves that was projected about 4 years ago, the current known and discoverable potential oil reserves are now limited to a 10- to 13-year supply at present rates of pumping (DOE, 1990; Lawson, 1991). Since the United States is now importing more than half its oil, a serious problem already exists (Gibbons & Blair, 1991).

The world supply of oil is greater than that of the United States and is projected to last about 35 years at current pumping rates (Matare, 1989). Both in the United States and the world, the natural gas supply is adequate for about 35 years and coal for about 100 years (Matare, 1989). Other estimates range as high as 150 years for total fossil energy, primarily coal (BP, 1991). However, these estimates are based on current consumption rates and current population numbers. If all people in the world enjoyed a standard of living and energy consumption similar to the U.S. average, and the world population continued to grow at a rate of 1.7% per year, the world's fossil fuel reserves would last a mere 20 years.

At present about 34% of total U.S. energy consumption is electricity, and nuclear energy provides 18% of the electric needs (USBC, 1991). Nuclear energy production of electricity has some advantages over fossil fuels because it requires less land than coal-fired plants, causes fewer human injuries and deaths, and its use does not contribute to acid rain and global warming (Holdren, 1991; Meeks & Drummond, 1991). However, there are several limitations to the expansion of the use of nuclear fission and fusion energy in the future.

First, uranium resources are limited worldwide and are expected to last about 100 years, without nuclear breeder reactors (Hafele, 1991). Second, the risks of disposing radioactive wastes and lack of public acceptance for storage of wastes may influence the widespread use of both fission and fusion energy (Hafele, 1991). Fusion technology will require a great many years of research for development before it will be ready for use (Matare, 1989).

Both nuclear fission and fusion technologies produce enormous amounts of waste heat, which is a serious environmental pollutant (Bartlett, 1989). For example, it has been estimated that if the number of nuclear power plants in the United States were increased from the current 108 to 1,500, the temperature of aquatic ecosystems in the United States would increase about 10°C (H. Kendall, Department of Physics, MIT, personal communication, 1992). This degree of heat pollution would cause a major loss of biological diversity in aquatic systems and would also alter

existing climate patterns which influence agricultural and forestry production.

TRANSITION FROM FOSSIL TO RENEWABLE ENERGY

With the imminent decline in fossil fuels, a transition should be made to move from reliance on fossil energy to renewable energy sources. Research on ways to convert solar energy into usable energy, and developing new sources such as nuclear fusion energy should be given priority. Many solar energy technologies have been developed but at present are in limited use. These include: solar thermal receivers, photovoltaics, solar ponds, windpower, hydropower, and biomass. Using available technologies, biomass also can be converted into liquid fuel such as methanol; however, this process is inefficient and costly (ERAB, 1981;1982; Brower, 1990).

As recently as 1850, when the U.S. population was only 23 million, the United States was dependent on wood biomass, a form of solar energy, for 91% of its energy (Pimentel & Pimentel, 1979). Gradually the use of biomass fuel declined, and today we depend on fossil energy for 93% of our energy needs, while biomass energy makes up only 3.5%; hydropower provides the remaining 3.5% (Pimentel et al., 1994).

In contrast, 33% of the total energy (about 90 quads) now consumed annually by people in developing countries is solar-based. In particular, poorer people in developing countries depend primarily upon biomass energy. Of the total solar energy source, biomass comprises about 81%; the remainder is provided by hydropower (UNEP, 1985). Of the biomass about 51% is fuelwood, 38% crop residues, and 11% dung (Pimentel et al., 1986).

If the U.S. population declines in numbers, then reliance on biomass energy will probably increase. However, use of biomass has several detrimental tions, including competition for land areas and degradation of the environment caused by the removal of biomass from the land (ERAB, 1981; Pimentel et al., 1989a,b; Pimentel, 1992).

Consider that the total amount of solar energy captured by vegetation each year in the United States is 54 quads, which includes all the solar energy captured by agricultural crops, forests, lawns, gardens, and wild vegetation (Pimentel et al., 1978). Because of limiting factors, such as lack of water and soil nutrients, this biomass yield cannot be increased to any great extent (ERAB, 1981). The total solar energy captured by U.S. agricultural crops and forest products is about 28 quads or slightly more than half of the solar energy captured by all vegetation (ERAB, 1981). Because

this portion of biomass energy provides vital food, fiber, pulp, and lumber, it can only be harvested and used to a very limited extent as biomass energy. This leaves only 26 quads of energy from other forests and wild vegetation to be used for biomass energy. However, each American uses large amounts of forest products for paper and building; and we now import 19% of the forest products (USBC, 1991). These needs further diminish the amount of biomass that can be used as an energy source.

During this era of fossil fuels, use of these finite sources of energy has escalated to a level where it is out of balance with supply. The more than 258 million Americans use 40% more fossil energy than the total amount of solar energy captured each year by all U.S. plant biomass (ERAB, 1981). In China and Europe the situation is more critical. Worldwide, humans burn over 50% more fossil energy than the solar energy captured by their total available plant biomass. American, European, Chinese, and other societies' consumption of resources, especially nonrenewable fossil fuels, is out of balance with the ecosystem.

The availability of land that can be devoted just to biomass energy production is a major constraint to reliance on it to replace fossil fuels. The United States is fortunate in having more arable land per person than any other nation on earth. At present three-quarters of this land is devoted to agriculture and commercial forestry (USDA, 1990); urbanization and roadways occupy another 10%. Thus a relatively small percentage of U.S. land is available for increasing biomass energy resources and developing other solar energy technologies. In most other nations (e.g., Europe and China) the availability of land per person is much less than it is in the United States and the need for more land to provide food is more critical because of increasing numbers of people (Buringh, 1989).

Estimates are that only approximately 0.1% of the total solar energy reaching the earth can be harvested as biomass in temperate and tropical regions (ERAB, 1981). With this constraint, large land areas are needed to produce adequate supplies of biomass (Tables 3 and 5). Solar energy is captured by plants only during the growing season, and production is limited in the temperate region by temperature and in the tropics often by lack of rainfall. Nutrient shortages also play a role in limiting biomass production.

Furthermore the limited area available for developing and expanding solar energy technologies leads to a conflict between land uses for food and forest products and that required for solar energy (Pimentel et al., 1984). This limits the potential of solar energy technologies. The amount of land required to provide solar-based electricity for a city of 100,000 people in the United States illustrates the land constraints. However, it must be

emphasized that electricity provides 34% of total U.S. energy used; therefore if total energy were supplied by these solar energy systems, 3 times more land would be required for a city of 100,000 people. To provide the needed 1 billion kWh/yr from a sustainable biomass wood system would require the maintenance of 200,000 hectares of permanent forest (Table 5). Hydropower also is, in part, land based. On average about 13,000 hectares of land are needed for an adequate sized reservoir to provide hydropower for 100,000 people. The environmental and cultural impacts of creating reservoirs are significant because the land covered with water is often productive agricultural land, or is land used in various ways for human sustenance (Thurston, 1991).

Photovoltaic units require a significant amount of land, 2700 ha, to supply 1 billion kWh per year (Table 5). Some of these units can be placed on the roofs of buildings to reduce land area requirements. It is calculated that approximately 10% of the needed area can be supplied by mounting the photovoltaic units on the roofs of buildings (based on the average sized housing unit, with an average number of stories, and average roof area [USBC, 1991]). Thus, all solar energy systems have significant land requirements, and/or environmental limitations because of the toxic materials used in construction (Pimentel et al., 1984). Equally important, large amounts of energy and mineral resources are needed to manufacture solar collectors.

The water resources used in agriculture and forestry are also needed to operate several of the solar energy systems including hydropower, bio-

TABLE 5

Land Resource Requirements for Construction and Function of Energy Facilities that Produce 1 Billion kWh/yr of Electricity for a City of of 100,000 People

Electrical Energy Technology	Land in Hectares
Solar Thermal Central Receiver	1,800[a]
Photovoltaics	2,700[a]
Wind Power	11,700[a]
Hydropower	13,000[a]
Forest Biomass	200,000[a]
Solar Ponds	5,200[a]
Nuclear	68[a]
Coal	90[a]
Geothermal	40[b]

[a]Modified after Pimentel et al. (1984).
[b]Flavin and Lenssen (1991).

mass, and solar ponds. Severe competition already exists for fresh water resources throughout the world and will escalate as solar energy systems encroach on water supplies (WRI, 1991).

Although the conversion of biomass like corn grain into fuel energy appears promising at first glance, 72% more energy is used in the production of ethanol than the energy it provides (Pimentel, 1991). Furthermore, the land area needed to provide the raw material is enormous; about 6 ha of corn grain is needed to provide the ethanol fuel for one U.S. car for one year, assuming zero energy inputs for the distillation. Then too, the land planted to corn for ethanol would not be available for food production.

If we make the optimistic assumption that the current level of 7 quads of solar energy collected and used annually in the United States could be increased 5-fold without adversely affecting agriculture, forestry, or the environment, then about 35 quads of solar energy could be produced per year (Pimentel et al., 1984; Ogden & Williams, 1989). This is only about 40% of the current energy consumption in the United States, which totals about 86 quads (Table 4). Producing the total 35 quads would require about 90 million ha or nearly 10% of U.S. land area devoted to solar energy systems. We project that hydropower, wind power, solar thermal, passive heating and cooling, and photovoltaics will provide most of the 35 quads needed per year. The remaining energy will come from the other solar energy systems.

Compared with the United States, the world terrestrial ecosystem is not as favorable. Estimates are that, if 500 to 600 million ha were devoted to solar energy production systems worldwide, about 200 quads of energy might be available each year. This is about two-thirds of the total current world annual use of solar and fossil fuels combined (369 quads). This is an optimistic estimate. It does not take into consideration current and future competition for land and water needed for food and forest production and the requirements of solar energy technologies. Most importantly, this projection does not take into consideration that the world population is projected to double or triple within the next 100 years and that vital land resources are being degraded or lost under the pressures exerted by the growing human population.

IMPROVED USE OF RESOURCES

The prime resources—land, water, energy, and biological resources—function interdependently and each can be manipulated to a degree to make up for a partial shortage in one or more of the others. For example, to bring desert land into agricultural production, it can be irrigated. This

can occur only if groundwater or river water is available, if sufficient fossil energy is available to pump and move the water, and if the soil is suitable for irrigation and fertile to support crop growth. Because the availability of these essential resources is fast diminishing, the options for substitution are also diminishing. This emphasizes the need to examine alternative strategies.

Large quantities of fossil based fertilizers are major sources of nutrient enhancement of agricultural soils throughout the world. Yet in the United States about $18 billion per year of fertilizer nutrients are lost as they are eroded along with soils (Troeh et al., 1980). Further, U.S. livestock manures, which have an amount of nitrogen equal to that in commercial nitrogen fertilizer applied to agriculture each year, are underutilized and wasted. Significant quantities of fossil energy could be saved if effective soil conservation methods were implemented, and if manures were used more extensively as a substitute for commercial fertilizer (Pimentel et al., 1989a,b).

Pesticides are also fossil based in their production and are wasted (Pimentel, 1990). Since 1945 the use of synthetic pesticides in the United States has grown 33-fold, yet crop losses to pests continue to increase (Pimentel et al., 1991). For example, despite a 1,000-fold increase in the use of insecticides on corn, corn losses to insects have risen nearly 4-fold (Pimentel et al., 1991). Pesticide use has increased because agricultural technologies have been changed. For some major crops like corn, crop rotations have been abandoned. Now about 40% of U.S. corn land is used to grow corn continuously as a monoculture. This has caused an increase in the number of corn pests and in pesticides required to protect the crop (Pimentel et al., 1991). Adopting sustainable and environmentally sound agricultural technologies, including a return to crop rotations, would stem soil erosion, conserve fertile land, reduce water requirements for irrigation, decrease pesticide and fertilizer use, and thus save fossil fuel, soil, and water resources (Pimentel et al., 1989a,b).

The use of more land to produce food reduces the total energy inputs necessary for crop production and would lead to greater solar energy dependence and sustainability in agriculture. This, of course, assumes the availability of sufficient land, halving crop yields per hectare, but maintaining the same total amount of food produced.

PROSPERITY AND AN OPTIMUM POPULATION

If the United States were to move to a renewable energy economy, with sustainable use of energy, land, water, and biodiversity, and a rela-

tively high standard of living, how large a human population could be supplied? Based on available land and solar energy technologies we project a future U.S. energy supply of approximately 35 quads per year and the use of about 90 million ha of land for solar energy without diminishing agricultural and forest production. It is assumed that individuals would reduce by one-half their current energy use through energy efficiency and conservation; utilize only 5,000 liters of oil equivalents per year; make a major effort to conserve soil and water resources, control air pollution, and efficiently recycle all resources. However, under the above conditions the optimum population would be targeted at about 200 million; significantly less than the current U.S. population of 258 million. Then it would be possible for Americans to continue to enjoy their relatively high standard of living. Fortunately, the United States has sufficient fossil energy reserves, particularly coal, to make this necessary transition and balance in energy resources and population numbers over the next 100 years.

Worldwide, resolving the population-resource equation will be more difficult than in the United States. Already overpopulation, maldistribution of resources, and environmental degradation are causing serious malnourishment and poverty throughout the world, but especially in developing countries (Birdsall, 1980; Lappe & Collins, 1986; Ehrlich & Ehrlich, 1990; Young, 1992).

Worldwide, renewable solar energy could be developed to provide 200 quads of sustainable energy per year, while maintaining needed agricultural and forestry production. That combined with active conservation efforts, a satisfactory standard of living would be possible for everyone. However, the human population would have to be much smaller than the present 5.5 billion.

Based on the estimate that 0.5 ha per capita is necessary for an adequate food supply and assuming a program of soil conservation was implemented, it would be possible to sustain a global population of approximately 3 billion humans. With a self-sustaining renewable energy system producing 200 quads of energy per year and providing each person with 5,000 liters of oil equivalents per year (one-half of America's current consumption/yr but an increase for most people in the world), a population of 1 to 2 billion could be supported living in relative prosperity. This adjustment could be made over a century or more if everyone agreed that protecting human welfare was vital and that all were willing to work to provide a quality life for future generations. Granted a drastic demographic adjustment to 1 to 2 billion humans will cause serious social, economic, and political problems, but to continue rapid population growth to 12 billion or more will result in more severe social, economic, and political conflicts plus catastrophic public health and environmental problems.

Efforts to reduce population numbers to the suggested numbers must occur with individual human rights firmly in mind. The freedom of individuals to decide their own reproductive and familial futures cannot be ignored in the name of population control. At the same time, to do nothing to control population numbers is to condemn future humans to a lifetime of absolute poverty, suffering, starvation, disease, and associated violent conflicts as individual pressures mount. The ultimate control of the human population will be imposed by nature.

CONCLUSION

Does human society want 10 to 15 billion humans living in poverty and malnourishment or 1 to 2 billion living with abundant resources and a quality environment? Citizens of the United States and the world must support their leaders in making these critical decisions for the future. This fundamental commitment to move toward a sustainable-sized population and an energy-secure future must include the active political participation of all people.

Given the present level of fertility and immigration, the U.S. population will double in 63 years to more than half a billion, or roughly half the size of present day China. Comparisons to the problems now being experienced in China emphasize why the United States will be unable to maintain its present level of prosperity and relatively high standard of living, unless population growth is controlled.

For Americans to continue to enjoy a high standard of living and for society to be self-sustaining in renewable energy and food and forestry products, given U.S. land, water and biological resources, the optimum U.S. population is about 200 million—significantly less than the current level of 258 million. However, with one billion people as now live in China, the U.S. population could be sustained *but* in relative poverty. Sometime soon the United States needs to determine its population policy and vision for the future.

At present the pressure imposed by the large and expanding world population is more serious than that being experienced in the United States. The world population is 5.6 billion with about 1.6 billion humans now malnourished and from 1.2 to 2 billion living in poverty. Fertile cropland, fresh water, and fossil energy resources are now in serious short supply in many regions of the world. Their scarcity accounts for inadequate food and forest production, a deteriorating environment, and a diminished standard of living for most people. At current use levels most oil, natural gas, and coal reserves will be used up within the next century, with actual

rates of consumption driven by population growth and rising consumer expectations. In addition, soil degradation is intensifying, water shortages and pollution increasing, forests are being removed, and more biological species are being destroyed than ever before.

Thus far, the Americans as well as world citizens appear unwilling to deal with the growing imbalances of human population and the energy and environmental resources that support all life. Humans have a disappointing record of effectively managing and protecting their essential resources and the environment from over-exploitation in the face of rapidly growing population. World leaders seem not to understand or acknowledge the interdependencies existing among individual standard of living, population density, availability of life-supporting resources, and the quality of the environment. Local, national, and global problems exist because governments have not tried to develop cohesive and cooperative policies that recognize how supplies of the natural resources are affected by human numbers and consumption levels.

Decision making tends to be based on crises; decisions are not made until catastrophe strikes. Thus, decisions are *ad hoc*, designed to protect and/or promote a particular resource or aspect of human well-being instead of examining the problem in a holistic manner. Based on past experience, we expect that leaders will continue to postpone decisions concerning human carrying capacity of the world (Fornos, 1987), maintenance of a standard of living, conservation of resources, and the preservation of the environment until the situation becomes intolerable, or worse still, irreversible.

Starting to deal with the imbalance of the population-resource equation before it reaches a crisis level is the only way to avert a real tragedy for our children's children. With equitable population control that respects basic individual rights, sound resource management policies, support of science and technology to enhance energy supplies and the environment, and with all people working together, an optimum population can be achieved. With such cooperative efforts we would fulfill fundamental obligations to generations that follow—to ensure that individuals will be free from poverty and starvation in an environment that will sustain human life with dignity.

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