Varuna, a thriving city with over 500,000 residents, is located on Australia’s southeast coastline. Nestled between the Pacific Ocean and the Diamond Mountains, it is surrounded by rolling foothills and white sandy beaches. The city has a concentrated urban area with major industries located across the bay. Moderate temperatures range from 6 to 26 degrees Celsius with annual rainfall averaging 90 centimeters.

Residents take pride in their city, a leader in sustainable living, renewable technologies, and state of the art transportation systems. However, Varuna would not be where it is today if not for a team of proactive city officials, engineers, and business owners 150 years ago. The growing urban population produced traffic congestion, noise and air pollution, and a strained infrastructure overwhelmed by personal vehicle use. (Figure 1)

Figure 1: 2013 Mode of Transportation Use

The team believed that transportation problems impacted economic, social, and cultural life and that without change, people would lose access to jobs, medical facilities and other
amenities critical for a high quality of life. They took action by conducting an assessment which highlighted the following issues:

- Projected 20% population increase every 50 years
- Increased life expectancies
- Projected 25% job growth
- Frequent stops, poor routing and accessibility hindered public transportation use
- Lack of capital funding for maintenance and expansion projects
- Pollution due to fossil fuels

Solutions to these issues were not solved overnight but rather implemented in phases with a clear goal to transition from personal vehicle to public transportation use and eliminate fossil fuels.

Phase 1 addressed road modifications and retrofits. Transportation engineers utilized the existing grid and repurposed roadways into walking and biking paths while redesigning others to accommodate buses and directional traffic flows. Geotechnical engineers developed pervious surfacing agents using obsolete tires and grit and sand, by-products from ocean harvesting. These surfaces are more cost effective and provide better storm water run-off solutions than asphalt.

Phase 2 engaged mechanical and transportation engineers to design the conversion from one-dimensional surface transportation to multi-dimensional with integration of the following:

- Addition of the Varuna Express Tube (VET)
- Construction of a centralized hub
- Implementation of a high speed link to Sydney

The VET is a three portal elevated track system with loops running above ground (Figure 2), underground, and underwater, connecting all residential, business, and industrial areas of Varuna.
Civil engineers constructed lightweight support buttresses and the portals using high strength, translucent concrete. This concrete contains optical fibers, making it possible to see light and colors through it. The thin yet strong design enabled installation above many existing roads. Driverless V-pods, varying in size and cargo capability transport people, goods and personal vehicles along the same tracks. Travelers may drive vehicles directly into a V-pod and use the VET similar to a ferry system. V-pods are designed to “float” above the track using electromagnets on the bottom and the sides to keep it steady. The electrical power source is built into the tracks. The only resistance it has is air resistance, making it fast. However, acceleration and deceleration are smooth and seamless to passengers. Individual V-pods are powered using solar energy harnessed through roof panels, while excess energy is stored in batteries.

Routes conveniently run directly through business and residential buildings, improving accessibility. Major stations are strategically located at ground level for ease of access, especially for passengers with disabilities. Today, the central hub houses a parking structure for cars and
bikes and the direct link to Sydney reduced travel from 4 hours to 45 minutes, making inner city and regional travel convenient for passengers.

Novel technologies impacted many parts of the design. All routine maintenance (cleaning and minor repairs) for the VET is managed by drones. All public transport modes utilize a biometric toll system, eliminating the need to purchase tickets. The hub’s Intelligent Roadway Information System (IRIS) incorporated GPS technology to monitor traffic conditions, re-direct traffic and sustain optimal flows. Surface vehicles, equipped with microchips, enable vehicle to vehicle communication. These “driverless vehicles” create safer road conditions and new opportunities for drivers with disabilities. Residents receive IRIS alerts on both their vehicles and personal devices which automatically reroutes them should issues arise.

Transportation improvements and new technologies bring risks, trade-offs and benefits. Automation brings the inherent risk of system failure which results in downtime and accidents. Therefore, backup switches were implemented to revert to manual driving if needed. Special transportation taxes were assessed to cover significant construction costs, whereas toll fares were allocated to fund ongoing maintenance. However, benefits of the improvements included:

- Shift from personal vehicle use to public transportation by 40%
- Enhanced convenience; the VET operates 24 hours a day
- Reduced average travel times by 38%
- Reduced noise and air pollution by 32% and 58%, respectively
- Provided uninterrupted regional travel

Varuna’s forefathers’ vision to improve infrastructure by utilizing sustainable solutions led to zero-emission power, fresh water and development of algal biofuels. The city is powered by ocean wave and thermal energy, called Venergy. Submerged buoys anchored to the ocean floor capture wave energy (Figure 3) while floating solar islands equipped with wind chargers provide a secondary source.
Figure 3: Venergy

This design is optimal for withstanding storms and wave currents are a predictable energy source. The desalination process provides 100% of residents’ fresh water supply. Additionally, petroleum engineers developed bio-fuels from algae replacing fossil fuels. All surface vehicles use this zero emission fuel. The warm effluent from Venergy quickly regenerates algae and seaweed for a constant supply.

Although various disciplines played critical roles in deploying these changes, mechanical engineers took the helm by designing key components and ensuring all systems were interlocked seamlessly through good project management. Varuna’s flourishing economy and environment are evidence they succeeded in developing a sustainable city that continues advancing onward and upward.

Word Count: 996
Works Cited


