KAIROS:
Progressiveness encouraged through architecture

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ABSTRACT

Progressiveness is defined as gradual betterment; *especially***:** the progressive, or continually improving, development of humankind. Humans have a subconscious desire for progressiveness; this is best exhibited in the modern attachment to the automobile. The fast-paced development of the automobile fuels progressiveness, while the customizability, adaptability, and controllability of the automobile bestows upon its driver an experience that keeps them wanting more. This thesis investigates the relationship between automobiles and the built environment and explores how architecture can take cues from high-performance automobiles with respect to the experience of high technology, the sensation of speed and independence of the user. How can the human experience within the built environment be more like the human experience of driving a high-performance automobile?

Through general design theory, the exploration of high-performance automobile components, and the exploration (and critique) of non-traditional architectural constructions, connections between the built environment and the automobile industry begin to point to potential design responses. Through experimentation and observation, a better understanding of appropriate demographic and geographic applications can be reached. In this thesis, the ultimate goal is to design an architectural response that improves the human way of life and can be applied to other programs and contexts. By designing architecture more like a high-performance automobile, the built environment can become the best, most efficient version of itself. It will simultaneously create a more interactive and enticing experience for the user, ultimately catering to progressiveness and improving the human quality of life.

Kairos

[**kai**·ros, **kī**¦räs]
The perfect, crucial moment: the fleeting rightness of time and place that creates the opportune atmosphere for action, words, or movement;[i] a time when conditions are right for the accomplishment of a crucial action.[ii]

INTRODUCTION

I remember at the age of 5, loving the roar of the engines and breathing the smoke from a burnout at a racing drag strip. My father used to take me to the drag strip on Saturday mornings during racing season and I have loved automobiles ever since. A few years ago I met a fellow enthusiast, a professional go-kart racer who dreams of racing Formula 1 cars. Through many conversations he has re-kindled my childhood love of cars and, from it, sparked a passion for the speed and sophistication exemplified in high-performance automobiles.

Society moves rapidly; technology is available at everyone's fingertips, styles and trends evolve monthly, and there never seems to be enough time in the day. Perhaps all of this is a direct result of the subconscious human desire for progressiveness, or the gradual and continual betterment of society. This desire, ironically, intensifies as progress is made; it has an addictive nature. Henry George takes an interesting stance on this philosophy in his book *Progress and Poverty*. "So this view now dominates thought: The struggle for existence, in proportion to its intensity, spurs people to new efforts and inventions. The capacity for improvement is established by hereditary transmission, and spread as the most improved (i.e., best adapted) individuals survive to propagate... Yet, we have reached a point where progress seems to be natural to us. We look forward confidently to greater achievements."[iii] Henry George focuses his writing toward the progress of civilizations and economics as a whole. He seems to imply that society must work collaboratively toward supreme equality on all accounts in order to continue achieving infinite progress. George also mentions that humans - presumably from all cultures - additionally reach for independence as individuals. He concludes that this paradox sparks conflict within the human race and consequently entertains a cycle of progression and regression that recurs throughout history. "But, without soaring to the stars, if we simply look around the world, we are confronted with an undeniable fact — stagnant civilizations."[iv]

The same stagnancy introduced in Henry George's philosophy can be seen within the built environment. Architects, engineers and business folk all have a tendency to remain independent from one another, halting true progress. A more collaborative approach to the everyday design problems faced by architects could introduce new opportunities for the spatial experience within architecture.

Automobiles constantly adapt and improve, aiming to always be the best, most-efficient versions of themselves. While most people do not (at least primarily) think about the efficiency of an automobile and its systems, they do know that driving, especially a high-performance automobile, always keeps them coming back for more. The major components in most automobiles are similar, and likewise with many architectural styles. There is a gap, however, between the two; architecture is not always the best version of itself, and it does not generally light the same emotional fire within a user that driving a high-performance automobile does. The question then becomes: how can architecture begin to take cues from high-performance automobiles with respect to the experience of high technology and the sensation of speed and independence? How can the built environment be more like a high-performance automobile to, ultimately, improve the human quality of life?

METHODOLOGY

One weekend I drove through Ohio observing how people interact with and react to one another on the road. I Followed up with a drive across the United States and then intentionally took different routes to and from work everyday in Los Angeles, California to continue my exploration. Through those experiments I was able to ponder the growing human attachment to the automobile. As an afterthought, I spent some time attempting to understand exactly what about a high-performance automobile entices people, auto-enthusiasts or not, to keep experiencing it.

Through the exploration of high-performance automobile components and the exploration of non-traditional architectural constructions, potential design responses emerge. I will break down the most advanced of high-performance automobiles - a Formula 1 car – and investigate its cross compatibility with architecture. I will follow the discussion of my initial research with critiques of existing architectural and technological applications that do not yet accomplish the level of collaboration and integration I desire. A number of technologies will be introduced that could create a more advanced and enticing architectural experience. I propose that by networking these technologies and systems together, it becomes possible to achieve a more interactive and responsive built environment that could also stand as the best and most-efficient version of itself.

DISCUSSION OF FINDINGS

I took a drive one weekend from Oxford, Ohio to Columbus, Ohio; the trip is around one hundred and twenty miles each way and consists of a good variety of country roads, highways, small towns, and one large city. My intent was to explore how humans interact with and react to one another on the road. It is necessary to mention that my percentages are approximate, as keeping an exact written tally while driving is difficult. There seemed to be a split of seventy-five percent to twenty-five percent in favor of drivers disregarding the speed limit. I found that almost every driver tried to travel at a different speed than the car in front of or beside them, and that somewhere around seventy percent of those drivers wanted to be the faster driver, regardless of speed – it reminisced motorsport racing. On country roads, almost all vehicles would pass a slower driver at the first available opportunity. Small towns have much lower speed limits and drivers seemed to have more patience and use more caution than highway drivers. The most surprising estimation I made was that for every ten cars an average of seven were occupied by the driver only.

Two weeks later, I had the opportunity to drive across the United States. It was interesting to see how automobiles have reshaped travel. Through the past several decades, things like drive-through fast food restaurants, self-pump fuel stops, highway rest areas, and automobile assistance companies like AAA can be seen at almost every highway exit in cities and every few dozen miles in between. It makes traveling by automobile the easiest, most convenient, and often the cheapest present option.

The final leg of my journey began when I arrived in Los Angeles, California. I had the privilege (or burden) of learning to handle Los Angeles rush hour. I decided to take a different route to and from work each day for one week in order to gather diverse results. The biggest thing I can report is that Los Angeles is nearly impossible to navigate without an automobile. As one of the younger cities in the world, it only makes sense that the automobile be part of the basis for economic development and infrastructure design.

These explorations support the undeniable human desires for speed, progress, and independence; people like to move fast, and they like to be in charge, hence the recurring desire to experience high-performance automobiles. Automobiles are growing increasingly customizable and they react to the driver's immediate commands, resulting in the illusion of increased independence. In Chapter 41 of his book, Henry George theorizes how progress occurs. "Mind is the instrument by which humanity advances. Through it, each advance is retained and made higher ground for further advances… Mental power is, therefore, the motor of progress. Civilizations advance in proportion to the mental power expended in progression — that is, mental power devoted to the extension of knowledge, the improvement of methods, and the betterment of social conditions."[v] The first step toward architectural and spatial progressiveness is better collaboration within the built environment. In order for that to occur, there must be an understanding of how a high-performance automobile is built and how it functions.

One of the most remarkable high-performance automobiles is the Formula 1 car. Modern Formula 1 cars are highly complex networks of systems working to achieve two simultaneous goals: keep the driver safe and win the race. New aesthetics are designed and new systems engineered each year (and fine-tuned throughout the season). Nigel MacKnight illustrates the major components in his book *The Modern Formula 1 Race Car.* MacKnight explains that the central structural element of a Formula 1 car is the Chassis – it is also what keeps the driver safe – and that all other load-bearing elements attach directly to the chassis.[vi] Other large components include the engine, gearbox, fuel cell, transmission and driveline, while smaller, more high-tech components include the Engine Control Unit, the Engine Management System, and the Energy Recovery System (which is critical and will be discussed a bit later). The body pieces are composed of carbon fiber, which is extraordinarily strong and extremely lightweight, making large contributions to the aerodynamics of the car as a whole. Peter Wright describes how in the 1960s, Formula 1 cars began using wind-tunnels to explore the best way to cut through the wind to create downforce (negative lift), thus giving them the ability to go faster and create more power, with the least amount of resulting drag (resistance) possible.[vii] The shape and aesthetic of the body pieces are also entirely customizable and, overall, make for a better, faster, and stronger Formula 1 car every season.

The lifespan of automobiles and buildings are diametrically opposed. In her research article "Survey for Actual Service Lives of North American Buildings", Jennifer O'Connor expresses the varying lifespans for a collection of buildings demolished in Minneapolis over a three-year span. Her article separates the buildings into age categories of twenty-five years; most of those buildings fell into the 76-100 year range.[viii] According to Jim Gorzelaney of Forbes Magazine, the average age of an automobile on the road in the United States is only 10.8 years.[ix] Just about every aspect of a high-performance automobile (with the exception of the structural frame) is intended to be customized and improved as time passes. Architecture is designed to be stagnant, because its primary purpose is to protect the users of the internal space from any harmful factors outside. Yet, regardless of lifespan expectancy, the primary purpose of the automobile is the same. The gap between architectural and automotive design begins here, because many designers fail to see the potential of a shift in design theory.

Maria Lorena Lehman's approach to architectural design speaks to this challenging relationship. "To ensure that your building's lifespan is long (and valuable to people), make sure that it stands not only because of strength of its materials, but also because of the adaptability of its composition. In other words, to create an architecture that stands the test of time, be sure to consider how it will weather, change and grow. Your building's ability to stand tall should also be balanced by its ability to flex as the winds of change blow in its direction – while still being true to the essence of its original design."[x] Lehman has written a number of books and articles discussing different approaches to design and the relationship between architecture and technology. "Of course, many architects can simply merge architecture with technology to make a building work, but few can fuse the two together to allow the rest of their design efforts to make their building a beautiful and meaningful experience.[xi]

The new McLaren Technology Centre is a fairly successful example of an architectural response to the automobile, but it also misses the mark on building the beautiful and meaningful experience introduced by Lehman. The high-performance automobile fabrication facility, designed by Foster and Partners, is located in the countryside just outside of Woking, Surrey, United Kingdom. "I am both delighted and proud that McLaren has become the world's first carbon-neutral Formula 1 team."[xii] Team boss Martin Whitmarsh is ecstatic about where McLaren's technological innovations have taken them. There are a number of sustainable systems and strategies employed in the McLaren Centre that contribute to its carbon-neutrality. One of the most impacting is the on-site lake; its 160-meter edge is a seamless waterfall, which cools the wind tunnel.[xiii] The subterranean walkways and lift systems making up most of the facility help to keep secretive operations remain secretive and also contribute largely the facility's self-sustainability.[xiv] The facilities are designed around the automobile and for the automobile, but not necessarily designed like the automobile. Exactly as Maria Lorena Lehman expressed in her writings, The McLaren Group constructed a facility that works with high efficiency by merging architecture and technology; but they did not focus on the fusion of the two to create the beautiful and meaningful architectural experience vital for the users.

An architectural response that better reflects this thesis would explore more specifically how a high-performance automobile functions and take cues from those systems. In 2009, Formula 1 engineers at Magneti Marelli created a Flybrid Kinetic Energy Recovery System, or KERS, in order to meet the racing regulations for the 2009 season. KERS was a vital innovation to the racing industry, because it recovers the energy that is created and stored under braking pressure, energy that is otherwise lost, and redirects it to be utilized by the driver for in the form of power boosts.[xv] The technology was improved again in 2014, now capturing even more lost energy. The concept behind energy recovery is not new, but designers, particularly throughout the last decade, have begun to reimagine it.

Wind technology can be a powerful energy harvester. Harvesting wind on both the inside and outside of the built environment reflects the way a high-performance automobile utilizes wind: over the top, under the bottom, and through various openings (spoilers and air intake/release vents). Often, wind energy is collected through massive wind turbines in large, open fields. By turning a traditional wind turbine perpendicular different advantages become available; Harsh Agarwal, Aditya Patnaik and Gourav Modi approached wind harvesting from this perspective. The authors designed and tested systems that capture the energy released in heat and exhaust of major mechanical units or machines inside a building and redirect it elsewhere in the building network. They refer to it as a Vertical Axis Wind Turbine, or VAWT.[xvi] Based upon their results, it can be concluded that installing a VAWT in a larger architectural application provides an opportunity to address mechanical systems more similarly to a high-performance automobile. Other technologies that react to users, such as light or motion sensors, piezoelectric flooring systems[xvii], and specialized HVAC system add-ons[xviii] can be introduced to further increase energy recovery within a building system. When all components are operating and communicating at full potential, efficiency is maximized and spaces become more customizable and adaptable, granting the flexibility necessary for program and use change over time.

With regards to the architectural exterior, employing a form that allows wind to pass through or across the building skin smoothly offers a number of advantages. Additionally, a skin with replaceable parts allows for evolution of various building pieces as a reaction to testing or as a result of damage – just like the body panels of a high-performance automobile. There are a handful of other building systems and materials being developed that shift typical automotive technologies outside of their original intent, such as façade panels that can be reinforced with carbon fiber instead of steel to offer thinner, more flexible, and easily replaceable pieces[xix]. I am not suggesting that a building form exactly resemble a high-performance automobile or Formula 1 car, rather that it take cues from some of the dimples, ridges, corners and curves (with respect to use and climate); this could, coincidentally, draw more attention from users with a more fast-paced aesthetic. Advancements like these suggest a new direction for architecture away from its stagnant nature and toward a more versatile future.

Automobile engines produce massive amounts of heat while generating energy (except in electric vehicles); that heat must be controlled. This is the job of the engine cooling system. Gogineni Pruvhdi, Gada Vinay, and G. Suresh Babu in their journal article, "Cooling Systems in Automobiles & Cars", illustrate the basics of a water-cooling system (the most common type). The authors begin by explaining that an engine houses a series of tubes, through which water and engine coolant flow, so the coolant can absorb heat from the various engine components. The other notable comment by the authors is that most vehicles today contain varying ratios of antifreeze (ethylene glycol) and water (respective to the surrounding climate).[xx] This brings about the Burj Khalifa in Dubai, just outside of Abu Dhabi; it is the tallest building in the world, reaching upwards of 828 Meters, or approximately 2,717 Feet. The Burj Khalifa is an impressive example of technological networking in an architectural setting as well as the beginnings of some reflection of the automobile within architecture. The Burj Khalifa underwent forty wind tunnel tests before a final design was settled, following which the resulting design was again rotated 120 degrees to further alleviate stress from prevailing winds.[xxi] The exterior is wrapped with 28,261 glass-cladding panels, all of which can be individually maintained and cleaned if necessary.[xxii] The Burj Khalifa was also necessarily strategic with the separation and locations of mechanical equipment, elevators, pressurized safe-areas (for fire safety), and creates ease of access for each of the components.

Perhaps the most direct relationship between the Burj Khalifa and a high-performance automobile is in the cooling strategy. Dubai is situated mid-desert; the desert sun can be extremely harsh and temperatures often reach uncomfortably high levels, especially in a space with glass walls. This necessitated a chilled-water cooling system throughout the structure of the tower. Carly Fordred reported on how this system functions in HVAC&R Nation magazine in 2010. She explains that the chilled water is mixed with a refrigerant inside giant ice reservoirs and pumped from chilling units at the local water plant to the Burj Khalifa.[xxiii] The chilled-water is then pumped through the walls and the floor until it reaches the top, at which point the warmer, more pressurized water returns to the plant. She adds that during peak cooling hours, the Burj

Khalifa could require up to 10,000 tons of cooling power per hour, which is equivalent to the cooling power of 10.2 million kg of melting ice in one day.[xxiv] This process (which should sound familiar) is the same exact process by which the engine of a car controls its temperature, only on a much larger scale. The Burj Khalifa is a profound example of the beginnings of cross-applying automotive technologies and theories with those of the built environment, but it still left some potential unexplored. This thesis offers to take the relationship a bit further and, by focusing on a smaller scale, also offers a more interactive and controllable spatial experience for the users.

Communication is the most vital player for the success of any system network. In a Formula 1 car, components cross-communicate, the driver communicates with his/her pit crew, and so on. Likewise, communication must be fostered between each component within a building system network in order to maximize efficiency. Connecting unrelated or separate systems can be daunting, but Lars Schor, Philipp Sommer, and Roger Wattenhofer wrote a journal article regarding how to do so smoothly and wirelessly.[xxv] Deborah Snoodian introduces additional resources for wireless/web networking systems in her article, "Smart Buildings", that provide further advantages. She names a couple of web interfaces that allow for different building systems to communicate with one another wirelessly, while also allowing those systems to communicate with manufacturers and maintenance professionals.[xxvi] This makes for streamline accessibility of the systems as well as ease of information access to address any problems that may arise. A solution can be quickly established, just as a Formula 1 driver would do with his/her pit crew.

The most inefficient aspect of many high-performance automobiles is their lack of sensitivity toward the environmental. Keeping this in mind, the industry strives to improve technologies quickly to make things better, faster, stronger, and more efficient. Aside from speed and aesthetics, Audi is known for their engineering advancements. They, along with many other high-performance automobile manufacturers, do not anticipate the fundamental human desire for speed, progress and independence to disappear; instead of sacrificing the experience of driving for the sake of the environment, they are innovating resources and energy we already have in new and different applications. Audi recently introduced e-diesel.[xxvii] It is a substitute for traditional diesel fuel that is made from a combination of carbon dioxide and water using a process known as electrolysis.[xxviii] Audi, like Tesla Motors, is embracing progressiveness and innovating for the sake of the experience. Tesla Motors creates clean air vehicles that run without gasoline, but instead operate entirely with batteries; the only moving piece in the engine is the rotor which makes for a smooth, quiet acceleration from stopped to sixty miles per hour in three seconds.[xxix] The excitement doesn't stop there though; Derek Klobucher of Forbes magazine covered a story about the next exciting Tesla advancement. It was recently announced that Tesla Motors has been partnering with solar energy service provider Solar City to create wall-mounted home solar chargers; they can either be used as back-up power in the event of a blackout or to manage a household's individual energy consumption needs. "We are talking about trying to change the fundamental energy infrastructure of the world," encouraged Tesla CEO Elon Musk at their design studio in Hawthorne, California. "You can be free of the grid."[xxx] Tesla Motors is striving to blur the boundaries between their automotive designs and sustainable solutions for the entire built environment, which even some of the most innovative architecture still fails to match.

CONCLUSION

Philosopher Henry George once said, "People progress by cooperating with each other to increase the mental power that may be devoted to improvement."[xxxi] By treating the built environment more like a high-performance automobile, architecture has the potential to become the best, most efficient version of itself without sacrificing the spatial experience within its walls. Cross-employing automotive theories with architectural theories opens the door for a new type of architecture. This new architecture is customizable, adaptable, and controllable and responds encouragingly to the human desire for progressiveness, while simultaneously offering a more versatile and responsive built environment.

The challenge proposed in this thesis is to design the built environment like the automobile, and Los Angeles, California's unwavering dependence on and attachment to the automobile creates an opportune atmosphere for such a type of architecture. Resident of L.A., Matt Novak, lived for one year without a vehicle – as an experiment – after his car died one morning. He wanted to really understand why L.A. drivers are so attached to their vehicles when there are a (very) few public transit systems that do exist. He concludes his report with, "But even with all of L.A.'s progress with mass-transit, my car-less experiment will probably come to a close this year. Life is just easier with a car in a city that still has a long way to go in order to make places like Santa Monica, Venice, the Valley and (perhaps most crucially for major cities trying to attract businesses and promote tourism) the airport accessible by train." As exhibited by Mr. Novak, Los Angeles is simply designed around the automobile, as are many other U.S. cities, and this attachment is not going to lessen anytime in the near future.

I propose to explore a community-oriented architectural response to this thesis to be designed in Santa Monica, California. Within the bounds of a city so architecturally diverse and so culturally vibrant, I foresee a positive and energetic response to the experience created within this new type of architecture. Maria Lorena Lehman's unique and inspiring design outlook is a great place to begin this new architectural journey. "Achieving true design is more than just erecting new forms that work, it is also about designing environments that are humane and lift the human spirit." [xxxii] If the model proves successful, those principles can be applied to other programs and contexts, ultimately creating a more efficient, interactive and friendly architectural experience globally.

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[ii] Definition as taken from Merriam Webster: http://www.merriam-webster.com/dictionary/kairos

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