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EASYCONNECT II: INTEGRATING TRANSPORTATION, INFORMATION, AND ENERGY TECHNOLOGIES AT TRANSIT ORIENTED DEVELOPMENTS

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ABSTRACT

The integration of innovative technologies with traditional modal options in transit oriented developments (TODs) may be the key to providing the kind of high-quality transit service that can effectively compete with the automobile in suburban transit corridors. The *EasyConnect II* project represents a multi-technology integration of innovative strategies planned to enhance transit use during the development and construction of a suburban TOD at the Pleasant Hill Bay Area Rapid Transit (BART) District station in the East San Francisco Bay Area. The project team represents a unique partnership including small technology businesses, private developers, transportation agencies, city and county government, and academia. The project components include the introduction of shared-use low-speed mode vehicles, smart parking management systems, electronic lockers, and power supplied by a hydrogen fuel cell at the proposed TOD. The various technologies will seamlessly be linked over the Internet in formats accessible to both end-users and project planners. The evaluation of the proposed study will provide insight into whether the introduction and integration of innovative technologies at TODs can significantly increase transit access and use. If the innovations introduced in this study prove successful, then their application could be expanded throughout the region, California, and the nation.

KEYWORDS
Transit oriented development, intelligent transportation systems, parking management, hydrogen fuel cell

INTRODUCTION

California's population is presently over 36 million and is expected to grow by about 19 percent (or 7 million new residents) by 2020 (*1*). Motor vehicle travel in the State is expected to grow from 337 billion miles traveled in 2005 to over 457 billion miles in 2020 (*1*). Smart growth policy strategies attempt to tame increasing auto travel, congestion, and vehicle emissions by redirecting new development into communities with a high-intensity mix of shopping, jobs, and housing that is served by high-quality modal alternatives to single occupant vehicles. The integration of innovative technologies with traditional modal options in transit oriented developments (TODs) may be the key to providing the kind of high-quality transit service that can effectively compete with the automobile in suburban transit corridors. A major challenge, however, of such an integration strategy is the facilitation of a well-designed and seamless multi-modal connection infrastructure – both informational and physical. The integration of advanced energy technologies can help to meet broader energy and environmental goals for the State, including recent Executive Orders for clean energy, energy efficiency, and energy security.

The outcomes of this project will be the introduction, integration, and evaluation of multi-modal transportation services, both traditional and innovative technologies, at the Pleasant Hill Bay Area Rapid Transit (BART) District station/TOD site in the East San Francisco Bay Area, known collectively as *EasyConnect II*. The project components include:

- Shared-use low-speed modes vehicles (electric bicycles, non-motorized bicycles, and Segway Human Transporters) available for commuting from the BART station to area businesses.
- Electronic lockers ("eLockers") at the station and nearby businesses that are a unique physical and technology design solution to the problem of low-speed mode access to traditional transit.
- Smart parking technology to provide cost-effective and space-efficient solutions to parking at the TOD site.
- A web-based information system that allows users to reserve, pay, and access travel information, moving seamlessly across a range of available modal options and transportation services.
- Innovative distributed power generation technologies to help meet growing electrical loads associated with the introduction of advanced electronic transportation and information technology systems.

The evaluation of the proposed study will provide insights into three critical research and transportation planning questions:

- Can the introduction and integration of innovative technologies at TODs significantly increase transit access and use, and reduce auto travel?
- Can modal connection infrastructure, both physical (e.g., eLockers) and informational (e.g., reservations via Internet), effectively link new technology transportation services to traditional line-haul transit service?
- Can the demand for the new technology information and transportation services support their existence as independent businesses?

The project team represents a unique partnership including small technology businesses, private developers, transportation agencies, city and county government, and academia. If the innovations introduced in this study prove successful, then their application could be expanded throughout the region, California, and the nation.

This paper includes the following sections: background on TODs in the United States and low-speed mode shared-use programs worldwide; the *EasyConnect II* field test design; and research evaluation plan.

BACKGROUND

Transit Oriented Development

A comprehensive overview of the state of TOD practice in the United States, examining opportunities, challenges, and benefits is presented in the recent "Transit Cooperative Research Program Report 102: Transit-Oriented Development in the United States" (*2*). This report represents an extensive review of the literature, surveys, interviews, and ten case studies, covering a range of TOD configurations and practices. What follows is a summary of the key findings relevant to the *EasyConnect II* project.

Currently, many transit agencies and communities across the country are participating in the creation of commercial, retail, and residential developments around transit facilities. While a range of configurations and definitions are found in the literature, there is general consensus among transit professionals as to what constitutes a TOD: "a pattern of dense, diverse, pedestrian-friendly land uses near transit nodes that, under the right conditions, translates into higher patronage." (*2*, p. 7)

TOD development is a complex process typically involving a myriad of stakeholders, each with a discrete interest in the ultimate development. Project partners often include transit agencies, private developers, environmental groups, alternative transportation advocates, supporters of affordable housing and open space preservation, private retailers, and private transportation service providers. Most interest groups agree that, if successful, TODs can yield many benefits, including increasing transit ridership and profits to public and private partners (*2*).

The pursuit of these objectives has resulted in the creation of over 100 existing TOD projects in the United States today. TOD projects currently exist primarily in conjunction with heavy-, commuter-, and light-rail stations, but also increasingly, in areas limited to bus service. Many TOD projects are located outside of major cities in new and mature suburbs. The San Francisco Bay Area leads the nation with the most identified TODs, served by BART (heavy-rail), Caltrain, the Amtrak Capital Corridor (commuter-rail), the Santa Clara Valley Transit Authority, and San Francisco Municipal Railway (light-rail) (*2*).

Considering the range and number of TODs, a natural question concerns the impact that these developments may have on local residents' travel patterns. Stakeholders are curious whether TODs are achieving their primary stated goals of increasing transit mode share, reducing use of single occupant vehicles, and encouraging use of other modes, such as walking and bicycling.

Beyond these basic questions, the TCRP report identifies several areas for additional research. Specific issues that have posed challenges to the development of TODs to date, include:

- The importance of a multi-modal emphasis and pedestrian supportive design to the success of TODs;
- A need for innovative parking solutions to enable transit agencies to meet commuters' needs without posing undue challenges for TOD developers; and
- A general desire for innovative, "out of the box" thinking with respect to TOD problem solving. (*2*)

All of these issues are directly addressed by the proposed *EasyConnect II* project at the Pleasant Hill BART station/TOD. To encourage transit ridership with a limited supply of available station parking, it is vital that TOD planners prioritize the creation of multi-modal connections at transit villages, including walking, bicycling, carsharing, and other supportive transit. The field test at the Pleasant Hill BART station emphasizes these supportive strategies that help passengers travel the first or last mile to or from the transit station.

The BART District's strict one-to-one replacement parking policy has hindered the potential development of several TODs because the cost to create replacement-parking structures is frequently prohibitive. Several TOD case studies point to the need for innovation in parking solutions (*2*). The proposed field test directly responds to this recommendation by introducing a smart parking management project at the Pleasant Hill BART station. The goal is to leverage parking turnover at the transit station to maximize efficiency of lot use and increase effective parking capacity without significant additional capital outlay.

In addition to the smart parking system, this field test includes a fleet of shared-use electric bicycles, non-motorized bicycles, Segway Human Transporters ("HTs"), and later possibly carsharing, directly responding to the call for innovative, out-of-the-box thinking in TOD problem solving (*2*). Leveraging public-private partnerships, this proposal incorporates such possibilities as electronic bicycle lockers to provide maximum safety and convenience for bicycle commuters, advanced parking reservations, and real-time parking information for motorists seeking to use transit. It is this kind of innovative approach that may ensure that TODs meet their broader goal of increasing transit ridership and encouraging the use of other sustainable transportation modes. The inclusion of shared-use, low-speed vehicles based at the TOD (with significant employment centers located within three miles) and aimed specifically at commuters represents a novel application of the shared-use low-speed mode concept.

Bicycle Sharing Programs

Bicycle sharing programs account for the vast majority of shared-use low-speed mode programs worldwide. Bicycle sharing programs vary significantly from one another in terms of their program goals, target demographic markets, operational models, and technological deployment. In some cases, programs operate with a membership fee and charge for bicycle use; more frequently, however, bicycle sharing programs operate free of charge and often consist of used and donated bicycle fleets. Most American bicycle sharing programs are located in small cities or college towns, and most operate as cooperatives whose goals are to increase mobility of target demographic groups (often students) and to encourage more sustainable mobility alternatives.

Additionally, the cooperatives offer service beyond bicycle sharing, such as bicycle sales and classes for repair.

DeMaio (*3*) has identified four "generations" of public-use, or shared-use, bicycles, each with increasing levels of technical sophistication. The more highly developed programs are currently under operation in Europe, with some technologically advanced programs under consideration for the U.S. Many of the European bicycle sharing programs are located in major cities and are specifically designed to help ease traffic congestion and increase mobility options in crowded city centers. The programs operate with a variety of technological sophistication. The most basic programs, such as in Copenhagen (*4*) and Helsinki (*5*), simply depend on a coin deposit of approximately $2, which is then refunded when the bicycle has been returned. However, some of the more technologically advanced systems, such as in Amsterdam (*6*) and Oslo (*7*), use innovations such as "smart" chip cards to gain access to bicycles stationed on computer-operated racks, automated systems that enable credit card billing, instant program sign-up, and instant reservations. These more sophisticated programs functionally operate in ways more similar to carsharing programs (i.e., short-term vehicle rentals) than to other, less advanced bicycle sharing programs. Across Europe, these programs are targeted to both tourists as well as residents. The programs, in general, are quite successful. An extreme example is given in Copenhagen, where a shared-use bicycle was followed by reporters for 12 hours, who found that it spent only eight minutes not in use (*3*).

The "Station Oxygène" was opened in December of 2004, in Lille, a city of 1.2 million residents in northern France. The station offers a total of 16 Segway HTs and 25 electric bicycles for rent by the half-hour, half-day, day, weekend or month, and there is a ten percent discount on rentals to anyone with a public transportation ticket (*8*). The station is located in the city center, near a large parking lot and railway station. The program is aimed at residents (including a large student population), tourists, as well as commuters. The program is specifically aimed to promote the need for "greater choice and connectedness of mobility options with transit." (*9*, p. 3).

EASYCONNECT II FIELD TEST DESIGN

Through its innovative components and emphasis on multi-modalism, the proposed field test addresses current and future TOD development challenges. The proposed project would entail a phased integration and evaluation approach that seamlessly links with the existing *EasyConnect* project, which consists of a field test of low-speed mode vehicles at the Pleasant Hill BART station. See Figure 1 below for a photograph of the existing Pleasant Hill BART station. The additional planned technologies are eLockers, a smart parking service, hydrogen fuel cell energy, and a mobility options protocol (i.e., an Internet-based multi-modal trip planning tool). Other innovations to be explored for this site include carsharing, hydrogen fuel cell vehicles, and real-time transit information. The sections that follow are a discussion of each technology phase.

FIGURE 1 Current site conditions, Pleasant Hill BART station.

Low-speed modes/*EasyConnect* field test and evaluation

PATH researchers are currently partnering with the BART District, Caltrans, Giant Bicycles, and Segway LLC to develop a field operational test that introduces shared-use electric bicycles, non-motorized bicycles, and Segway HTs (known as the "low-speed modes") at the Pleasant Hill BART station, to allow commuters to connect to surrounding employment centers. The field operation test – known as *EasyConnect* – is designed to appeal to those who would like to take BART to commute to work, but are stymied by the inevitable "last-mile" problem. The low-speed mode vehicles will be stored nightly at the Pleasant Hill BART station. Commuters will be able to ride the units from the BART station to their offices in the morning and back to the station at the end of the day. See Figure 2 of rider on a bicycle trail in Pleasant Hill.

An evaluation of the use of the three devices is expected to contribute significantly to an understanding of the context in which the different low-speed devices may increase transit ridership.

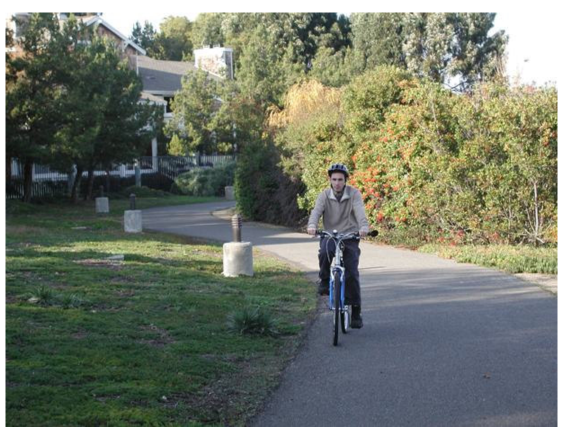

FIGURE 2 Bicycle rider in Pleasant Hill.

ELockers

As Grover (*10*) points out, traditional bicycle lockers are relatively inefficient because usually each locker is reserved for an individual who has pre-paid for the locker on a yearly basis. Often, the lockers will sit empty and unused. A shared-use, technologically advanced electronic locker system ("eLockers") can increase approximately five-fold the number of cyclists (and other low-speed mode users) that can be served by traditional lockers. See Figure 3 for an illustration of increased number of bicyclists served by eLocker technology. The secure eLockers work like metered curbside parking: users only pay for the eLockers when they are using them. The lockers will be accessed using specially designed smartcards, which will facilitate manual phone-in reservations, automated secure pick-up of vehicles, and data collection for fleet management and assessment (*10*).

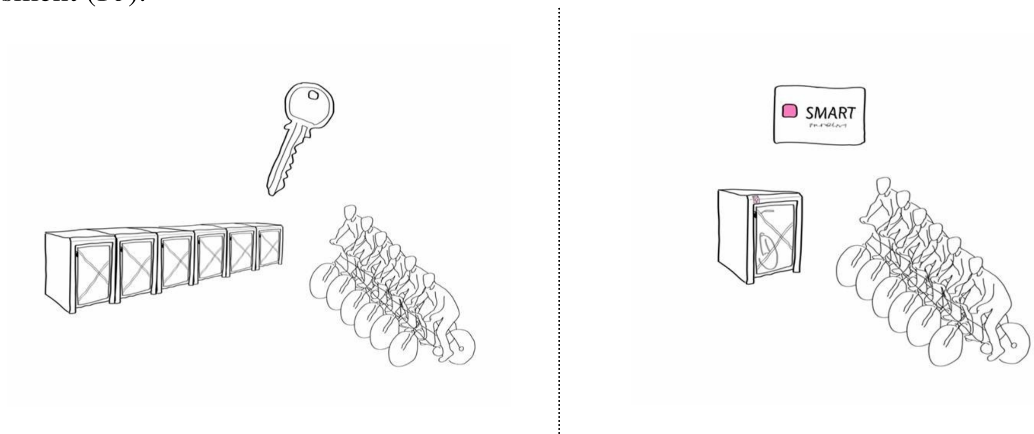

FIGURE 3 Diagrammatic illustration of increased number of riders served by eLocker technology, reproduced from (*10*).

Smart parking

Closely related to providing multi-modal station access is the need to address station parking demands. At Pleasant Hill, the goal is to leverage parking turnover at the transit station to maximize efficiency of lot use and increase effective parking capacity without significant additional capital outlay. A smart parking system (broadly defined as the use of advanced technologies to help motorists locate, reserve, and pay for parking) holds the potential to serve as a parking service optimization system, or parking broker, permitting advanced reservations, and dynamic pricing based on demand.

Smart parking integration into the Pleasant Hill *EasyConnect II* proposal is based on experienced gained from the transit-based smart parking project currently underway at the Rockridge BART station. (See (*11*) for more information about smart parking field test at the Rockridge BART station.) This field test involves two real-time user interfaces: a Variable Message Sign (VMS) that displays parking availability information to motorists on an adjacent commute corridor into downtown Oakland and San Francisco (Highway 24), and a centralized intelligent reservation system that permits commuters to check parking availability and reserve a space via telephone, cell phone, Internet, or PDA. See Figure 4 for photographs of smart parking technologies employed in the smart parking field test at Rockridge station, including sensor technology, roadside VMS, and parking sensors embedded in parking lot at BART station.

FIGURE 4 Images of smart parking field operational test.

Hydrogen fuel cell

General Motors is pursuing a near-term strategy of experimenting with fuel cell technology by placing its systems in stationary power settings to gain operational and technical experience, as described by Lipman (*12*). The company is planning to place a donated 75-kilowatt (gross power) proton exchange membrane fuel cell system at the Pleasant Hill BART station and to use the system to "peak shave" electricity demands at the site including recharging the fleet of battery electric vehicles–Segway HTs and electric bicycles. See Figure 5 for photographs of the actual fuel cell components to be donated to the *EasyConnect II* project. In the event that a carsharing organization initiates service at the Pleasant Hill BART station, this service could be integrated into the reservation system, and any electric or hydrogen fuel cell vehicles included in their fleet could be recharged by the stationary fuel cell stack or hydrogen refueling system. The demonstration project would potentially be followed by a more permanent fuel cell or other distributed power generation system at the Pleasant Hill TOD site (*12*).

FIGURES 5 Hydrogen Fuel Cell Components, reproduced from (*12*).

Mobility Options Communications Protocol

Over the last several years, there has been significant development and proliferation of automated reservation systems throughout society in general. For example, lodging, traditional car rental, and the airline industries now employ automated reservation systems that can be accessed both from the phone (entering data via a touchtone pad) and from the Internet. The Mobility Options Communications Protocol (MOP), as outlined by Grover (*10*), will allow trip planning tools to go beyond fixed-route, fixed-schedule carriers and incorporate real-time status; last-mile providers; and reservations for vehicles, rides, and parking. It will integrate the project component technologies into a simplified, web-based interface, which will seamlessly facilitate inter-modal access, options, and efficiency. It is quite possible, and even likely, that each modal option will be provided by a different vendor. The technology integration effort component is designed to manage the resulting multi-modal, multi-vendor data in a commercially feasible manner. The specific objective is a system that:

- Provides a seamless experience for end users who wish to view their modal options or reserve a particular modal choice;
- Is attractive to new modal choice vendors, who may join the information web;
- Requires little administration by the operating agencies; and
- Offers rich opportunities to syndicate data to interested parties.

Initially, the modal option vendors are all part of the same team; however, in the future competitive companies may bid for the franchise to operate a particular service (such as carsharing) at a particular location or multiple vendors may offer competitive services. A completely vendor-neutral solution, which is easy to understand will attract the best and most qualified bids for any future requests for project. This solution will be validated with an industry technique known as a "plug fest," where all interested vendors are invited to connect into the system, testing and debugging the methods chosen. The MOP addresses all of the following types of information components, allowing users to make good connections that require coordinating schedules: status, reservations, and payment information from different sources (*10*). Researchers also will identify opportunities for extending the integration of system components to include carsharing operations (by major national operators of carsharing services; for more information on U.S. carsharing, see (*13,14*)) and real-time transit information, such as “Nextbus” technology.

CONCLUSION: RESEARCH EVALUATION PLAN

The *EasyConnect II* research evaluation plan will be designed to test the hypothesis that the seamless integration of new technologies into an existing rail station and new TOD can significantly enhance transit access with related travel, health, and economic benefits. Researchers will employ before-and-after instruments, as necessary, including:

- Observational analyses related to modal and parking use in and around the site;
- Focus groups that include users and bystanders;
- In-person interviews with users and bystanders; and
- Questionnaires and travel diaries.

The evaluation plan will be designed to provide answers to the following key questions:

- What are the unmet access and egress travel needs in and around the Pleasant Hill BART station/TOD site?
- What are the key field test service design requirements to best meet those needs (e.g., ease of use, security, and reliability)?
- How do the new field test services affect travel patterns (e.g., mode choice and auto use)?
- What are the health effects of the field test services (e.g., net increase in physical exercise from increased transit and bike use)?
- What are the economic benefits of the new field test services (e.g., reduced fuel and vehicle ownership costs, and time savings)?

- Can the demand for the services introduced by the field test support their continued existence as viable independent businesses?

In sum, the evaluation of the integrated technology *EasyConnect II* field test will include behavioral responses, cost-effectiveness of the integrated technologies, and summary of lessons learned that can be applied to future technology enhanced transit TOD developments.

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