

JOURNAL REPORT | THE FUTURE OF CITIES

Boring Has Never Been So Exciting

New advances in technology have dramatically reduced the cost—and disruption—of building tunnels

BY DANIEL MICHAELS

CITIES ARE GOING DOWN.

To manage relentless growth, urban centers are expanding underground at an unprecedented pace. But it isn't just the crush of humanity above the ground that is behind the subterranean push. It also is the result of dramatic advances in a field almost as old as civilization: tunneling.

Engineers in recent decades have developed mechanized and automated systems to chew through deep rock or muck and immediately line an excavation to prevent collapse—all without disturbing the busy city above. That means projects that once would have taken armies of men years to dig now can advance in a fraction of the time and at much lower cost.

Massive robotic worms have been burrowing rail, road and utility tunnels under New York, Singapore and London, little noticed by residents. Washington, D.C. and Indianapolis are boring vast underground cisterns to store rainwater. And Cleveland is punching narrow sewer-pipe ducts through dirt and rock without ripping open streets or lawns.

Even cities prone to seismic activity, such as Los Angeles and Istanbul, are building tunnels thanks to innovations in equipment and techniques. In the Turkish megalopolis, a new roadway under the deep Bosphorus waterway includes joints that permit sections of the tunnel to move during an earthquake without structural damage.

"Major cities just can't function without going underground," says Joe Guertin, a retired geotechnical engineer who worked on tunnels in the U.S. for five decades, including New York subway projects in the



Boring machines for London's new Crossrail rail link are digging 13-mile-long tunnels that cross beneath the city center.

1970s. "Technology has changed the equation."

Urban stealth

Not all projects advance smoothly. Under Seattle, one of the world's largest tunnel-boring machines sat idle for two years until December, undergoing repairs after unexpectedly hitting metal pipes near the start of a highway dig. But Seattle's experience—which attracted a lot of attention because of the project's problems and delays—is unusual these days.

"There are tunnel-boring machines all over the world in very complex geology that never get any attention," says Michael Mooney, a professor of underground construction and tunneling at the Colorado School of Mines.

Indeed, the number of tunnel-boring machines, or TBMs, in operation has surged since 2000. **Herrenknecht** AG, one of the world's biggest TBM makers, says it is providing machines for as many as 100 projects annually, up from as many as 20 some 15 years ago.

"The ability to deliver a tunnel on time and on budget has changed a

lot...and really pushed the industry," says Achim Kühn, a spokesman for the privately held German company, whose tunnel-boring machines can cost more than \$50 million each.

Few places illustrate the progress more than New York. The metropolis was a tunneling pioneer a century ago, but financial woes after World War II ended that. Today, urgently needed rail tunnels are again advancing.

Few New Yorkers are aware of the underground work that is going on, which makes the city's top rail tunneler happy. Michael Horodniceanu, president of capital construction for the Metropolitan Transportation Authority, keeps a photograph of central Manhattan streets ripped open to build the Broadway subway line around 1900. The old construction approach, which turned the famously busy thoroughfare into a massive trench, cut off buildings and snarled traffic while the avenue was excavated and resurfaced.

Tunnelers then "weren't concerned with the impact of the construction on the surrounding area," says Mr. Horodniceanu. Today, upending lives and commerce isn't an

option.

MTA projects now snake through spots with more than 100,000 people per square mile, including along Manhattan's Second Avenue and posh Park Avenue.

"The technology allows us to go and dig without people knowing we are there," Mr. Horodniceanu says.

Dramatic savings

Pioneering urban tunnels—including London's Thames Tunnel, which opened in 1843, and New York's Holland Tunnel, which opened in 1927—were dug by workers with picks and shovels. Supplying air to workers and fortifying the dig before it could collapse were constant challenges. Tunneling through hard rock required blasting that threatened the buildings above.

Machines began replacing human tunnelers in the 1950s, after American mining engineer James Robbins built a giant auger to eat through shale for a hydroelectric dam in South Dakota. The tunnel-boring machine, a cylinder with cutting wheels protruding from its circular face, dug up to 10 times as fast as traditional methods.

But most cities sit on softer ground that can collapse after excavation, like sand on a beach. Many urban tunnels must run below the water table in saturated, fluid earth. Even mild subsidence can damage pipes, rail tracks or buildings above. So during the 1970s, Japanese and German engineers learned to use water and air pressure to stabilize the ground around a borer. They developed tunnel-boring machines that could robotically install precast concrete tunnel-lining panels immediately behind the cutting face, leaving a nearly completed thoroughfare in their wake.

The savings from automation can be dramatic. Mr. Horodniceanu says the MTA recently had to manually dig a particularly difficult 120-foot tunnel at a cost of almost \$1 million per foot. By contrast, tunneling 3 miles under Second Avenue with giant machines cost about \$19,000 per foot, he says.

"The fact we can utilize TBMs makes a hell of a difference," he says.

Other recent advances in tunneling technology include precision guidance to thread around existing infrastructure and electronic monitors to track vibrations, which let tunnelers stop at the first hint of trouble. Advances in chemistry allow engineers to thicken loose ground or soften hard terrain.

These innovations have enabled tunneling in areas once considered impassable. Miami recently dug a traffic tunnel beneath a busy waterway by eating through a mix of saturated ground and porous coral rock that previously defied affordable excavation. The dig was "wildly successful," Prof. Mooney says.

New technologies, analytical tools and materials have "facilitated the design of tunnels under adverse conditions," says George A. Munfakh, director of geotechnical and tunneling at engineering firm WSP-Parsons Brinckerhoff. With science and technology, "the engineering and economics of urban tunneling have definitely changed."

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New Rochelle, N.Y., aims to create a more urban downtown with projects like this around the town's Library Green.

Suburbs Hope to Be the New Cities

Some places think it's the way to attract young workers

BY ELIOT BROWN

FOR MORE THAN a generation, the suburb of New Rochelle, N.Y., has been struggling with a stagnant economy, closed storefronts and tax revenue that has fallen even as New York City has boomed just 15 miles to the south.

Now this bedroom community is forging ahead with a plan to remake its low-slung downtown into a landscape checkered with office towers, high-rise apartments and new retail. Over the past year and a half, it has changed its zoning and signed on a team of developers to start building some of the planned towers—all in a bid to attract new employers and residents and breathe life into the local economy.

In short, this suburb is trying to look urban. And it isn't the only one. Urbanization efforts in New Rochelle, a city of 79,000, offer a glimpse of changes taking shape in suburbs around the country. While the approaches vary, what they share is a general desire for urban-style development meant to appeal to youth and attract employers who might otherwise gravitate to cities.

Coast to coast

Tyson's Corner, a giant collection of suburban-style office parks in Virginia near Washington, D.C., is pushing developers to build apartments, tall office towers and street grids. North Carolina's Research Triangle Park—a bastion of isolated

corporate campuses built in the second half of last century—is now trying to develop about 1,500 apartments mixed with offices for multiple companies, a first for the park. Officials there hope more will follow.

Similar campaigns are under way from Plano, Texas, to San Ramon, Calif. These efforts mark a major shift, planners say, particularly

College-educated young adults are drawn to urban living. Suburbs hope to provide that.

given that cities were trying to compete with suburbs just a few decades ago, plowing highways through downtowns and building enclosed urban malls.

"The suburbs are mimicking cities like just cities were mimicking suburbs," says Bruce Katz, who focuses on urbanization at the Brookings Institution, a think tank in Washington. "This is really an upending."

Of course, these changes are still nascent. It's too early to say how the broader market will react to these still largely isolated visions. In the 1990s and early 2000s, many developers bet on "new urbanism," a concept that generally sought to build mixed-use communities on empty swaths of land. The efforts never took off on a large scale, sty-

mied in part by the 2008-2009 housing bust.

Youth migration

But part of what is driving suburban redevelopment now is the migration by young Americans, particularly the college-educated, out of the suburbs to city centers. From 2000 to 2010, for instance, the population of college-educated 25- to 34-year-old residents in downtowns grew 44%, three times as fast as the rest of the metro areas for the 50 largest cities, according to a pair of researchers from University of California, Berkeley, and the University of Pennsylvania.

The researchers, Victor Couture and Jessie Handbury, say in a working paper that "urban revival" in the 50 largest U.S. cities "is accounted for almost entirely by the rising share of college-educated individuals."

Trends like these have made it harder for suburbs to attract new employers, who often want to be nearer to the young, talented workforce. Hence the widespread drive to bring more aspects of urban living to suburbia.

A dense downtown "can enhance our civic image and provide a sort of heart to the community," says New Rochelle Mayor Noam Bramson. "If we want our children and grandchildren to be able to live in places like New Rochelle, then we've got to position our community to be attractive to those communities."

Far older than many U.S. suburbs that sprouted after World War II—New Rochelle's population grew fastest in the early 20th century—the town has been struggling economically for the past few decades, with almost no new office development and relatively little apartment construction.

Now a pair of developers—the city hopes others will follow—are forging ahead on a set of development sites downtown. Ultimately, over the next 10 years, city officials are anticipating construction of 5,500 apartments and more than 3 million square feet of retail and office space, enough to fill the Empire State Building.

Tomorrow's town

In part, the suburb's old age adds to its allure for this type of development. Built up before cars were widespread, it has a train stop on the commuter rail just half an hour from Midtown Manhattan, and its own downtown where residents can tolerate dense construction.

"The beauty of New York suburbs is they have real downtowns," says Seth Pinsky, an executive vice president at RXR Realty. Mr. Pinsky's firm and developer Renaissance Downtowns completed a deal late last year with New Rochelle to take the lead in the redevelopment of the downtown—and they're working on similar efforts in other New York area suburbs.

In New Rochelle, the two developers are planning to start on their first large building this year or early next, an apartment building nearly 30 stories high.

Should high-rise building in places like New Rochelle indeed take off, that could help relieve pressure on New York City housing, says Mr. Pinsky, who was a top economic-development official for former New York City Mayor Michael Bloomberg.

"New York City continues to become more expensive, which makes it more and more difficult for people looking for an urban environment to find it affordably in the five boroughs," Mr. Pinsky says. If those people can indeed be attracted to urban-style living in the suburbs, employers should follow, he says.

The young and educated "are increasingly looking for a different lifestyle, and when the suburbs don't offer that lifestyle, they lose that population," he says. "That population is a significant part of the workforce for which businesses are looking."

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Can Curfews Cut Crime?

BY BROOKE ANDERSON

AS U.S. CITIES grapple with crime, many have initiated curfews for youths, betting that if they can keep young people inside at night, they will have fewer problems.

But do curfews really work? New research suggests they don't and in fact may be counterproductive to public safety.

In a working paper, Profs. Jillian B. Carr of Purdue University and Jennifer L. Doleac of the University of Virginia tracked gun violence during curfew times in poor sections of Washington, D.C. They found that gunshot incidents increased during curfew hours.

The Wall Street Journal recently spoke with Dr. Doleac about her research. Here are edited excerpts:

WSJ: *What inspired you to conduct this study?*

DR. DOLEAC: There is no empirical evidence that curfews work, but voters and legislators have it in their mind that juveniles shouldn't be out that late.

WSJ: *What is the most surprising thing you learned?*

DR. DOLEAC: That juvenile curfews are counterproductive for public safety. When the curfew switches [from midnight to 11 p.m. in Washington in September] gun violence goes up during the 11 p.m. hour. Because nothing else changes suddenly during that hour, and we don't see similar effects in other hours of the day, we can be sure the increase is due to the curfew.

WSJ: *Why do you think gun violence goes up?*

DR. DOLEAC: Having people around helps deter crime by increasing the likelihood that an offender will get caught. Curfews incentivize law-abiding citizens to be at home instead of out on the streets.

Also, enforcing the curfew distracts police from doing other things. If those things were effective, then switching police attention to curfew enforcement will increase crime.

WSJ: *What should be the takeaway from this study?*

DR. DOLEAC: All else being equal, I'd hope police would err on side of caution and end these curfews.

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