New Concepts for Context-Based Design of Streets and Highways

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Street and highway designers are increasingly being challenged to develop context-based design solutions that support the development of places that are more livable or that are compatible with meeting goals for sustainable development. However, conventional design standards have not yet caught up to this new design paradigm and so do not fully support the needs of designers working in this new environment. The evaluation of the AASHTO-based approach to design in this paper shows the two main areas of concern that must be addressed in developing a more coherent and context-based approach to design. Specifically, the issues of (*a*) how to define context better and (*b*) how to design for appropriate operations (including speed) need to be addressed. In addition, there is a clear need for a comprehensive and coherent design framework that ties together the urban (or place) function and the mobility function of streets and highways and that takes into account the full context for the design, including multimodal accommodation and full integration into the context.

The field of thoroughfare design is currently undergoing a period of rapid transformation. The past decade or so has seen the completion or development of a number of highly acclaimed new street and highway projects, such as Glenwood Canyon in Colorado and Octavia Boulevard in California, and the introduction and spread of a new type of intersection—the modern roundabout (NCHRP currently has two projects looking at roundabout issues). More and more cities and towns are using traffic calming as a routine part of their design approach. In addition, five states (Maryland, Connecticut, Kentucky, Minnesota, and Utah) have been designated by FHWA as pilot states in adopting a context-sensitive approach to design and have now been joined by others (including Nevada, Vermont, New Jersey, and Washington) in this effort.

Some of these changes at the state and local levels were fueled by federal actions, including the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the publication by FHWA of *Flexibility in Highway Design* in 1997. These changes have empowered communities to take a more proactive role in determining the types of thoroughfares that are built in their neighborhoods and towns.

Designers also have had to grapple with new challenges resulting from a renewed emphasis on multimodal transportation facilities. Not only must they integrate pedestrians and bicyclists, but increasingly they also must find room for bus and rail transit. And they are expected to develop new and innovative approaches for this increasingly complex environment for design. In short, people from all sectors of society have begun to focus on the important role that thoroughfare design plays in the safety and efficiency of travel and in shaping communities. There is clearly a need to bring some order to an exciting but chaotic situation by developing a better basis for making design decisions.

The design approach embodied in the AASHTO Green Book is the approach that prevails in the United States at the state level and also at the local level in most cases. The AASHTO approach evolved from design methods that were first codified in the 1930s. The Green Book has gained such wide currency because it is based on a large body of research relating vehicle performance to geometric characteristics. This system of design has proved to be effective for designing safe and efficient high-speed freeways and highways. The system evolved in an era when American engineers were focused on building what is now the most extensive and most advanced network of highways in the world. Therefore, it is not surprising that as they pursued these goals they created such an effective tool for designing high-speed highways.

With the Interstate system effectively complete, the design focus during the past fifteen years began to shift, with the beginning of a better understanding of the conflicts that can arise when the AASHTO design approach is applied without modification to contexts in which lower speeds are expected and desired. With regard to this issue of context, there is a growing desire to improve livability in activity centers by slowing down traffic and by creating a better environment for nonmotorized modes of travel and also for transit. In a country in which more than 5,000 pedestrians and cyclists die each year, the issue of the safety of vulnerable road users is one that is also drawing increased attention. Traffic calming and context-sensitive design are both attempts to address some of these problems. However, to varying extents, both measures are merely stopgaps and do not fully address the need for a coherent design philosophy for all design contexts.

For example, traffic calming is based on the precept that some situations need a design to encourage drivers to travel at lower speeds. Even though the AASHTO approach to design recognizes this need, it currently does not provide any guidance for achieving this goal. And in fact, the concept of traffic calming is at odds with the way many designers have been trained to interpret the AASHTO approach to design, since they generally try to accommodate the speeds that most drivers would like to go. Worse, there is no coherent body of research that is readily available to designers who wish to use traffic calming techniques as part of their design repertoire.

In like manner, context-sensitive design is based on the premise that state highway designers need to understand better the design context and must develop appropriate solutions for this context (including, when appropriate, measures to better accommodate multimodal traffic or to reduce traffic speeds) (*1*). In this paper the focus is on context-based design and not context-sensitive design. The two

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concepts are related but not equivalent. Context-based design implies that the street or road is designed to be fully compatible with its context. In context-sensitive design, in contrast, context is taken into account but is not necessarily a governing factor in the design.

The shortcomings of the current system for producing context-based (or even context-sensitive) design are beginning to be widely recognized. This has led to many efforts now under way to develop solutions to various facets of this problem. Much experimentation in developing improved systems of design has occurred at the local level, but now more research in this area of inquiry is seen at the federal level. For example, NCHRP 15-25 is a project that is reexamining the concept of "design speed" as the main basis for design.

The other important national study that is addressing some of these themes is the collaborative initiative between ITE and the Congress for New Urbanism (CNU)—with funding from FHWA and the U.S. Environmental Protection Agency (EPA)—that is looking at developing a context-based design approach for urban streets. The ITE-CNU study is addressing the issue of how to define context and the types of road that are suitable for various design contexts.

These studies illustrate that there is now significant recognition of the need to improve the process for street and highway design. This paper will present an evaluation of the specific ways in which the current system of design falls short in supporting a context-based approach to design. It will also discuss the various initiatives under way to address different aspects of the problem and additional work that is needed to improve the system of design. The goal in this paper is to bring all these ideas together so as to encourage discussion of the street and highway design process as a system and not just constituent components. This more global approach is believed essential to advance the art and science of design in producing streets that support the making of more livable and sustainable places.

BACKGROUND

The history of street design in the United States is a long and proud one that has produced many innovations and outstanding projects that are renowned not only for their functionality, but also for their beauty and grace. People from around the world go to Savannah, Georgia, to marvel not only at the architecture but also at the appealing and effective layout and design of the streets in this picturesque gem of American urban design, which dates from the mid-1700s. The streets in Savannah work because they complement the context and accommodate all road users.

Many roads developed by the National Park Service, such as The Blue Ridge Parkway and the Baltimore–Washington Parkway, are marvels. They blend the talent of engineers, architects, and landscape architects of the 1920s to produce a happy marriage between aesthetics and function (*2*). These roads do indeed "lie lightly on the land," as was the wish of Stanley Abbott, the chief landscape architect on the Blue Ridge Parkway. They are pleasant to drive and beautifully integrated into the natural landscape. These days, this type of effective multidisciplinary collaboration in highway design appears to be the exception rather than the rule. There is clearly a need to re-create an environment in which this type of multidisciplinary approach to design can again thrive.

The AASHTO-based system of design does not come out of this tradition of multidisciplinary design, since it was developed to fill a very specific function—the pressing need for design criteria to meet the demanding requirements of motorized vehicles. Hall and Turner report that before 1920, most roads in America were designed for horse teams, not for motorized vehicles (*3*). By 1915, more than two-thirds of all vehicles on the roads were motorized vehicles, and engineers began to realize that they had to do something to accommodate the much greater speed, size, and weight of motor vehicles. Through the 1920s and 1930s, individual states began to address this issue, and technical understanding of geometric design to accommodate motor vehicles improved. However, the situation was quite confused across the country, as standards varied widely from one state to the next.

In the late 1930s, AASHO (the original name of AASHTO) moved to bring some order to this chaotic situation by publishing a series of pamphlets giving design guidance on such issues as highway types, sight distance, and intersection design. Although there is no unifying statement outlining a design approach, the organization of the data in these pamphlets suggests that the approach to design then was very similar to that used today (*4*). Over the years, the process has become more structured and formalized, but AASHTO has remained true to its original mission of providing technical guidance on geometric design for motor vehicles. Clearly, at its formation AASHO did not focus on issues of context and interconnectivity between the various decisions (including decisions about the land use adjacent to the road) that go into making a good design for a place. To a large extent, this is still true today.

This paper will try to provide a clear sense of both the strengths and weaknesses of the AASHTO-based approach to design. A good starting place to assess the current state of design in America is to look at research efforts under way at the national and local level that are designed to improve the design process. At the federal level, in addition to NCHRP 15-25, there is also an ITE-CNU-FHWA initiative to develop context-based design guides for urban streets. The ITE-CNU initiative will be examined as a starting point to understand some of the issues that relate to developing a more context-based approach to design. Then, issues addressed in NCHRP 15-25 concerning the concept of design speed will be discussed. Finally, an approach will be outlined for a conceptual design framework that takes into account the full range of factors that must be considered in a successful design project.

ITE-CNU RESEARCH ON CONTEXT-BASED DESIGN FOR MAJOR URBAN STREETS

ITE-CNU research initiative Context-Based Design for Major Urban Streets, which began in December 2003, is a major national effort sponsored by FHWA and EPA (*5*). The goal of this project is to "encourage street and network design that creates and strengthens places, that is truly multimodal, that features walkability, and that supports compact, mixed use development." The desired product from this project is a design guide for streets and street networks that is compatible with the natural and built context and with the human activities that are supported in that particular context.

The result of the ITE-CNU initiative will be a design guide containing the following elements:

- Design framework—define the context and the integration between context and road,
- Design process—the process for using the design framework to produce designs that meet the full range of goals for the project, and

• Design criteria—define road typology and the road network that is compatible with the various design contexts.

The initial direction for the ITE-CNU study came out of preliminary work done at the first CNU Transportation Summit in Oakland, California, in December 2002. The request for quotations (RFQ) points to the work product from the summit as a starting point for developing the design framework in the ITE-CNU study. Therefore, a sense of some of the priorities of the ITE-CNU study can be obtained by examining the main document from the summit, which is a matrix relating various types of urban context to compatible road topology.

There are three main points in this matrix that represent a significant change or notable augmentation to the AASHTO-based design process. The first of these is that there is a much more detailed and comprehensive description of context than is currently available in the AASHTO-based procedure. The second important point is that this matrix identifies not only road typologies that are compatible but also those that are incompatible with a given urban land use or context. The third point of divergence is that the matrix gives a maximum desired speed for each road typology.

A review of the literature on context-sensitive design shows that the three points (defining context, compatibility between road type and context, and maximum desirable speed) discussed in the previous paragraph are the main points of contention with regard to the AASHTO-based system of design. The three points are interrelated and therefore will be discussed under the following two headings: (*a*) context and road typology and (*b*) speed and road typology.

Context and Road Typology

Context is a broad term that really encompasses an understanding of both the goals and the constraints for a given design project. Many experienced designers would consider the characterization of context to be the most important step in the design process, since it sets the stage for the design process. Furthermore, context is linked to road typology because of the recognition that some types of roads are not compatible with certain contexts. For example, a highway with moderate or high speeds is generally acknowledged now to be incompatible with a residential area—such a road could go on the edge of the district but not through its center.

In the AASHTO-based approach for highway design, functional classification is the mechanism that is primarily used for defining context. The concept of function classification is a relatively new one. It was not mentioned in any AASHO or AASHTO guide until 1973, with the publication of *A Policy on Design of Urban Highways and Arterial Streets* (*6*). In 1984, AASHTO dispensed with having separate guides for rural and urban roads and first published what became popularly know as the Green Book (*7*). It was in this first version of the Green Book that functional classification was introduced as an integral part of the design process. Since then, there have been three updates to the Green Book (1990, 1994, and 2001) in which the concept of functional classification has remained virtually unchanged from the 1984 version (*8–10*).

Functional classification in the AASHTO mold is a relatively simple concept: land use is characterized as urban and rural, and the highway types are arterial (principal and minor), collectors, and local roads. The advantage of this system lies in its simplicity, but this simplicity appears also to be the major weakness of the system. In particular, the characterization of land use into two categories is considered to be unsatisfactory, because two categories alone cannot do justice to the wide range of land use types that exist.

As shown in Table 1, the matrix from the CNU Transportation Summit in 2002 has a much more fine-grained characterization of land use context. It is also worth noting that the classification system used in some other parts of the world is quite different from that in the AASHTO system of design. For example, the Germans use the concept of road classification, but they have developed a more nuanced system, one that appears to better account for the range of

TABLE 1 Thoroughfare Type and Land Use Compatibility from CNU Transportation Summit

Definition					Thoroughfare Type	Land Use Type							
Speed (mph)	Transit	Parking	Bicycle	Sidewalk		Natural/Rural	Rural Residential	Suburban	Walkable Neighborhood	Village Center	Town Center	City Center	Districts
55–70	Exp bus	No	No	No	Freeway	X	X						
55–65	Exp bus	No	@	No	Expressway	X	X						
45	No	No	@	No	Parkway	X	X	X	X	X	X	X	X
45–55	Bus	No	@	No	Highway	X	X	X					X
35	Bus, LRT, streetcar	Yes	@	Yes	Boulevard (multiway)			X	X	X	X	X	X
30	Bus, LRT, streetcar	Yes	@	Yes	Avenue		X	X	X	X	X	X	X
25	Bus, LRT, streetcar	Yes	@	Yes	Connector	X	X	X	X	X	X	X	X
25	Local bus	Yes	@	No	Road	X	X						
20	Local bus	Yes	@	Yes	Street		X	X	X	X	X	X	X
5	No	No	@	No	Mews/court			X	X	X	X	X	X
5	No	No	@	No	Alley			X	X	X	X	X	X

X—Indicates thoroughfare type that is compatible with a given land use type.

context and better acknowledges the nonmotorized function of the roadway (*11, 12*).

The characterization of roadway type as arterial, collector, and local also has come under scrutiny because these terms describe the traffic-carrying function of the road and not its design features—nor its non-traffic-related functions. For example, both a limited access freeway and a four-lane divided urban roadway can be considered arterials, but their relationship to and impact on the surrounding land use are quite different. Therefore, this terminology does not give the designer any guidance about the compatibility between road typology and context. The CNU matrix also has attempted to address this issue by developing a lexicon for road types that better reflect the design and multifaceted function of the road. For example, in the proposed CNU lexicon, highways and roads are identified as rural thoroughfare types and avenues and streets are urban thoroughfares.

An ongoing European Commission study of road design in nine European countries has identified similar problems associated with the use of functional classification in most of these countries (*13*). The study notes that the conventional classification in most of these countries is really "roadway classification" and not "functional classification," suggesting that functional classification should take into account all the functions of the thoroughfare and not only its vehicle-moving (or road) function. It goes on to note that a classification system for sustainable (or context-based) design should explicitly consider the place (urban) role of a thoroughfare separate from its movement role. All these observations apply to the American context and are good guidance, pointing to specific steps needed for improving the system of functional classification.

Speed and Road Typology

Vehicle speed is fundamental to the design process. How speed is treated in the design affects the look and feel of the facility and also the safety of all users, including pedestrians, cyclists, and vehicle occupants. In general, for roads in built-up areas, lower speeds lead to designs that are less intrusive and safer for all users. But in setting speeds, designers must consider the function of the road or street in the transportation network and the behavior of drivers in response to the design and feel of that road. In addressing the issue of speed in street and highway design, there are two very different questions that must be addressed. What is the appropriate speed for the context? What speeds will drivers choose given the design and the context? Conflicts arise when both of these questions are not fully considered in the design process, and conflicting messages end up being sent to the driver with the design.

In the AASHTO-based design approach, speed is accounted for in a variety of ways, depending on the design feature that is being considered. However, most features are designed on the basis of the concept of "design speed." In AASHO's 1940 *A Policy on Highway Types (Geometric),* design speed is defined as follows:

> The assumed design speed of a highway is considered to be the maximum approximately uniform speed, which probably will be adopted by the faster group of drivers but not necessarily by the small percentage of reckless ones. The assumed design speed selected for a highway is determined by consideration of the topography of the area traversed, economic justification based on traffic volume, cost of right-of-way and other factors, traffic characteristics, and other pertinent factors such as esthetic considerations.

This policy goes on to state that design speed influences the choice of the type of highway and the design of many features. It also points out that raising the design speed reduces the capacity by decreasing traffic density. This policy also makes a tentative connection between speed and design features by pointing out that wider lanes and shoulders may invite higher speeds.

By 2001, the concept of design speed had been more tightly defined and had also been re-interpreted in many subtle but important ways. An extract from the definition in AASHTO's 2001 *A Policy on Geometric Design of Highways and Streets* follows:

> Design speed is a selected speed used to determine the various geometric design features of the roadway. The assumed design speed should be a logical one with respect to the topography, anticipated operating speed, the adjacent land use, and the functional classification of highway. Except for local streets where speed controls are frequently included intentionally, every effort should be made to use as high a design speed as practical to attain a desired degree of safety, mobility, and efficiency within the constraints of environment quality, economics, aesthetics, and social or political impacts.

The changing attitude to speed in the AASHTO design process is signified by some important differences in language between the 1940 and the 2001 definitions of design speed. One important example is that the 2001 guide no longer refers to the design speed as the maximum safe speed, as was the case until 1994. However, the 2001 guide explicitly encourages the use of the highest design speed practical within the various constraints. The 1940 guide does not encourage the use of the highest design speed, and in fact points out that higher design speeds can have negative effects on capacity and in inviting higher operating speeds.

To confound the situation further, the 2001 guide recognizes the need for speed control in some situations, but only on local roads. The guide, however, gives no recommendations about how speed control can be achieved. Also it is not explained in the guide why this exception should be made for local roads but not for other types of road that are in a similar land use context. Overall, the 2001 guide places a greater emphasis on context in setting design speed. But, as has been previously discussed, the framework for defining and characterizing context is too weak to give the designer the appropriate guidance for properly considering context.

Design speed on its face is a straightforward concept, but in practice it is not as simple as it appears. In addition, the changes in language and interpretation over the years appear to have confused the original intent of this concept. To understand the idea of design speed fully, it is necessary to consider how it is used in practice. An example will be used to illustrate the process by which a design is produced, and the end products that can result from this process will be examined.

Figure 1 shows the horizontal alignment for two sections of freeways in the northeastern United States (*14*). The actual design speed is not known, but given that both are Interstate freeways built in the 1950s and 1970s, respectively, it can be assumed that the design speeds are comparable and in the range of 60 to 70 mph. (A design speed of 60 mph will be assumed—as will be shown, the choice of 60 or 70 mph has little effect on the comparisons being made in this example.)

Under the AASHTO procedure, the design speed is used to determine the minimum radius of curvature for the roadway section. For a design speed of 60 mph, the minimum radius of curvature is 1,300 ft. The designer can then choose to use any radius larger than this value. It can be assumed that this procedure was applied to these two sections of highway. The figure also summarizes the alignment used on both roads. In the case of Highway A, all the radii used are signifi-

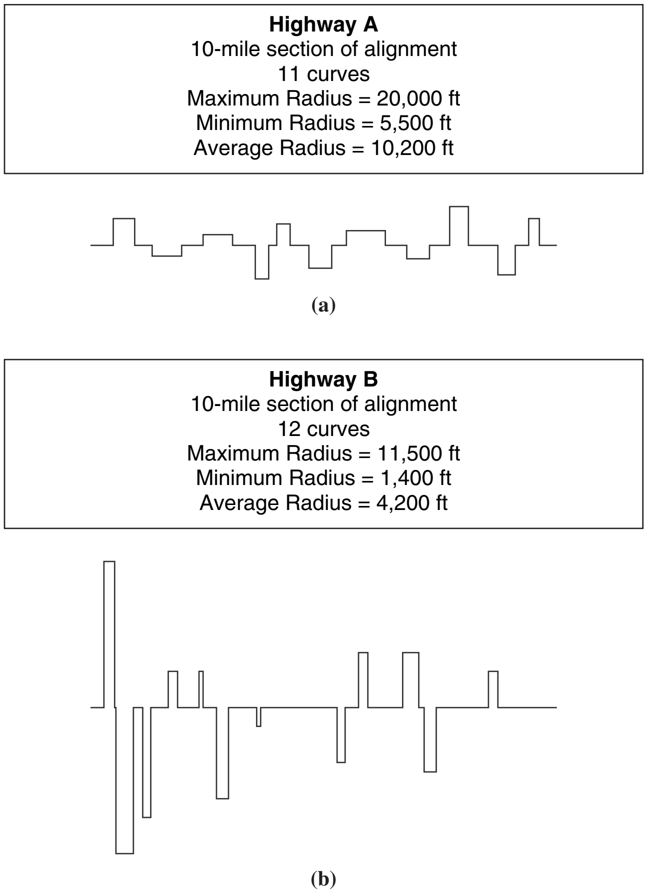

FIGURE 1 Comparison of alignment of two freeways in northeastern United States. (*Y*-axis is plot of the inverse of the radius of each curve; *X*-axis is distance along the road.)

cantly larger than the minimum. In fact, the smallest radius used is 5,500 ft (the average is 10,200 ft); using the AASHTO formula, this radius would be equivalent to a design speed of about 120 mph. An operating speed of 120 mph might not be expected, but it is clear that this entire section of road could be traversed comfortably by most drivers at speeds well in excess of the design speed. The alignment for Highway B is quite different. The smallest radius here is 1,432 ft, and the average is 4,200 ft—less than that for Highway A. But again the result is the same. The potential operating speed would be higher than expected, given the design speed.

This illustrates an important feature of the design-speed approach that is not always appreciated by all designers. The design speed sets a minimum level for the potential operating speed on a roadway. This is not a major problem on the two roads that are used as examples here. In both cases they are high-speed freeways where there is no risk of conflict between human activities along the road and the speed of the vehicles on the road. This becomes a big issue, however, when one is designing roads in a context in which high speeds affect livability and safety of other road users, including pedestrians. The problem is that the design-speed approach gives no guidance to the designer on how to design for an upper limit on speed for a given project. The result is that many newer roads and streets have the look and feel of roads that are designed for 50 or 60 mph but are sign-posted for 25 or 35 mph.

An experienced and knowledgeable designer can use this design-speed approach and the technical information in the AASHTO or similar guide to design context appropriate roadways. However, the design-speed approach does not readily facilitate the development of a context-based design solution, and in fact all too often it is used to produce context-inappropriate designs. In this regard, the design-speed approach can be considered to be too flexible. This is illustrated by the two very different design solutions that are represented by Highway A and Highway B. Both highways are designed by using more or less the same criteria, but the choices made about the alignments are very different. Of the two roads, Highway A is more continuous, since the discontinuities between curves and tangent sections are not as sharp and the alignment is more curvilinear. Highway A is also more consistent, since all the curves are about the same radii. However, Highway A also has the potential for much higher operating speeds because the curve radii are so large. (The actual operating speeds will depend to some extent on other design factors, such as the vertical alignment and the width.)

During the past several years, there is a growing awareness of the importance of considering continuity and consistency for alignment design, especially as they affect safety (*15*). FHWA has developed a tool for evaluating consistency with its Consistency Design Module, which is a part of its Interactive Highway Safety Design Model (IHSDM) (*16*). However, the issue of varying operating conditions for the same design speed can best be addressed through changes to the concept of design speed and how it is used in the design process. In other words, the design procedure must provide an approach to consider both the maximum and minimum desired speeds on the roadway. The design-speed approach controls only minimum speed on a road segment and gives no guide for controlling maximum speed.

Under the AASHTO approach to design, the design speed influences the choice of a host of design parameters, and not only alignment design. These include features such as lane width, shoulder width, median width, and the clear zone. Design speed is also used to help decide on whether a specific element should be part of the design for a given roadway. The theory or research linking design speed to these various design features is not always clear. One key study, NCHRP 15-18, shows that in urban areas, operating speed is relatively insensitive to geometric characteristics (*17*). In rural areas, operating speed is sensitive to radii and grade but less so to other geometric characteristics (*18, 19*).

On the basis of these and other studies, some have questioned the validity of applying the concept of design speed to such a broad set of parameters. Many researchers have made the point that design speed is valid only for a narrow range of parameters and is misapplied when it is used to determine parameters such as lane width. Others have pointed out that design speed is useful only for the design of freeways and rural, two-lane roadways and has little real function when applied to urban streets.

CONCEPTUAL FRAMEWORK FOR CONTEXT-BASED DESIGN

The above evaluation of the AASHTO-based approach to design shows that there are two main areas of concern that must be addressed in developing a more coherent and context-based approach to design: (*a*) how to define context better and (*b*) how to design for appropriate operations (including speed). However, there is a third issue that must be addressed in developing a true context-based approach to design. A more coherent and comprehensive framework for design is needed

that encompasses the full range of issues that affect the design process. This issue is beginning to be tackled by a number of agencies at the local level.

For example, the city of Charlotte, North Carolina, has been testing a street design framework that has a much broader consideration of context and multimodal function than is typically done by design agencies (*20*). The city of Berkeley, California, has also used a comprehensive design process in developing its bicycle boulevard network (*21*). Although this Berkeley plan focuses on bicycles, it also demonstrates the value of taking a more integrated, systems approach to planning and designing a transportation network of any kind. With these two projects as a starting point, the following generalized framework for a comprehensive approach to highway design has been outlined.

A Four-Step Model of the Highway Design Process

The highway design process is more akin to other creative design fields, such as architecture, landscape architecture, and urban design, that combine both technical and aesthetic values, and is less akin to other types of engineering design in which a premium is placed on technical considerations. The technical issues are without question very important in highway design, but the nontechnical considerations of context, livability, and appearance are just as important in determining the ultimate success of the design. The expression of design in creative fields such as this is a complex, interactive system that involves the balancing of numerous factors and represents an interrelated decision-making process on many different levels.

The basic processes needed to produce good highway design solutions can be modeled as shown in the flowchart of Figure 2. This is an imperfect representation of the system because of the inherent complexities of the design process. Nevertheless, it is important to attempt the representation in order to better understand the interrelationships in the steps that lead to a design solution. This model is proposed to provide a clear framework for teaching and discussing the highway design process.

Step 1. Define the Context

The first step shown in the highway design flowchart is that of defining the context for the project. Context refers not only to the transportation issues but also to the social, physical, fiscal, ecological, and political background for the project. Understanding the transportation context includes looking at all the modes of travel that exist in the area and understanding how the facility will fit into the full transportation network—not just the highway network. The importance of a network solution rather than a road-by-road solution is one that needs particular emphasis, since this aspect of design has been neglected over the years. It is also at this stage that the needs of the local communities must be assessed. In many cases, decisions relating to context are made outside of the highway design process; nonethe-

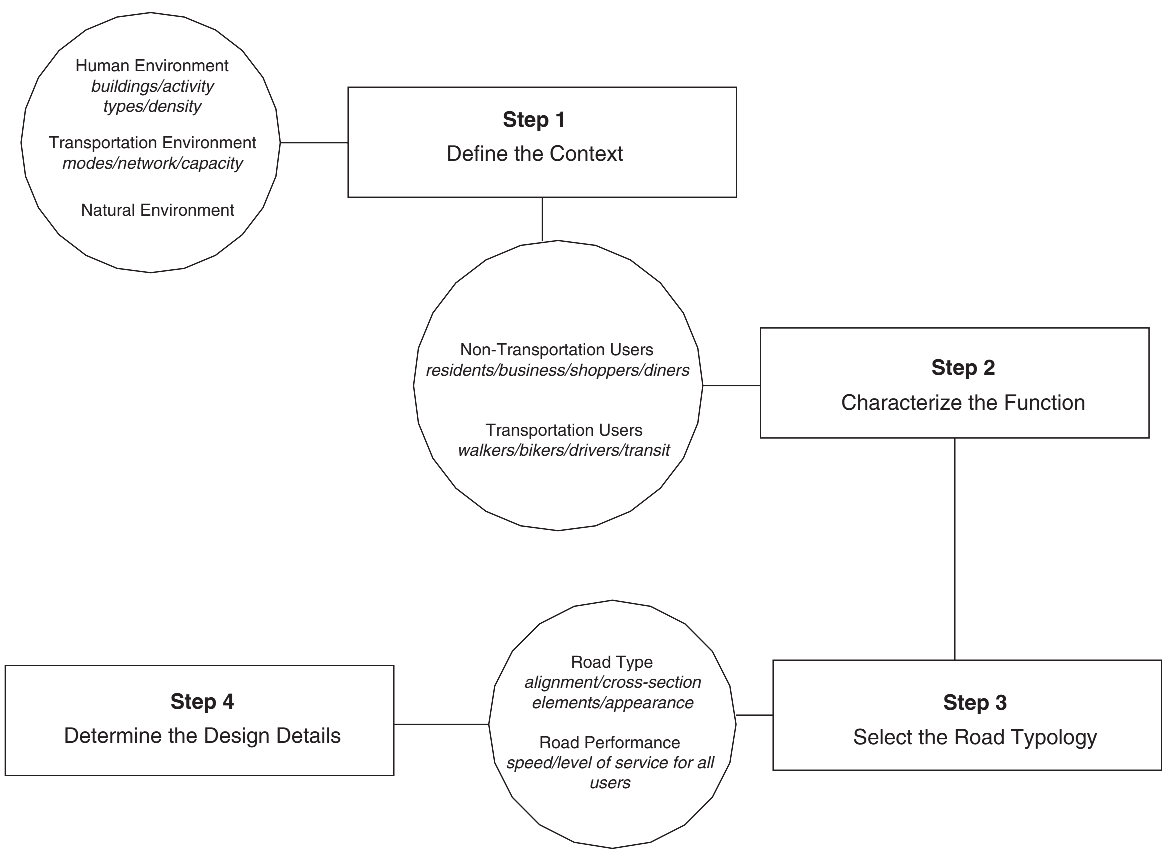

FIGURE 2 Four-step model of highway design process.

less it is important to explicitly consider the full range of factors that affect context.

Step 2. Characterize the Function

Once the context is fully defined, the next step is to determine the different functions for a facility that will be best suited to this context. As shown in the figure, it is important to explicitly consider all the various functions that the given street or road might serve and to design to accommodate these functions as necessary. These functions must explicitly include both the transportation functions (for pedestrians, cyclists, private vehicles, and transit) and the nontransportation functions (for entertainment, retail, public gathering, and recreation). It is worth stressing again that function relates not only to the details of the specific project but also to the way the project fits into the overall transportation network.

Step 3. Select the Road Typology

The third step in the design process is to determine the typology of road that would serve the desired function determined in Step 2. The four most important factors governing the typology of the road include its physical components, the arrangement of these components, definition of the network, and the desired speed. The completion of this step results in a conceptual design for the project.

Step 4. Determine the Design Details

The fourth step involves the detail design for the conceptual plan from Step 3. These details include both engineering and aesthetic factors that contribute to the proper performance of the roadway. Included would be aspects such as the alignment design; the cross-section design; the choice and placement of trees and street furniture; and the relationship of the road to the surrounding buildings, land use, or natural environment (including issues of access control and building frontage). An important element in determining the design is to ensure that the selected plan gives the desired performance in both the transportation and nontransportation functions. In particular, it is important to ensure that the design leads to the desired operating speeds on the road. Therefore, it is essential to have a good theoretical knowledge of the link between design factors and measures of performance, including operating speed.

A complete and coherent system of design should facilitate a process such as the one outlined in the figure. The AASHTO-based procedure, as it stands, provides detailed technical guidance for some of the vehicle movement issues—but nothing about the land use issues—that must be addressed in Step 4 of the process described. Also, it does not provide the strong overall conceptual framework that is needed at Steps 1 and 2 and, to a large extent, Step 3 of the design process. And it does not have a decision-making process that supports this integrated approach to design. It is essential to develop a system of decision making that supports all four steps in the design process described.

As has been mentioned, a number of initiatives are under way to start to develop a better design framework. These efforts are being undertaken at the local, state, and federal levels, and include not only research but also pilot programs in design agencies. These include the Charlotte framework mentioned previously and efforts under way to develop LOS measures that are needed as part of an integrated decision-making process for the design and planning of thoroughfares. However, it is time to move beyond a piecemeal approach and begin to tackle the design process as a coherent whole.

SUMMARY

Street and highway designers are increasingly being challenged to develop context-based design solutions that support the development of places that are more livable or that are compatible with meeting goals for sustainable development. Conventional design standards have not yet caught up to this new design paradigm, however, and so do not fully support the needs of designers working in this new environment. The evaluation of the AASHTO-based approach to design in this paper shows that there are two main areas of concern that must be addressed in developing a more coherent and context-based approach to design. Specifically, they are the issues of (*a*) how to define context better and (*b*) how to design for appropriate operations (including speed). In addition, there is a clear need for a comprehensive and coherent design framework that ties together both the urban (or place) function and the mobility function of streets and highway, and that takes into account the full context for the design, including multimodal accommodation and full integration into the context.

As discussed, many efforts are under way to address these issues at the local and federal levels, and also internationally. For example, a federally funded study currently is in progress that is focused on the issue of context. This ITE-CNU collaborative study is looking at better ways to define context and is also examining the road typologies that are most appropriate for each design context. It is expected that the road typology will be defined in terms of both the physical characteristics of the road as well as the desired speed on that roadway for a given context. There is also an NCHRP project, NCHRP 15-25, that is focused on the issue of design speed and how it is used as part of the decision making process to ensure that the road performs as desired for all users.

All these initiatives are important in their own right in that they are looking at ways to improve specific aspects of the design process. This paper examined the interrelationship between these and other initiatives aimed at improving the process for designing thoroughfares that support their context. The need for an overarching design framework that integrates all facets required for good design also was discussed. This larger framework (as expressed by the four-step process described earlier) is believed to be essential to design truly context-based thoroughfares that facilitate the operational and safety issues of all users and that also address the issues of context and livability that affect how well our streets or roads function as places.

REFERENCES

1. Neuman, T. R., M. Schwartz, L. Clark, J. Bednar, D. Forbes, D. Vomacka, C. Taggart, M. Glynn, K. Slack, and D. Abere. *NCHRP Report 480: A Guide to Best Practices for Achieving Context Sensitive Solutions.* TRB, National Research Council, Washington, D.C., 2002.
2. Fisher, E. E., H. Hohmann, and P. D. Marriott. Roadways and the Land: The Landscape Architect's Role. *Public Roads,* Vol. 63, No. 5, March–April 2000.

3. Hall, J. W., and D. S. Turner. Development and Adoption of Early AASHO Design Criteria. In *Transportation Research Record 1612,* TRB, National Research Council, Washington, D.C., 1998, pp. 26–33.
4. *A Policy on Highway Types (Geometric).* AASHO, 1940 (reprinted 1985 by Criterion Press).
5. Greenberg, E., and F. Dock. Design Guidance for Great Streets: Addressing Context Sensitivity for Major Urban Streets. *Proc., 2nd Urban Street Symposium,* Anaheim, Calif., July 2003.
6. *A Policy on Design of Urban Highways and Arterial Streets.* AASHTO, Washington, D.C., 1973.
7. *A Policy on Geometric Design of Rural Highways.* AASHTO, Washington, D.C., 1984.
8. *A Policy on Geometric Design of Urban Highways and Arterial Streets.* AASHTO, Washington, D.C., 1990.
9. *A Policy on Geometric Design of Highways and Streets.* AASHTO, Washington, D.C., 1994.
10. *A Policy on Geometric Design of Highways and Streets,* 4th ed. AASHTO, Washington, D.C., 2001.
11. Garrick, N. W., and T. Kuhnimhof. Street Design and Community Livability. *Proc., Urban Transportation 2000,* Cambridge, United Kingdom, July 2000.
12. Forschungsgesellschaft für Strassen—und Verkehrwesen. Richtlinien für die Anlage von Strassen RAS Teil: Leitfaden für die funktionale Gliederung des Strassennetzes (in German). FGSV Verlag, Cologne, Germany, 1988.
13. Marshall, S. *A First Theoretical Approach to Classification of Arterial Streets.* European Commission Fifth Framework Program, Arterial Streets Towards Sustainability (ARTISTS), 2002.
14. Tunnard, C., and B. Pushkarev. *Man-Made America: Chaos or Control.* Yale University Press, New Haven, Conn., 1963.
15. Fitzpatrick, K., J. D. Blaschke, C. B. Shamburger, R. A. Krammes, and D. B. Fambro. *Compatibility of Design Speed, Operating Speed, and Posted Speed.* Report FHWA/TX-95/1465-2F; Research Report 1465-2F. Texas Transportation Institute, College Station, 1995.
16. Interactive Highway Safety Design Model (IHSDM). FHWA, U.S. Department of Transportation, 2003. www.tfhrc.gov/safety/ihsdm/ihsdm.htm. Accessed July 16, 2004.
17. Fitzpatrick, K., P. Carlson, M. A. Brewer, M. D. Wooldridge, and S.-P. Miaou. *NCHRP Report 504: Design Speed, Operating Speed, and Posted Speed Practices.* Transportation Research Board of the National Academies, Washington, D.C., 2003.
18. Ottesen, J. L., and R. A. Krammes. Speed-Profile Model for a Design-Consistency Evaluation Procedure in the United States. In *Transportation Research Record: Journal of the Transportation Research Board, No. 1701,* TRB, National Research Council, Washington, D.C., 2000, pp. 76–85.
19. Krammes, R. A. Design Speed and Operating Speed in Rural Highway Alignment Design. In *Transportation Research Record: Journal of the Transportation Research Board, No. 1701,* TRB, National Research Council, Washington, D.C., 2000, pp. 68–75.
20. Newsome, T., N. Steinman, and R. Ewing. Charlotte Urban Street Design Guidelines: A Context Sensitive Decision-Making Method. *Proc., 2nd Urban Street Symposium,* Anaheim, Calif., July 2003.
21. *Berkeley Bicycle Boulevard Network: Bicycle Boulevard Design Tools and Guidelines.* Planning and Development Department, City of Berkeley, Calif., 2000 (with Wilbur Smith Associates, 2M Associates, HPV Transportation Consultants).

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