USHERING IN NEW MOBILITY WITH USER-CENTERED DESIGN

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Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. RMI has offices in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and Beijing.

INTRODUCTION

Three core new-mobility technologies—autonomy, shared ride platforms, and electric powertrains—offer the promise of cheaper, cleaner, safer mobility for everyone, and are advancing by the minute. Still pundits and technologists foresee many years passing before new mobility is a real and common solution for consumers. So why aren't we all using smartphone apps to summon electric, driverless chauffeur services to whisk us around? The problem is twofold: (1) the technologies are not yet perfect (and even well-tested technologies are not yet available for public use), and (2) perhaps more important, new mobility services do not yet deliver a complete mobility package. In other words, consumers cannot use new mobility to replace all use cases. When they decide whether or not to purchase a vehicle, they often must still default to personal vehicle ownership, locking in their mode of transportation for an average of **seven years**. The lack of a compelling alternative across a strong set of use cases creates a self-reinforcing cycle whereby consumers continue to purchase vehicles, inhibiting the growth of the new mobility market. This cycle of personal car ownership must be broken in order to move mobility to a cleaner, cheaper, and more space-efficient system. At present, however, there is no clear pathway to transition from exciting but theoretical new mobility concepts to large-scale implementation of services in a way that adds value relative to vehicle ownership and is desirable for consumers.

McKinsey Design recently **reported** that prioritizing design and creating user-centric, well-conceived products can help companies in a variety of industries to double their growth and returns compared with their competition. Likewise, using design thinking, new mobility companies can find ways to encourage consumers to switch from personally owned vehicles to shared, electric, and autonomous mobility services. The process of user-centered design thinking defines the problem while keeping a keen eye on what the customer desires in a product and then uses an iterative and experimental approach with rapid-fire brainstorming, prototyping, and testing to identify innovative solutions. With the use of practical, creative, solution-focused design thinking, the conversation can shift from what the new technology is to how technologies can be implemented together to form a new system that delivers for the consumer.

This report describes a path to usher in new mobility that reduces personal-vehicle ownership faster and at scale by:

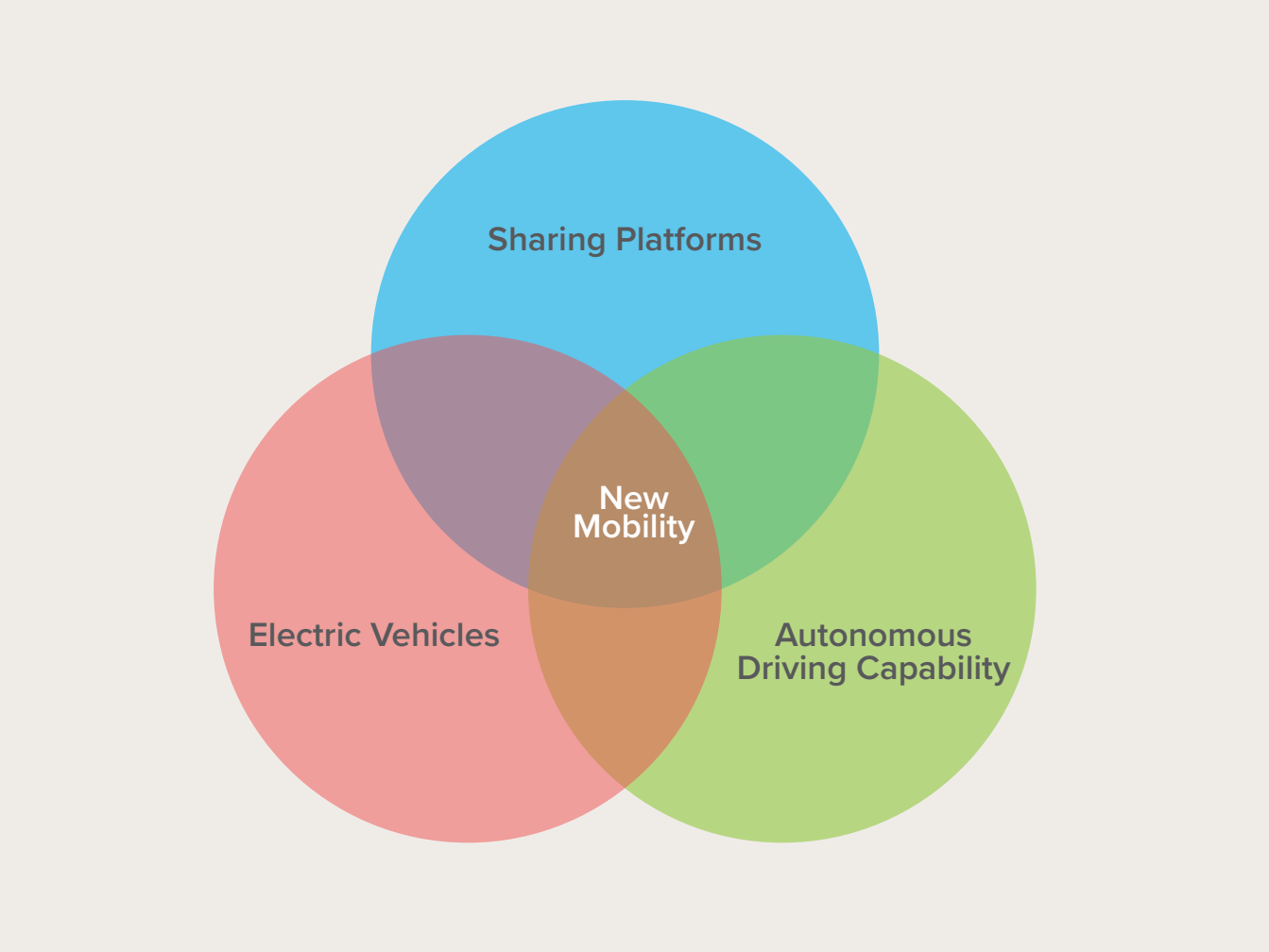
1. introducing the application of design thinking to the design of both the physical vehicle and the service offerings
2. showing how mass customization can unlock the new mobility market potential
3. illustrating early applications of design in the industry

THE VALUE OF NEW MOBILITY

New mobility, defined as the triad of shared, electric, and autonomous vehicles (SEAVs) offered as a service, is a new, well-publicized, conceptual system for the mobility sector. Elements of this system are receiving major investments, with **$111 billion in disclosed transactions since 2010**. Driven by significant pain points in the current mobility system (emissions, cost, congestion, wasted time, valuable land use, safety, and health), new mobility is emerging via the accelerated development of electrification, autonomy, and platforms for sharing. Although not fully mature, these three technologies appear to have an inevitable path to technological maturity, with steady improvements leading to decreasing costs and (for autonomy) operational capabilities in increasingly complex environments. As a result, the desired end-state of these technologies is becoming clear. However, to get from technology to widespread deployment and adoption of public-facing new mobility, the industry must design innovative products and services that meet customer needs.

FIGURE 1

THE TRIAD OF NEW MOBILITY TECHNOLOGIES



The value proposition of new mobility is well-supported by techno-economic analysis (see Figure 2). The three technologies implemented together provide positive feedback to one another and overcome the major pain points of mobility today. For example, relative to an internal combustion engine (ICE) powertrain, electric drive has a lower fuel cost and less down time due to fewer maintenance needs, improving the cost and quality of service that a mobility service platform can provide. Mobility service providers charge customers' vehicles for their planned journey, eliminating range anxiety and the burden of long charging periods. Autonomy assists service providers in deploying a sufficiently charged, ideally designed vehicle from their fleet for a given trip. Similar feedback loops for SEAVs can be established for a number of other pain points besides fueling. To realize the potential value from these new technologies, they need to be offered as an attractive service, which means mobility transformation professionals need to shift their focus from *what* to *how.*

An autonomous vehicle being used for public transport in Downtown Las Vegas, Nevada.

FIGURE 2

THE VALUE PROPOSITION OF NEW MOBILITY

DEFINITION OF A VEHICLE

Picture a vehicle in your mind. What does it look like? Most likely it looks like a common car or truck because that is what we know and see every day. In this report, we redefine the term vehicle to mean any powered mover of people or goods of any size or shape. This definition is more permissible because new mobility removes historical design constraints.

WHAT ARE WE SHARING?

There are two main types of sharing for mobility services: shared vehicles and shared rides. With shared vehicles, or assets, multiple unrelated persons use the same vehicle but not necessarily at the same time, like a taxi service today. A shared ride is when more than one person uses the same vehicle for similar trips, like a carpool or a pooled ride-share ride. Having high market penetration of shared vehicles is a critical part of the new mobility ecosystem and one of the main drivers of cost savings. Optimization of this fleet, a major source of value for new mobility operators, cannot be realized without the shift from personal ownership to mobility-as-a-service. A shared ride is one type of service provided in a business model that could be offered for price- or emissions-conscious customers. In this report, shared services refers to shared vehicles operated in a fleet, unless otherwise specified.

ASSUMPTIONS

Use case: Of the three personal mobility use cases—urban, rural, and highway—this report is written specifically about urban personal mobility in the United States.

Charging infrastructure: This report does not address the complex needs of charging infrastructure. An in-depth analysis of the challenges and opportunities that the necessary electric vehicle infrastructure creates for the grid and utilities is presented in Rocky Mountain Institute's ***Gas to Grid*** report.

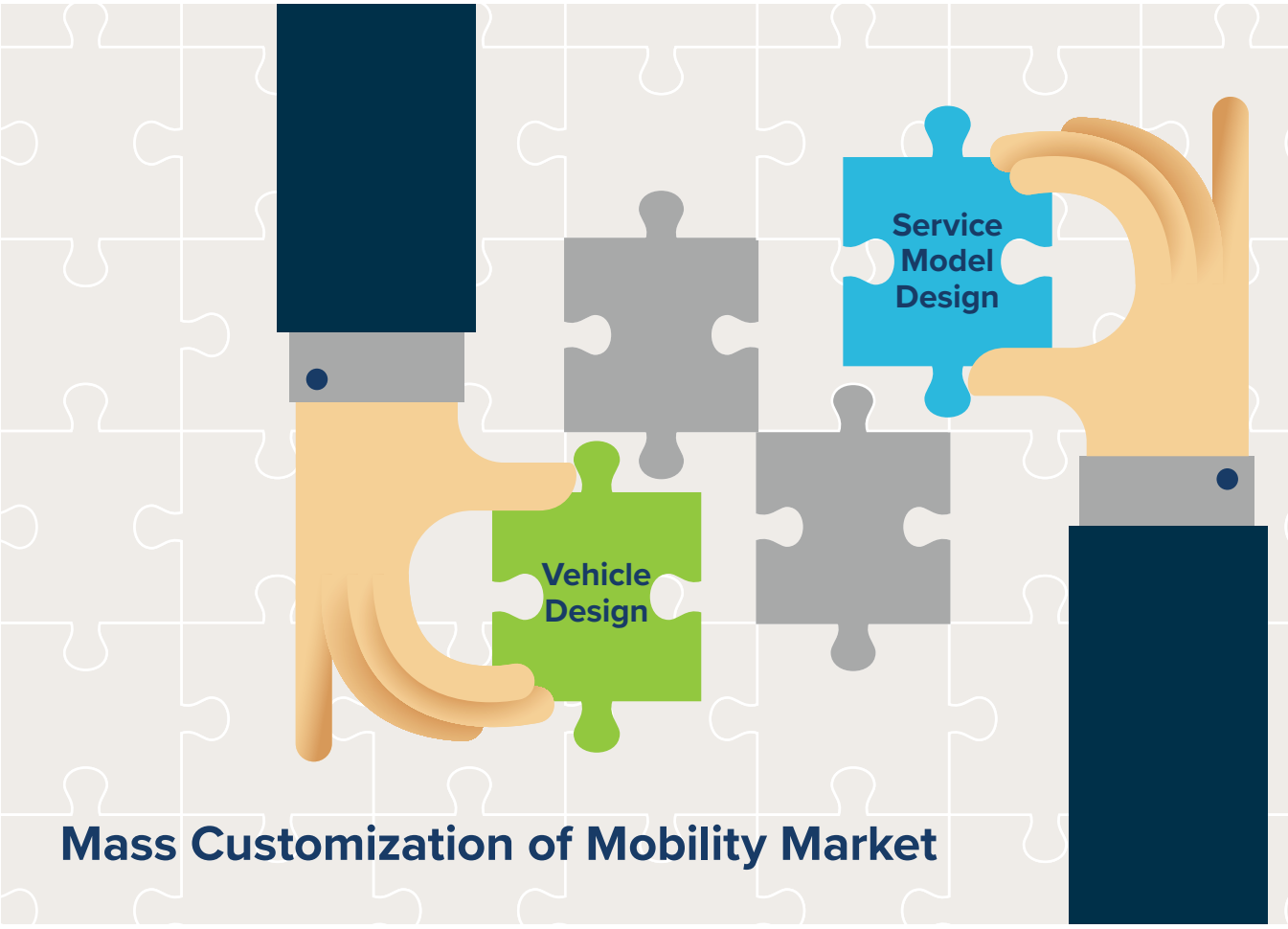
Technology performance: This report assumes that new mobility technology will fully mature and will provide all of the expected benefits. As with any new development, there is a risk that this ideal will not be met safely and effectively. Should the technologies ultimately fail to perform as necessary to properly serve our society, the design of that system should, of course, not be pursued.

NEW MOBILITY DESIGN OPPORTUNITY

Deploying SEAV technologies creates an opportunity to design new mobility services to address mobility pain points and ensure that SEAVs are a competitive alternative to individually owned, gas-powered vehicles by enabling customers to summon a vehicle specific to their needs and desires. Through the application of design thinking, the value proposition of SEAVs for consumers can be realized faster and at scale. This design challenge has endless opportunity because the service offerings can be as unique as the humans that use it. Such mass customization can truly unlock the market potential for SEAV mobility services. Rather than continuing to make incremental improvements to current vehicles, these technologies enable a fundamental paradigm shift in the mobility sector. User-centered opportunities for design of both the physical vehicle and the service model illuminate a path toward the mass customization necessary to achieve the desired mobility market transformation.

FIGURE 3

NEW MOBILITY DESIGN OPPORTUNITY



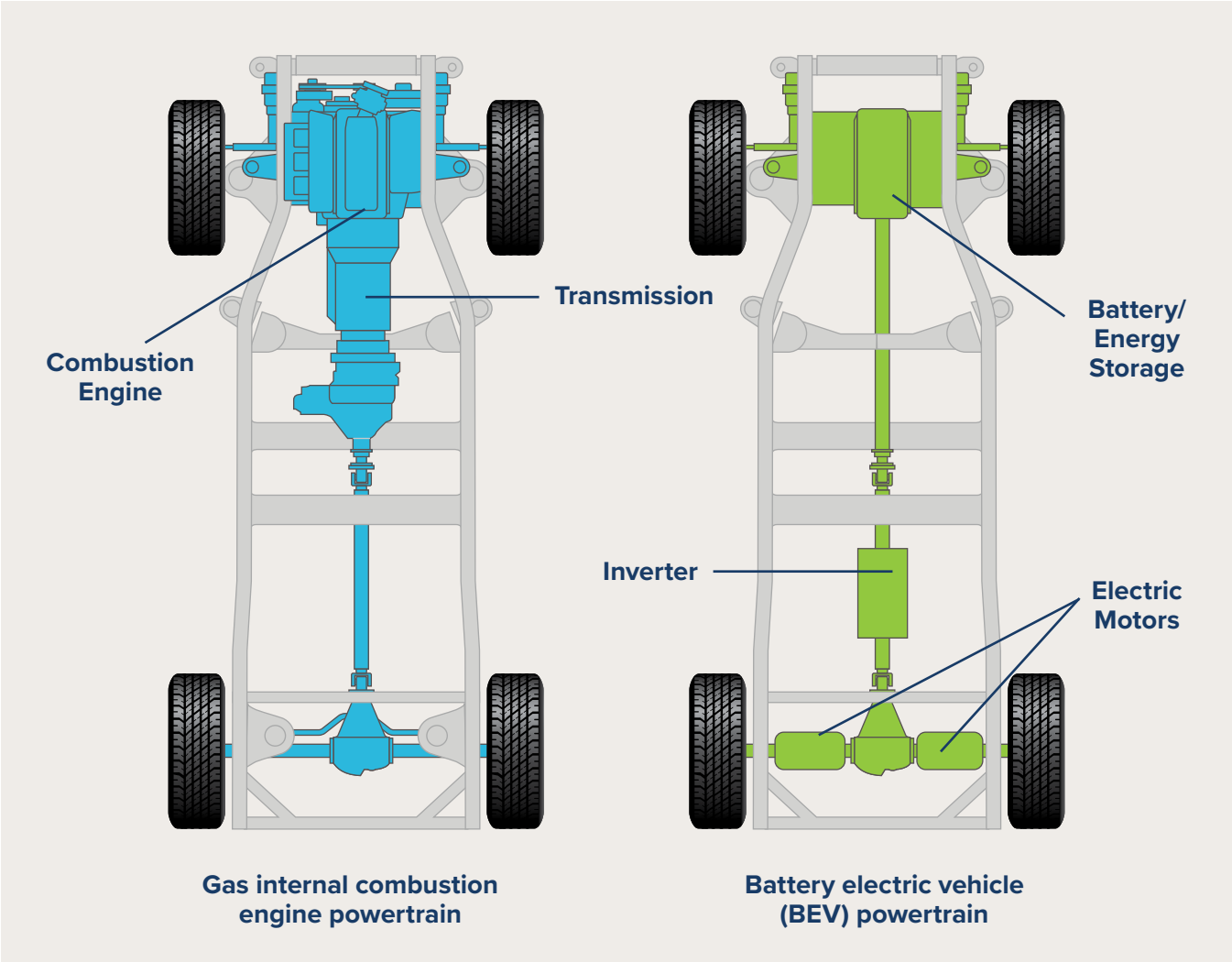
VEHICLE DESIGN

SEAVs enable an attractive, new service-oriented mobility market by removing many design constraints. Currently, vehicles are purpose-designed but not optimally used or shared. Electric powertrains, customized vehicle shapes, and eventually autonomous fleet optimization change this dynamic. When designed for specific use cases, vehicles can be engineered with specific capabilities in mind.

In the new mobility paradigm, the shape of a vehicle can be vastly altered due to the design of the electric chassis. The electric powertrain releases a number of vehicle design constraints that apply to ICE powertrains. For example, the main power source of an electric vehicle (EV), the battery, is thin relative to the vehicle, which allows it to be positioned below the cabin, making a skateboard-like powertrain. Without the bulk of the ICE powertrain, which needs significant space and protection, the vehicle cabin can be reimagined.

FIGURE 4

EV VERSUS ICE POWERTRAIN



Full autonomy creates additional vehicle design opportunities by removing the need for driver controls. Without an operator, vehicles do not require space for the steering wheel, accelerator and brake pedals, dashboard controls, and a forward-facing seat with unobstructed views. Removing these constraints creates new opportunities for the shape and functional design of the vehicle cabin such as designing for privacy, comfort, or entertainment.

Different environments such as urban, rural, and off-road may require different body design, and the distance traveled will dictate the size of the vehicle battery. For long urban trips, public charging or even battery swapping could reduce battery requirements, whereas long rural or off-road trips will need larger battery capacity to complete the trip without recharging. Weather may also be a factor, necessitating that vehicles have snow tires in the mountains or be low profile for high winds. While autonomous vehicles may prove to be very useful in many of these applications, there may be some in which autonomy offers little value or is not well suited. But, for these cases, electric, shared, human-driven cars will likely continue to be available as part of a service platform.

Specific vehicles can be customized for specific types of trips and then deployed only when that type of trip is taken. For example, safely transporting children is a critical consideration that prevents many families from giving up car ownership. Although the vehicle may not need a driver, safety monitoring may still be an important requirement for trips with minors onboard. In addition to transporting families and friends, specific vehicles could be designed with extra space for groceries and shopping or racks for recreational sports gear, amenities not needed for a typical commute to work or school. The ability to divide these tasks and use the right vehicle for the job will unlock cost savings, improve service, and optimize the whole mobility system.

SERVICE MODEL DESIGN

The ability to customize the mobility service model creates an opportunity to design more convenient, cost-effective, and accessible transportation options, addressing major pain points of the current mobility system. Today, personally owned vehicles are used for trips as varied as commuting to work, running errands, and taking family vacations. As a result, vehicles are designed to handle many use cases—including those that very rarely happen—rather than being optimized for a specific one. Seven-passenger SUVs with large cargo capacity routinely carry one person and a briefcase to work.

When mobility is provided by a service fleet, the right vehicle for the job can be deployed, saving customers money while also saving energy and space on the road. For example, a customer may choose the affordable commute service to get to work but select a sports car for a date night and a pickup truck to haul new dirt to his or her garden. In addition, adding autonomous capabilities to electric, shared service vehicles reduces costs (by removing the operator), improves fleet efficiency, and will improve safety as the technology improves. Service providers can optimize their fleet of autonomous vehicles across an entire geographic area to accurately and efficiently provide rides that meet customer specifications as well as ensure that vehicles are charged, cleaned, and serviced. The improved safety provided by autonomous technology should also reduce downtime and repairs.

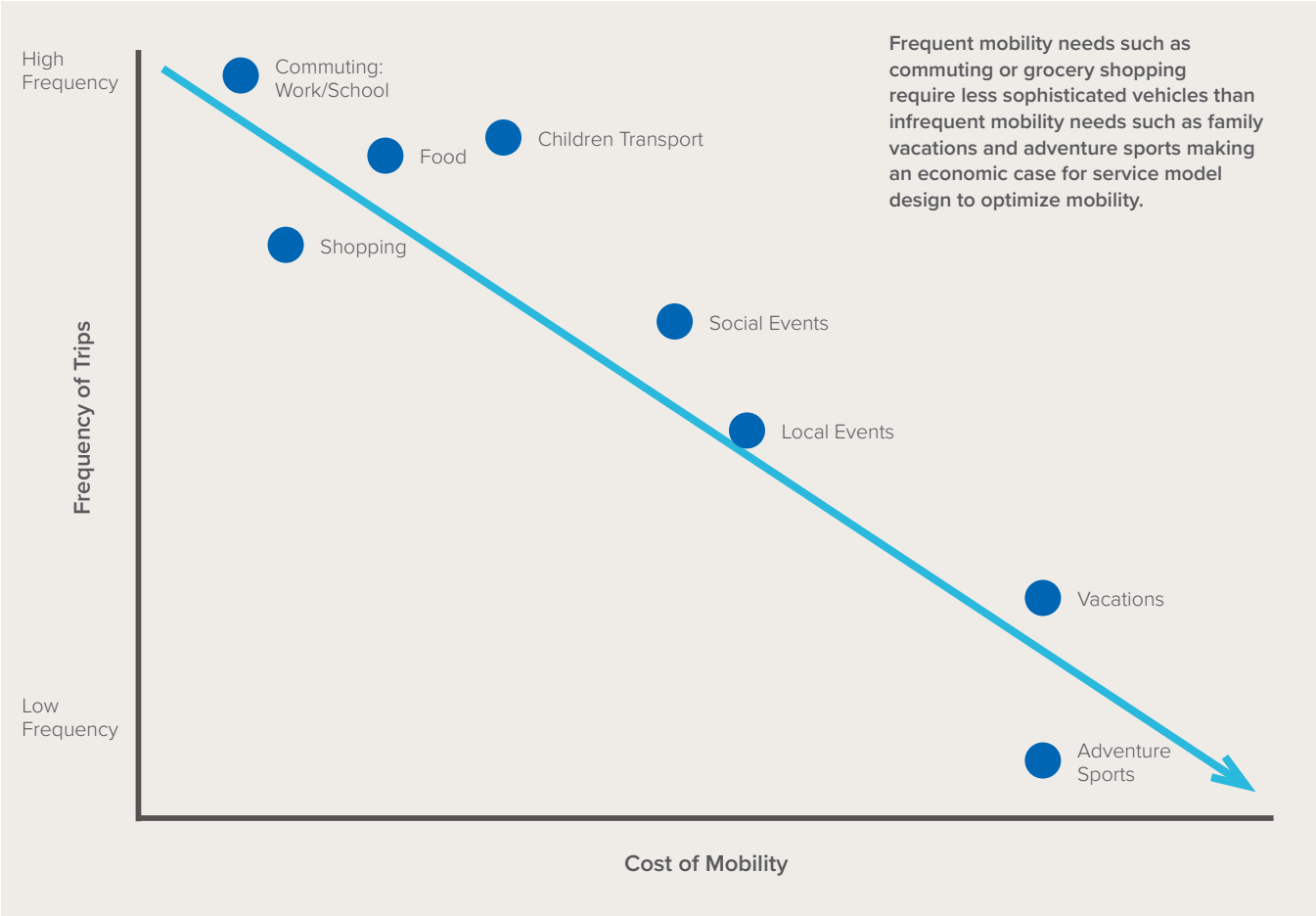
Compared with new mobility, highly customized vehicles in today's ownership paradigm are inefficient (from both an economic and energy perspective), but convenient. Having customized vehicles in a mobility-as-a-service model means that customers can have the right vehicle for each specific use case without paying for every feature every time or needing to store and maintain every vehicle. As a result, the design

challenge is: which systems or business models for these mobility services actually work? Given the variety of factors that affect how people make mobility decisions, experimenting and iterating with possible system designs is necessary to identify the optimal final product.

When deployed as a service, this customization, whether it is vehicle selection or other areas of service, can meet the needs of a wider variety of use cases, creating significant value, especially for those who cannot afford car ownership, while also allowing for more unique features and personal expression (see Figure 5). For example, at the most basic level of service, inexpensive people movers provide a low-cost option that can ensure all community members have access to food, school, and work. These could even replace conventional heavy-duty transit vehicles on routes with low ridership. At the next level of service, a higher price can be charged for necessary but infrequent uses that require a more purpose-designed vehicle, allowing more people to access specialty vehicles than today's car-ownership paradigm. In addition, features such as large capacity (e.g., for recreational gear, tools, luggage) or high performance can be made available at a premium price.

FIGURE 5

THE COST SPECTRUM OF MOBILITY NEEDS



Although more convenient, cost-effective, and accessible mobility is the goal, what is convenient, affordable, and accessible for one user is not necessarily the same for another user. No single fleet mix or service design could address cost and convenience for 100% of users and use cases. Instead, for a given environment, specific instances of these pain points can be targeted and designed out. For example, SEAVs in an urban environment increase convenience for customers with far-away or expensive parking. In addition, those who want the benefits of carpooling but without a rigid schedule or the hassle of organizing it will benefit from the versatility of SEAVs.

A (near-term) way to think about the market during the transition to SEAVs is by segmenting it according to how many vehicles a household owns. Households with one vehicle could avoid buying a second vehicle and two-or-more vehicle households could entirely replace a vehicle with SEAV services. (The average car ownership per household in the United States was **1.97 in 2016**, so this represents a significant market opportunity.) Service providers will shape their offerings differently when trying to replace some use cases, as is the case for transitioning a two-vehicle household to one where the household still has one vehicle available, versus needing to satisfy all use cases when replacing all of a household's vehicles.

In order to transform personal mobility from an ownership paradigm to one based on SEAVs, the critical mobility use cases need to be identified and services must be designed to meet them. This process must advance in conjunction with technological maturity.

MASS CUSTOMIZATION UNLOCKS SEAV MARKET POTENTIAL

Ubiquity of service is key to fully unlocking SEAV market potential. This means creating a system design that fits most types of personal use cases as well as supplying enough vehicles so that on-demand service is available when needed. This ubiquity provides the comfort that personally owned vehicles parked in the driveway give today. Only when this feeling is matched will the majority of people begin to change their mobility purchasing decisions. When done well, the service will still feel custom, but have scale and critical mass. This is called mass customization.

Designing SEAV systems for mass customization will require experimentation because, although we can estimate the cost of future mobility services, we do not know the actual price consumers will pay. In addition, the cost and customer's willingness to pay will depend on the trip distance and type of mobility the customer needs.[i] One way to start thinking about this new design today is to reimagine the market segmentation that new mobility will require. In going from a vehicle-focused market to a service-delivery-based market, segmentation will shift from "minivan" versus "compact" to "urban dweller" versus "suburban traveler," putting the emphasis on groups with similar travel patterns and use cases. These will be the segments that services target with different business models to attract more customers to their platform.

[i] Willingness to pay is the maximum amount of money a person is willing to pay to acquire a good or avoid something undesirable.

NEW MOBILITY DESIGN EXPERIMENTS TO DATE

Change is building in the mobility industry and many new technologies are already implemented in mobility services today. Although mobility services represent a small percentage of today's mobility market, the rate of development of new technology suggests SEAV services will be widely available in the very near future. Below are a few implementations of new mobility technologies that also apply design thinking concepts as discussed above.

- **Lyft and Uber:** Early players in the explosion of ride-hailing companies, Lyft and Uber offer users the ability to request a certain vehicle size. Choosing from options as small as one seat or as large as six seats allows their customers to pay for the space they need, making the service applicable to many needs. These companies have also dabbled in additional needs such as car seats and bike or ski racks, but these challenges remain largely unsolved.

- **BMW ReachNow:** BMW ReachNow offers both rideshare and carshare on its platform, addressing its customers' varied use cases by allowing customers to select the option that best fits their needs. ReachNow Chief Customer Officer Dr. Simon Broesamle said the company "expects that the number of miles traveled will become the new currency for automakers instead of number of cars sold," and the company believes the path to deployment will be a multifaceted approach with different services for different needs and communities. Understanding how customers respond to this style of platform and marketing holds key insights to how consumers respond to a mobility service that would replace the current one-size-fits-all-needs vehicles.

- **Maven:** Maven has combined the shared and electric components of new mobility by deploying EVs in coordination with local charging companies like Austin Energy and EVGo. EV charging infrastructure availability, both real and perceived, is a common challenge to bringing EVs to market. Maven has tackled this barrier by piloting free EV charging in partnership with local infrastructure providers to help new customers feel comfortable with the technology. This problem-solving pilot design is an interesting way to accelerate the adoption of unfamiliar technology.

- **AAA and NAVYA:** AAA and autonomous shuttle company NAVYA have deployed an **autonomous shuttle on the Las Vegas Strip**. This pilot design suits the autonomous technology today due to the relative simplicity of the route. Working in this small area is important because autonomous technology's path to market is different from shared and electric. Autonomous vehicles have a high bar for safety, so companies face scrutiny both for changing the definition of driving as well as introducing potential safety hazards to the roads. In AAA's pilot, the vehicle learns one specific operating environment well and has the goal of demonstrating safer operations compared with human drivers, especially in a distracted driving environment like the Las Vegas Strip. With applications such as this one, service providers could have a large and profitable market before fully autonomous technology is perfected.

SHIFTING THE CONVERSATION FROM WHAT TO HOW

New mobility offers promising value over the current personally owned mobility system, but at present there is no clear path from the current technology and ideas to valuable and desirable service implementation on the road. Design thinking illuminates a path toward how SEAVs can replace personally owned vehicles through practical, creative, solution-focused idea implementation. To capture this opportunity:

1. Mobility thinkers and advocates should shift their focus to how to make new mobility happen in parallel with technological advances.
2. Mobility thinkers, advocates, and market stakeholders should encourage the iterative testing of SEAV technology in different use cases to understand which features and amenities customers most want, their willingness to pay, and which business/pricing models work, while helping people perceive SEAVs as a compelling alternative to personally owned vehicles.
3. Investors of all kinds should fund organizations and individuals focusing on how, with an emphasis on creative, design-centric solutions.

We need to enable SEAVs to create value for consumers, beyond simply cost savings, in order to overcome the major pain points in today's transportation system. We can open the door to this new mobility future with an intentional focus on the design of SEAV services.

ENDNOTES

[1] https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions

[2] https://www.sciencedirect.com/science/article/pii/S0967070X17300811

[3] http://sustainablemobility.ei.columbia.edu/files/2012/12/Transforming-Personal-Mobility-Jan-27-20132.pdf

[4] https://transportgeography.org/?page_id=4609

[5] https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812115

[6] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4049576/

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