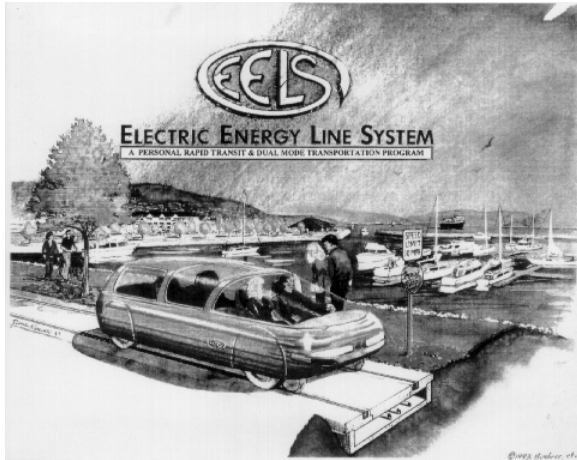


# WHOLISTIC ENGINEERING: APPLIED TO PRT & DUAL MODE TRANSPORTATION

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As the world's ground transportation problems continue to grow the need to develop and implement new solutions becomes more urgent in order to meet future needs.

Traditionally, regional transportation planning has been viewed as the provision of an adequate network of highways and streets. Sometimes the concept of reserved bus/express lanes or a light rail route has been introduced, or hiking and biking trails proposed. Such planning falls far short of the possibilities. There is a growing need for a fresh, creative, and total approach to the safe, pleasant, and efficient movement of both people and goods.

In order to provide essential mobility for tomorrow's needs, entirely new concepts of transportation must evolve. This includes **Personal Rapid Transit (PRT)** systems and **Dual Mode Systems (DMS)**. In Dual Mode (DM) transportation, vehicles can run either on normal streets or on a guideway under fully automated control. While its vehicles are on a network of guideways, a DMS operates exactly like a PRT system, i.e., all stations are off-line and all trips on the network are nonstop. DM vehicles (DMV) can also enter or exit the automated guideway from the streets. Dual Mode Transit (DMT) is a special case of

a DMS where passenger service is provided only by common-carrier vehicles and may be on a personalized or group transit basis.

The name **Electric Energy Line System (EELS)**, pronounced as "Eels") was coined to help provide a simple method for communicating a new type of transportation that encompasses a broad range of applications with the potential for solving many of today's existing transportation problems.

DM advantages for automobile drivers are that 1) the same vehicle may be taken from home to any destination, similar to driving an automobile, and 2) congestion may be avoided because of the shorter headway and managed flow possible on the automated guideway. In many respects, DM is much like the system envisioned by advocates of Intelligent Vehicle Highway Systems (IVHS), except that narrower and less expensive guideways could be used.

A wholistic engineering approach, applied to PRT and DMS transportation recognizes that the effectiveness of any new transportation system is dependent on numerous unpredictable influences, and therefore, the whole situation relating to the mode of transportation must be taken into account. A wholistic engineering approach would result in the implementation of a public/private partnership to create a *new and complete* transportation system by building upon and expanding many different types of existing technologies and systems.

This paper provides an overview of a wholistic engineering approach. The applications of engineering solutions are emphasized to demonstrate that the feasibility of a functioning PRT/DMS is possible with today's available and emerging technologies.

## WHOLISTIC ENGINEERING APPROACH

**Goal.** The many challenging situations facing communities and businesses today involve

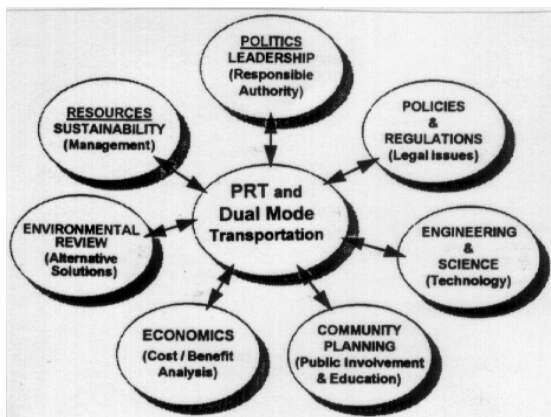
cross-relationships among many complex components, such as technology, economic and environmental issues, politics and special interests, laws and regulations, social concerns, and resources. The goal of wholistic engineering is *to provide simple economic solutions to complex environmental issues ...to meet future needs.*

**Definition.** A Wholistic Engineering approach is defined here as a management method for "problem solving", which includes the comprehensive analysis of all issues and possible conditions related to the primary task or mission. A wholistic view also recognizes that all initially reported facts and assumptions will continually change and therefore will require constant supervision of the planned action.

**Wholistic:** *relating to a complete and total system or organization of parts fitting or working together as one. A system, which may also exist within a whole system, includes a group of units or method of procedures so combined as to form a functioning whole and operating in unison: an organized whole.*

**Engineering:** *a science by which the resources and properties of matter and sources of energy are made useful to humankind in systems, structures, machines, and products.*

The following figure provides a wholistic overview of the important aspects regarding PRT/DMS transportation. The team members involved will be determined by current and geographic conditions (scope of influence), and the extent of an individual member's involvement will change over time.



**Leadership and Community Planning.** Many practical and simple strategies can be part of a cooperative team approach that encompasses expertise within various public and private entities, along with the active participation of the general public. This begins with leadership and also requires "tearing down walls" and "building bridges" between diverse interests.

This type of internal and external collaboration for public works projects can result in better decisions, savings in time and money during project development, as well as avoiding costly lawsuits that are ever present in today's legal and political climate.

**Economic and Environmental Benefits for Sustainability.** The implementation of a new transportation system or plan developed with a wholistic engineering management approach gains strength by concurrently evaluating all potential costs and benefits to the planned action. The EELS program concept plans ahead for future sustainability.

Financial planning elements are critical to any program's success and require regular analysis and adjustment to accommodate changes. The plan might include, but not be limited to:

1. **Capital Improvement Plan.** Long-range proposals, costs, methods of financing, and priorities.
2. **Capital Budget.** Income-level projections, proposed expenditures, debt limits, funding.

Through an Environmental Impact Statement (EIS) process, the EELS program could be analyzed and determined as a feasible alternative. The following would be part of the environmental analysis:

1. **A description of the project.** Such as the location and nature of the system and implementation schedule.
2. **A listing of any foreseeable negative impacts.** Including their degree of severity, and means by which they have been ameliorated insofar as feasible in the project planning.
3. **A listing of the positive environmental features and implications.** A clear explanation of how these benefits have

been increased through scientific analysis and competent design.

4. **An accurate appraisal of the overall community gain or loss.** Taking into account variables of each community.

The environmental benefits, together with the economic boost of implementing a new and functional transportation system, would help achieve long-term security for citizens and industry at both national and local community levels.

**Legislation (Legal Issues) That Provides Guidelines and Standards Necessary for Public/Private Partnerships.** The successful implementation of a new concept, such as the EELS program, would require the efforts of two important entities:

1. **National/International EELS Program Authority Board.** The first step requires the adoption of the program by national governments. Then, a board of directors - consisting of respected and representative civic leaders - would be chosen. In addition, a competent director and well-educated and experienced personnel would be retained. The authority board would be responsible for overseeing the development and establishment of EELS standards, and would also coordinate efforts of industry to continue implementation of the EELS infrastructure.
2. **Local Jurisdictions.** The implementation of the EELS program at the local level would include defining the limits of the district where the physical plan of the EELS infrastructure would be located. Key elements for the local jurisdictions include the re-examination of urban planning and education of the community.

**Development of Engineering Solutions: Allowing for Changes.** As society and human needs change and technology rapidly advances it is essential that cities and their surrounding regions respond to and accommodate the evolution. Steps to accomplish this might include:

- View changes as opportunities, thereby making current problems beneficial, which lead to new and better solutions.
- Keep plans free & flexible within a creative framework, in terms of land use, systems of movement, and services.
- Modify and improve plans when new technologies emerge or new opportunities are presented.
- Encourage freedom of choice and innovative design.
- Prepare a staged program for implementation, including provisions for necessary administrative unit, team members and personnel, legislation, and capital funding.
- Launch an all-out drive to accomplish the first phase objectives.

#### ARRIVING AT SIMPLE SOLUTIONS

**The Next Step.** Based upon the many complexities and costs of developing and constructing a dual-mode transportation system, it is clearly evident that the next step toward a new transportation solution is *not* the implementation of a DMS, particularly one that would begin with the unrestricted use by privately owned vehicles.

Rather, the next appropriate step would be the implementation of a PRT system that is founded on simple technology, together with the flexibility to be upgraded to accommodate new technological improvements as they become available, such as comments of a DMS. But it is very important that the next step should also provide the necessary framework and planning to incorporate the possibility of a fully operating DMS into the operating PRT system for compatible future system expansions.

**Automobile + PRT (CyberTran) = Dual Mode (EELS).** To arrive at a point in time where the advantages of a DMS are recognized the development of the system's architectural structure must first be successfully achieved. Fortunately, the CyberTran, ultra-light rail / PRT system provides a compatible foundation. Through more than ten years of development and

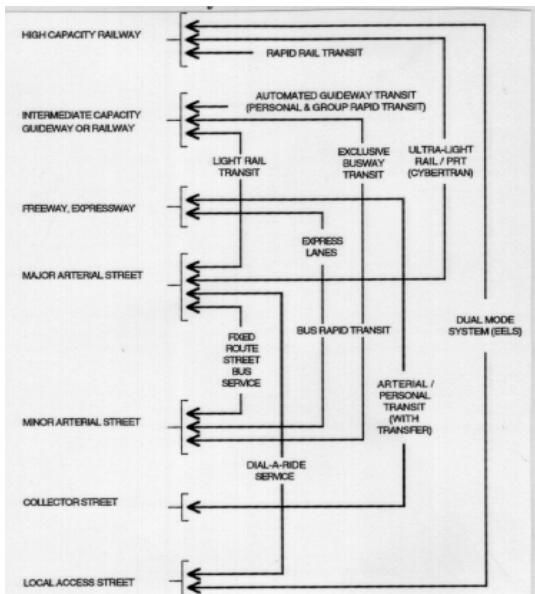


testing, CyberTran is now approaching implementation.



The general technical specifications of CyberTran (i.e., guideway design, system controls, and vehicle parameters) are all compatible with the criteria under which the EELS transportation program was independently developed. This match provides the starting point for a new type of PRT to naturally evolve into a fully functioning DMS.

The following figure provides a summary of functional classes of systems relating to their general service areas. The figure has been updated to indicate the range of service the new CyberTran system is designed to accommodate and also shows the full range of service a future DMS based on a CyberTran-PRT system would provide.



The CyberTran system - a new ultra-light concept in mass transit - has been developed at the Idaho National Engineering Laboratory (INEL), a facility operated for the U.S. Department of Energy. Fast, lightweight and at a very low cost, CyberTran (stands for Cybernetic Transportation) uses computer controlled, low occupancy vehicles that typically travel on elevated guideways located within existing right-of-ways. The vehicles carry 6 to 14 passengers at speeds of up to 150 mph in intercity corridors or 14 to 32 people at speeds up to 80 mph in urban and intra-city areas.

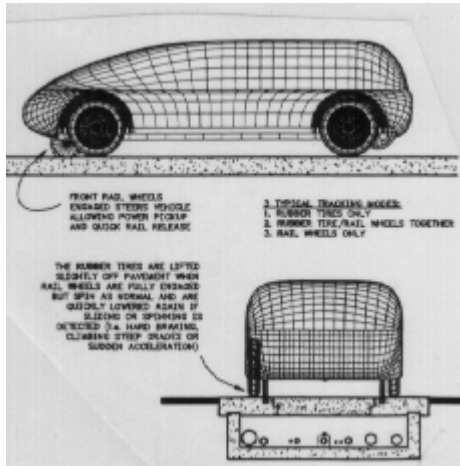
CyberTran is an on-demand transportation system that provides available transport 24 hours per day at the user's determined time of departure and with direct non-stop travel to the user's requested destination. At present the only systems that provide this type of service are automobiles and elevators. Other systems are either scheduled time (airplanes, intercity trains) or scheduled frequency (metro buses, light-rail transit).

It can be anticipated that once the system has been in local operation for a period of time, users will recognize the possibilities of privately owned vehicles that could be safely incorporated into the system. This could range from fixed-rail vehicles that companies use to move goods in "mini-containers", perhaps at a lower fee rate during night time hours, to privately owned dual mode vehicles that are operated on the CyberTran system as well as on standard roadways.

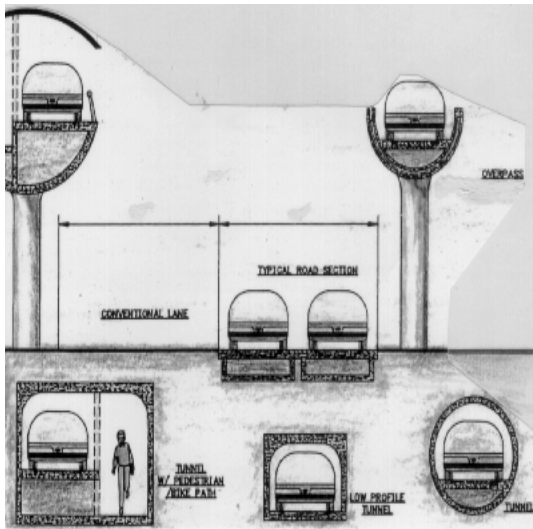
Another very important aspect regarding the timing for the development of DMS is related to recent technical advancements in the automobile industry, due in part to the computer revolution, together with on-going public/private investments in Intelligent Transportation Systems (ITS). Much of the research began in the United States under the Department of Transportation's - Intelligent Vehicle Highway Systems (IVHS) Projects can be used in DMS development. This amount of valuable and applicable technology comes just in time to be part of the solution as transportation systems move into the 21<sup>st</sup> century.

## APPLICATIONS OF A PRT / DUAL MODE TRANSPORTATION SYSTEM

This section highlights some of the design elements and applications the EELS program will provide and illustrates how it will also accommodate future system expansions and services. The hybrid EEL vehicle design is based on existing proven technology.



Typical EEL Vehicle Design Configuration and Operating Modes.



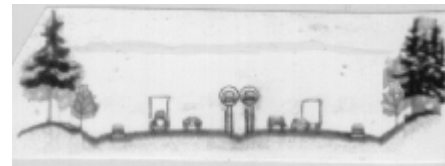
Typical EEL Guideway Sections

The figures shown on this page depict examples of route applications, built in a phased construction sequence under the EELS program. Typically, in a phased approach, routes would be established in a priority-ranked basis similar to methods currently used for transit services, such as rider demand forecasting and intermodal

transit system connection points. Various route types are individually identified and organized with a wholistic engineering approach to form a functioning whole system.

Examples of route designations would include (either separately or combined):

Interstate Highway/Expressway Routes; Primary/Commuter Routes; Secondary Routes; Utility/Railway Right-of-Way Routes; Commercial/Residential Routes; and Scenic Routes



- Typical EELS Commuter and Commercial Goods - Expressway Route
- Expressway & Roadway Right-of Ways
- Elevated/Tunnel Sections (Typical)
- High Speed/Continuous Flow (non-stop)
- At-Grade Intersections Eliminated
- One-Way Dedicated Traffic Flow
- Operable Under All-Weather Conditions
- A Two-Direction EELS can handle more passengers per hour than four automobile expressway lanes with: 80% to 95% less Right-of-Way requirements and 1/10th to 1/100th of the \$Cost to construct and maintain.
- "Mini-Containers" Allow Quick, Efficient Movement of Goods Compatible with Shipping Industry Standards.
- Park Access
- Outdoor / Nature Enjoyment
- Quiet Vehicle Operation
- Environmentally Compatible
- Limited Right-of-Way Requirements
- Construction of Guideway Completed by Equipment Located on Tracks with Very

Minimal Disturbance of Ground, Water Crossings, and other Sensitive Areas.

- Controlled Access & Operations
- Low Speeds
- Convenient
- Safe: Zero Annual Accident/Death Goal
- Emissions Controls: Zero-Emission Vehicles (ZEV's).
- Energy Efficient System: Very Low Energy Consumption Guideway (Rail) Design



Typical Residential Street / EELS Parkway Route.

## SUMMARY

There are many good engineering and management practices used today throughout the world that are simple and proven, and are typically based on local knowledge of both past successes and failures. These types of economical and environmentally sound, "common sense" approaches for solving problems, combined with today's emerging transportation technologies and advanced information managing tools (computers), continue to gain importance as the real value of our world's resources are recognized.

As a Personal Rapid Transit (PRT) & Dual Mode Transportation Program, the Electric Energy Line System (EELS) provides a simple, cost-effective, solution for existing transportation problems, including the movement of both passengers and goods. The EELS program also provides a flexible system which can accommodate changes to meet future needs.

*"It takes only one properly communicated vision to motivate and inspire individuals to become a unified*

*team who together strive to reach their common goal."*

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**Author's Biography:**

[Mark S. Buehrer, P.E.](#): Mr. Buehrer is a registered professional civil engineer and inventor, and has a broad range of engineering experience in transportation, structural, environmental, geotechnical, water resources and planning. Mr. Buehrer is the founder and director of [2020 ENGINEERING](#) which focuses on providing simple economic solutions to complex environmental issues in order to meet future needs.

**Author's Note:**

This paper is dedicated to my mother, Gaye Anne Buehrer, who died in an automobile accident on October 10, 1996.

**Presented at:**

The International Conference on Personal Rapid Transit (PRT) & Other Emerging Transportation Systems  
November 18-20, 1996

The Institute for Intelligent Transportation Systems (ITS)  
Center for Transportation Studies  
University of Minnesota, USA  
US Department of Transportation's Intermodal Surface Transportation Efficiency Act (ICTEA, 1991)

(See next page for a conceptual design of the **Electric Energy Line System**)



