TranScan

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Geometric Design Practices

Roads in Proper Context: Providing Mobility, Safety, and Aesthetics

Today's highway designers know that there is more to designing a roadway than addressing safety and mobility issues; they know they must also consider the community's wishes and design a roadway that complements the natural and human environment. This philosophy, known as context-sensitive design (see sidebar), is increasingly at the heart of roadway improvement projects in the US and other countries.

To take a look at how context-sensitive designs are being applied in several European countries, a scanning team (see page 3) that included representatives of FHWA, AASHTO, the American Public Works Association, and academia headed to Sweden, Denmark, the Netherlands, England, and Germany in June 2000. There, they met with numerous representatives from transport and highway ministries, research organizations, and consulting firms and got first-hand looks at roadway facilities that had been designed with safety, mobility, and community concerns in mind.

Context Sensitive Design

Context-sensitive design involves all stakeholders in developing a transportation facility that enhances its physical setting and preserves scenic, aesthetic, historic, and environmental resources, without impairing safety or mobility.

The 1995 National Highway System Designation Act included language that allowed new or reconstructed highways on the National Highway System to be designed with consideration for—in addition to the customary factors of safety, durability, and maintenance—the natural and constructed environment of the area, the environmental, scenic, aesthetic, historic, community, and preservation impacts of the project, and access for other modes of transportation

In 1997, FHWA published *Flexibility in Highway Design*, encouraging designers to take advantage of the flexibility in highway design by being creative in addressing project needs.

More information on context-sensitive design is available on the Web at www.fhwa.dot.gov/csd.

Project Development

The team found the project development process in the five countries visited to be very similar to that of the US, with two notable exceptions. First, more time is devoted to the planning component, and the focus is on longer sections (i.e., entire corridors). This gives designers and agencies a broader look at the roadway system, which in turn encourages them to identify and address system-wide needs and deficiencies. Second, the Europeans put greater emphasis on addressing the public's call for slower speeds and more attractive roadways in urban communities. For example, a "lid" was placed over a freeway section in Germany, and a public park was developed on the lid; the result was not only visually appealing, but also cut down on traffic noise (see Figure 1).

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The team members were impressed by the level and impact of public involvement in all of the countries they visited. "Some of the concepts and methods to involve the public in project development could be transferred to the US, where they might prove beneficial in streamlining existing practices," says Sandra Otto of FHWA and co-leader of the team. "One example is the Dutch design workshops, where agency staff and community representatives work together to develop alternatives for a project and then present those alternatives to the public for consideration and input."

Design guidelines in the five countries are typically stricter, and in fact serve almost as standards, for motorways than for urban streets. Each country has a process for applying for variances from the design guidelines, but this process is only infrequently applied to motorways. The public is much more tolerant of design conformity or inflexibility with motorways because the very purpose of the motorway—i.e., unimpeded through travel between communities—makes mobility at the expense of aesthetics and pedestrian and bicycle travel more acceptable.

Environmental considerations—particularly those relating to noise reduction and historical preservation—receive a great deal of attention in all five of the countries. "We were interested to find that several of the countries have copied or adapted the US National Environmental Policy Act (NEPA) for their use, and they seem to have integrated it more efficiently into the project development process," says Otto.

When new right of way is required for a project, land redistribution is sometimes effective at mitigating claims of property loss. For example, if a new road will bisect two pieces of property at an angle, leaving two small pieces of land isolated from the two main pieces of property (see Figure 2), the agency might broker a deal in which the property owners swap the two isolated pieces of land, giving each owner a complete piece of property.

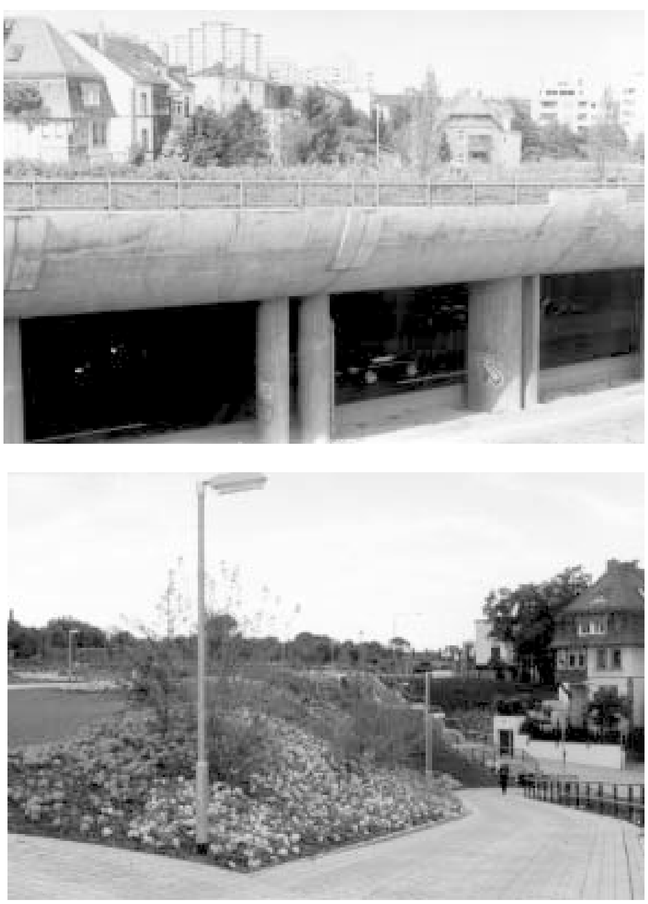

Figure 1. A public park camouflages a freeway and cuts down on traffic noise in Germany.

Successful Strategies

The team members identified several strategies that serve well in Europe and may prove beneficial in the US.

All five countries embrace the philosophy of the "self-explaining, self-enforcing" road, in which the physical design of a roadway encourages motorists to travel at the appropriate speed. The appearance of the roadway clearly tells the driver what speed is appropriate, and drivers seem very accepting of the lower speed limits on those streets. The roadway is designed so as to make driving above the so-called environmental reference speed uncomfortable or difficult, which provides positive enforcement for the driver to stay within the speed limit. Speed limits are thus very much in line with expected operating speeds.

Run-off-road crashes are a major concern in all five countries. High speed is usually the key contributing factor in those crashes; thus, the countries are focusing on controlling and reducing speed by implementing self-explaining, self-enforcing highways.

To improve capacity and safety, England, Denmark, Sweden, and Germany employ "2+1" roadways instead of 4-lane roadways on high-volume rural highways. A passing lane is sandwiched between the two opposing travel lanes, and the right to use the passing lane alternates between the two directions of travel (see Figure 3). Such roadways can be built within existing roadway right of ways. In Germany, for example, the passing lane is 3.25 m wide, the adjacent same-direction travel lane is 3.5 m wide, and the opposing-direction travel lane is 3.75 m wide (paved shoulders line both sides of the road). All four countries report capacity gains and safety improvements associated with conversion to 2+1 roadways.

Narrower lane widths—accomplished either by physically narrowing the travel way or by creating an illusion of a narrower travel way (such as by painting wider edge lines or eliminating center line striping)—are another effective tool for reducing speeds on rural roads.

Numerous traffic calming devices and strategies are being employed to reduce speeds in urban areas, including the following:

- Prewarnings, typically provided by lines on the pavement, sometimes accompanied by rumble strips.

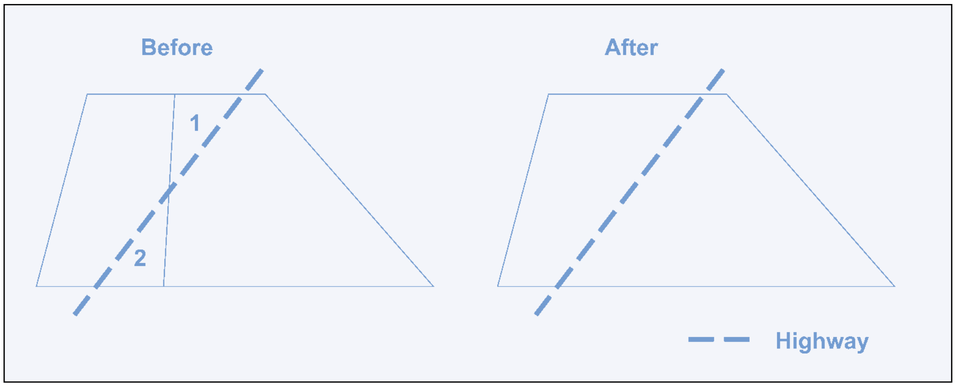

Figure 2. Land redistribution concept.

Figure 3. German 2+1 road.

- Gates that, through the use of different pavement color or structures, indicate a transition between traffic environments.
- Narrowings, in which the available travel way is narrowed through the addition of islands, the use of wider edge markings, or by eliminating one lane in a two-lane road.
- Humps and tables of varying profiles.
- Roundabouts, which often serve as gates.
- Chicanes, in which the curb is broadened at an intersection to reduce approach lane widths.

Not only do these devices produce the desired speed reduction, but they also reduce the number of crashes (in Denmark and England by more than 60 percent). "Speed humps are effective traffic calming measures, but they must be carefully designed and constructed to yield a comfortable ride when driven over at the desired speed," says Otto.

According to the study team, a key element of any successful traffic calming strategy is a system-wide approach, which continually gives the driver a clear message about appropriate travel speed. This also ensures that individual components, installed at different times, will be easily integrated into the total scheme, providing a more visually appealing roadway and a consistent message.

"Many US communities are already using certain traffic calming elements to control traffic," says Otto. "We think many of the techniques we learned about on this scanning tour are transferable to the US, while recognizing, of course, the differences in land use, development, and transportation patterns between the US and Europe."

Roundabouts—or traffic circles—are also commonly used as an effective means of controlling traffic at intersections in the five countries visited (Figure 4). Studies in those countries have shown a reduction in accidents and injuries after installation of a roundabout, as well as an increase in capacity. The team recommends that when roundabouts are introduced into a community, they be placed only in areas where the traffic could be accommodated with single-lane approaches to the roundabout.

The five countries place significant emphasis on addressing the needs of pedestrians and bicyclists; in some countries, the bicycle network rivals the vehicle network. The team members pointed out that the US needs to change its philosophy regarding bicycles and pedestrians—i.e., to do more to ensure the safety of these vulnerable road users, which will in turn encourage more people to bike and walk.

For More Information

The full report, Geometric Design Practices for European Roads *(Publication No. FHWA-PL-01-026), is available from FHWA's Office of International Programs (tel: 202-366-9636; fax: 202-366-9626; email: international@fhwa.dot.gov). It is also available on the Web (www.international.fhwa.dot.gov).*

Figure 4. Medium-size roundabout in Denmark.

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Roadway Lighting: Key to Safe and Efficient Traffic Flow

The United States is increasingly a 24/7 society—grocery and hardware stores in many areas are open all night, every night, and flextime policies in many offices give workers the opportunity to set their own schedules. As the population increases, so does the number of cars on the road morning, noon, and night. The accident rate goes up once the sun goes down, and nighttime crashes are often more severe. With darkness a major contributing factor to those crashes, roadway lighting can play a major role in improving traffic safety.

In April 2000, a team of nine roadway lighting and safety experts traveled to Finland, Switzerland, France, Belgium, and the Netherlands to observe roadway lighting systems in those countries. Their goal: to return home with ideas and technologies that would be helpful in updating the next edition of AASHTO's *Informational Guide for Roadway Lighting* (due to be published in summer 2002).

Of the five countries visited, all but Switzerland are members of the European Union (EU); lighting standards for individual EU countries are now being harmonized into one CEN document, which will serve the entire EU (see sidebar, page 5).

General Observations

In general, the team found European roadway lighting to be brighter and more uniform than what we are used to here in the US. Lighting equipment appears to be of a higher quality and better maintained than that usually found in the US, and lamps are replaced on a 3- to 5-year cycle. But the Europeans face the same problem the US does—namely, maintaining the same level of overall lighting (photometric) performance on a system over time.

"Once a system is designed and built," says Karl Burkett, co-chair of the study team, "no lighting measurements are made on a systematic basis, and no controls are placed on replacement luminaries. This causes system performance to deteriorate."

The Swiss have developed new recommendations for lighting crosswalks and roundabouts, which are based on the visibility principle of highlighting objects so they will appear in positive contrast (i.e., the pedestrian is brighter than the background). Installation of such lighting systems have resulted in a two-thirds reduction in crashes involving pedestrians and vehicles, but an increase in minor vehicle-only crashes (typically, rear-end crashes resulting from sudden stops). Lighting levels at roundabouts are higher than on the approach streets in all five countries.

As tunneling techniques have improved, traffic engineers are increasingly turning to tunnels as an option for moving traffic through urban areas. The Swiss believe that tunnel walls, if adequately lit, will provide motorists with positive guidance. They have found that motorists perceive tunnels outfitted with fluorescent lights as brighter and more comfortable than tunnels lit with point sources, and they attribute this to the higher wall luminance achieved with fluorescent lights.

In Finland and Switzerland, overhead signs are customarily lit by top-mounted luminaires. As a cost-cutting measure, however, the Finns are switching to microprismatic sheeting material for their overhead signs, thus negating the need for fixed lighting (the sign is made visible by a car's headlights)(see Figure 3).

Visibility Design

There are three methods for designing roadway lighting systems: luminance, illuminance, and small target visibility (STV).

Luminance design is based on the principle that that road surfaces are made visible by light reflected from them. The reflective properties of the pavement are thus an integral component of the design. The French are researching a special pavement composed of white gravel and cream-color binder.

Illuminance design involves lighting the roadway surface at sufficient levels to make the roadway clearly visible.

STV design is based on the visibility of a small target in relation to its background.

Recommendations

The panel made a series of recommendations, based on what they learned during their site visits and meetings. Those recommendations include the following:

- Master lighting-design plans should be developed in urban areas to improve coordination among agencies on lighting levels and styles.
- Reporting systems should be developed to incorporate lighting conditions at crash scenes. In Zurich, Switzerland, the police analyze the cause of traffic crashes and make recommendations on how lighting might be improved.
- To improve visibility and legibility, microprismatic materials should be used on unlit signs mounted over the roadway and on the left shoulder,
- When possible, high-quality lighting materials should be used; the higher price will be offset by lower maintenance costs and better durability.
- Energy-absorbing poles, which flatten, rather than break away, on impact, should be investigated for use in certain situations.
- The CEN standards (see sidebar, page 5) should be reviewed for possible application in the US.

The team returned from their scanning tour with a renewed emphasis on research in lighting design. "European engineers

CEN

Cen is the European Committee for Standardization. It works with CENELEC (European Committee for Electrotechnical Standardization) and ETSI (European Telecommunications Standards Institute) to promote voluntary technical standardization (harmonization) in Europe. Harmonized standards are developed through an open, transparent, and consensus-based process. They are intended to diminish trade barriers, promote safety, allow interoperability of products, systems, and services, and promote common technical understanding.

The technical specifications in the standards comply with European Commission directives, which define the "essential requirements" (such as protection of health and safety) that goods must meet when they are placed on the market.

CEN works with public and private organizations and cooperates with the International Organization for Standardization (ISO). More information is available at www.cenorm.be.

seem to be quicker than we are at implementing new technologies, perhaps because of their aggressive and progressive research programs," says Burkett. "They also conduct practical experiments on in-service roadways, which accelerates the implementation of innovative strategies and technologies. But that's a lot easier to do when litigation is not as much of an issue."

For More Information

The full report, European Road Lighting Technologies, *is available from FHWA's Office of International Programs (tel: 202-366-9636; fax: 202-366-9626; email: international@fhwa.dot.gov). It is also available on the Web (www.international.fhwa.dot.gov).*

Figure 1. Underground roundabout, Switzerland.

Figure 2. Milchbuck Tunnel, Switzerland.

Figure 3. Microprismatic sheeting material on overhead signs in Finland.

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Note: Affiliations shown here were current at the time of the scanning tour.

Sponsored Participant Report

9th World Conference on Transport Research

July 22–27, 2001—Seoul, Korea

Based on a report by Ossama Abd Elrahman, New York State DOT

This conference drew hundreds of managers, policy makers, and academics who were eager to exchange perspectives on the practice of transport research, particularly how research results relate to policy making. The conference, which was jointly hosted by the Korean Society of Transportation and the Korea Transport Institute, featured 800 papers and presentations, 3 technical tours, and 100 transport-related exhibits.

A wide range of topics were covered, including: integrated planning of transport systems, safety analysis and policy, traffic control, traffic management, pricing policy, maintenance, network design, optimal routing and scheduling, operation and management of different transport modes, transport modeling, performance measurement, spatial and environmental economics and engineering, public-sector performance, public/private partnerships in major transport projects, deregulation, privatization, and issues affecting transportation operations and management in developing countries. This report provides a snapshot of a few of the sessions that were held at this conference.

Providing a decision support system for selecting the location of intermodal terminals was the subject of one presentation. Another discussed an integrated network model of transport that would improve transport alliances and line shipping mergers through coordination and interconnectivity. It was agreed that although very little is known, liner companies may be making decisions on potential cost savings from alliances and mergers that are not achieved in practice. The formation of sustainable urban land use transport strategies was the focus of a presentation that reviewed the results of a survey of 54 cities in 25 European countries. The purpose of the survey was to examine the decision-making processes in regard to formulation of transport strategies. The study concluded that decision-making processes are complex and differ considerably from one city to another.

Participants received a report about ongoing work to produce an international knowledge base that would provide up-to-date information on the performance of a wide range of transport policy investments. The knowledge base will be available through the Internet. The question of whether more urban roads solve or add to the problem of traffic congestion was tackled at another session. Four presenters argued that building new roads in urban areas does not lead to adverse traffic and environmental conditions when appropriate safeguards are taken. A well-balanced policy to provide adequate road capacity and reliable public transport was advocated.

Participants received a report about ongoing work to produce an international knowledge base that would provide up-to-date information on the performance of a wide range of transport policy investments.

A Finnish research project evaluated the environmental, social, and health effects of integrated planning of urban transport systems and land use. The study recommended procedures for taking welfare impacts into consideration in the different stages of the planning process.

The Swiss Federal Railways have developed CAPRES, an effective decision support system for analyzing railway network capacity. The methodology and logistics involved in developing this system, as well as the basic operating principles of the system, were discussed.

The "paradoxes" and "inconsistencies" of an environmentally friendly and efficient transport and distribution system were the subject of another presentation, which argued that the transportation industry has developed very narrow and specific interest in regards to the "green logistics." Since the outcomes of government-imposed regulations are often unpredictable, bottom-up solicitation would be the industry preference.

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Abbreviation Key:

AASHTO	American Association of State Highway and Transportation Officials
FHWA	Federal Highway Administration
NCHRP	National Cooperative Highway Research Program
TRB	Transportation Research Board
DOT	Department of Transportation
PIARC	World Road Association
OECD	Organization for Economic Cooperation and Development
IRF	International Road Federation

Improving Traffic Flow and Safety in Work Zones

Work zone delays are an increasing source of irritation for US motorists. Work zones are seemingly everywhere, as highway agencies strive to protect and preserve roadways and to reconstruct the aging portions of the system. In addition to being the source of traffic jams, work zones pose a risk to workers and travelers. In 1999, almost 900 people were killed as a result of work zone crashes in the US.

To see how several other countries manage traffic flow through temporary work zones, an 11-person scanning tour headed to Cologne, Germany; the Hague, the Netherlands; Antwerp, Belgium; Edinburgh, Scotland; and Paris, France (see sidebar). The scanning tour focused on three key goals:

- Improve service and cut delays in work zones
- Reduce motorist frustration
- Improve safety for both workers and travelers

The team found that highway agencies in the five countries spend a great deal of time and resources evaluating how a roadway rehabilitation or maintenance project will affect their customers—the highway users. They then use that information to develop and implement strategies to minimize or mitigate those effects.

Those highway agencies place a great deal of emphasis on developing and implementing a communications plan to give the public plenty of advance warning and information on alternate routes during the construction period. They also rely on intelligent transportation system (ITS) technologies to provide real-time travel information.

Recommendations for US Practice

Based on what they saw and learned on this scanning tour, the team came up with a list of nine key recommendations for US highway agencies.

- *Shorten the contract time.* Lane rental charges, for example, can be used to encourage contractors to be innovative and can provide significant incentives for them to do it right the first time—to "get in, stay in, get out, and stay out."
- *Improve communications with motorists.* ITS technologies can monitor actual traffic conditions, accurately predict travel times, and communicate effectively with the public. For example, actual travel times, based on real-time conditions, can be posted on variable message signs. Instead of a vague "backup ahead" warning, the signs tell motorists how long they can expect to take to reach a point downstream, based on existing conditions. As highway engineers in the Netherlands explained, "Even when there is enormous amounts of congestion, people tell us they were very happy to be informed—that they could plan their trip and their day."
- *Adopt a coordinated policy, planning, and programming approach to work zone planning and operations.* Intra-agency and inter-agency communication links are strong, reliable, and effective in the five countries visited, and they are vital to ensuring a well-coordinated project.
- *Don't be afraid to reduce lane widths in work zones.* In all the countries visited, the highway agencies placed a high priority on maintaining the same number of traffic lanes in a work zone—that is, they don't shut down lanes, but instead shift traffic on to the shoulder as necessary (Figure 1). In some cases this means that the inside lanes must then be slightly narrower than customary, to allow the shoulder to be wide enough to carry trucks. Trucks are then restricted to the outside lane.
- *Design for future maintenance.* For example, shoulders can serve as travel lanes, but only if they are designed to carry traffic.

Figure 1. Both lanes have been narrowed in advance of a work zone in Germany, and trucks are restricted to the somewhat wider right lane.

- *Evaluate the use of yellow markings in work zones.* Germany, France, the Netherlands, and Belgium use yellow markings in work zones (normal road markings are all white) as a highly visible reminder that "something is different" and extra caution is needed (Figure 2). [The study team prepared a research problem statement and presented it to the Subcommittee on Research.]
- *Consider using highly visible traffic control devices* and equipment, such as large truck- or trailer-mounted signs and portable sign gantries, to warn motorists of, and guide them through, work zones (Figure 3).

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Improving Traffic Flow,
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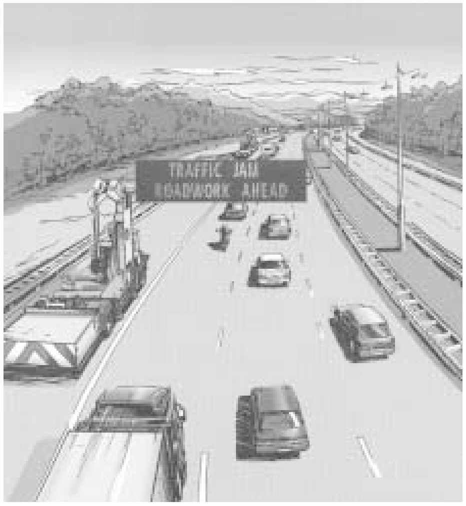

Figure 2. Germany uses yellow markings to delineate travel lanes in work zones; the white markings are left in place, and motorists are taught that yellow markings take precedence over white markings.

Figure 3. Trailer-mounted variable message signs are linked to video cameras in Belgium; as traffic slowdowns are detected, a warning is posted on the sign.

- *Implement quality control/quality assurance programs for traffic and worker safety.* Safety audits and job-specific traffic control plans can improve safety for both motorists and workers.
- *Encourage innovation.* "Think outside the box." The Netherlands has an exemplary program, called "Roads for the Future," which concentrates on long-term thinking and short-term action. Some of their ideas seemed a bit far-stretched to the team, but they agreed that innovations won't happen if thinking is restricted to the tried and proven.

For More Information

The full report, Methods and Procedures To Reduce Motorist Delays in European Work Zones *(Publication No. FHWA-PL-01-001), is available from FHWA's Office of International Programs (tel: 202-366-9636; fax: 202-366-9626; email: international@fhwa.dot.gov). It is also available on the Web (www.international.fhwa.dot.gov).*

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