Multimodal Transit and a New Civic Architecture

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MULTIMODAL TRANSIT AND A NEW CIVIC ARCHITECTURE

A Thesis Presented

by

SAMUEL BRUCE HILL

Submitted to the Graduate School of the
University of Massachusetts Amherst in partial fulfillment
of the requirements for the degree of

MASTER OF ARCHITECTURE

May 2020

Department of Architecture
ACKNOWLEDGMENTS

I would first like to thank Professor Riahi for her feedback—honest when I was avoiding the truth, strong when I was stubborn, and supportive when I was uncertain. Thank you also for acting as my advocate in situations unknown, and for believing in my ideas.

I would like to thank Professor Lugosch for her steady hand at the tiller through the choppy waters of writing and design.

I would like to thank Professor Mann for her guidance in shaping all of our nascent projects, and for pushing us to push our own comfortable boundaries and assumptions.

I would like to thank Professor Williams for his thoughtful feedback, his ever-willingness to help, and his kind words when my project felt hopeless.

The opportunity to pursue this degree and career has been an experience unparalleled in my life. Thank you to my peers for their constancy through it all.

Finally, I would like to thank my family, without whom, none of this would be possible.
We live in an age defined by the automobile and its infrastructure. This paradigm of movement has shaped how we live our lives, and the urban frameworks we inhabit. Cars as a form of transportation damage the environment and engender unsustainable lifestyles. They also create anti-social spaces with the infrastructure they require, and therefore their success is inverse to that of the pedestrian experience.

I seek to adapt this transit paradigm with a more flexible and resilient multimodal system. My work focuses on reinvigorating a rail line in central Massachusetts and designing a modular station system that can serve as a new kind of civic architecture. The station grows and shrinks between towns of different sizes, and over time. It slots into existing communities with little disruption, and is programmatically fluid and diverse, such that an array of stakeholders become invested in its success. It also presents as a new type of civic architecture; a building that represents a larger system, while also maintaining its place in local communities.
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At the close of the First World War, the United States was riding on a new high. Though they arrived late, the Americans played a key role in the Allied victory against the Austro-Hungarian alliance. They had performed on a global stage, demonstrating technological prowess, political force, and great economic potential. The capacity of American capital had only been enhanced by the large wartime orders of machines, munitions, weapons, and necessities. As soldiers and military staff made their way home, they did so carrying this potential, distributed—though unevenly—amongst them.

This potential was not only in capital, but in aspirations. Young people started families with an eye on the bright future that had started to coalesce after half a century of untiring advancement. They wanted to make a homestead for their children, and to take advantage of the technology bringing comfort and convenience; in ways not possible when their parents were packed in tenements, picking their way through dirty, crowded streets, chasing down the trolley to a job in hot, low-wage danger.

These young Americans wanted this new life. And on the backs of post-war prosperity, they went out and bought it. Large detached homes, filled with all the modern conveniences; clean, high-status jobs in the city; and a stylish ride to link these now separated spheres of life. Never again would work encroach on
their lives of quasi-rural idyll. Never again would a carriage, motor car, or errant tram threaten their playing children.

We now look back on this dream, and though the reality is far less rosy, it can be hard for some to imagine a lifestyle that is different—many Americans live miles from their jobs, with private plots of land behind their detached homes, homes with conveniences and electronics that were unimaginable just a couple generations ago.

In short, the dreams of these returning soldiers came to fruition. The paradigm of lifestyle, weighty and slow as a tectonic plate, sent the first tremor up through the soil in this interwar period. Though the shifting ground beneath the feet of the average American would take decades to settle—when it did, the vast lands of this nation would be unrecognizable. Though this period of change is rich in stories of innovation and invention, there is one advancement in particular that is significant, though understated—When the breadwinners of the young post-war families left in the morning, they did not walk, nor bike. They did not trace a hard-worn path out to tend their plot or wait for a train or tram. They drove.

That they drove is more significant than it appears on the surface. Before the First World War, cars were not only extremely expensive and therefore merely toys for the rich—they were also complicated to operate, quick to break and difficult to fix once broken. The roads over which they travelled were rough
and unfinished, and meandered from farmstead to village to town without any particular haste.¹

Just before, during, and especially after the war, the car industry went through a transformation. The infamous Mr. Ford reinvented industrial production, and in so doing brought the car in reach of the middle class. Manufacturers started to coalesce around a standard layout for controls, and engine technology improved reliability and repairability. Just as important as the changes to the automobile itself, infrastructure started to catch up with the four-wheeled visionaries. Roads were smoothed-over and paved, new routes--now straight and fast--were cut past the winding and rutted tracks of old.² There was even construction of roads on which all forms of transit but the car were banned--a totally foreign concept up to this point.³

And so, the new moderately-monied masses flocked to the automobile.

With the new parkways and state routes, the car was catching up with even the fastest of trains. They were extremely convenient, allowing an individual to move between their start and end points directly, on whatever schedule they decided on. In addition to a convenience, the car was a symbol.⁴ It not only symbolized the disposable income that was invested into it; the driver of the automobile lived in the clean new suburbs. They moved freely, with no central schedule to adhere

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to. They explored the busy city and the idyllic countryside equally well. They transported the nuclear family as its own unit.

Culture started to blossom around this popularity. This young, energetic class not only consumed homes and appliances—they explored and roamed as well; they travelled to difficult-to-reach areas of leisure. They picked up lunch at a roadside restaurant, and took in an evening flick without ever leaving their automobile. They rested for the night in convenient motor-hotels. Commercial enterprise and infrastructure oriented itself around the car and its lifestyle. This reorientation of business was just one aspect of the built environment that began to bend itself around the new life ushered in by the internal combustion engine. The car was what today we would, without irony, call 'disruptive'. The young, white-collar, white picket, white American families were living the future, and they got there in their car.

In 1929, the dream America was driving stalled out. A decade of prosperity gave way to a decade of hardship. The middle class saw the cruel underbelly of the market that had served them so well since the war. Those who could not afford the middle class got to know this cruelty firsthand. Before the Crash, progress had been breakneck—when the bottom dropped out, hundreds of innovators and speculators dropped out with it. Production dropped by 75% and

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5 Swift, *The Big Roads...*, 136-139
dozens of niche and luxury manufacturers went out of business. The survivors dug in and waited out the hard times.

Despite this drop in business, the car did not recede from its new place in American culture. Examples are evident movies, books, and pop culture of this period—In *The Grapes of Wrath*, the Joads limped their way across four states, piled into a seventy-five dollar ’26 Hudson truck. Bonnie and her lover fled the police in their ’34 Ford. Bootleggers ran their contraband across state lines under false floorboards and faux spare tires, outrunning the authorities with modified big-block V8 engines, which led directly to the development of NASCAR. The automakers that survived pivoted towards making reliable low-cost vehicles, and the pace of innovation quickened.

However, at the current rate of invention and adoption, cars had lost their early momentum. Though they had a solid place in America’s transport infrastructure, it was far from universal. Just like the First World War gave them an early boost, the coming global conflagration was poised to give them a second life.

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8 DeLucia, “Positioning Steinbeck’s Automobiles…”, 140.
Europe was again torn down, in physical and political ashes. Another war had transformed the Continent into a hellscape. The United States, on the other hand, was in a familiar position. It had again joined in a devastating global conflict. It had emerged not just as a leader on the battlefield, but as a dominant political superpower. Once again, the nation had demonstrated its technological, military, and industrial prowess, and financed much of the effort to boot. This second economic boom and dominance of the international stage tends to be better remembered today. Indeed, it has a more direct link with the conditions of the modern day than what came after WWI. However, it was the aftermath of the first of the two that set a significant part of the cultural course following the second.

Returning soldiers, more numerous than before, swelled the ranks of the middle class. They did so with better benefits as well; many of those who fought abroad came back to a guaranteed education and low-interest loans. Those who were afforded these benefits took full advantage, flooding universities and then the workforce, bringing high-tech skills to the industrial beast that had helped win the war. They also followed similar social trends as their parents two and a half decades earlier. New and growing families moved into rapidly multiplying suburban developments, and outfitted these dwellings with the ever-increasing variety of home goods and technology available to those in this

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income bracket. They too returned to their cars, both as a method of transportation around their increasingly sprawling neighborhoods and towns, but also again as symbols of class.

Manufacturers, who had all but stopped production of civilian cars during the war, returned with gusto. Flashy new designs began to reference the atmospheric ambitions of this freshly-minted superpower, in a race with a new type of adversary. The car brands that had struggled through the Great Depression were now behemoths, building millions of vehicles every year, and inspiring rabid brand loyalty. The convenience and comfort of the car increased even further, with features like automatic transmissions and air conditioning that were reserved for only the most luxurious cars pre-war.\textsuperscript{12}

Again, however, it was not the luxury, culture, or the technology that defined this reborn automotive age. It was the incredible infrastructural advancements that cemented the car as the mode of transportation in the United States.

Most notably, it was the Interstate System that connected this country in a way that had not been achieved for a century. However, this was not the result of a speculative bubble with haphazard encouragement by the state--it was instead a carefully-planned government policy aimed at improving the military capabilities of the United States, and guarding against a foreign land invasion that many seemed to think was only a matter of time.\textsuperscript{13}

\textsuperscript{12} Swift, \textit{Big Roads...}, 19-22.

\textsuperscript{13} Swift, \textit{The Big Roads...}, 178-180
In fact, this vast network is still officially called the “Dwight D. Eisenhower National System of Interstate and Defense Highways”. The political will generated by the fear of the Soviet Union and communism generally was enough to approve a project that ultimately cost a quarter of the gross national product.\(^\text{14}\)

This incredible network provided a route for white flight and a backbone for suburbanization. As those who had benefited after the war fled the cities, they took their tax dollars and political will with them. They left behind those that the government had decided not to afford equal treatment or opportunity, namely black Americans. They had fought and died abroad, but returned to a country no less discriminatory than before.\(^\text{15}\) They not only did not receive government aid as often as their white comrades, but additionally were actively and systematically discriminated against through practices like red-lining.\(^\text{16}\)

These programs were aimed at preventing black Americans from moving to suburbs alongside white neighbors. Instead, the cities and the suburbs became increasingly racially stratified. This stratification followed the same contours of interwar racism, but was now reinforced by class signals, like the detached home in the suburbs, and the new and shiny automobile.\(^\text{17}\)

On top of these active policies and underlying bigotry, the planners behind the Interstates came to the cash-poor and distressed cities and cut deep into the flesh of the urban landscape. When the interstates met a city, they curved gently

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\(^{16}\) Madrigal, Alexis C. “The Racist Housing Policy That Made Your Neighborhood”. The Atlantic, 22 May 2014.

\(^{17}\) Humes, “How the GI Bill Shunted Blacks…”, 92-104
around the central business district and then plowed into millions of acres of homes, businesses, neighborhoods, street corners—whole lives and histories. All large projects come with their fair share of destruction. The Interstate system is unique in the scale of the carnage, and in the inequality of who was affected by it.  

When the overpasses planted their concrete piers into a city, they broke what made cities tick; they created deep divisions between places that had previously been inseparably interwoven. They moved people off their feet and into seats, and insulated them behind thick glass.

The driver arrived in the city at speed. They descended from above, off the ramp and into the melee. Speeding steel pressed through narrow streets, clogged and spilling over onto areas once the preserve of the pedestrian. And so the roads were widened, and the steel rushed by. The drivers stacked up against the sidewalks, and pretty soon could not find a spot.

Then, the eyesores that were also homes and shops and were not as nice as they once were, were pulled down, and their empty scars were filled in and paved over. Whole blocks were converted to asphalt. When even this would not do, they built new buildings on the scars and filled them not with those who had lost their homes, but with ever more cars.

When the car came to the countryside, it linked the faraway corners that were unimaginably isolated before. It brought people to nature, and helped the

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18 Swift, Earl. “The Human Obstacle”. In The Big Roads
nation explore its fantastic variety. When it came to towns, it helped them grow faster than they ever had, eating up land with lots and plots.

When cars came to the city, it grated against an environment that was inherently pedestrian. In communities across the country, it relieved this friction by tearing down the offending density. In other places it had less success, and neighborhoods like Sommerville, Brooklyn, and the North End, poverty was assumed as the only future--these places were not adapted to survive.¹⁹

The decline of urban areas continued unabated--though not unrecognized--for the next several decades. Though the impact of the car on cities had been highlighted before, most notably by Jane Jacobs, it was not until the end of the decade that there was a national reckoning on the role of the car, and the impact of humans on the environment more broadly. The year after Jacobs published her tome, the equally-consequential writer and scientist, Rachel Carson, described a dark endpoint for the country’s current growth.²⁰ In 1969, a body of moving water caught fire²¹, and an ocean harbor was filled with oil²². The next

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²¹ The Cuyahoga River is a major waterway running through Cleveland, Ohio. On the 22nd of June 1969, sparks from a passing train ignited oily debris floating in the water.
²² On January 28, 1969, an offshore oil platform experienced a blow-out of its well, resulting in a month-long oil spill off the coast of Santa Barbara, California. This spill still stands as the third-largest in the United States.
year the first piece of broad environmental legislation was passed, followed by an even more powerful act two years later.\textsuperscript{23}

This half-decade of rapid progress on environmental issues was underlined in just the following year, when the US was stunned by the ‘73 Oil Crisis. This was the first stutter in an otherwise seamless growth curve, the first indication that the automobile was not a golden bullet without consequences. For the first time, it was driven home that the world the car had created might be inefficient and energy-intensive. This energy was also unstable and finite, and the scars of decades of unrelating growth at all costs were showing up everywhere. It took the combination of these dramatic events and important thinkers to reveal the assumptions on which our nation’s growth was based. This recognition of the limits of the system in place is also a recognition of the potential for a change in that system.

And yet, to this day it is difficult to imagine a future that is not primarily carried by cars, or perhaps their futuristic descendants. On the contrary, this feeling of inevitability and eternity are the result of the limits of perception; they are not truth. To understand how the backbone of a whole nation’s transportation network can grow, peak, and die, we must look back to when America was just a little more than fifty years old.

\textsuperscript{23} In January 1970, President Richard Nixon signed the National Environmental Policy Act, followed by the founding of the Environmental Protection Agency later that same year. In 1972, a presidential veto by President Nixon on the Clean Water Act was overridden by both houses of Congress.
CHAPTER II

IT’S QUICKER BY RAIL!

**Early Origins: 1840 - 1860**

In 1840, the United States was still a bit player on the world stage. The country was primarily agrarian, with only 10% of the population living in urban areas.\(^{24}\) It was on the cusp of a transformation, however; one that would change where people lived, worked, how they moved around—even the cultural make-up of the country.

This shift was already occurring in Great Britain, which held the seat of Western hegemon that the United States would eventually inherit. This change was the culmination of revolutions in manufacturing, in political thought and governmental structure, and in class and economic theory. The technology on which this progress moved, however, was powered by steam.

Between 1830 and 1840, the United Kingdom was draped in a spaghetti of rail lines that connected all the major cities and many minor municipalities. The United States would undergo the same transformation in the following decade. These early trains were constructed mainly to compete with canals and river transport for a share of freight. Trains were faster, more reliable, and could be sent wherever there was a will to build track.\(^{25}\)

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As for moving passengers, the major method of medium and long-distance transportation up to this point was by stagecoach. Though comfort had developed gradually, this was not fundamentally different from the animal-drawn wagons that had been used around the world for millennia. The same benefits of speed, flexibility, and efficiency that made it an attractive choice to move freight applied equally to passengers, and companies speculating on passenger rail lines grew quickly alongside their shipping counterparts.26

Rapid Growth: 1860 - 1880

Within only twenty years, all the major cities of the Northeast and Midwest of the United States were linked. These services were made possible by public-private partnerships and wild speculation that was fast becoming a part of the modern industrial economy. In the Northeast, private rail companies financed the construction of new rail lines and independently operated these services when they came online.27 Fierce competition meant there were often multiple lines between major cities, increasing the density of rail transit in the region. Lines competed on price, brand, and location to pull customers from their competitors.28

In the Midwest, rail companies were granted millions of acres by the federal government, on which they could build rail lines and even whole cities with which they could populate with passengers. This was not an act of goodwill by Washington—the land the rail companies were granted was often tied up in inconvenient treaties with the long-time occupants of that land, and establishing rail lines and Anglo settlements gave the military a population they could protect from the ‘invaders’—mainly by slaughtering and resettling the native population.29

Though taking land by force was not new, the methods of financing and operating these companies was revolutionary. So too were the way rail companies shaped the landscape to their aims and technology. Not only did rail lines cut through mountains and soar over valleys on rickety trestles—it created a grid of new settlements across the country, all lying alongside and depending on the train tracks that were their lifeline. Technology has always come to shape the landscape and culture it is adopted by—however, it has rarely happened so quickly.

**The Bubble Bursts: 1880 - 1900**

Throughout and following the cultural and physical chaos of the Civil War, railroads started to shift from the exciting upstart to the established norm. In much of the country, rail travel was ubiquitous and essential. However, the bubble of speculation that had fed its rapid growth and densification was at its breaking point. The Panic of 1873 was the trigger for a severe economic

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depression that affected much of the Western world. Though the causes were complex, speculative overinvestment in railroads and other industries has been highlighted as a major factor.  

The depression caused the closure of hundreds of rail companies, and the general consolidation of the industry into just a few large players. Though the downturn certainly slowed growth, there were still enormous profits to be made in the sector, which was only enhanced by a reduction in competition. The survivors of the depression morphed into monopolies that, along with the titans of finance, manufacturing, and resource-extraction, defined the period dubbed ‘the Gilded Age’ by the famed polyonymous Missourian humorist.

Despite this and later downturns, this was still a period of huge growth in industry and technology, and even improvements in wages and working conditions. This was also a period of massive immigration, which created an important layer of the cultural bedrock of contemporary America. These immigrants and native-born citizens arrived in major cities in vast numbers, such that by the end of the century over 40% of the country lived in cities. These urban residents were no longer self-employed farmers or tradespeople, but

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30 Ward, James A. “The Problems of Empire”. In Railroads and the Character…
employees of large companies, working in centralized factories and offices, and living in dense tenements and apartments.\textsuperscript{33}

This shift in lifestyle was created in large part by the system of transport that underpinned this growth, depression, institutional corruption, and political change. The Progressive Era which followed the Gilded Age was in large part a response to these perceived changes for the worse--both in terms of economic and social conditions of workers and the cities they inhabited, but also in terms of the cultural changes resulting from immigration that some people found threatening. This era was also defined by the aggressive action its supporters took against the industrial monopolies of the previous era.

\textbf{Interurbans: 1900 - 1930}

Though this new era pushed back against the lumbering rail companies that had caused so much economic and social pain, the transport paradigm on tracks was not yet over. As cities swelled and expanded past their traditional boundaries, a new form of mass transit entered the scene: this was the electric interurban service; a hybrid between a streetcar and a train. Streetcars had existed for several decades, first pulled by horses, and later by cables or powered by electrified overhead lines. The interurban adopted the efficient overhead lines and street-laid tracks of the tram and combined it with the range and speed of the train. These services ran on and off public streets, serving both the busy central business districts of large cities and the suburbs and hinterlands.

\textsuperscript{33} Krupczynski, Joseph and Max Page. “Holyoke’s Historic Richardson Station”. \textit{The City of Holyoke}. August 2014. 10.
between urban areas. They differed from commuter services in that they did not radiate around one metro, but instead were spun—web-like—from one settlement to the next.\textsuperscript{34}

In large cities, these interurbans took some pressure off the suffocating density that was pressing in on the metro cores. They allowed workers to live further from where they worked, shopped, and took leisure time, without sacrificing time or comfort. In rural areas they brought the benefits of rail service to regions where train companies did not bother to build stations or extend lines. In just a couple decades, interurbans services cropped up in nearly every major city, and many of the in-between areas as well. They were so prevalent that an entirely new settlement typology emerged: the streetcar suburb.\textsuperscript{35}

However, it was a hybrid that inherited many of the flaws of its predecessors; just like trains, interurbans had grown quickly and densely as a result of poorly-considered speculation. Both to save on construction costs, and to ensure the lines were installed quickly, the investors of these companies funded shoddy-quality lines that had reached the end of their lives within a decade or two. Few of the lines ever turned a profit.\textsuperscript{36}

This coming-home of problems coincided with the country’s first major political and cultural test on the global stage—the First World War.

\textsuperscript{36} Grant, “Interurbans in Daily Life”, in \textit{Electric Interurbans}…, 124.
The War was the death knell for both the young interurban and the venerable train. The train companies started to face long-overdue scrutiny and regulation that cut down on their profits. During the war they were nationalized to improve their ability to serve the war effort. When they were re-privatized at the end of the conflict, any cultural currency or excitement around them had fully evaporated--the city was a dirty, crowded place for immigrants and the poor. The train was the vehicle for these people and their way of life. The future lay in a return to the rural roots of the country, made by possible a freeing new invention.\(^{37}\)

Interurbans died for these reasons, as well as for much more pragmatic issues--their cheap infrastructure was already falling-apart, and the investors that had lost money for a decade were not enthused about paying for the repair of these money pits. Rail and interurban travel peaked in the States in 1920. A steep decline and decades of neglect lay ahead.\(^{38}\)

Figure 1: The new interurban service, Gorham, ME. Photo by John A. Waterman, 1901

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\(^{38}\) Grant, “Interurbans in Daily Life”, in *Electric Interurbans*, 75-98.
CHAPTER III.

SO SWIFTLY HOME...

_Here and There_

Thus far, we have explored two paradigms of transportation: first, how the United States became dominated and shaped by the automobile. Second, the motive power of the nation before the car, and its relationship to the making of the modern economy.

When contemporary critics bemoan the dearth of mass transit in the United States, without fail they point to the dozen or so other nations that have seemingly seamless, mature, and popular national and regional networks that put the likes of Amtrak and the MBTA to shame. The common response to these whinings is that the places in question--Western Europe, East Asia--are too different from the US for anything like what they have to work here. Europe is so much denser, Asia is so much more populous.

These counterpoints are of course true. Mass transit thrives on density and large populations, and Asia and Europe are a world apart from the US in these two areas. However, as has been outlined the preceding two chapters, the way the built environment appears today is in large part because of how its transportation system developed in the past. The United States is large and largely empty\(^39\), but the places people do live grew to their current form primarily

\(^{39}\) According to USDA, ~75% of land in the US is farmland or undeveloped. A fair proportion of the remaining 25% is also not occupied by development, but their data is not granular enough to express exact figures.
because the car allowed them to do so--i.e., what the primary method of transit in this country is has less to do with than the latter has to do with the former. 40

To emphasize this, we only need to look to the previous chapter--though the United States inherited rail technology from abroad, it embraced it more energetically than any other country. Between 1840 and 1920, the changes to the American workplace, home, and city were made possible by rail--and these changes reinforced the position of importance of rail. However, the multitude of changes to the country during the interwar and postwar periods, as described in the first chapter, resulted in a fundamental shift of the transit paradigm in this country.

When we review the development of transportation in other nations, we can see forks that split off American development from the previously very similar transit landscape of these mass-transit ‘utopias’. For example, the United Kingdom is an excellent point of comparison to the States. Not only was it the birthplace of rail travel, but settlement patterns are culturally and spatially more similar to the United States than most Continental and Asian examples.

**Rail in Britain**

The US and the UK have similar trajectories of the growth of train transport in the 19th century, except that the UK was about a decade more advanced at the start, and the US industry was far more powerful by its end. Britain had a well-developed network by 1840, and was utterly changed by rail by

the end of the century. Also like the US, the UK nationalized its rail service during the First World War. This vastly increased the efficiency of the network, which had previously been highly fragmented and over-invested. Following the conflict, the UK decided to only partially-reprivatize the network. The numerous lines were grouped into four geographically-distinct and independent organizations. These were private companies, but their activities and interactions were closely controlled by the State. Though there was no geographic competition, the ‘Big Four’ competed fiercely on the perception of their brands. The economic boom following the Great War was muted in comparison to the US, and there was less growth of the middle class. This, combined with stricter regulation and taxation of cars and their infrastructure meant that rail did not face as intense competition from this desirable new technology. This allowed train companies to move with the times more readily. The suburban rural ideal was just as attractive to smog-choked Londoners as it was to New Jersey-bound New Yorkers. However, suburban expansion was made possible in some areas by the rail companies themselves.41

For example, the oldest railroad in London, the Metropolitan, invested heavily in developing a commuter line running deep into the rural counties of Hertfordshire and Buckinghamshire. Like in the US, this rail company was granted land on either side of their right-of-way, on which the Metropolitan developed idyllic villages of quaint arts-and-crafts cottages.42

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41 Taylor, A time of unprecedented change…., 15
The same pull and push factors that affected the American middle class—cultural changes, post-war prosperity, fear of newcomers—led to the rapid growth of commuter belts around most major British cities. However, the sum of the small differences in conditions meant that while the American suburbs were built for and by the automobile, British development was more hybridized, and more often spurred by additional rail development.

**The Second World War to Today**

The Second World War again pushed the transit trajectories of the United States and Great Britain further apart. While the US experienced an unprecedented post-war economic boom, the United Kingdom had had a much more difficult time in the war, and faced a far steeper cost for the physical repair and cultural re-positioning of a nation that had been badly bombed and conclusively knocked out of its former position on top of the world.

While the ‘Big Four’ had independently-operated as one entity during the war, the national mood in the late-40s was far to the left. Rail, among many other industries, was nationalized towards the end of the decade, and took the form of the behemoth British Rail. Nationalization initially resulted in heavy government investment into the infrastructure and technology that had fallen by the wayside during the war. By the mid-1970s the UK had developed its first high-speed line, which reduced the trip time between the capitals of England and Scotland by an
hour. These new speeds easily outstripped cars, and brought rail in direct competition with the growing air sector.\textsuperscript{43}

However, this growth was not without setbacks--in the mid-1960s, a low period in funding and political will resulted in many of the rural services in the country being cut. At this time, the nation started to construct its first motorways, giving a serious boost to car transport in the country. Following the introduction of high-speed rail, a decade of Conservative leadership severely hindered the growth potential of the network, and left British Rail saddled with deferred maintenance, old trains, and plummeting ridership.\textsuperscript{44}

These compounded problems were too much for the public and government. In 1995, BR was broken-up and broadly reprivatized. Management of track and coordination between rail companies is still handled by a state-owned entity. Regional groups of lines are granted to private companies to source trains and staff, and operate for an allotted period. At the end of the contract period, the line is opened up to all-comers to make their management case.\textsuperscript{45}

Whether it was this change in the structure of the network, or a latent desire for a return to the rails, mass transit ridership in the UK has experienced explosive growth in the past quarter century. The areas that enthusiastically adopted motorways have started to try and undo some of the damage done by this construction and change in lifestyle. In this regard, the UK is in a fairly

\textsuperscript{43} Taylor, \textit{A time of unprecedented change}…, 17
\textsuperscript{44} Taylor, \textit{A time of unprecedented change}…, 17.
\textsuperscript{45} Taylor, \textit{A time of unprecedented change}…, 18.
different place than the United States. Like the US, it is covered in defunct rail lines that are under-consideration for renewal. However, unlike the States, these rail lines were only cut in the 1960s, and there is a cultural thread of rail transit that survived lean times unbroken. The US lost many of these lines in the inter-war period, and in many parts of the country it has been nearly a century since anyone can remember taking a passenger train anywhere.

Figure 2: Station serving Cumberland, Maine. Photo by John A. Waterman, 1898
CHAPTER IV
A NEW CIVIC ARCHITECTURE

Why Bother?

In the United States, dreamers seek the reintroduction of service to single lines, here and there. In the UK and elsewhere, mass-transit is not a vague dream, but an assumed keystone of their future. Given this historical divergence, the challenges the US faces, and the seeming lack of political will to move towards a more networked transit system in America, there arises an excellent and pointed question: Why bother?

The answer to this question and the possible path the United States could take is the aim of this thesis. The answer to why we should bother is two-fold: First, the world is facing the unprecedented collective threat of climate change, which, for us to address, will require every person and country to fundamentally shift their ways of life. Second, the automotive infrastructure that we currently rely on is anti-social and inequitable.

The common response to these issues is that of the technocratic Valley entrepreneur: a future moved by comfortable, fast, and autonomous electric vehicles that seamlessly transport their users from start to endpoint, possibly through slick tunnels, bored under the packed and sweltering freeways above.

This vision has several major issues. First, and most importantly, though the cars might be electric, autonomous, shared, and networked, they still rely on
the same automotive infrastructure as ever. Even if they speed through underground tubes, when they emerge on the other side, their sheer size relative to the pedestrian will mean they dominate the landscape of our cities and towns, just as roads, intersections, ramps, and overpasses dominate our modern settlements.

Second, this imagined future is likely to leave out a significant portion of the population who will not be able to pay for it for quite a long while. The technologies on which this vision relies on are necessarily expensive, and in order for it to make financial sense to dig private underground expressways to skip traffic jams, these tunnels will be expensive, and exclude those who fill the clogged highways that make them a necessity in the first place. Even with potentially lower maintenance costs associated with electric vehicles\textsuperscript{46}, or the ability to share rather than own a car, the period of transition will be unavoidably painful, and all for outcomes that are not that impressive.

For example, early studies suggest that the touted benefits of autonomous and/or shared vehicles may be out-weighed by their use patterns. The City of San Francisco conducted a study in 2019 on the impacts of car-sharing companies on the city that found that over half of increases in road congestion in the last couple years was due to this new transport service.\textsuperscript{47}

\textsuperscript{46} Logtenberg, Ryan, James Pawley, and Barry Saxifrage. “Comparing Fuel and Maintenance Costs of Electric and Gas Powered Vehicles in Canada”. 2 Degrees Institute, (Sept 2018)

\textsuperscript{47} Castiglione, Joe, Drew Cooper, Bhargava Sana, Dan Tischler, Tilly Chang, Gregory D. Erhardt, Sneha Roy, Mei Chen, and Alex Mucci. “TNCs & Congestion”. Civil Engineering Reports. 1 (2018).
A study conducted in 2018 by the former deputy commissioner for traffic and planning in New York City found that these Transit Network Companies (TNCs), like Uber and Lyft, increased driving by 180%. This report also found that, at least in the largest cities, TNCs more than doubled the amount of miles driven by cars in the city.

A study conducted by researchers at the University of California Berkeley in 2018 looked at the potential impact of autonomous vehicle ownership on vehicle miles travelled. It found that individuals who had access to an autonomous vehicle not only drove far more than when they only had access to their private car, but also that many trips were highly-inefficient. Because autonomous vehicles and TNC vehicles are picking-up and dropping-off individuals, they spend a great deal of time traveling ‘empty’. Therefore, not only are these emerging forms of transit not comprehensive, they are sometimes more harmful than broad-scale private car ownership, and additionally reduce the utilization of already efficient public transit networks.

The whole need for new technological paradigms to improve personal experience is the same mentality that led the world to a place of severe

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50 The study involved a group of test subjects with private vehicles in San Francisco. The subjects were given access to a chauffeur after a control week, to simulate the experience of autonomous vehicle ownership. The study found that people quickly acclimated to having access to the chauffeured vehicle, and not only drove more than normal, but used the ‘autonomous’ car for inefficient trips, such as being dropped off at work and picked up again at the end of the day.
51 Wilding, Mark. “Private companies want to replace public transport…”
environmental degradation in the first place. There is always a cost to improving speed, comfort, flexibility, or technology, and we now know full-well that this cost is often externalized to the environment. We are beginning to realize that we will now be paying back this backlog of debt for the foreseeable future.

The mentality going forward needs to lose the rocket-age or industrial-age dream of endless and infinite advancement and enlargement as synonyms for improvement. Quality-of-life can get better and do so with greater equality if we focus our energies on this itself, rather than a solely-technological framework on which to hang these improvements. This is neither a call to return to perfect olden days, nor a rejection of technology. The former is ignorant and limited, blind to the change in culture and forgetful of the flaws of the past. The latter is foolish, as modern technology is a powerful tool, and innovation is a fundamental and indelible part of our humanity.

These broader ideas can be embodied in how we move and settle. Rather than relying on a golden-bullet method that shapes the world to its will, we can develop and encourage a multi-modal system that achieves flexibility not through a dominance of type, but through actual systematic give.

**The System**

Moving forward, I have chosen to focus my study on the Northeast, not only because I am most familiar with this region, but also because it holds a lot of promise for a rigorous multi-modal mass-transit hybrid. In particular, my study

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focuses on reinvigorating a historic rail corridor, running from the city of Fitchburg in north-central Massachusetts to Providence, the capital of Rhode Island. This line will both link a number of larger ‘Gateway Cities’\footnote{A “Gateway municipality”, as defined by Massachusetts law, is “a municipality with a population greater than 35,000 and less than 250,000 with a median household income below the commonwealth’s average and a rate of educational attainment of a bachelor’s degree or above that is below the commonwealth’s average.”}, but also many of the termini of the MBTA commuter rail system. Just as Interstate 495 acts as a ring road for Boston, this line will start the transition of eastern Massachusetts from a hub-and-spoke around Boston to a denser node-on-web system.\footnote{A hub-and-spoke system is centered around one important hub, like Atlanta is the hub in its county, with all developed reaching spoke-like towards the center. A node-on-web system consists of a number of large cities that feed one-other. The New York Metro area is a good example.} This relationship helps move growth from the nearly-saturated urban core to cities with huge potential on the outskirts. It also reinforces relationships between these culturally-linked locales.

In addition to passing through larger cities and towns, the proposed line will also have the potential to make stops in smaller settlements that would not typically be served by mass transit systems. This ‘village’ typology has several advantages: first, these places have fairly-dense quasi-urban cores, with a mix of uses, housing types, and retail and industrial businesses. Second, these villages have locally-recognized names and identities. I believe this is an essential part of establishing something like a train station, that has the dual purpose of transit and civic space.
Station buildings that are placed in dross landscapes\(^{55}\), like park-and-rides, lack community ownership. Therefore they are entirely reliant on the oversight of the system for everything from maintenance of a clean, safe space, to alternative programming and the encouragement of use. Though these villages currently have quite small populations, I believe they are ideal nucleation points for future sustainable growth. Dense but discrete nodes spread along a transit line are also entirely sufficient for a good service; there is no need for continuous European-levels of density from Leominster to Woonsocket for the project to be successful.

At the level of a single town, part of the aim of this project is to split current transit patterns into several modes, rather than funnel all current transit into trains. This is for several reasons. First, the dominant mode that is being replaced, cars, is a comprehensive transport method, that is just as convenient for trips of a half mile as it is one hundred miles. Trains, on the other hand, are most definitely not comprehensive in this way. Their peak temporal efficiency occurs somewhere between five and five hundred miles, depending on the speed of the service. This is certainly a broad range, but the average daily trip length is under ten miles, and many trips are under five. In order to capture these trips in modes other than the personal automobile, we must look to other means of transport. The major flaw of a multi-modal system is that it requires transitions

\(^{55}\) Dross is used in this case as a reference to the term-of-art *drosscapes*, pioneered by Alan Berger, professor of urban design at MIT. He used the term to refer to the waste land that results from productive economic activity.
between modes, which can account for a significant portion of travel time. Therefore, because multi-modal transit is essential in a geography with a backbone of rail, the places where these infrastructures and modes intertwine must be well-designed to improve transfers between types.

Within a single town, it is important for the broader system to express itself in a recognizable manner that is familiar and cohesive, while also a typology that can be adopted and modified by a place based on differences in culture and geography, but also over time as these towns grow and change. We can see another architectural type that has done this exact job for hundreds of years in the largest of cities and smallest of towns: the U.S. Post Office. These buildings range in size and program from massive neoclassical distribution hubs to literal shacks on remote islands. However, they are often quickly recognizable for what they are, and can be used by anyone, no matter their level of familiarity with the town. Post Offices are also very often places for informal community interaction, despite the fact that they are typically fairly programmatically-restricted.

With this system, I aim to establish a new civic architecture that references the larger system for the unfamiliar visitor, morph in character from town-to-town, and serve as a locus for community, however formal or informal that might be. It also must serve the needs of the rail network, integrate a variety of transit modes, and become part of the town’s fabric.
This project would be implemented in multiple stages. First, work would begin on the existing track infrastructure, both to transfer ownership to a single agency, and then to refurbish and improve the condition of the track and ballast to suit the higher-speed services and stand-up to the greater capacity of the line. Though most of these improvements would be simple and relatively inexpensive\(^{56}\), there are potential areas of complexity. First, the tracks from just south of Fitchburg to Leominster center have been removed, and the right-of-way would need to be reestablished. Second, the line would benefit from the doubling of single track in some higher-capacity areas, with the ultimate goal of doubling the track along the entire length of the line. For the first stage, strategic increases in capacity would be sufficient. Third, all level crossings would need to be catalogued and considered for improvement. A level crossing is a point where a road and a track cross at the same grade, and there is therefore a greater potential for accidents. The ideal line would have no level crossings, but the investment required to change the approaches of the roads and/or tracks and construct hundreds of bridges would be enormous. A better solution would be to strategically build bridges at crossings that are particularly busy. At other crossings, large and impenetrable automatic gates would be sufficient.\(^{57}\)

One important consideration in establishing this rail infrastructure is the need and accessibility of maintenance. Typically, modern rail services run off of


\(^{57}\) This style of gate is far larger and more difficult to circumvent than the single-land gates used in most of the United States. This style of gate can be seen as part of high-capacity transit networks abroad.
electrified overhead lines, and receive much of their ‘traffic’ information from sophisticated sensors embedded in or adjacent to the track. This method leaves the system open to vulnerabilities due to weather or vandalism, and requires travel and therefore time to fix problems that arise. As this style of regional rail transit would be introduced as a package, these issues could be addressed from the start.

First, the trains would be powered by a battery or hydrogen fuel cell, eliminating the need for overhead lines. This mode is well-suited to battery power as the journeys are of a fixed and known length, there is a great deal of potential for regenerative recapture during frequent braking, and the trains necessarily terminate at facilities that could be setup for fast recharging or battery-swapping.

Second, the trackside infrastructure could be significantly reduced by bringing many of the sensing requirements into the trains themselves, and making them autonomous. Not only would these services be safer and more consistent, much of the expensive and fragile sensing componentry would be contained on the rolling chassis that would return to a storage facility every day, where sheltered inspection and maintenance could occur. A failure could be addressed by pulling a single train from service, rather than shutting down an entire section of track.

Third, these trains could be derived from refurbished retired rolling stock from other systems. There is a company in the United Kingdom that is doing just this: using the aluminum shells of retired London Underground trains as the base
for modular battery-electric and hydrogen fuel cell regional trains.\textsuperscript{58} This would not only reduce cost, but reduce the environmental impact of the system, while still maintaining the benefits of a custom solution. New York City is regularly retiring subway cars without plans for reuse.

Once the tracks were refurbished and the trains were built and purchased, the next step would be to start running services as soon as possible. Part of the success of this system would lie in convincing the public of its utility. The cheapest way to do this is to run services between the largest cities on the line, especially those with existing stations. This would include Fitchburg, Leominster, Worcester, Woonsocket, and Providence. These cities all have dense populations of over 40,000, and already see significant commuting flows between and among each other. Because the trains would be making few station stops, the service could make the journey from Fitchburg to Providence in an hour—faster than the same journey undertaken in a car in off-peak traffic conditions.\textsuperscript{60}

The second stage would consist of several substages of incremental expansions of service. As ridership and popularity grew, more stations would be brought online in small groups. The initial services would be rebranded as ‘express’ trains, and new time slots would stop at all stations. Just ten train-sets

\textsuperscript{58} The company, Vivarail, converts D78 London Underground chasses into two new classes of British Rail rolling stock classes, one for use on lines across the UK as a replacement for diesel trains or a stopgap for electrification projects, and the other for use on the Isle of Wight.

\textsuperscript{59} As calculated via the formula: \([\frac{L}{s} \times 60] + \left[\frac{d}{60}\right] \times n\] + (n) = \(T\); where \(L\) is length of the journey in miles, \(s\) is average speed in miles per hour, not including stopping, \(n\) is number of intermediate stops, \(d\) is station dwell time in seconds, and \(T\) is the total trip time in minutes. The addition of the sole variable \(n\) accounts for time lost during deceleration into and acceleration out of station stops. Formula developed by author.

\textsuperscript{60} As calculated by Google Maps for a Monday in February 2020.
could provide half-hourly express service, and the same interval of stopping services, thereby resulting in a train in each direction departing a station every fifteen minutes.\textsuperscript{61} The stations would be brought on in groups so as to minimize the frequency of schedule changes riders would need to adjust to. However, at an interval of four trains per hour in each direction, most riders would likely not need to plan journeys in advance—a huge step in moving individuals out of their cars.\textsuperscript{62}

The final stage would be a revisiting of early infrastructural improvements. At this stage, the line could host as many as two dozen stations, and there would be a need for an expansion of doubled track and additional construction of bridges to reduce the number of level crossings. These three stages of growth of the rail network would also be accompanied by top-down and market-driven multi-modal supplements to the rail corridor, which forms a backbone of the project, (fig. 3).

![Figure 3: Phased mapping of route. Drawing by author.](image)

\textsuperscript{61} As calculated via the formula: \(\frac{(2 \times L \times f)}{[(L / (T / 60))]} = R\), where \(L\) and \(T\) are the same as defined in a previous footnote, and where \(f\) is frequency in trains per hour, and \(R\) is number of train-sets required. Formula developed by author.

\textsuperscript{62} Dec, Rachel Adele. "Budgeting for the transformation of commuter rail".
Multi-Modalism

Though the core of this project has been focused on rail infrastructure and its associated architecture, in order for it to be successful the rail would be just part of the approach. As mentioned previously, cars out-perform mass-transit in their ability to serve the transport needs of a traveler over any distance. In order to achieve a significant reduction in car ownership, (perhaps a short-term goal of most families becoming single-car households), there would be several types of transportation that would be integrated with the rail network as it grew.

First, the experience of the pedestrian and the bicyclist in the center of the towns and villages along this line would need to be prioritized, often at the expense of the private driver. The asphalt strips that intersect the built environments in our cities are, on a fundamental level, simple pathways for movement. This seems obvious, but requires emphasis because of the overwhelming and oft-forgotten dominance that cars hold over these paths. When one takes a cross-section of most streets in this region, upwards of 75% of the road surface is given over to cars. In order to operate safely, cars take up a great deal of space, not only with wide travel lanes, but shoulders, parking, turning lanes, interchanges, etc. It's no wonder that pedestrian movement is limited in most American cities; they are simply not given much space, nor priority.

Part of this proposal includes the reallocation of space in urban centers, such that at least a majority of the road surface is given over to modes other than the private car. This space in established cities is necessarily bounded, and this
change in share would also necessarily inconvenience the private driver. Strategies such as removing on-street parking, making roads one way, and instituting traffic-calming, (and therefore traffic-slowing), measures would all make it increasingly difficult to navigate cities as we currently do. This is purposeful. Private car ownership and use must be reduced in order to make an impact on the unsustainable and anti-social externalities of the mode.

However, this new space for the pedestrian user would change the nature of many streets. Sidewalks would become two or three times as wide, and would be divided via contrasting surface materials to indicate areas for people on foot and bicyclists. This puts a curb between cars and bikes and pedestrians, rather than dangerously grouping bikes with car traffic. There would be physical space to plant or reintroduce trees, which in aggregate would minimally impact atmospheric carbon dioxide, but also provide important shading to the streets and adjacent homes. The explosion of growth of electric bikes in Europe and Asia could precede a boom in popularity stateside, and would go a long way in turning life-long car commuters into bicyclists—the simple addition of a small motor and battery can increase the comfort of the rider in the heat and cold, improve one's ability to navigate traffic, and encourage bike use by people of a variety of ability levels and ages.

The second mode of transportation that would need to be integrated is that of buses and shuttles. Many of the largest towns on this proposed line have city bus services, but they are universally insufficient and subservient to the
private car. A general reconfiguration of the transit landscape of these towns would create a new opportunity for city buses to become a major intra-city mode.

One of the main flaws of buses is that they move at the same speed as cars, but also make stops, and travel in sometimes meandering paths in an attempt to make up for a limited number of lines. Equivalent journeys can therefore take two or three times as long in a bus as in a car.\textsuperscript{63} However, buses can be a great option for those who can’t or do not want to walk or bike, and during inclement weather. Simple changes could significantly improve bus reliability. First, more services with smaller buses would make routes more direct and therefore quicker. This is currently a huge cost for a small municipality, but this price tag could be shrunk via emerging technologies like autonomous driving. Though this is not as straight-forward as automating trains, buses maintain distinct routes and travel at relatively low speeds; there is already a small autonomous shuttle pilot project running in Providence.

A second change would be to make some roads or lanes bus-only. This has been shown to work in numerous large urban contexts, and would likely be helpful in smaller cities. Finally, improving the design of bus-oriented infrastructure could improve the general experience and therefore ridership. Building dipped roads next to bus stops that would allow for level boarding is a minor alteration, but one that could drastically improve the usability for anyone with limited mobility, or even for those with full hands. Providing contactless

payment cards compatible with other public transit options could allow for all-door boarding, and remove the time-consuming line of riders fumbling with change. Centrally-organized bus services could also be supplemented or in small towns fully replaced by shuttle-style car share services. The two largest transportation network companies (TNCs), Uber and Lyft, both currently offer an inexpensive service that groups individuals traveling in a similar direction into one vehicle. This could work with even larger shuttles, or by creating a web of informal ‘stations’ that the shuttles would make demand-determined stops at.

Third and finally, private cars would remain a part of the transportation equation for a while to come. It is not necessarily the car itself that is so destructive to our environment and our urban quality of life, but the infrastructure they require. By reducing the role of cars in everyday transit, we reduce the need for and dominance of their exclusive infrastructure. Even in large cities where car ownership is quite low, there are still popular car sharing platforms that allow the use and convenience of a private automobile for everything from furniture shopping to road trips, without the many personal and societal costs of widespread individual car ownership. Currently, car ownership in Massachusetts is about 2 cars per household. Halving this would be a dramatic improvement and change to the character of our cities and towns, without actually eliminating a form of transport that is familiar and reliable for many people, (fig. 4).

Combining a variety of modes of transportation is not only more sustainable and friendly, but more resilient as well. Systems that have one major
cog that is central to their operation are both as strong and as brittle as that largest component. Though cars are incredibly flexible and convenient, because our system is so reliant on them, anything that puts cars out of commission results in near total-failure of transportation as a whole.

It is easy to imagine, (or even witness), the effect that natural weather events and disasters can have on road systems, and we can only expect these effects to continue and increase in intensity. In contrast, a multimodal system is inherently safe-to-fail, as each mode overlaps significantly with other modes in terms of their most suitable usage distances and environments. The failure of one mode does not then cripple movement as a whole.

Figure 4: Site plan of Fitchburg station, showing multimodal connections. Drawing by author.
The Architecture

Civic architecture includes the obvious municipal buildings: town halls, meeting houses, post offices, libraries. I would argue it includes less obvious examples as well: elegant congregational churches grace many of the cores of New England towns. Gas stations are distinct but repeated cornerstones; Dunkin Donuts and Walmart are familiar mainstays, and informal community centers. All of these places have a core programmatic function, but are mainly enhanced by their unplanned roles. They have recognizable and repeated architectural features, but are distorted to varying degrees based on their context.

Each of these examples offers something to learn from in attempting to join their ranks. Town offices and the like often combine multiple government functions into a single structure, thereby putting a consistent face on the public’s interactions with these public agencies. Transit networks are almost always public in some ways, and are perceived as public utilities. I have spoken of my affection for post offices, and their place in a town. They are particularly valuable in teaching how to adjust for local character and size. Churches are excellent examples of civic architecture that have stood the test of time, and can inform us of how a building changes over hundreds of years, while continuing to serve a community. Though they are not a central pillar of towns as they once were, they still offer a place of respite and service that is disconnected from commercial activity.

That being said, commercial establishments play a huge role in civic life. There are traditional examples, like a small hardware store or diner. Increasingly
however chains are filling this role. Though the architectural expression of these outposts is usually strictly determined down to the window signage and stock employee phrases, daily patterns establish relationships, places for discussion and gossip, and even help in times of need.

A transit network is inherently centralized, and often part of a variably-popular government agency. Many station buildings, bus stops, and train halts are built in a consistent and budget-conscious style, and though they might be maintained when times are good, they quickly become undesirable zones when times are tight. Smaller towns tend to get just a 'halt'; i.e. a platform, sometimes too low to even allow level-boarding, and sometimes a canopy, perhaps a bench and a trash can as well. The strips of the land alongside tracks are almost inherently marginal, and so adding this insufficiently interesting new space to an already challenging site does not do the station any favors; nor, by extension, the system. Even larger stations do little better. Though they might be based in historic buildings that during the height of rail hosted programs as diverse as doctors, general stores, and mail depots, they now are home to little more than peeling paint and dusty corners. Rail operators, already monetarily-constrained, are not willing to invest a great deal in spaces that are really only pass-throughs for their passengers.

Part of this is due to drops in ridership; however there is an important aspect in the changing nature of rail transit. During the golden age of these rusticated Romanesque station stops, there would have been numerous full-time
employees of the railroad at every major station. All or almost all ticket transactions occurred in the station building, as did assistance with reading timetables and schedules that was not yet achieved through the internet. Steam locomotives required water stops, coal deliveries; switches in the tracks were operated manually, and signaling was the job of one or several permanently-stationed individuals. The character of these places was entirely different, simply because there were people always present, and people who had a reason to keep an eye on the space. When these people disappear, these empty stations and dirty platforms naturally become marginal and uncomfortable.

Therefore, a core part of my proposal is to bring programmatic diversity to these imagined rail stations, (fig. 5). This cannot be done via increasing the number of network employees present—in fact, the tight margins of these operators mean that a corporate presence at all but the largest stops is unlikely. Therefore, there are three criteria: the new tenants need to be self-supporting, have reason to be at that particular site, and have reason to look out for the space.

Figure 5: The module has the potential for various programs. Drawing by author.
The second criteria is easily addressed: in order to maximize usability and walkability, all my proposed stations are centrally-located in the densest parts of town. These are also the areas with the most foot-traffic-fed commercial establishments, and the areas with the highest retail rents. By adding programatically-flexible spaces to the main station infrastructure, network operators are actually gaining a source of much-needed income. Commercial tenants would be necessarily self-supporting. Non-commercial organizations looking for space could benefit from the subsidized nature of these networks; reduced rents could be provided through a mixture of state and local funding sources for groups offering valuable local services at no profit.

The third criterion is satisfied via human nature—it is in the self-interest of the tenants to keep ‘eyes on the street’; or in this case the platform. Services like trash collection, landscaping, and general cleaning can be supported via the station’s rental income, and administered by the interested common party: the network owner.

This systematic approach is essential to designing a space that persists and grows into a community, rather than inserting unwelcome parasitic entities that remain forever marginal. The next step is to determine and describe the architectural expression of these new civic spaces. First and foremost the station

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64 ‘Eyes-on-the-street’ is a phrase lifted from Jane Jacobs’ book, *The Death and Life of Great American Cities*. She used it to describe the phenomenon that occurs in dense mixed-use neighborhoods, when the stakeholders in a community, (shop-owners, stoop-sitters, gardeners, passers-by), protect their space from crime and/or decay through their mere observation and perceived shared ownership of public spaces like the street.

sites should be orientated towards the pedestrian, both in approach and access, but also in character, (fig. 6). Rather than placing parking between the street and the station, this space should be given over to programmatically-flexible park space. However, other modes will of course still require access. This auxiliary vehicular access should be grouped and offset, so that it remains close, but does not obstruct pedestrian approach paths. Vehicular access should be hierarchical, with public buses, shared shuttles, and accessible parking prioritized; and other parking, and carshare and private car drop-off secondary.

Figure 6: The station orients itself towards the pedestrian. Drawing by author.

The station is based on a core unit measuring 18' by 36'. Platforms are 12' deep at the center, shrinking to 6' at their farthest extents. Even the smallest station halts should have one station unit, providing a semi-conditioned waiting room, and at least 252’ of platform length. This seemingly-arbitrary number is
derived by the base platform unit size of 36’, and services at most a three-car train. The basic architectural unit can be halved for auxiliary programs like bathrooms, or lengthened through doubling or tripling for every imaginable program, from bar to store-front church, temporary shelter to workshops, (fig. 7).

Figure 7: The station module can grow for larger stations, like Fitchburg, shown. Drawing by author.

This flexible sizing is made possible via modular construction. Rather than excavating an expensive and disruptive full foundation, the station and platforms sit on piers. The horizontal structure for both elements consists of pre-tensioned double tees. These are cheap, modular, shippable on the back of a truck, and can be exposed directly to the elements without additional finishing. On top of the concrete base are attached panelized CLT walls. Each panel is 6’ wide, and is machined to the correct height and form based on where it is to be located in the station. Each panel can also be manufactured with a window or door opening, allowing each station to be custom-designed without any additional construction.
or planning costs. There is a total of 32 possible wall panels, and two types of roof panels. Because of the limited depth of the units, the CLT panels manage lateral forces in addition to standard vertical loads, (fig. 8).

Figure 8: Phases of assembly. Drawing by author.

On the CLT are attached 2” x 8” and 2” x 10” wood studs, on the walls and roof respectively. These studs provide a cavity filled with rockwool insulation, while also providing a nailing base to attach the rainscreen. This final vertical finishing element uses stabilized weathering steel as a durable and unique facade. This finish also has an earthy tone that blends in with both the industrial and natural surroundings, while presenting as firmly contemporary. Weathering steel also has the benefit of aging beautifully, even when stabilized to reduce
ground staining. The roof uses identical construction, save for the deeper insulation cavity and a standing-seam electro-plated zinc roof, (fig. 9).

The walls achieve approximately an R-value of 24, with the roof closing in on R30. Though this is hardly going to satisfy passivhaus standards—especially with the thermally-unbroken double tee foundation—it is sufficient for the mix of semi-conditioned and conditioned spaces that would occupy its walls. Additional thermal comfort could be achieved through applying flooring onto the concrete, like vinyl, carpet, hardwood, or even finished plywood or OSB. For a unit designed from the beginning as a thermally-conditioned space, the double-tee could be slightly shortened and topped with a board-insulated floating slab.

Figure 9: Axonometric assembly detail. Drawing by author.
Each 36’ unit, or every 36’ in larger units, there is a combined solar chimney and lightwell. The 10’ square chimney extends above the shed roof and drops down into the space, and is glazed with a recessed, sloped, fixed window. The slope directs water off the glass while also defending against direct solar infiltration through the use of a directionally-sensitive coating. The high-side of the glazing allows for the concentration of heated air, both via air rising through the space and via additional radiative solar heating of the air directly below the glass. This is then vented out the high side of the chimney, which when combined with operable windows facing the shaded platform, draws cool air into the space via convection. This chimney also reduces the amount of electric lighting required in the space during daylight hours.

Figure 10: Cross-section of station showing solar chimney. Drawing by author.

Electricity is supplied to each unit from below, and run through the space via exposed galvanized conduits hung right at the seam between the high side of the shed roof and the wall. Plumbing is provided only to units that require it, but
can easily be retrofitted to units that grow to need it. All plumbing must be located along one of the short walls, which can be built out with an internal stud-wall to provide a chase for the piping. HVAC is tucked into a single unit located behind the solar chimney, and consists of, at base, an HRV, and a compact condensing boiler supplying hot water to hydronic radiators located under each window on the high side of the shed roof. These basic services can be supplemented or partially replaced with a ductless mini-split evaporating cassette. The condenser unit can be located under the double-tee on one side of the unit, for both shelter and security, (fig. 10).

Figure 11: Building services as integrated into the module. Drawing by author.

This design seeks a balance between competing factors in this typology. It establishes itself as contemporary, rather than attempting to mirror or imitate
local historical styles. These styles were important and necessary in their context, but are artificial and culturally prescriptive when applied today. It also seeks to be materially and formally consistent rather than locally polymorphous. This form then acts as a signifier of type, and of unity. It is the designed melding of the type to particular sites as well as the inevitable modification over time that adapts the module to each geography. The design also seeks to be affordable, but not cheap. That is to say, it does not sacrifice durability and longevity for the sake of budget, but achieves these aims through its limited and manufacturable kit of custom parts, as well as its rapid constructability.

Figure 12: Integrated station site in Uxbridge. Drawing by author.
The success and dominance of the automobile was enabled by the cataclysmic changes of two world wars. They were not merely technological marvels, but symbols of status and class in a society that often prizes its classlessness. The hegemonic dominance of the United States meant that it could and did adopt this new mode whole-heartedly, and constructed a durable infrastructure to support and enhance the efficiency of the automobile. By the time the cracks of environmental degradation and social decay appeared in the works in the 1970s, it was already well-established and ingrained.

However, this mode is one we are so familiar with, it is hard to imagine our world without it. In order to better establish the impact of transit paradigms on the landscapes and people they are part of, we must look back, before the contemporary dominance of the car. Before the car, the train was the primary motive power behind American growth. They started in the mid-19th century as an upstart industry, but their advantages of previous were so numerous and great that the start-up-style rail companies of this era experienced explosive growth, and blanketed the country in tracks.

However, it was a classic speculative bubble, and after some uncertain years the dream popped. The industry changed, and consolidated into just a handful of monopolistic enterprises. Styles of rail changed as well; the steam
train was supplanted by the electric interurban, which danced between city streets and rural right-of-ways with speed and flexibility. The combination of the now-venerable train network and the improved interurban permanently altered the layout of our cities and towns, and fundamentally changed the country's economy and people. These changes echo through to the modern world, despite these modes’ eventual decline during the Great Depression. However, when we understand and compare these paradigms of transit in the United States, it brings up the question of why the same pattern was not followed abroad.

To explore that, we must look to a country that has similarities to the United States, but a very different transit landscape. The United Kingdom developed train networks around the same time as America, and saw many of the same growth milestones. However, while the United States came out of the world wars a leader and economic powerhouse that could invest where it saw fit, Britain was damaged and reliant on older networks. This initial disadvantage meant that automotive growth in the UK was always dampened in comparison to the United States, and therefore when the popularity of mass transit networks improved in the 1990s, Great Britain was better positioned to build on both their existing infrastructure, and their cultural understanding and acceptance of mass transit.

So, given that the US is different, and the odds of change seem so long, why should we bother? As stated earlier, I believe cars are environmentally
unsustainable and antisocial. They are inefficient in-and-of themselves, no matter the motive power, and they engender unsustainable lifestyles. Their infrastructure, and the sharp contrast in scale and speed that they present to the pedestrian experience means that places that are ideal for cars will always be the opposite for the pedestrian, and vice versa. We need a transit network that is modally-compatible, not mutually-exclusive.

The response to these issues is typically technocratic, i.e. emerging technologies like car-sharing, electric cars, and autonomous vehicles will be able to replace the private car as we know it. However, this doesn’t change the need for infrastructure, is inequitable, and might even cause more congestion and car use than before. The solution cannot be a ‘golden-bullet’ that solves everything in one fell swoop, and needs to move past the growth-oriented convictions of the past, and rather focus on quality-of-life.

I therefore propose working in an area of Massachusetts, establishing a rail line on historic track, running between the Gateway cities of Fitchburg, Worcester, and the capital of Rhode Island, Providence. Incremental additions of groups of new stations will densify the line nodally, rather than continuously. Stations are located in the centers of established existing ‘village’-type settlements with potential for density, and these zones of density are strung together via the train, without there needing to be bleed-over density between settlements.

Within a settlement, the station would need to be a hub for multimodal interchange, as well as expression of the larger system of which it was a part.
This system would be established in several stages over a decade or more. First, the track would be repaired and improved, trains would be acquired, and an express service between the handful of the largest cities on the line would begin. As ridership grew, smaller station stops would be added in groups, and the frequency of the service would be increased with a mix of trains that stop at every station, and the initial express services. This could provide service every fifteen minutes, which would be essential in creating an option that does not need to be planned for in advance, thereby more rapidly shifting people out of their cars.

However, just as cars are not singular solutions, trains cannot be the entirety of the system. In fact, it needs to be strongly multimodal, with opportunities for linkages between modes of transit both contemporary and imagined. The system needs to especially prioritize walking and biking, as these are the modes most closely associated with the pedestrian-experience that makes dense, livable areas pleasant.

This approach is not just concerned with designing the rail network, then, but considers the design of the cities and towns in which each station exists, down to the share of the street given over to different modes, and the programmatic uses of buildings in the area. It also is not opposed to private vehicles or to other future forms of mobility, like autonomous vehicles. The former will likely remain a part of the area for a while yet, and the goal is not to eliminate but reduce the need for a private car--to make 2-car families into functional 1-car families.
This multimodalism has benefits beyond those stated above; systems like this are more flexible and safe-to-fail in events that range from catastrophic to simply out-of-the-ordinary; in short, multimodal systems are more resilient.

With a sketch of the system established, the architecture that expresses this system needs to be described. The direct inspiration for these stations are examples of ‘civic architecture’; post offices, municipal buildings, religious establishments, even chain stores. Some of these have consistent program but variable architecture, (post offices), while others have both consistent program and architecture, (chains).

The stations that are part of this system then need to both express their connection to the system, as well as connect to the local community. I decided on a consistent architectural language and a flexible programmatic arrangement. Station buildings would be immediately recognizable as such by the form and finish, but would be enveloped by the town because of the flexibility of their spaces. Rather than define these stops as solely places of transit and interchange, the stations would be open and able to accept a wide diversity of different programs, commercial and non-profit, formal and informal. Not only does this make the stations in a ‘place’ in the community, but it improves the long-term maintenance and safety of the buildings and spaces, as they have a diverse set of stakeholders and ‘eyes-on-the-street’.

The stations themselves would be fully modular, both so that they are inexpensive to build and install on sites, but also so that they can grow and
shrink between communities of different sizes, and change over time. The construction would use CLT as the base structural unit, with natural-toned and hard-wearing materials like corten and zinc as a rainscreen. In addition to being made out of modular components, the station would be split up into a series of modules that could linearly grow and shrink along the liminal space that borders many train tracks.

The thesis then operates on multiple levels. It views transit as fundamental to shaping the patterns of our lives and our landscape. It critiques the dominant mode of the past century, and offers up a systematic alternative to the automobile. This system is multimodal, flexible, resilient, more sustainable and equitable. It is also not growth-oriented, inherently and comfortably indeterminate at its edges, and subtle rather than brash in its revolutionary attitude. It seeks to suggest a civic architecture and its accompanying multimodal system that can act as the paradigmatic transit backbone that supports our efforts to face the challenges of the next century.
Figure 13: Exploded axonometric of module and site. Drawing by author.
Figure 14: Fitchburg central station, site plan, detail. Drawing by author.

Figure 15: Fitchburg station, site plan, post office detail. Drawing by author.
Figure 16: Exploded axon, module detail. Drawing by author.

Figure 17: Exploded axon, train detail. Drawing by author.
Figure 18: Quinsigamond Village station, rendering. Drawing by author.

Figure 19: Uxbridge station pedestrian approach, rendering. Drawing by author.
Figure 20: Quinsigamond Village station, site plan. Drawing by author.

Figure 21: Uxbridge station, site plan. Drawing by author.
Figure 22: Thirty-two unique CLT panels. Drawing by author.

Figure 23: Door and window panel options. Drawing by author.
Figure 24: Selected station sites. Drawing by author.
Figure 25: Stations examined along the Blackstone Line. Drawings by author.
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