Elevated Small Vehicle Limited Access Thoroughfares

Daniel T. Price, P.E.
Position: None
Company: Self-employed
Colorado Springs, Colorado 80905
Email: dtprice21@gmail.com

Word Count: 6572

Submitted June 16, 2024

ABSTRACT

Urban elevated Small Vehicle Limited Access Thoroughfare (SVLAT) concept is introduced as a re-envisioned optimization of urban transportation infrastructure due to recent technological trends. The SVLAT arterials are to be installed over urban transportation corridors providing bespoke zero-second wait time non-stop urban transportation for small electric vehicles, bicycles and pedestrians. The article notes the potential for wide pitch spacing of highways, increased modal speed, congestion relief and improved urban experience. Daunting Technical challenges are noted including: regulatory hurdles, fire safety, aerodynamic design, underground interference, design details, vehicle designs, integration with existing transportation networks, and issues yet unknown. Potential high value applications are identified which may provide additional economic incentive including bridges over wide rivers, additional capacity for special venues, mitigating storm recovery and mitigating rising water levels. Auxiliary uses for the structure are noted including cable or pipe routing. Options for the new highway are noted: potential for connection with existing LAT, covering the highway, full self driving, roadway vehicle charging, and integration with above ground malls. The article concludes that since urban small vehicle modal speed will be increased and costs lowered in some applications research into urban elevated SVLAT should be funded.

Keywords: highway, elevated, bicycle, electric vehicle, last mile, expressway, thoroughfare

INTRODUCTION

Transportation systems design is undergoing rapid change from trends in battery electrification and self-driving. While changes have focused on optimizing existing systems, little attention has been brought to the topic of systemically re-envisioning transportation infrastructure to best utilize the results of these technological trends.

This article is intended to hypothetically introduce novel urban non-stop Small Vehicle Limited Access Thoroughfare (SVLAT) systems as a solution, while also philosophically balancing the results of a comprehensive desktop conceptual feasibility study. The SVLAT system is to be a zero-second-per-mile wait time urban highway for small electric vehicles, providing a bespoke level of service that is currently only available to urban automobile users by way of the non-stop Limited Access Thoroughfare (LAT).

Improving transportation can dramatically improve liveability in an urban environment. Imagine the following fictional scenario: getting off work in a congested city, wanting to go across town to an event and then travel home for the evening. In this scenario, on a holiday morning these trips via automobile could take 15 minutes. If you took the subway each trip could require 30-45 minutes. However, if you unfolded your bicycle and rode a feeder bicycle lane to a SVLAT highway, you could make each trip in 15 minutes during rush hour. Without the highway, you might choose to not go to the event.

We can easily conjecture that any major transportation change will be facilitated by lower cost and higher trip speed. For this conceptual study it is assumed that if both cost and trip speed are indicated to be as good or better than existing alternatives in select applications' then funding for future study is warranted. Also important at the genesis stage, is identification of any technological or regulatory developments which can mitigate problems.

Accessibility is a topic that has gained increased focus in recent times, the basis of the proposed concept is to enhance accessibility by dramatically increasing infrastructure for small low cost vehicles, bicycles and pedestrians. [1]

SVLAT highways represent a systemic change for urban transportation philosophy and experience, the last systemic change to transportation infrastructure was the LAT highways. Modern urban designers have not encountered a systemic transportation change proposal, therefore, there exists no recent examples for how to proceed. Logically the primary issues and philosophies should be understood and agreed on prior to committing significant funding. This article's primary goal is to philosophically reconcile whether to proceed with funding. This article is also intended as a forest for trees scoping that can encourage researcher into SVLAT and provide funding organizations an overview of how SVLAT research contributes to their overall goals.

A proposal to introduce a systemic change to the urban transportation network can initiate very complex discussions that can only be touched lightly upon in a comprehensive overview. Virtually every issue encountered in LAT highway design is needing study for SVLAT systems, therefore there is a paucity of data to facilitate decision making. This issue rich and data poor environment greatly complicates development of this article. In addition, it is very difficult to know what has driven major transportation systems change in the past. Major transportation systems change has been likened to a biological morphological (evolutionary) process where the genesis of change, individual decisions, has been lost in time. [2] Research for bicycles along traditional roadways is at times able to illustrate key points. Most research for existing systems is not directly applicable to this novel transportation concept, therefore at times statements utilize engineering judgment to make hypothetical observations. It is acknowledged in the future at least some of the statements will be found wanting.

This article uses innovative means to develop hypothetical understanding of select primary factors such as average modal speed, highway spacing and cost comparisons in order to illustrate potential outcomes. These hypothetical understandings should be validated through subsequent research. This article, therefore, makes the first small step in a larger process which could systemically alter urban transportation philosophy. This summary presentation is derived from a detailed white paper study by this author. [3]

METHODOLOGY

This desktop study was funded and performed solely by the author.

This article is organized to address two themes. One theme to logically reconcile if the proposal is worthy of further research. The other theme is to develop a forest for trees perspective of challenges, opportunities, and characteristics associated with SVLAT implementation. The first requires numbers derived from literature be found. The second requires narratively painting a highly detailed mind's eye picture of what this proposal entails. Satisfying both themes is necessary when conceptually considering a novel option.

In accordance with Project Management Institute recommendations a brainstorming process developed topics for this study. The items were listed and later further described. The process departed from PMI recommendations as the only person available to generate input is the author. However the author has decades of engineering experience, including significant experience with extremely large and complex projects in the industrial realm.

Literature investigations were performed mostly at University of Colorado Colorado Springs library to provide technical guidance or provide research derived parameters which could be used to develop critical observations. The literature search was not comprehensive. Since the concept is novel, there is a paucity of applicable research. The best research is for bicycles which is often found wanting because the research was intended for another purpose.

Editorial assistance for a prior version of this article was provided by UCCS technical writing support group.

AI, Bard, was used in the first drafts to develop outlines from information contained in a prior article version presented at a conference. Later after information was added, AI was employed to draft introduction and conclusions. AI generated text has been extensively edited.

Internal traffic studies were performed during rush hour using the google maps trip tool. The study was performed within Houston Texas during approximately 2010.

Elevation view sketch study was performed using measured dimensions of a local street, Colfax Avenue along Capitol Hill within Denver, Colorado USA. Sketch studies are commonly used in brownfield industrial projects to assure adequate space prior to project initiation.

In all cases estimates are conservative in nature. When developing conclusion statements the accuracy of the estimates was further distanced by careful construction of the concluding statements. For example the capacity estimates derived from the 2 second rule were only used to indicate capacity being *similar* regardless of speed, actual capacity from the method was not used in the philosophical development.

In addition the purpose of these statements is to point the way for further research which by it's nature should be directed to independently verify the veracity of this paper's final conclusions of increased modal speed and potentially lower costs for select applications. In effect treating these conclusions as hypothesis in future research. If the veracity of these general arguments are verified, as the author believes they will, then it would seem significant research funding for SVLAT should be authorized.

Effort was made to include as many observations as possible. The utility of this is to provide a better forest for trees perspective. However, some potential debates such as vehicle classification regulations are bypassed for brevity.

A prior version of this article was presented at EVS37 Seoul South Korea April 2024. A copy of the article was provided to conference participants. This article was revised for Transportation Research Board (TRB) format, reference added, edits performed, and outline re-organized for improved flow. No AI was used in the revision process for subsequent TRB submittal.

ENHANCING URBAN MOBILITY

Adding high speed transportation capacity can be important for enhancing urban mobility. Adding non-stop arterial capacity above existing corridors without significantly interrupting traffic below can add significant capacity and therefore improve urban mobility in an otherwise congested area.

Congestion Relief Through Additional Capacity

SVLAT highway capacity is not readily estimable. However, capacity is an important economic factor to understand how congestion can be relieved and if costs can be shared by a large number of users.

Insight can be gained from drivers' teaching tools which advises 2 second spacing between vehicles when driving. [4] This 2 second rule advises for all speeds to maintain time to react to conditions ahead. This rule leads the driver to a system of counting car lengths between vehicles depending on speed. The net result is slower highways with the same length vehicles have tighter spacing and approximately the same number of vehicles per hour regardless of speed. However, it is expected SVLAT highways will be mostly utilized by vehicles less vehicle length than LAT systems. Certainly there are significant limitations in using this rule for estimating highway capacity, but it can be observed that to the first approximation faster speed does not necessarily result in higher capacity per lane.

Ignoring the reduction in vehicle length for SVLAT , it can be stated that each lane of Class 3 SVLAT should have similar vehicle carrying capacity compared to automobile LAT per lane. Transportation congestion has been noted throughout history and has historically been relieved by adding additional transportation capacity. [2]

Therefore it is likely SVLAT systems with a similar capacity as LAT systems will provide significant new transportation capacity for highly congested areas. Thereby SVLAT systems have the potential to relieve a significant amount of congestion.

Increasing Average Small Vehicle Modal Speed

Increasing average modal speed for small vehicles is one of the primary benefits identified for the SVLAT system. The non-stop SVLAT system will provide higher average speed than navigating shared streets with the same mode. In addition, there will be cases where average speed compares well with other existing transportation modes.

In comparison with urban automobile mode: internal studies indicate routing SVLAT non-stop over an automobile street with many traffic control lights can allow SLVAT users higher average modal speed than the automobile below in many urban areas. This can be true even if the maximum speed SVLAT is less than the maximum speed on the street below.

In comparison with mass transit mode: The trip to and from the SVLAT highway is using a vehicle which travels faster than walking to mass transit. In addition, internal studies indicate zero second-per-mile wait time can result in less time on the highway than along many bus or subway lines.

Increased modal speed will affect user preferences but also creates economic benefit by reducing travel time or by increasing distance people are willing to travel. However, justification of costs to achieve increased modal speed benefits is complex and subject to the difficulty of predicting the future.

Modal speed can be a factor for individual users when determining which transportation mode to utilize. Higher modal speed in congested areas can draw users from other slower transportation modes. [5, 6]

It is concluded SVLAT could be preferred in some areas by transportation users over other modes of urban transportation.

FEASIBILITY CONSIDERATIONS

A new transportation system must be feasible to install into a highly congested urban core. Reconciling and balancing costs/benefits for each locality can require much effort, expensive tools, and specialist input. This article focuses on non-local issues, where significant solution sharing across projects and cultures appears possible.

It is impossible at the conceptual stage to assess construction feasibility for a particular locality. However, feasibility can be assessed in general terms by determining if there is adequate urban space, if SVLAT highways can be widely spaced, if vehicles exist, if construction methods exist, and if costs can be lower than some alternatives.

Availability of Urban Space Feasibility

Physical interferences between the new highway and existing infrastructure within a city must be avoided or reconciled. One method to effectively demonstrate new infrastructure is to demonstrate installation using less than ideal assumptions. A sketch study (results shown in the following figures) has therefore been prepared assuming installation over a relatively narrow street while demonstrating installation of three classes of lanes: Pedestrian, Class 1 vehicles and Class 3 vehicles. While relocation of electric lines and traffic signals is expected, building interferences are to be avoided.

Figure 1 displays basic sketch study results for a relatively narrow street, Colfax between Pennsylvania and Pearl in Denver, Colorado. The study was performed for a single level highway accommodating 3 types of traffic: Class 1, Class 3 and Pedestrian. Traffic corridors for the study are 12' (3.66 m) square, mounted 24' (7.32 m) over an 80' (24.38 m) wide street.

It was found that three classes of traffic can fit into a single level configuration into the area available above this relatively narrow street utilizing current regulatory structure.

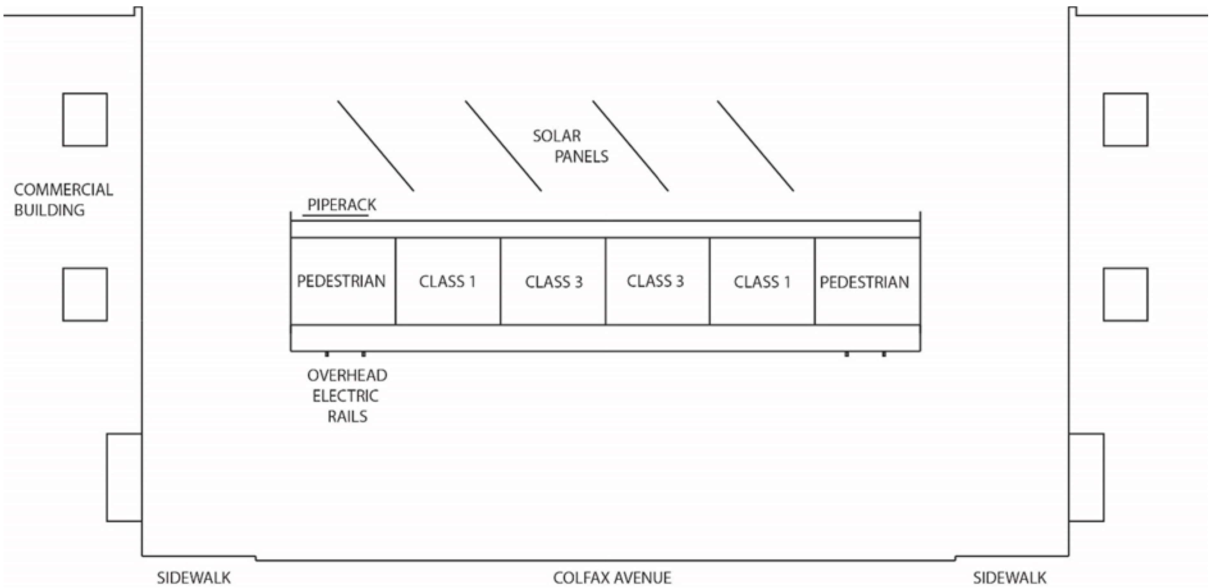

Figure 1: Two vehicle classes and pedestrian lanes over an 80' (24.38 m) wide street

Another key element is fit of intersecting non-stop highways over an intersection of existing roadways. Figure 2 shows two highways and traffic circles can be stacked 24' (7.32 m) over the top of an intersection and maintain a height of less than 100 feet (30.5 m). The fully electric Class 3 traffic circle is located higher than Class 1. Presumably, Class 3 electrics can navigate elevation change better than Class 1 manual bicycles.

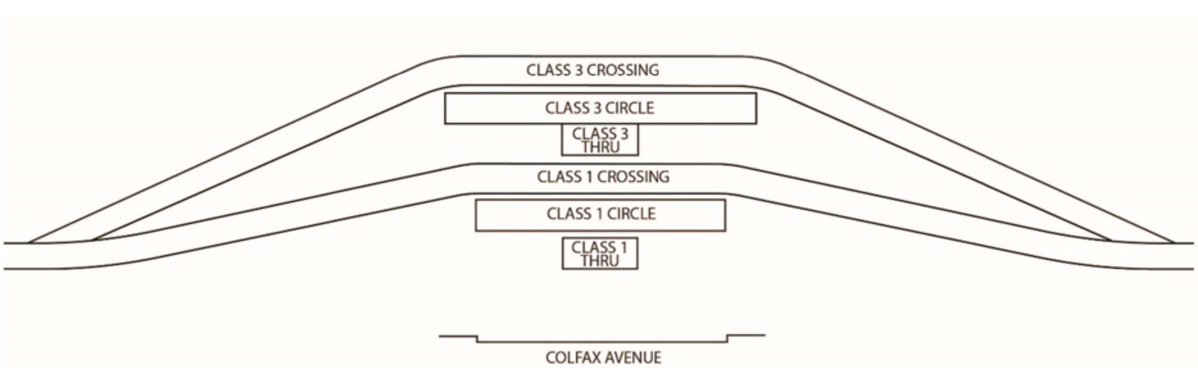

Figure 2: Two vehicle traffic circles over 80' (24.38 m) wide street.

Installing the SVLAT system over an existing street has therefore been conceptually demonstrated.

Vehicle Design Feasibility

Vehicles can be provided by system operator, some other operator or supplied by system users. In any case costs for smaller, lighter, lower speed vehicles can be less than that for significantly larger vehicles. Considering some of the challenges identified such as fire risk, indoor pollution and potential for fully automated highways, it is likely regulations need to be developed to assure vehicle designs provide uniform and acceptable level of safety.

According to Kelly Blue Book electric bicycles outsold electric automobiles in the years 2018 through 2022. [7]

Full self-driving has been cited as a means to increase highway capacity and to reduce accident risk. Detailed studies to limit new SVLAT Class 3 highways or select lanes to fully autonomous usage could be undertaken. While wholesale modification of traditional highways for autonomous driving may be infeasible, it would be prudent to consider if an entirely new highway such as SVLAT could be designed with novel features such as centralized monitoring/control, communications or fixed highway sensors to facilitate autonomous driving safety.

The health effects of cycling comprise a combination of exercise benefits, outdoor exposure, pollution exposure, and injury from accidents. Studies indicate that both traditional and Pedelec cycling benefit health and well-being. [8, 9] Some of these benefits are due to being outdoors which in the case of enclosed systems can be at the start and end of the trip.

It will be prudent to consider, while there exists evolving concepts for velomobiles [10] and a UPS delivery van test project [11], vehicle concepts can continue to evolve. In fact, it is reasonable to postulate SVLAT installation may encourage vehicle evolution by creating a desire for vehicle designs not yet envisioned.

It is concluded that vehicle exist for SVLAT systems and design evolution is ongoing.

SVLAT Highway Spacing Feasibility

An important economic factor, therefore feasibility factor, is the required spacing between SVLAT highways and ramps. Wider spacing requirement will reduce overall system installation costs by reducing the number of arterial highways required. Work commuting often takes priority when considering transportation system feasibility. One USA study indicates people will travel by bicycle up to 4.36 km (2.7 miles) from a mass transit stop to work location. [12] Presumably, that distance could be greater when using electric assisted vehicles. Therefore, since most SVLAT users will be driving or riding a vehicle, SVLAT highways have the potential to resolve last mile issues associated with mass transit systems for work commuters.

The 4.36 km (2.7 miles) travel capability can also inform of required highway pitch spacing. Conceivably highways could be spaced every 8.72 km (5.4 miles), or greater, and still achieve full coverage for work commuting.

We are likely to find 8.72 km (5.4 miles) highway pitch spacing too wide for many urban uses. However, the wide spacing requirement indicates highway alignment may be flexibly chosen over many city streets without dramatically compromising utility. This flexible alignment can be exploited in the design phase and possibly save significant costs or provide more benefits than a less flexible requirement.

It is concluded there are many feasible alignments and ramp locations for SVLAT systems and these can be spaced wider than some transportation infrastructure alternatives due to most users using a vehicle.

Highway Infrastructure Construction Feasibility

While infrastructure cost estimation is not a trivial undertaking, costs could be relatively predictable since design and construction methods are well known due to occupancy, building height and loading being similar to existing low rise commercial structures. Most of the corridors can be classified as low rise extremely long commercial buildings. Factors which greatly impede a conceptual cost estimate include routing studies, underground characterization, and various technical issues identified by this study. However, it is possible to philosophically compare some relative costs based on fundamental characteristics.

Herein it is assumed estimates of system capacity, system loading, and corridor size can be philosophically compared with that of traditional automobile LAT which are designed to handle all vehicles up to the size of a motor freight truck, 18 wheelers in the USA.

For the special case of bridges a reasonable philosophical cost comparison can be made. We can assume freight vehicles on the SVLAT can be allowed at least up to the weight limit of small SVLAT passenger vehicles which results in much less design load than LAT. The lane size for SVLAT is assumed to be ½ the height and width allowing 4 times the number of lanes in a similar volume. It has previously stated that SVLAT highways will have similar capacity as LAT systems. Lower design load and lower volume for the similar capacity can result in lower costs per incremental capacity for bridges when comparing SVLAT with LAT systems.

Societal costs for existing small electric vehicles navigating traditional roadways is as little as $1/6^{th}$ the cost of traditional automobiles [13]. Compared to automobile systems, parking requirements are much less for bicycles and can require as little as $1/6^{th}$ of the land area for automobiles [14]. This results in lower parking costs for bicycles and small electric vehicles than traditional automobiles. For the special case of folding electric assisted bicycles or automated parking structures this parking land use can be even lower per vehicle. [15] The combination of reduced parking costs and the reduced overall societal costs for balance of system, provides rational to spend more to construct arterial highways for this otherwise low cost mode of travel.

New foundations can interfere with underground utilities. Underground interference mitigation can influence routing and above ground design details. Therefore, each locality must be uniquely considered to undertake the design work. Undertaking this design work and reconciling the costs/benefits will require significant expenditure of time and resources.

It is concluded that existing design and construction methods can be employed for the bulk of SVLAT highways. Also concluded that increased spending for SVLAT systems could be justified by lower societal costs for this transportation mode and/or decreased costs for critical structures such as bridges. However, significant expenditures are required to know what the cost/benefit balance may be for a particular locality.

ADDRESSING CHALLENGES AND RISKS

There are as many challenges and risks with novel SVLAT systems as have been known over time with the very similar automobile LAT systems, a daunting metric. On one hand, the similarity is informative. On the other hand, SVLAT systems design will be compared with proposals for the highly evolved automobile LAT systems and therefore be held to a higher standard than current automobile LAT systems. These high comparative standards will present barriers to entry since reconciling all possible issues is impossible. While we can identify design topics from past automobile LAT systems designs and factor from those solutions, mostly unique solutions will likely be desired.

Transportation Equity

Key public groups are keen to see efforts are made to consider transportation equity early in the development cycle. SVLAT systems can enhance transportation equity by reducing costs. For the user, not only are smaller vehicles less costly but the operating costs for lower speed small vehicles can be less.

As an entirely new roadway it is possible to consider the latest automation transportation innovative proposals such as full self driving. In addition, virtually every service or vehicle running on LAT for disadvantaged users can be re-designed for SVLAT systems providing a high level of individualized service for disadvantaged users.

Higher speed transportation mode, lower user costs, potential for automation and high capability of providing services for disadvantaged individuals indicates transportation equity may not suffer from SVLAT installation and could be beneficial to many users.

Regulatory Issues

Some studies have noted rising accident rates for bicycles. [16] Since increasing mode speed is likely to increase small vehicle traffic in the local area, further research is is needed to understand the causes and develop effective mitigation strategies either on or off the SVLAT system.

To maximize complexity within the current regulatory framework and therefore study validity, the conceptual study of SVLAT is performed assuming co-located pedestrian, Class 1 and Class 3 corridors. It is not clear if existing classifications will ultimately make sense for the SVLAT systems or if new classifications may be more economical. It is also not clear if additional corridors not currently within our regulatory frameworks will be desired. However, for brevity it is prudent to bypass the potential debate and consider the most complex case within the current regulatory framework.

An evolving change in transportation systems design is the advent of self-driving or driving assisted vehicles. It is reasonable to study how self-driving can be best applied in an entirely new roadway. We can ask if there are roadway design features which will facilitate function of automated systems. We can also ask if Class 1 or 3 vehicle lanes could be exclusively automatic all the time or at certain times of the day. Class 1 includes electric assist as well as manual vehicles. Therefore, full automation may not be feasible. When considering the degree of automation, we also could be considering what commercial services can be facilitated by full automation. One application that comes to mind is automated cargo, which can facilitate highly distributed manufacturing systems.

Indoor pollution caused by tire wear is known in other transportation applications. [17] Tire chemistry and highway surface characteristics affect indoor pollution which can be mitigated through highway surface standards, maintenance strategies, regulations, vehicle design, ventilation and tire design.

Regulatory issues can be the most difficult to resolve in a timely manner. Therefore, early identification of potential regulatory issues is prudent. The issues which seem the most amenable to regulatory solutions are vehicle class for highways, design loads, highway design standards, vehicle design standards, emergency systems, indoor tire particle pollution, accident precursors, and others not yet identified.

Safety

Battery recharge coils in the roadway surface is a technology which could be evaluated. Not only is ease of charging beneficial, but widespread availability could reduce battery size which may reduce indoor fire risk.

Acceptable battery safety systems design is affected by cultural and legal contexts. Combustible loading by way of the vehicles and batteries is unique. Electric vehicle technology developed for confined space applications such as mining could prove to be enabling for enclosed highways. [18] These and other battery issues are complex, and study is non-trivial. Extensive research into battery regulatory and design issues could be conducted with the overall goal of providing framework for balancing outcomes.

Long continuous buildings and corridors are not unknown. However this application is extremely long. SVLAT systems will also have a unique flammables loading. Therefore SVLAT systems fire safety systems should be uniquely assessed.

Vehicular accident precursors are unknown for envisioned highways. SLVAT highways could create increased small vehicle traffic on surrounding roadways. Increased traffic could result in more accidents and therefore become a more important safety consideration. Therefore, more understanding of accident precursors on and off the highway is a topic to pursue further.

It is concluded SVLAT systems present novel safety hazard challenges. Therefore, risk characterization and study is recommended ongoing with the design and demonstration phases.

SVLAT Transportation Network Integration

SVLAT will interface with existing transportation networks, parking structures and other places where mode shift is desired. While many of these design needs can be informed from existing examples for other modes, there will be likely unique needs which can be addressed with innovative solutions. Below some interface methods are listed and discussed.

High volume terminals for transitioning from vehicles to walking can be installed in some areas. Valuable urban real estate space can be conserved by locating terminals above and/or below the highways. These terminals can be co-located with automatic parking structures, thereby minimizing parking footprint and costs.

Exit/Entrance ramps are areas where riders can transition between the highway and the street level without dismounting. Developing safe and user-friendly transitions for SVLAT systems will require careful design, innovative solutions and community input.

It is possible to conjecture some vehicles could be designed to navigate not only the lower speed Class 3 SVLAT but also the existing LAT system. These may be electric motorcycles or other small vehicles that stay within the weight limits but area otherwise legal to operate on traditional roadways. Efforts to develop regulations to manage this option will not be trivial and require ongoing effort. Interface with LAT system could extend the range for select SVLAT vehicles and reduce congestion on LAT systems by bleeding traffic off the LAT in select areas. The economic potential of LAT system interoperability is difficult to assess at this time but could provide an additional pathway to gain acceptance by providing some unique capabilities.

LAT interoperability could also facilitate emergency response and therefore safety. Since commercial structures are designed for crush load, the design load for these structures is similar to low volume bridges for passenger vehicles. Therefore, some emergency vehicles could travel from home by LAT to the SVLAT for emergency service.

Lower volume elevated feeder 2-4 lane highways exclusive for pedestrians, Class 1 or Class 3 vehicles can be considered. Feeder highways could resemble recreational paths where the vehicles classes and pedestrians intermingle or could resemble automobile highways with pavement markings. These feeder highways could provide service to high volume entertainment venues, residential housing, work locations or shopping districts. This elevated feeder highway concept could also be used as a transitional transportation system to encourage traffic to build as arterial SVLAT systems are planned and constructed. As needs develop 2-4 lane small vehicle feeder highways could be re-purposed to SVLAT corridors.

In line with the modern transportation design philosophy of maximizing accessibility for active forms of travel, the preliminary design of the proposed SVLAT provides physical accessibility by incorporating features that encourage pedestrian and traditional bicycle traffic. Providing economical accessibility for the user can be as simple as ensuring vehicle affordability or as complex as choosing SVLAT alignments. [19]

Contiguous pedestrian access likely is required for emergency egress. Therefore, pedestrian corridors can be provided along the entire highway with stairways strategically located to provide emergency egress. These manual mode lanes can maximize accessibility by making possible elevated pedestrian indoor mall concepts anywhere along the entire highway. Crossing over city streets without stopping can improve urban pedestrian and cycle experience. Providing conveniently located bridges, ramps and elevators can further facilitate access. Allowing Class 1 riders to transition from riding to pedestrian mode by using systems of bollards in high traffic areas can help maximize accessibility.

Class I traffic corridors could be configured as feeder lanes (much like a frontage road) for speed limited Class 3 vehicles, thereby maximizing accessibility potentially at a lower cost than providing for separate ramps or access points.

SVLAT integration with existing transportation networks can be complex, identified herein is potential for feeder roads, LAT connections, emergency egress, ramps, terminals, parking and shopping mall integration.

Aerodynamic Design

SVLAT highways can range from open air to fully enclosed and air conditioned. In any case aerodynamic studies are needed. Wind shielding for open corridors can help minimize energy usage and can contribute to safe operation.

Totally enclosed corridors can be studied for internal air friction and ventilation. Vehicle air friction in enclosed space can vary depending on length of corridor, number of vehicles, vehicle speed, corridor size, aerodynamic design of the corridor interior and other factors.

UNIQUE APPLICATIONS AND OPPORTUNITIES

At the conceptual level, unique applications and opportunities are difficult to identify and more difficult to assess. Experience and need will be the best informers of these opportunities.

Auxiliary Uses

Significant value can be realized by utilizing this critical structure for additional uses. Identifiable uses include electrical or fibre-optic cable routing, pipe routing, package conveyors, entertainment venues, solar collectors, and exercise corridors. While some of these auxiliary uses could be included at the time of initial build, providing space and load capability for future changes may be economical.

Potential High Value Highway Applications

Potential high value applications are described herein to give insight into how the new infrastructure can provide unique value proposition over other modes ,and therefore, to illustrate factors which can create impetus for a first of a kind installation. This list is non-exhaustive. It is expected that where one or more of the factors described below exist the installation could have the highest economic impact. Ideal locations do not exist but those which can solve more than one major problem can more easily bear the cost of new technology.

Many large cities are built near to waterways which divide parts of the cities. Bridges and tunnels crossing these waterways are often included in congestion pricing schemes. [20] Due to historic shipping capacity needs, cities built near waterways often have high clearance bridges over navigable waters. The envisioned traffic corridors for SVLAT systems is ½ the height and ½ the width of traditional LAT bridges, allowing 4 times the number of lanes in the same volume. In addition, small vehicle corridors can have lower design load per lane than LAT systems. This combination of less load and fitting into a smaller volume can significantly lower bridge construction costs for the same amount of traffic.

Transportation upgrades are often required as a part of the application process for world venues such as the Olympics or World Fair. These upgrades must be undertaken in an existing urban area where cost of subways or other transportation infrastructure is high. It is possible these SVLAT alternative solutions could save significant cost, because of the features of reduced parking space, low design loads, elevated traffic corridors, wide coverage and high capacity.

In some coastal cities there are concerns with flooding and more so with climate changes or land sinking. Increased intensity of storms or increases in static water levels have resulted in various proposals to mitigate impacts. An enclosed, elevated transportation network designed in accordance with modern codes and with consideration of recent climate changes could significantly alleviate some of these challenges. A modern structure built in accordance with latest standards can be more likely to be functionally intact following natural disasters and therefore could help alleviate disaster response costs.

In many cities, transportation networks such as subways and urban LAT highways were installed years ago while the city economy has continued to grow, placing strain on these legacy transportation systems. The costs to upgrade these legacy systems can be prohibitive and often upgrades are limited in scope, unable to significantly improve transportation for more than a few years. SVLAT highways may be lower cost and therefore more capacity may be added for the same expenditure compared to LAT highways in the same area. Considering that SVLAT highways can have higher speed than some other urban transportation modes, users may prefer to utilize SVLAT highways as a complete replacement for automobile, rail, bus, tram or subway systems in certain localities.

Urban design is a process of reconciling competing priorities for the same land area. Transportation systems access is a primary need and often overrides other needs. SVLAT has the potential to dramatically reduce surface transportation system demands by using underutilized space above existing transportation corridors. Modern traffic modelling methods can estimate the potential benefits of new technology for the users. Funding traffic modelling design studies, where SVLAT is an option, for congested areas is likely to reveal and quantify potential SVLAT benefits.

It is concluded that acceptance of SLVAT as a design option could create opportunities for creative solutions that heretofore have not be considered.

SUMMARY

This article proposes a novel transportation system called the Small Vehicle Limited Access Thoroughfare (SVLAT), a bespoke urban network of elevated non-stop zero second wait time highways designed for small electric vehicles, bicycles, and pedestrians. The proposal aims to revolutionize urban mobility by offering zero-second wait times, lowering costs, enhancing accessibility, reducing congestion and lessening environmental impact.

Key conclusions of this article are:

- Zero-second wait times: SVLAT ensures constant movement thanks to its dedicated lanes and minimal on/off ramps.
- Increased average modal speed: SVLAT systems are expected to provide a level of service better than using city streets for small vehicles. In addition better service than some other transportation services.
- Increased accessibility: The system promotes accessibility by providing ubiquitous pedestrian and bicycle access all along the SVLAT highway.
- Reduced emissions: Smaller vehicles and lower speeds for SVLAT systems can lead to decreased air pollution.
- Reduced urban congestion: Adding significant transportation capacity in highly congested areas can reduce overall urban congestion.
- Potential to resolve last mile issues: Mass transit is mostly accessed by people walking whereas the SVLAT envisions most users will be riding or driving a vehicle.
- Potential for wide highway pitch spacing: Studies for bicycle systems designed to service mass transit stops have found people are willing to travel long distances 4.36 km (2.7 miles) by bicycle from transit stops for work commuting.
- Fire safety analysis will require complex focused attention.
- Existing regulations may not be adequate for this mode.

The article presents and philosophically balances results of a conceptual study exploring the feasibility, challenges, and potential benefits of novel SVLAT arterial highways. It discusses design considerations, infrastructure integration, unique applications, regulatory issues and safety concerns. The study suffers from lack of funding, lack of data, myriad issues and daunting complexity. Overall, the author argues that elevated SVLAT offers a promising solution for cities struggling with growing congestion and limited space for transportation infrastructure. The article makes an intellectual contribution by introducing the topic, making difficult observations, establishing a broad based understanding for pursuit of future research and development, and doing all this in a relatively short article. A post production audit of this article counted more than 90 nuanced observations, most of which can be future research topics.

While the article is optimistic about the potential of SVLAT, it acknowledges several challenges that could benefit from further research. However, it concludes that the potential benefits of lower cost and higher speed warrants further exploration and investment into the SVLAT concept. It is intended the article to enable and encourage others to study the SVLAT concept for application in their local area.

References

[1] Capasso Da Silva, D. C., D. A. King, and S. Lemar. 2020. *Accessibility in practice: 20-minute city as a sustainability planning goal. Sustainability*, 12 (1), 129. https://doi.org/10.3390/su12010129.

[2] Vance, J. E. 1990, *Capturing the Horizon: The historical geography of transportation since the 16th century*. London: John Hopkins University Press.

[3] Price, D. 2022. *Are Elevated Urban Pedelec Highways Our Future? – A Conceptual Study*. https://doi.org/10.31224/2664.

[4] Colbourn, C. J., I. D. Brown, and A. K. Copeman. 1978. *Drivers' judgments of safe distances in vehicle following.,* Hum. Factors, 20 (1), 1–11. https://doi.org/10.1177/001872087802000101.

[5] Rayaprolu, H. S., C. Llorca, and R. Moeckel. 2020. *Impact of bicycle highways on commuter mode choice: A scenario analysis.*, Environ. Plan. Part B, 47 (4), 662–677. https://doi.org/10.1177/2399808318797334.

[6] Hallberg, M., T. K. Rasmussen, and J. Rich. 2021. *Modelling the impact of cycle superhighways and electric bicycles*., Transp. Res. Part A, 149, 397–418. https://doi.org/10.1016/j.tra.2021.04.015.

[7] Levin, Tim 2025. *The Incredible Earth Saving Electric Bicycle is Having a Moment.*, Business Insider, www.businessinsider.com/electric-bikes-popularity-sustainability-evs-2023-4#:~:text=Last%20year%2C%20Americans%20bought%20just,-bike-industry%20trade%20group. Accessed 6/16/2024.

[8] Sundfør, H. B., and A. Fyhri. 2017. *A push for public health: The effect of e-bikes on physical activity levels.,* BMC Public Health, 17 (1), 809. https://doi.org/10.1186/s12889-017-4817-3.

[9] Leyland, L. A., B. Spencer, N. Beale, T. Jones, and C. M. van Reekum. 2019. *The effect of cycling on cognitive function and well-being in older adults.,* PLOS One, 14 (2), e0211779. https://doi.org/10.1371/journal.pone.0211779.

[10] Ferrari, M., N. Biachi, A. Doria, and E. Giolo. 2013. *Development of a hybrid human-electric propulsion system for a velomobile,* Eighth Int. Conf. Exhibit. Ecol. Veh. Renew.

Energies (EVER) 978-1-4673-5271-0/13/$31,00.

[11] DaSilva, S. 2022. *UPS is testing pedal-powered delivery bike-van-thingies in NYC.,* Jalopnik, 12:30 pm.

[12] Zuo, T., H. Wei, N. Chen, and C. Zhang. 2020. *First-and-last mile solution via bicycling to improving transit accessibility and advancing transportation equity.* Cities, 99, 102614. https://doi.org/10.1016/j.cities.2020.102614.

[13] Gössling, S., and A. S. Choi. 2015. *Transport transitions in Copenhagen: Comparing the cost of cars and bicycles., Ecol. Econ.,* 113, 106–113. https://doi.org/10.1016/j.ecolecon.2015.03.006.

[14] Lee, A. and A. March. 2010. "Recognising the economic role of bikes: sharing parking in Lygon Street, Carlton." *Aus. Plan.*, *47*(2), 85–93. DOI: https://doi.org/10.1080/07293681003767785

[15] Jaffe, S. November 16, 2019. *Cycling safety concerns grow in US cities.,* http://www.thelancet.com. Lancet, 394 (10211), 1791–1792. https://doi.org/10.1016/S0140-6736(19)32757-6.

[16] Roy, D., E. S. Lyou, J. Kim, T. K. Lee, and J. Park. 2022. *Commuters health risk associated with particulate matter exposures in subway system – Globally.,* Build. Environ., 216, 10936. https://doi.org/10.1016/j.buildenv.2022.109036.

[17] Meng, L.; Wang, G.; See, K.W.; Wang, Y.; Zhang, Y.; Zang, C.; Zhou, R.; Xie, B. Large-Scale Li-Ion Battery Research and Application in Mining Industry. Energies 2022, 15, 3884. https://doi.org/10.3390/ en1511388

[18] Parker, S. K., H. M. Hinson, and R. Porter. 2021. *Spatial accessibility of bicycle routes in the Quad Cities: Impacts for environmental justice.*, Leisure/Loisir, 45 (3), 371–396. https://doi.org/10.1080/14927713.2021.1880338.

[19] International Conference on Applied Sciences Journal of Physics: Conference Series 1426 (2020) 012028 IOP Publishing doi:10.1088/1742-6596/1426/1/012028

[20] Wikipedia contributors. (2023, December 20). Congestion pricing. In *Wikipedia, The Free Encyclopedia*. Retrieved 16:59, February 10, 2024, from https://en.wikipedia.org/w/index.php?title=Congestion_pricing&oldid=1190958842