CELLULAR TOWER PROLIFERATION IN THE UNITED STATES

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ABSTRACT. Since the early 1980s the growing popularity of cellular communication has wrought dramatic landscape changes on the American scene through an invasion of thousands of cellular telephone towers. Objections raised to new tower construction by local residents, interest groups, and regulatory boards range from visual impacts to perceived health risks. This essay traces the origins of wireless telephony, its proliferation across the United States, and the visual impacts associated with tower construction. Three stages in the geographical expansion of wireless networks are identified. *Keywords: landscape aesthetics, technology, telephone, wireless communication.*

> *In relation to service rendered, the cost of the telephone is one of the smallest items in the monthly business and family budget. Few things purchased are of such real, constant, and increasing value.*
>
> —American Telephone and Telegraph Co. 1931

Almost overnight they appear in business parks and industrial areas, near suburban shopping malls, and along rural highways. Silhouetted against the sky or squirreled behind trees or buildings, cellular telephone towers are everywhere in the cities, suburbs, and towns of America. Following major highways, rows of towers evolve from self-supporting monopoles in densely populated areas to tall, tapered columns or wire-anchored masts in the countryside. An estimated 128,000 cellular antennae distributed across the United States symbolize the nation's growing freedom from wired communication.

Faced with federal licensing requirements, cellular companies (known also as cell or wireless service providers) are under pressure to extend their networks' geographical boundaries. Forecasts in the late 1990s suggested that 100,000 cellular telephone towers would be in place by 2010 (Phair and others 1998); by the end of 2001 that count had already been exceeded (Figure 1). Despite public insistence on new or expanded service, the growth of cellular networks is a source of controversy in cities and towns. Objections focus on visual impacts and perceived health risks associated with the towers, some of which are more than 250 feet tall. Attempting to manage the proliferation of towers, many communities have initiated zoning ordinances or other actions, such as temporary tower-building moratoriums. Notwithstanding local government efforts to deny permits for the construction of towers, cell providers have successfully overturned local restrictions through litigation, citing the Telecommunications Act of 1996 (Public Law 104–104, 110 Stat. 56 [1996]), which prohibits communities from imposing outright bans on wireless equipment. In cases where local government decisions have been overturned, individuals and small NIMBY (not in my backyard) groups have lobbied to prevent new towers or

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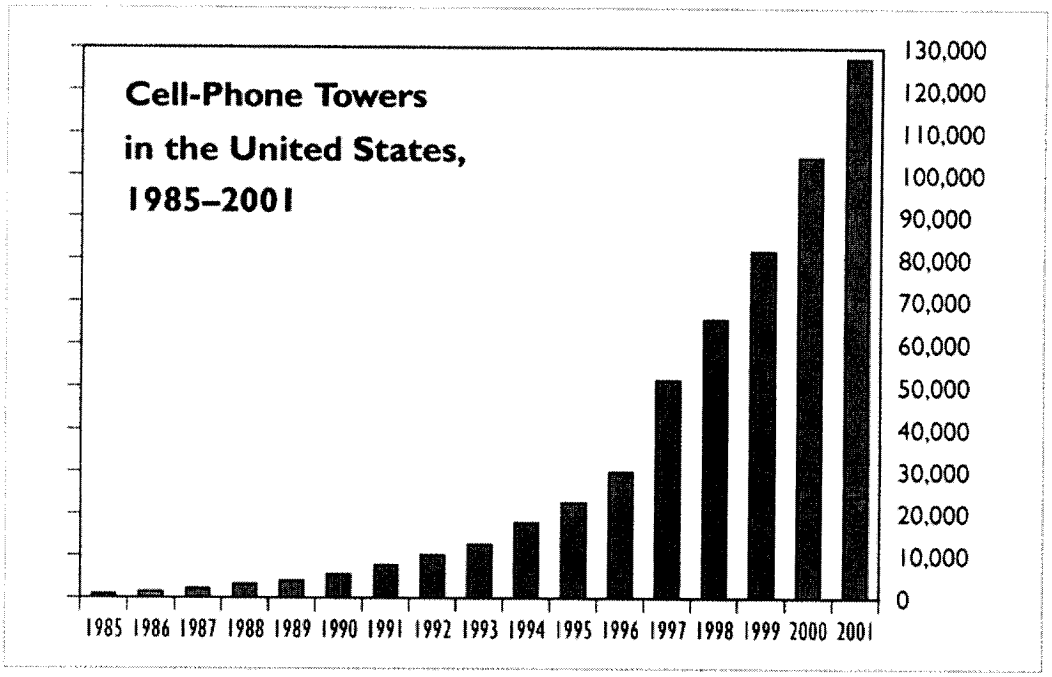

FIG. 1—Cell-phone towers in the United States, 1985–2001. *Source:* CTIA 2001.

remove existing ones. Increasing opposition to towers has prompted unique methods for reducing aesthetic objections to tower construction, such as disguising cellular equipment placed on buildings or camouflaging towers as more acceptable structures.

Previous research has looked at the impact of technology on the landscape (Hess 1992; Riley 1994; Thayer 1994) and of utility siting on property values (Hull and Bishop 1988; Hamilton and Schwann 1995). Geographers, landscape architects, and others have examined visual blight, landscape aesthetics, and other issues associated with changes in cultural landscapes (Lowenthal 1968; Lewis 1970, 1973; Tuan 1973, 1989; Blake 1979; Balling and Falk 1982; Smardon 1984; Kennedy, Sell, and Zube 1988; Chenoweth and Gobster 1990; Fulmer 1991; Linder 1997; Stamps 1997; Stilgoe 1998; Pasqualetti 2000). Most of the studies that have analyzed the impacts of wireless technology focus on legal challenges to tower siting or on perceived health issues associated with the electromagnetic radiation produced by cellular equipment (Boney 1998; Hughes 1998; Foster and Carrel 1999; Yant 1999; Jacobson 2000). In this essay I examine the expansion of wireless technology on the American landscape, along with challenges faced by wireless providers and communities in dealing with aesthetic issues associated with the proliferation of towers.

BREAKING FREE FROM WIRES

In contrast to developing nations, where cellular technology has expanded in response to basic telephone infrastructure needs, the cellular industry in North America

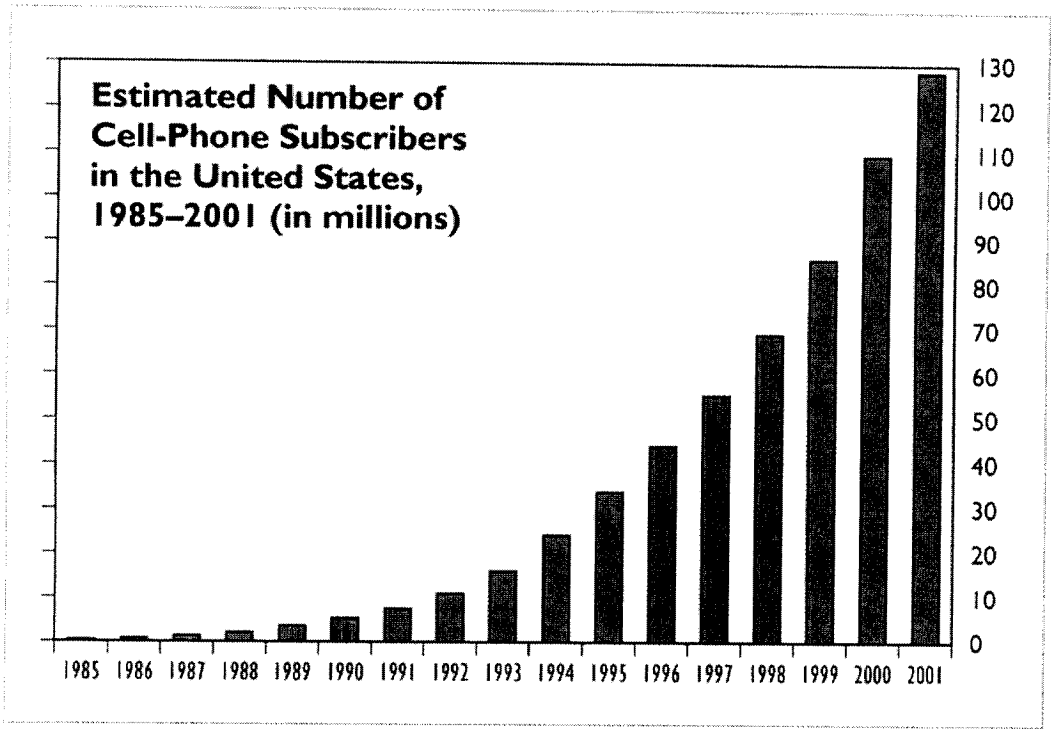

FIG. 2—Cell-phone subscribers in the United States, 1985–2001. *Source:* CTIA 2001.

has grown with demand for communications mobility (Kuruppillai, Dontamsetti, and Cosentino 1997). Today about one-third of U.S. workers are mobile, spending an average of 20 percent of their time away from their primary workplace (Schneiderman 1999). For these persons, cellular technology has transformed the home–office commute via automobile, bus, or train into productive time for family- or work-related telephone calls. At the same time, falling prices and expanded availability have brought cellular communication within reach of an increasingly wide range of persons, from corporate executives and building contractors to plumbers and high school students.[1] Marketing efforts have increasingly targeted nonbusiness users. A brochure for Motorola's Talkabout, a digital wireless telephone, promises the answer for getting "your ballerinas, Cub Scouts, and ducks in a row." An estimated 128 million Americans use cell phones, a figure that grew by 23 million between 2000 and 2001 (CTIA 2001) (Figure 2).

The utility of wireless mobility extends beyond voice communication. Integration with other technologies enables wireless telephones to send e-mail and faxes, to page people, and to gain access to the Internet. Linked to global positioning system receivers, cell phones can be used to obtain highway directions or to assist authorities in finding a stolen vehicle. For many, cell phones bring a sense of personal security by providing commuters access to roadside assistance or the chance to reassure family, friends, or party hosts about a travel delay. In the new world of personal communication, cellular calls are increasingly made to people rather than

places, and telephone numbers gain more importance in a person's identity than addresses.[2] Cellular technology has also created a spatial jargon for users of wireless communication. Telephone usage is measured as "airtime," and subscribers become familiar with the spatial boundaries of the "service area" as defined by their contract, including enclaves of poor reception. Outside their service area, callers must access the cellular networks of other providers, with additional charges for "roaming." Beyond urban areas and major highways is a communications wilderness still uncolonized by providers and largely without service.

Despite the convenience and other benefits of cell phones, their use is not always appreciated in classrooms, theaters, libraries, and other public areas. In some restaurants the nuisance of ringing telephones and one-sided conversations has prompted the designation of "cell-free" areas. Those who insist on carrying and answering their cell phone wherever they go invite interruptions in intimate conversations and intrusions into previously unreachable spaces. Solitude and personal privacy are often abandoned by cell-phone users as the price of maintaining connectivity.

A Brief History of Wireless Telephony

Until the invention of the telegraph, long-distance communication required people to move messages physically from place to place, a time-consuming activity involving travel by horse, boat, stagecoach, or other vehicle. Because of the difficulty in this type of one-way communication, messages were simple and utilitarian. The telegraph, and later the telephone, helped decrease the dependence of communication on transportation, making the space between people less important and their messages longer but often less consequential (Thayer 1994). As a result of its privacy and convenience, the telephone revolutionized business and personal communication (Harlow 1936; Brooks 1976; Pool 1977). The first public telephone exchange was developed in New Haven, Connecticut, in 1878, and thereafter exchanges spread rapidly across the United States. As the geographer Ronald Abler noted, telephone networks were mostly confined to metropolitan and adjacent areas until the 1890s (1977). In the years before 1900, cross-country telephone lines required wire an eighth of an inch thick: The New York–Chicago line alone consumed 870,000 pounds of copper (Pool and others 1977). Eager to be connected, some farmers strung their own telephone wires along fence lines, helping to extend service into rural areas (Pool 1983).

As telephone service spread, long distances were suddenly less important, and family or business contacts could be made to any location linked by wires. The physical congestion of poles, wires, and cables was little short of devastating to the urban landscape, enough so that the establishment of "fully underground utilities" became a selling point in late-twentieth-century elite subdivisions (Stilgoe 1998). Describing the effects of the telephone on American society, Ray Brosseau suggested that the telephone "destroys the barrier between city and country. Henceforth the country is but a vast suburb" (1970, 8). In 1940, 40 percent of American households had telephones, and by 1980 the number had grown to 97 percent (Fischer 1992).

The feasibility of a wireless telephone system was discussed in the early years of radio communication, and the first overseas radiotelephone experiments took place in 1915 (Pool and others 1977). Although practical for ship-to-shore communication, early radiotelephones had poor reception and were too bulky to use in automobiles. In a 1922 commentary, A. H. Griswold dismissed the radiotelephone as a supplement to but not a substitute for the wired telephone, suggesting that service would be costly and inferior. The turning point for portable communication came with advances in radio design in the 1940s, especially the development of frequency modulation (FM), which was less susceptible to interference than was amplitude modulation (AM). Law enforcement agencies were among the first to use mobile FM radio systems for dispatching and communicating with patrol cars. One limitation of radio communication was that only one person could talk at a time, inhibiting the spontaneity of normal conversation. The telephone's ability to support talking and receiving at the same time (synchronous communication) was achieved using two separate radio frequencies. Another problem, communicating over longer distances, was facilitated through remote transceivers, called repeaters, located on mountaintops or in other high places.

Having an early radiotelephone symbolized wealth and prestige. While serving in the U.S. Senate, Lyndon B. Johnson once bragged about being the first member of Congress with a telephone in his limousine. Eager to report the installation of his own mobile phone, a Senate colleague placed a call to LBJ's limo. Not to be outdone, Johnson asked the senator to hold so he could answer a call on his "other" telephone. Yet ranchers in the American West from the 1950s into the 1980s often used FM radio bands for communication across the long reaches of ranch property; difficulties aside, FM was far easier to maintain than were landlines.

The open nature of radiotelephones, however, also meant that conversations could be overheard by eavesdropping radio enthusiasts or other users waiting to make a call. Another difficulty was that the limited number of frequencies available meant that only a few users could talk simultaneously. Despite these drawbacks, demand for radiotelephone licenses soon outpaced their availability. For example, New York City had twelve radio channels available in 1976 for 545 users and a long waiting list of hopeful subscribers (Harte, Levine, and Prokup 1997).

Conceived by Bell Laboratories, the first experimental cellular licenses in the United States were issued for Chicago and the Baltimore–Washington, D.C., area in 1977. The term "cellular" was derived from the hexagonal-shaped regions that subdivide the larger service areas assigned to providers (Figure 3). Theoretically, hexagonal cells are the most efficient way to achieve maximum coverage with the fewest cells possible, but in practice topography and other conditions affect the shape of cell areas (Enterprise 2002). In contrast to earlier radiotelephones, which used high-power transceivers, cell-phone equipment uses relatively low power, resulting in limited transmission and reception distances. As a result, frequencies in nonadjacent cells can be reused, enabling a limited number of channels to be shared by a large number of subscribers (Lee 1995; Pelton 1995).

Cell systems depend on computers that automatically transfer a mobile call in progress to the cell site with the strongest signal in a switch known as a "handoff." Each network has a central facility called a mobile telephone switching office that interconnects all cells to the larger system and manages the transfer of mobile calls among cells (Gavish and Sridhar 1995). Stationary antennae located in the center of

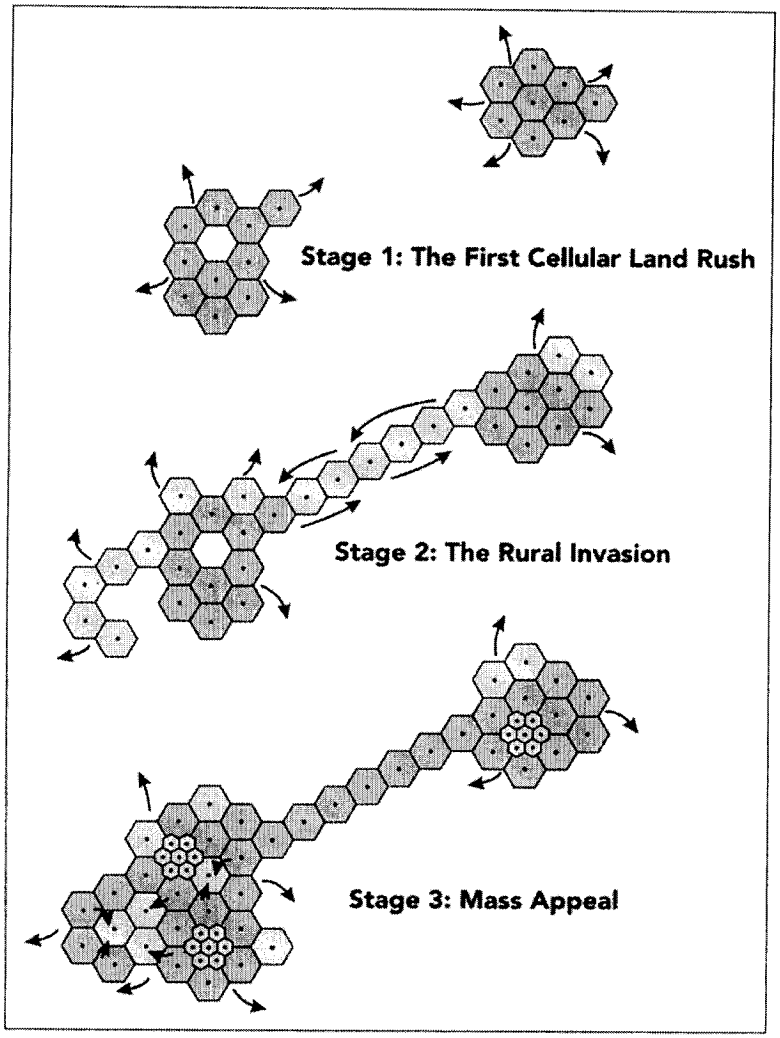

FIG. 3—Stages in the growth of cellular-telephone networks.

each cell are typically separated by 6 to 12 miles, with closer spacing in cities and suburban areas that handle large numbers of subscribers. The number of cells needed in an area is a function of the number of users and local terrain. As the number of subscribers in an area increases, a provider may need to subdivide a cell into smaller units in order to increase the capacity of the system (Kuruppillai, Dontamsetti, and Cosentino 1997). Topography also influences the number of cells and towers needed in a given area. For example, in contrast to the flat terrain of southern Florida, where

radio signals travel uninhibited, West Virginia's ridgelines and heavily wooded areas may impede or entirely block cell signals, necessitating additional towers.

In 1987 there were fewer than 100,000 cell-phone users in the United States (Tsakalakis 1997). Two events of the mid-1990s had a profound influence on accelerating the geographical expansion of cellular service. In 1995 the Federal Communications Commission (FCC) auctioned a portion of the radio broadcast band to 107 companies providing personal communications services (PCS). PCS is a digital version of cellular telephony that is capable of clear reception and data transmission. To provide for competition, the FCC divided the PCS radio spectrum into 734 service areas, each with an A and B carrier. In establishing these areas the FCC stipulated that the A carrier could not have a controlling interest in the local telephone company, whereas the B carrier (often a local Bell company) was permitted to have controlling interest in local wired telephone services. Because PCSs use higher frequencies than do analog cellular systems, their signals travel shorter distances, requiring larger numbers of shorter towers for similarly sized areas. The large investments made to acquire PCS licenses, along with FCC requirements for each licensee to serve 37.5 percent of its assigned geographical market area in the first five years and 75 percent within ten years, created pressure on providers to extend systems as rapidly as possible (FCC 1996b). The second event took place when Congress passed the Telecommunications Act of 1996 to promote the development of wireless technology. The act placed restrictions on the ability of local communities to regulate the placement of cellular equipment (FCC 1996a).

Stages of Growth

Wireless networks were first implemented in a few cities to supplement or replace earlier radiotelephones used for mobile business communication. Cell technology and mobile telephone subscription services at first remained relatively expensive, with the majority of telephones operating from motor vehicles. A second stage of expansion can be identified with the construction of towers along major highways connecting urban areas to meet the communication requirements of early-adopting business commuters (Figure 4). Increasing demand for cellular service among nonbusiness users has led to a third stage of cellular-network growth, marked by overlapping networks of competing providers, declining airtime charges, the subdivision of large cells into smaller units to handle increased demand, and the expansion of networks into previously unserved enclaves, such as residential neighborhoods.

STAGE 1: THE FIRST CELLULAR LAND RUSH

Early cellular networks were established in metropolitan areas to meet the needs of business users, so service focused on transportation thoroughfares, industrial parks, convention centers, and airports. The abundance of tall structures within urban areas, such as stadium light poles, water towers, and especially rooftops, provided alternatives to the expense and controversy of constructing towers. As service began

to extend to the edges of metropolitan areas it became more difficult for providers to find structures on which to situate antennae, making tower construction necessary. The most common tower design used in urban and suburban areas is the cylindrical steel monopole (Figure 5), with a height of 25 to 125 feet (Enterprise 2002).

As networks expanded into suburban areas the process of locating land for cell towers became more difficult because of objections to aesthetic impacts. In addition, cell providers do not have the legal powers accorded to traditional utilities for obtaining property. In contrast to sewer, water, electrical, and telephone services that receive rights-of-way on private property through the power of eminent domain, the wireless industry must negotiate to purchase or lease property through the free market (Jacobson 2000). Challenges in locating land that meets requirements for antenna placement often prompt providers to employ "site hunters" to find tower locations, and in a few cases the most attractive tower sites have led to bidding wars among competing wireless companies. Depending on local property values and the availability of alternative sites, landowners are typically offered $500 to $2,000 per month as part of a lease agreement, with higher rates paid in areas where property values are higher or sites are more difficult to locate.

STAGE 2: THE RURAL INVASION

If the first "land rush" of cellular-network expansion took place in cities and suburban areas, the second began in the early 1990s as service expanded into rural areas along U.S. interstates and other major highways to provide uninterrupted service for commuters and business travelers. Commuters soon found that cell-phone technology provided something that earlier radiotelephones were not capable of: synchronous communication outside urban areas. The majority of towers built along rural highways during this period were self-standing towers or guy-wire-supported masts that were capable of providing coverage over large areas (Figure 5). Using information from an FCC database of towers more than 200 feet tall (Figure 6), it is possible to compare rural tower locations before and after the rush (FCC 2002). In 1987 most cell towers more than 200 feet tall were located near major metropolitan areas. A very different situation can be seen in 2000, when towers followed virtually every U.S. interstate and many other highways.

Because rural areas receive less wireless traffic, the space between cells is larger, requiring less precision in the location of towers. In areas where towers follow interstates and highways, cell providers have exercised the option of either leasing property within a state or federal highway right-of-way or negotiating a lease arrangement with a private landowner. The situation along Interstate 5 in rural Oregon helps to illustrate the influence of increasing demand and competition on the proliferation of towers. Initially, towers in Josephine County were placed on mountaintops near existing television, radio, and emergency-service antenna arrays. Only three mountaintop cell antennae were needed to handle the county's 1,641 square miles (Quinn 2000). New competition among providers beginning in the mid-1990s changed this, starting a modern-day land rush for tower sites along

FIG. 4—Cellular service towers can be relatively small features on a landscape, serving interstate highway travelers, in this case near I–680 in the San Francisco Bay Area. They also serve the interests of the landowner, who can realize an income of up to $2,000 per month for providing a location for the towers. (Photograph by Paul F. Starrs, June 2001)

Interstate 5. Dozens of new towers were constructed as competitors sought to expand their service areas to capture a larger share of new subscribers.

The construction of cell towers in rural areas is often compared with the siting of power-line rights-of-way. However, power lines can often be located to minimize impacts along scenic highways or other visually sensitive areas, whereas cell towers must be located directly adjacent to roadways in order to be close to users. In addition to the aesthetic impact of towers in the daytime, flashing navigational beacons contribute to nighttime light pollution for rural residents, and generators needed to power communication equipment can interrupt the relative quiet of the countryside. Unlike cities, most rural areas are beyond the protection of zoning ordinances, so residents are powerless in their objections to the aesthetic impacts of new towers.

STAGE 3: MASS APPEAL

The third stage of expansion in cellular networks was sparked by enormous growth in numbers of subscribers, especially nonbusiness users (Figure 3). To address this demand, providers have subdivided existing cells or expanded service in underserved or unserved enclaves, such as residential neighborhoods. Another factor contribut-

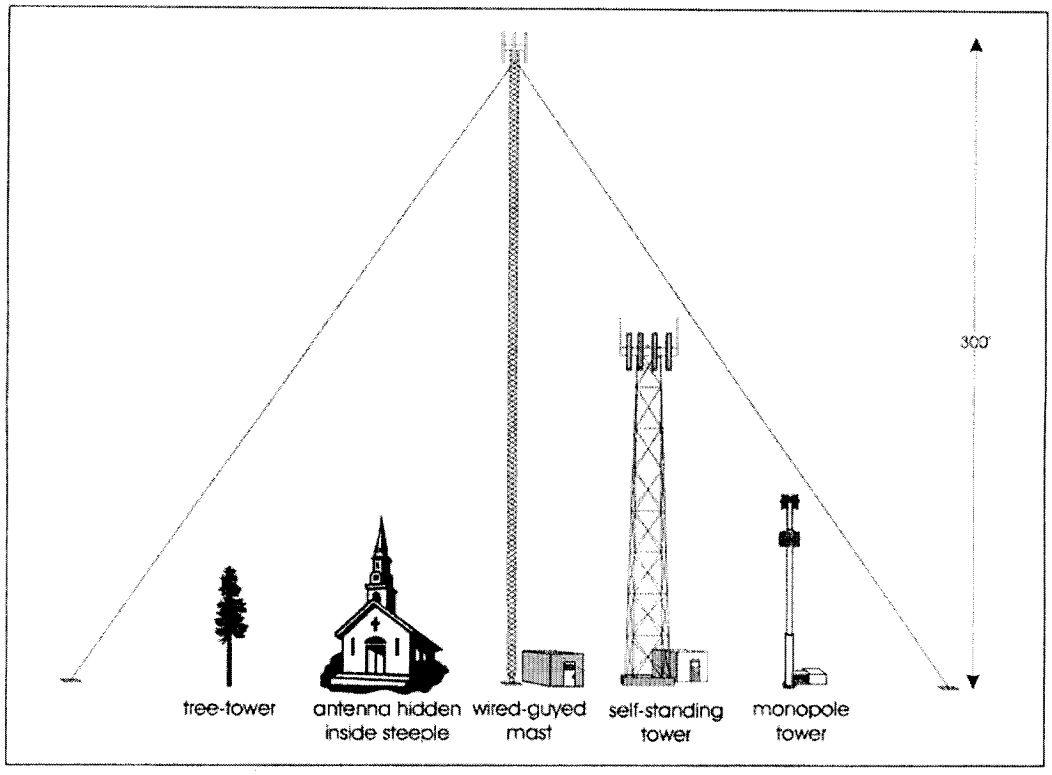

FIG. 5—Comparative heights of five types of cell-phone towers.

ing to the need for more towers has been the growth of PCS networks, which have more numerous antennae and smaller coverage areas, ranging from a square mile to a few city blocks. A considerably larger number of PCS minicells are needed to cover the same geographical area as analog systems cover. Microcells with equipment small enough to fit inside a suitcase are also becoming more common in areas with large numbers of subscribers, such as business complexes or airports. One advantage of PCS minicells and microcells is that towers are relatively short (often less than 25 feet in height), making them easier to disguise.

The three stages of wireless growth resemble patterns of hierarchical diffusion discussed by Peter Gould (1969). As Gould noted, rather than spreading uniformly across the landscape, innovations spreading through hierarchical diffusion begin in central places that serve as focal points, then move to smaller cities and so on down the hierarchy. Wireless networks in the United States began in a few large cities and subsequently spread to other large and medium-sized cities in order to serve business needs. The expansion of networks is also represented by the spread of towers along heavily traveled interstates and, subsequently, secondary highways. The most recent expansion of networks is characterized by infilling within cities and suburban areas, as tower networks become denser in response to greater competition and efforts to increase calling capacity in order to meet growing demand.

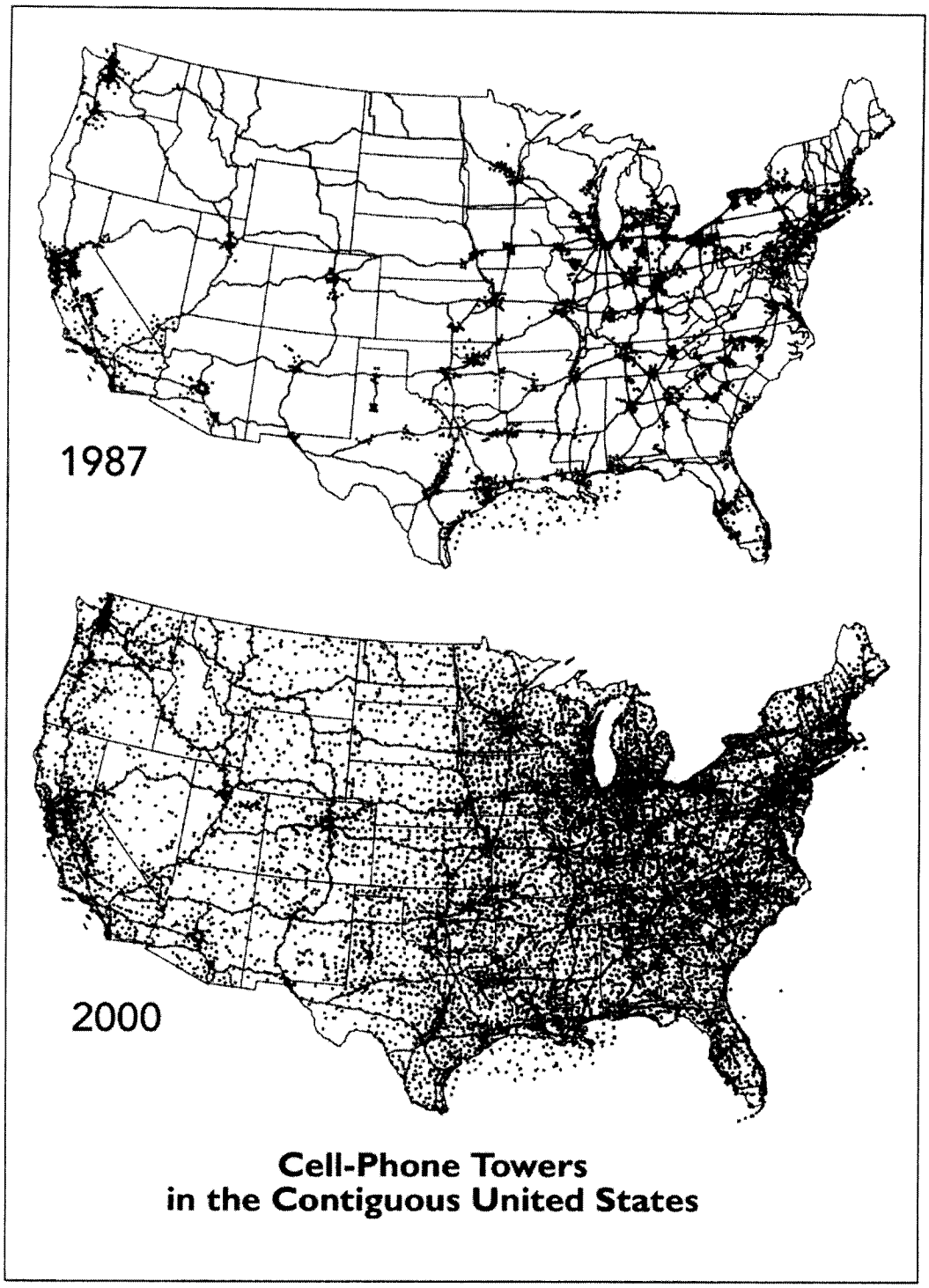

FIG. 6—Distribution of cellular-telephone towers in the United States, 1987 and 2000. Only towers that more than 200 feet tall are included. *Source:* FCC 2000.

Rural Towers: Wireless but Hardly Invisible

Peter Blake (1979) and John Stilgoe (1998) noted that, compared with Europeans, Americans are more accepting of sky clutter, such as overhead wiring and billboards. Likewise, David Lowenthal observed that Americans are "predisposed to accept present structures that are makeshift, flimsy, and transient, obsolete from the start" (1968, 76). The majority of Americans who use and value cell phones seem willing to overlook the visual impacts of towers. Peirce Lewis sheds light on this by suggesting that the frontier philosophy of Americans has led to acceptance of landscape elements viewed as functional, such as barbed wire (1973). In the final section of this article I examine factors that influence the visibility of cell towers and ways in which communities and providers have responded to demands for expanded cellular service.

Studies of tower visibility help identify factors that may influence the aesthetic impacts of cell towers. Towers with high visual impact are on flat terrain, are self-standing or wire guyed, are more than 50 feet tall, are of a color that contrasts with the background, are in settings where leaves are absent in winter, are in the foreground or middle ground of a vista, are visible from scenic highways with speed limits of less than 55 miles per hour, and have a steady or flashing aircraft beacon on them. Towers with low visual impact are in hilly or mountainous terrain, are monopoles, are less than 50 feet tall, are painted to match the sky or the terrain, are in settings where leaves are present in summer, are in the background of a vista, are visible from interstate highways with speed limits of 55–75 miles per hour, and are not lighted (Carruth 1977).

Towers in rural areas are generally less visible on rolling or mountainous terrain than are those in flat areas, which can be framed against the sky. Because of their height and complexity, self-supporting towers or wire-anchored masts with multiple antennae are the most visually imposing tower designs, whereas individual antenna monopoles resembling telephone poles are least objectionable (Enterprise 2002). Towers that are more than 200 feet tall may appear domineering and out of scale on the landscape compared with other cultural features. In some areas, cell providers have attempted to minimize aesthetic impacts by painting the lattice of the tower to match the sky or background landscape; some providers construct towers in the apparent form of conifers, painting them green, in an attempt to blend into the local landscape. Such measures may not be possible near airports, where federal aviation requirements often stipulate that towers be painted to maintain high visibility. Season influences the visibility of towers in areas dominated by deciduous trees. The distance between the viewer and the tower determines whether a tower can be seen in the foreground, middle ground, or background of a viewing area. Finally, speed of travel influences the duration of time that a cell tower is visible to a viewer (Fels 1998).

Cell Towers and Residential Communities

Although there is disagreement concerning the extent to which towers are responsible for decreases in property values, financial gain for one owner at the perceived

expense of others has resulted in damaged relationships among neighbors.[3] Ironically, many communities with covenants, conditions, and restrictions (CC&RS) or ordinances to regulate the location of overhead telephone, power, and cable-television utility lines did not anticipate requests from cellular companies to construct communication towers (Thayer 1994). Faced with proposals for new tower sites, some communities have passed temporary moratoriums on the construction of towers in order to provide additional time to consider the implementation of new policies. Controversy over tower siting has also led to the formation of NIMBY groups opposed to tower construction (Foster and Carrel 1999). For example, one organization, "Citizens Against the Tower" successfully lobbied the Bedminster, New Jersey, town council against approval of a 110-foot-tall cellular monopole (Schneiderman 1994).

Unfortunately for residents, citizen groups, and communities, denial of a permit may not stop construction of a tower (Campanelli 1997; Boney 1998). The Telecommunications Act stipulates that local zoning ordinances can be enforced but restricts the authority of local communities to impose outright bans on cellular equipment. The act provides for federal court review of siting decisions unfavorable to cell providers (Ziegler 1998; Foster and Carrel 1999). Among the reasons for a permit denial, aesthetic impacts caused by towers can be difficult to substantiate legally.[4] This may be due to perceptions that such judgments are arbitrarily applied and cannot be implemented consistently (Cats-Baril and Gibson 1987).

Some communities have taken proactive approaches to controlling tower proliferation and influencing the conditions under which new towers can be constructed. Along with Overland Park, Kansas, the cities of Sonoma and Daly City, California, have passed ordinances requiring applicants for cell-tower construction permits to complete photographic simulations as a means of evaluating the aesthetic affects of a proposed facility on the local landscape.[5] The evaluation process may include raising a crane, to enable residents to visualize how a proposed tower would appear when seen from their homes. Other communities have adopted tiered review processes that provide quick approval of permits for antennae on existing structures, such as buildings or water tanks, and more scrutiny of applications to construct new towers (Senville 1997).

Faced with increasing opposition to new towers, providers work to decrease tower proliferation or to mitigate aesthetic impacts. For example, wireless companies have entered into agreements with local utilities to site antennae on the top of electrical transmission towers (Phair and others 1998). The practice of positioning antenna equipment for two or more providers on single tower, called "collocation," is another method that reduces the proliferation of towers (Morozzi 2000). The city of Solon, Ohio, mandates investigations of possible collocation before issuing a permit for a new tower. Communities may collocate cell antennae with radio equipment used for public safety, including fire or police dispatch. Although collocation improves aesthetics by reducing the number of towers needed, it can have negative visual impacts by requiring taller towers to accommodate separation requirements

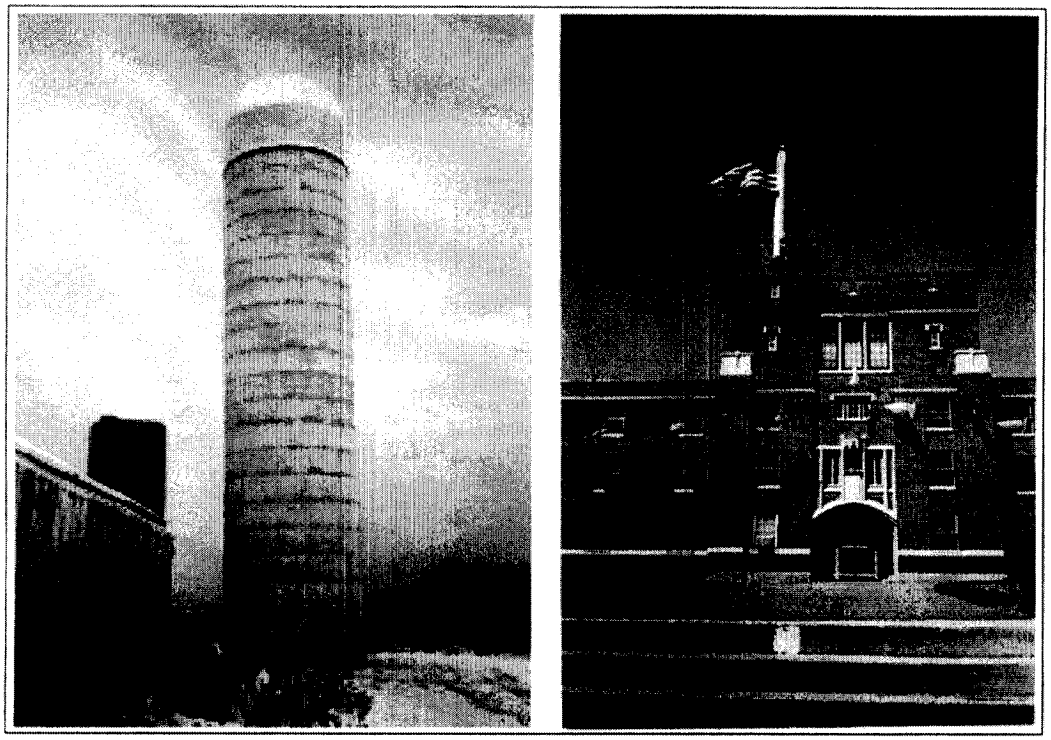

FIG. 7—Stealth tower designs: on the left, a silo in Honeoye Falls, New York, constructed of cast-in-place concrete and capped with radio-wave transparent panels; on the right, a flagpole atop a school in Waynesboro, Pennsylvania, containing a cellular antenna. (Photographs by Stealth Network Technologies, 2002)

for the antennae. Not every city or town views towers unfavorably: The communities of Arlington, Canton, and Marshfield, Massachusetts, invited wireless providers to erect towers as a means of raising local revenue. The city of Gastonia, North Carolina, receives income from five separate towers located on municipal land (Senville 1997).

DISGUISING CELL EXPANSION: THE STEALTH TOWER

In considering cultural elements on the landscape, Robert Thayer observed that technologies necessary to support life in the United States are often considered unworthy of visual expression, whereas nostalgic or futuristic ones are more acceptable (1994). In an effort to make technology less objectionable, landscape architects often hide or camouflage equipment, such as utility meters or trash dumpsters, with vegetative screens or enclosures (Brown 1989). An example of this can be seen on drilling islands in Long Beach Harbor, California, where oil derricks surrounded by palm trees have been disguised to look like high-rise condominiums.

Facing increasing objections to cell towers in suburban and residential areas, many providers now contract with companies that specialize in "stealth" tower designs to camouflage or disguise antennae (Byko 1999). For example, in wooded ar-

eas pine trees have been constructed with synthetic bark and limbs to hide cell antennae. Protests against a tower along Interstate 25 near Monument, Colorado, prompted construction of one such "tree tower," and a compromise between local landowners led to a similar synthetic tree near George Washington's home at Mount Vernon, Virginia (Hughes 1998). In rural areas antenna equipment has also been hidden inside imitation grain silos (Figure 7) or structures built to resemble fire lookout towers.

In suburban areas and towns, where tower sites are most difficult to secure, wireless providers have negotiated with church leaders to conceal antennae inside steeples or clock towers constructed at the expense of the provider (Christe 1999). Since 1983 the National Cathedral in Washington, D.C., has housed several cellular antennae in exchange for monthly lease payments. Churches are rapidly becoming among the few acceptable locations for hiding cell antennae in historic districts. Removed after a hurricane that struck Massachusetts in 1962, the steeple on the 159-year-old First Baptist Church in Nantucket's historic district has been replaced with a wood-and-fiberglass replica that hides a cellular antenna (Balling 1999). Antennae are disguised as chimneys, flagpoles, lighthouses, sculptures, or windmills or are built to fit within motel or restaurant signs. The flagpole on the Waynesboro, Pennsylvania, school shown in Figure 7 hides a PCS antenna. A commercial area in Irvine, California, features a minicell built inside an artistically designed monument. Along Interstate 285 in Atlanta a cellular antenna is hidden inside a gas-station sign (Stealth Network Technologies 2002). Attempting to blend with its desert surroundings, an antenna in Arizona has been disguised inside a 30-foot-tall artificial cactus (Larson Co. 2002). Antennae located on the sides or tops of buildings can be disguised by adding a facade matching the building's architectural style. Cellular equipment hidden inside false roof enclosures positioned along building sides can be virtually impossible to distinguish. Many cities and towns have begun to enact ordinances that encourage the use of stealth towers or other types of antenna concealment. For example, the town of Matthews, North Carolina, encourages the use of camouflaged towers by permitting them within residential areas where monopoles and other tower forms are excluded.

Conclusion

Beginning as a business substitute for the radiotelephone, the cell phone is now a product of mass appeal, with consumer demand driving the geographical expansion of networks. Networks have grown as towers crisscross the United States along nearly every major highway, multiplying through the subdivision of cells within populated areas and colonizing underserved or unserved enclaves, such as residential areas. With technological advances, wireless providers add new types of connectivity that extend beyond simple voice communication, increasing the value and importance of wireless technology. Today, cell phones rank with microwave ovens, fax machines, and CD players as conveniences important to the daily lives of millions of Americans. But in contrast to most other technologies developed over the

last twenty years and despite efforts by cell providers to make towers more acceptable through screening or camouflage, the expansion of cellular technology has brought profound changes to the American landscape.

Notes

1. In a study of 10,000 persons, James E. Katz and Philip Aspden found key elements of cellphone ownership to be race / ethnic background, household income, the need to be in touch, and social or work mobility (1998). In another study, Hyosum Kwon and Laku Chidambaram suggested that perceived ease of use influences the adoption of cellular technology (2000). General attitudes about cell phones are reviewed in Hart (1996).

2. Joshua Meyrowitz argued that electronic media have contributed to the dislocation of social place (1985).

3. Stanley Hamilton and Gregory Schwann found that properties adjacent to high-voltage electrical transmission lines lost 6.3 percent of their value as a result of visual impacts, whereas more distant properties lost about 1 percent of their value (1995). Other evidence concerning the influence of cell towers on property value can be seen in Lake County, Illinois, where the Cuba Township assessor reduced the value of twelve homes following the construction of a cell tower (Brozynski 1999). In another case, a Houston jury awarded $1.2 million to a couple because a 100-foot-tall cell tower was determined to have lessened the value of their property and caused them mental anguish (Nissimov 1999).

4. Enterprise provides an overview of legal actions initiated against communities in cases where providers have challenged that the denial of a permit violates the Telecommunications Act of 1996 (2002).

5. For example, see Ordinance 96–23, City of Sonoma, California, at [http://www.abag.ca.gov/bayarea/telco/samples/sonoma.city.html].

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