Factors Affecting the Feasibility of Urban Infill Development Over Freeways
Another shade of green: Implementing complex multidisciplinary work

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Abstract:
This paper presents a brief introduction to types and examples, historic and current, proposed and built, of efforts to reclaim land from freeways for urban design and urban reconnection. We present examples of freeway mitigation/urban design plans that we have developed over the last few years as design research and we suggest some key factors that should be considered as part of a method of identifying and assessing potential opportunities for this work. This is a progress report of on-going research.

Opportunities for Infill Development Over Freeways
Compact urban form, higher densities, closer proximities, pedestrian and transit oriented communities, are widely considered green principles and alternatives to sprawl in the discourse of urban design. But availability of urban land in quantities sufficient for significantly large infill developments is limited even in "low density" cities.

The construction of the interstate freeway system left many cities with freeways in important locations. Important because they provided large-scale regional connectivity at key central points but severed the urban fabric and separated and isolated urban neighborhoods from each other. Freeways occupy a large amount of urban land in these locations. Covering them presents the opportunity for significant and strategic central urban infill development and repair. But implementation of such infill development is challenging and requires many shades of multidisciplinary green thinking.

Urban infill development through reclamation of the right of way airspace over freeways can accomplish several "green" agendas at once:
1. Re-connect urban fabric that was severed by freeway construction for pedestrians, bikes, etc.
2. Provide large amounts of strategically located desirable developable "land" (airspace) in the centers of cities for higher density housing, mixed-use development, and public open space.
3. Mitigate negative impacts of freeways: noise, air and water pollution, views, etc for adjacent communities.
4. Pay for themselves and improve the quality of life for urban dwellers.

This kind of urban infill development requires constructing a structure above a new or existing roadway,
(or rail line, water body or other transportation system)
that can support a variety of uses.
This is a very old concept. Communities have been building over roadways, railways, and water bodies for centuries, mostly as an effort to maintain or reconnect neighborhoods that would otherwise be cut off from each other or from a major civic resource or geographic amenity. Successful decking efforts are diverse in scope and widespread in location. Exemplary projects exist in notable locations like New York City and the Capital Mall in Washington, D.C. Very large projects exist in places like Seattle and of course Boston. Smaller projects exist in places like Monterey, California and Duluth, Minnesota. There are projects throughout the world, old and new, in places such as Barcelona, Spain, Sydney, Australia and Florence, Italy. The uses developed in these reclaimed urban spaces range from passive parks to active sports, shopping malls and convention centers and from small-scale residential housing to high-rise housing or office complexes.

Initial studies suggest promising freeway lid deck opportunities at over 200 feasible and very beneficial sites in the United States. Our on-going research has focused on development of a methodology for determining the feasibility of implementing freeway lid projects.

Topography
Old roads were subject to topography. The interstate freeways subjugated the topography including cities. Mountains were cut, valleys filled, rivers crossed, and cities divided. The topographic relationship between the freeway and the adjacent land is the most important physical factor affecting the feasibility of implementing a freeway lid deck project. At any given point or for any

given length, freeways in a city are either on grade, above grade or below grade. The least expensive freeway deck is one that covers a freeway that is already in an excavated "trench." Below grade freeways were usually constructed to keep roadway slopes from becoming too steep while cutting through hills and/or to allow cross streets and roadways to pass over. Where a freeway was originally constructed below grade in a city to allow several streets to pass over, a lid can "finish the job" of covering it. Obviously this is easiest if the below grade freeway is deep enough to simply be covered without additional excavation as was the case with the lid decks over I-5 in Seattle which support the Washington State Convention and Trade Center and "Freeway Park". The depressed portion of I-405 in Portland presents an excellent opportunity for this kind of project to be completed.

The minimum required vertical clearance for freeways varies somewhat throughout the nation but it is generally 15'-18' above the roadway surface. 20-25' clearance is required between the roadway surface and the bottom of the structure supporting a lid deck. This is necessary to allow lighting, signage, ventilation and other equipment to be installed and still maintain the minimum height clearance for traffic.

"Cut and cover" is the common approach used for depressing freeways under lid decks. Obviously this is easiest for freeways that are at grade or just slightly below grade. But this approach was also used most famously for depressing portions of the elevated central artery freeway in Boston.
When the grade is higher on one side of the freeway and lower on the other, a grade transition lid deck can be employed such as at Freeway Park in Seattle or at Riverfront Plaza in Hartford Connecticut where a descending freeway lid deck was constructed to connect the downtown to the Connecticut River.

Fig. 1: Lid decks have been proposed for I-405 trench in Portland that separates downtown from hillside neighborhoods. (USGS)

Fig. 2: The Washington State Convention and Trade Center and Freeway Park cover a depressed portion of I-5 in Seattle. (Photo by J.Reich)

Other Infrastructure
One of the many reasons that Boston's Central Artery Tunnel project was so expensive was the presence of other infrastructure. The "Big Dig" project had to weave a complex course over, under, and around city utility systems, the subway, bridges, ship channels, the Boston Harbor, and its own continuously operating freeway itself. A more complex setting could hardly be imagined. Obviously the fewer existing urban infrastructure and utility systems that are in the way the more feasible any lid deck project will be.

Geography, urban morphology, adjacent land use, and development potential
Construction of freeways has severed urban communities from each other and from natural geographic amenity features such as waterfronts. A principle reason for building a lid deck over a freeway is re-connection. The layout of the city, density of development and land-use of adjacent areas to be re-connected are important. What

is being reconnected determines success. A freeway that cuts through the middle of a town is a more likely candidate for a lid deck than one on the edge of a town. Freeway right of ways often include landscaped shoulder embankments and median strips. Together with the driving lanes this adds up to a substantial area of land, about 45 acres per mile of interstate and from 50 to 150 acres per interchange. (For example a freeway alignment traversing Vancouver BC on the route of Highway 99 would eat up about 200 acres or about 15% of the land downtown just to cross downtown.)
But what gets built on top of the lid deck is also very important. The area created by the lid deck may remain in the public realm or private development may be facilitated.
Therefore as in all matters of land development strategic location, strategic amount, and strategic use are all crucial. Freeway lid decks that have re-connected cities to their waterfronts, usually with new public open space, have proven to be very successful. Examples of this include Hartford, Duluth and Monterey.
Decking over the 4th Avenue rail lines to create Park Avenue in dense Manhattan and decking over the Papago freeway in sprawling largely single-family Phoenix were very different projects. In Manhattan the priority was covering the rail lines for the benefit of the adjacent densely populated housing. A side benefit was the creation of a more open, now famous public boulevard.

Construction of a new section of freeway in Phoenix allowed access to funds appropriated for "mitigation" of the freeway's impact even though relatively few people were directly affected. Instead the whole city was more generally affected by the creation the 29 acre Deck Park which is the city's second-largest downtown park and

Fig. 3: One proposal for covering the I-70/I-71 freeway to connect Columbus Ohio with its neighborhoods would provide new public open "green" space and mixed-use housing. (Image by Mid-Ohio Regional Planning Commission)

Fig. 4: One preliminary idea for Sacramento's lid over I-5 includes "Vancouver style" housing towers. (Image courtesy of "Bridging I-5 Project")

now considered the heart of Phoenix's downtown cultural center. It helped catalyze revitalization of the surrounding downtown area, including the construction of a new library, new market rate and affordable housing projects, and the expansion or renovation of nearly all the area's museums.

Columbus Ohio's traditional downtown core on the banks of the Scioto River is surrounded on the other three sides by freeways which hinder easy connection with the otherwise nearby residential neighborhoods. Freeway lid decks are proposed for Columbus that would provide both a more pedestrian friendly open space connection and new privately developable sites for infill mixed-use buildings.

Sacramento's current plan for capping Interstate 5 and re-connecting its downtown to its namesake river envisions three uses: public open space (streets, plazas and parks), public buildings, and privately developed mixed-use housing. This kind of combination of uses seems to be the most promising as it represents more stakeholders and more sources of funding.

Sound
A freeway is a noisy, dirty and polluting neighbor to have. The typical freeway produces a noise level of about 70 decibels at a distance of 50 feet, just a little quieter than a typical hairdryer, and well above Federal standards for continuous noise exposure. Traffic noise is the number one noise complaint of people in cities. Most freeway noise is roadway noise (as opposed to engine noise) so development and widespread use of hybrid or quieter engines will not eliminate it. There are pavements that are quieter but they only reduce the noise slightly. Freeway sound walls are costly and sometimes simply reflect the noise into other neighborhoods. A lid

deck virtually eliminates freeway traffic noise and completely transforms the general livability of adjacent neighborhoods. Much political support for a lid deck project can be gained from people wanting traffic noise reduction.

Air
Air pollution from freeways is very dangerous both locally and globally.
Exhaust fumes produced by vehicles as they travel under a lid deck can be collected into ventilation stacks, filtered and cleaned using electrostatic air cleaners or catalytic air cleaners. This would result in cleaner air. Such air cleaning is costly and is just now beginning to be included in lid deck projects. Changes in vehicle fuel technology over the life of a lid deck may yet make such air cleaning unnecessary.

Water
The amount of storm water drainage and runoff from freeway areas is significant and most freeways have not been designed to mitigate the problems of peak flooding and polluted runoff. These issues are most vivid in cities that may already be dealing with runoff problems. Freeway lid decks present the opportunity to comprehensively design improved storm water management (and rainwater harvesting where needed) into a large area at once.

Construction materials & methods
The logistics of construction of freeway lid decks are affected by the availability of staging area around the project and by the necessity for the freeway to remain open while under construction. Careful traffic planning and management during the long construction period are important. The inevitably disruptive impacts that a lid deck construction project will have on neighboring businesses and residents need to be mitigated. About one third of the $14 billion cost of Boston's Big Dig project was for mitigation of construction period impacts.

The lid deck structure should be designed for maximum potential weight for flexibility in what can be put on top. This eliminates the need to add or re-do supports/ reinforcements later. Multi story buildings and up to 5' soil depths are common on these projects.

Cost & Funding
Freeway lid decks are expensive and assuming they are physically possibly their feasibility is principally a function of cost. But cost is relative to value and value can be measured in different ways. Almost all of the lid decks we surveyed have proven to be considered successful and worthwhile in spite of their cost.
For example Riverfront Plaza in downtown Hartford spans I-91 to reunite downtown Hartford with the river. The site includes a permanent high tech canopy over a stage with lawn amphitheater seating for 2,000 people and a boat dock for large ships and excursion boats. The Plaza is equipped with two elevators for handicapped access. This relatively small lid project of all public space completed in 2000 cost $24.6 million. It has generated about $16 million in direct user revenues (by 2004) and claims to have catalyzed more than $1 billion worth of development projects, including housing on sites within walking distance.

Developing a freeway lid deck requires funding from several sources each with their own funding criteria. The larger lid deck projects have been accomplished in conjunction with freeway construction or reconstruction projects using Federal Highway Administration (FHWA) Transportation Equity Act (TEA) funding from the U.S. Department of Transportation (USDOT). This is because of the federal legal requirement that the cost of mitigation of the impacts of freeway construction be included in a new freeway project. (This crucial and seemingly obvious rationale is actually fairly new and contentiously subject to pork barrel politics and differing basic values. The concept of environmental impact has only relatively recently begun to include community and social impacts.) Some have raised the question of whether the Federal government should make funding available through a "reparations" program to fix past damage done to urban communities by past freeway construction.

Additional sources of federal funding for projects have included HUD for the housing and community

Fig. 5: The square ventilation stacks indicate where the 12 lane I-90 freeway would be clearly visible if not for the half-mile long lid. This project includes active and passive open space park, a public elementary school, and infill housing. (Photo by J.Reich)

development aspects of lid decks, the Department of the Interior for open land and recreational area development, and the Environmental Protection Agency for projects that may include clean up of the environment.

Other sources of public funding have included state transportation departments, regional planning agencies, and county and city general funds. Taxes and fees have also been assessed to support lid deck projects including added parcel taxes, state gasoline tax, and water fees (where the project related to preservation of a clean water supply).

Lid decks create developable space and they can produce overall economic development for a community and even income over time. Local property values need to be high enough to make it worthwhile to create what is essentially new developable space. Freeway lid decks produce a saleable commodity in the form of "air rights" which are simply the right to occupy or use the air space above a specific property. Depending on the location this space may be even more valuable than the surrounding land. Land in Manhattan is of course very valuable. Land in Phoenix is also very valuable if it is in the right location.

Land adjacent to a lid deck will be worth more than land adjacent to a freeway. More valuable land will generate more property tax revenue depending on its use (commercial, residential, etc.). Assessing the impact of this ripple effect is one of the major questions remaining for our research.

We assume that uses accommodated on lid decks would cover their own normal operations and maintenance costs. Public spaces (parks plazas and streets) would be maintained by the city as usual and private spaces would be operated and maintained as part of normal business expense. Funds for operating and maintenance of a lid deck itself need to be combined from a variety of sources. These sources include usual state transportation department operations budgets (funded indirectly by taxes paid on the "new" space), income generated from portions of the land for commercial or multi-family residential use, rental or other fee types for playing fields, tennis courts, skateboard park, etc. It may be possible to develop agreements with utility companies for power and maintenance of the tunnels ventilation systems in exchange for clean air credits.

San Luis Obispo Case Study Project

We have proposed a two-mile long freeway lid over Highway 101 in San Luis Obispo California. The construction of the 101 freeway severed the city in two.

Fig. 6: Analysis of proposed freeway lid deck over 101 in San Luis Obispo, California (By Duk Chang (w/JReich)).

Fig. 7: Urban design of proposed 101 lid in San Luis Obispo could provide a substantial amount of strategically located mixed-use multi-family housing and public green space (by Duk Chang (w/ JReich)).

Our research suggests that San Luis Obispo is an excellent site for such a project. There is a growing population and severe housing availability/affordability crisis. Sprawling development of the surrounding agricultural and open land has been resisted and has tended to produce only very high end housing anyway. Most of the freeway is already depressed (though some cut and cover would still be required). The length we have considered is relatively unencumbered with other infrastructure. 101 has sloped embankments and a small median strip so there is sufficient space for construction staging. Covering 101 would re-connect torn urban fabric (including bicycle and pedestrian access) and provide San Luis Obispo with the most strategically located re-developable land in the city. The lid project would produce 35 acres of land (air rights) and directly affect another 100+ adjacent acres. (For comparison, SLO's downtown core is about 70 acres.) Ultimately 2000+/- housing units could be developed between and

Fig. 8: Proposal for a green landscaped, mixed-use, multi-family boulevard which could be developed on and adjacent to a 101 lid and which could become a new kind of neighborhood for San Luis Obispo. (Photo by J.Reich)

within walking distance of the two principle centers of the city which are Cal Poly State University and downtown. Land values are extremely high which could encourage private investment. And of course the town would be quieter and the air would be cleaner.

Conclusions

The places we make and the places we preserve are the best evidence of our socio/cultural values. In 1956, as a response to the desire for economic growth, modeled on the modern efficiency of the German autobahn system, and justified by the cold war, the U.S. began constructing the largest continuous single-use structure in the world. The freeway system was designed with incredible efficiency for its own purpose and with little regard for the natural or urban environments it traversed. This reflected the socio cultural emphasis on movement over rooted ness, on economic growth over cultural development or natural preservation, and on the suburbs over the city.

Passage of the National Environmental Policy Act (NEPA) in 1969 triggered the well-known environmental impact assessment process. Scientifically quantifiable impacts on the (primarily) natural environment began to be addressed (though it has always been a battle). But the transportation planning and NEPA, processes never adequately addressed urban community, neighborhood, social and "people" impacts. Transportation planners and project managers repeatedly claim that these types of impacts are qualitative and that methodologies do not exist to address them, (even though laws and requirements to address social, economic, and environmental impacts during transportation planning, project development, and decision making have been around for 30 years). The impacts of transportation investments on urban communities, neighborhoods, and people have usually only been introduced late in the process, prompted by controversy, complaints, or lawsuits. It wasn't until 1996 that FHWA initiated efforts to re-educate transportation professionals and enhance their expertise on how to address these issues by publishing a primer called "Community Impact Assessment" on how to assess the impacts of a freeway on urban communities.

Freeways have separated as much as they have connected. Covering them in strategic locations can mitigate this impact. In rural areas "naturally" landscaped lid decks known as "critter crossings" have been constructed to reconnect severed wildlife migration routes and connect wilderness areas. In cities, where there is a necessity for proximity, and for the efficiency of multi-use space, the urban design value of lid decks is beginning to be realized.

The complexity inherent in creating usable urban space above transportation corridors in cities requires cross-disciplinary holistic thinking and coordination. These projects raise questions of transportation infrastructure, urban planning, urban design, landscape urbanism, funding mechanisms, land values and revenues, as well as a host of legal, political, cultural and natural resource issues. But the desired result is too important to be left to transportation planners, engineers, policy wonks and other specialists. The urgent community based demands for freeway mitigation to result in quality urban space outcomes suggest that leadership by generalists such as architects, urban designers, landscape urbanists, capable of managing interdisciplinary teams of specialists is necessary.

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Fig. 9: A "naturally" landscaped wildlife crossing (aka land bridge, "eco-duct" or "green bridge") in Switzerland. (Photo by Scott Jackson/FHWA)

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