Bridge Aesthetics Fundamentals

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What is Aesthetics?

- **aesthetic** (*plural aesthetics*)
  - The study of art or beauty.
  - That which appeals to the **senses**
  - Concerned with beauty, artistic impact, or **appearance**

- For purposes of this presentation, aesthetics relates to visual perception and the appearance of highway bridges
Questions

• Question 1:
  – Do you think it is important to consider aesthetics when designing a bridge?
    • Yes
    • Somewhat
    • No

• Question 2:
  – What percentage of construction costs should be allocated to aesthetics?
    • Less than 1%?
    • Less than 5%?
    • Less than 10%?
Scope: Workhorse Bridges

- There are over 600,000 bridges in the National Bridge Inventory (NBI).
- Of these, approximately 98% have spans < 300 feet.
- This presentation addresses short and intermediate span “Workhorse” bridges.
Why care about bridge aesthetics?

• Considering the visual implications of design decisions is part of our job.
  – Many routine decisions made during the design of a bridge have implications on the appearance of bridges
  – In many cases, the visual implications of bridge design decisions are only discovered when construction is completed
Why care about bridge aesthetics?

“Adverse visual impacts are not consciously designed into a project. They creep in when decisions are made without considering visual consequences.”
Why care about bridge aesthetics?

- Public Perception
  - Bridges are some of the largest scale and most prominent structures in our landscape and neighborhoods.
  - Bridges have a long lifespan and are a legacy of the times that created them.
  - Bridges are also major public works constructed largely by public agencies and financed with public money.

“Stark functionality is no longer enough. Americans have come to expect more attractive designs in aspects of life: cell-phones, kitchens, dentistry and televisions. Public demand for an aesthetically pleasing built-environment is also growing and bridges are a part of that environment.”

– Communication with state DOT bridge engineer
Perception

• Designers have been taught to see bridges as orthogonal projections. However, bridges exist in a three dimensional world.

Elevation view of pier

Oblique view of same pier
Perception

- What is the observer’s position, speed and distance?

**Position (Viewpoint)**
- Beneath and traveling under the bridge?
- Above and traveling over the bridge deck?
- At eye level with the deck?

**Speed**
- Pedestrian?
- Bicyclist?
- Motorist?

**Distance**
- 10 to 20 feet?
- 100 to 200 feet?
- 100 to 200 yards?
Perception

• What is the source, quality, and orientation of light?
  - Daytime
    - Shadows and light
      - Orientation of the bridge relative to north (azimuth)?
      - Time of day is the bridge being viewed?
    - Humidity / haze
      - Distance from viewpoint
  - Night
    - Light source location and intensity
    - Type of light source
Bridges and Buildings.

- The structure of a bridge is inseparable with its function and provides the majority of its aesthetic appeal.
- Don’t try to make a bridge something that it is not.

Parking structure facade in urban area. Bridge functions almost always preclude use of structural camouflage.
“There are at least two ways not to design a bridge:

• to decide what it should look like and then work out how to make it stand up and how to build it;

• to work out the most economical structural / constructional solution and then decide how to make it look nice.”

“The first is the architect’s pitfall, the second the engineer’s. In each case, by the time the decision has been made it is almost certainly too late to get it right. All the important issues have to be kept in mind from the start.”

UK Highways Agency, Design Manual for Roads and Bridges
The Ten Determinants of Appearance

1. Horizontal and Vertical Geometry
2. Superstructure Type
3. Pier / Support Placement / Span Arrangement
4. Abutment Placement and Height
5. Superstructure Shape
6. Pier Shape
7. Abutment Shape
8. Color
9. Texture, Ornamentation and Details
10. Lighting, Signing and Landscaping
#1 Horizontal and Vertical Geometry

- Roadway geometry influences bridge geometry. The roadway surface is the “roof” of the structure.
- Horizontal and vertical clearance requirements beneath the deck level also influence bridge geometry.
#1 Horizontal and Vertical Geometry

- Few bridges:
  - Are located on straight alignments
  - Have flat horizontal deck surfaces
  - Have supports oriented at right angles to the superstructure
  - Have constant cross section widths
  - Are located on a flat site

- Reverse horizontal curvature
- Compound vertical curvature
- Variable deck width
- Variable deck superelevation
- Skewed supports
#1 Horizontal and Vertical Geometry

- Bridges close to the ground appear massive and dark
- Think of the space beneath the bridge

Fremont Troll under the Aurora Bridge in Seattle

Photo: raincity guide.com
#1 Horizontal and Vertical Geometry

- Wide overpass bridges and viaducts can be perceived as barriers
- How does this influence the substructure design?
#1 Horizontal and Vertical Geometry

- Collaborate with design team members to achieve the best possible geometry that accommodates both functional and aesthetic objectives.

Atypical pier cap is visually discordant.
#2 Superstructure Type

- Bridges frame the landscape and become windows. The shape of the “window frames” influences our perception.

"Buildings contain space. It flows through bridges." WJR Smythe
#2 Superstructure Type

- Bridge types are representative of their times and evolve in parallel with construction and materials technology, and the marketplace.

Early 20th century truss bridge

Mid 20th century simple span steel girder “interstate” bridge

Photo: Oklahoma DOT
#2 Superstructure Type

- At this point in time, economy dictates that the majority of workhorse bridges are constant depth girder type structures assembled from standard structural components and systems.
#2 Superstructure Type

- Variable depth superstructures provide visual interest

Combination of variable depth superstructure and massive abutments creates a community portal.
• Rigid frames and slant leg frames can create gateways and portals
Combining multiple superstructure types can result in visual discord and a lack of integrity.
#2 Superstructure Type

- Consistent superstructure type can visually unify a complex arrangement of bridges

Steel box girder bridge type used in four level system interchange
#2 Superstructure Type

- The bridge type should be appropriate to its scale

Is a through arch bridge with hangers and floorbeams required to span less than 100 feet?
#3 Pier and Span Arrangement

- Structure depths are proportional to spans
- Shorter spans with thin superstructures may visually emphasize the substructure

Shallow slab bridge depth relative to height above grade results in slender superstructure appearance
#3 Pier and Span Arrangement

- Longer girder spans have deeper superstructures, which become dominant visual features.

Deep structure relative to height above grade results in a massive superstructure appearance.
#4 Abutment Placement and Height

- Tall abutments visually anchor a bridge to the ground and strongly frame the landscape backdrop.

Bridge with tall abutments serving as a gateway into residential development.
#4 Abutment Placement and Height

- Short abutments increase transparency
- Reduced abutment mass reduces the bridge’s visual “frame” effect

Short abutments increase span and provide views of the backdrop, but result little natural light penetrates to areas near abutments.
#4 Abutment Placement and Height

- Mid-height abutments also provide a strong anchor while providing more visual transparency.
- Trade-off of longer spans versus shorter abutments.

Abutment locations distant from shoulders reduce massive appearance and increases visual transparency relative to tall abutments.
The superstructure fascia is a major visual feature.
Deep relief, shadows, and ornamentation were historically used on prominent bridges to provide for visual interest.
Most contemporary bridges have overhangs.

Wide overhangs place the fascia in shadow and make the bridge appear more slender.
#5 Superstructure Shape

- Contemporary bridges are often constant depth superstructures with little ornamentation.
- Reliance on horizontal layers to provide visual interest.

Uninterrupted fascia emphasizes horizontal lines.
Many bridges use cantilevered pier caps with cantilevered caps.

Recessed columns in shadow emphasize horizontal structure lines.

Gateway viaduct combines modified precast concrete fascia girder with urban streetscape elements.
#5  Superstructure Shape

- Flat fascia surfaces result in a more massive appearance relative to layered surfaces
#5 Superstructure Shape

- Accentuating vertical elements and interrupting horizontal lines is an alternative strategy.

Columns projecting from fascia visually interrupt spans. Art deco detailing also provides visual interest.
#6 Pier Shape

- “Framed” piers with multiple columns and drop pier cap are the most common pier type
#6 Pier Shape

- Single column hammerhead piers increase transparency, particularly on skewed crossings

Slender pier caps emphasize superstructure and result in a more transparent structure
#6 Pier Shape

- Wide column spacing may make sense on urban bridges to provide for more reflected light and an open appearance.

Post tensioned pier caps allow for longer cap beam spans. Reflected light and unobstructed sight lines makes the under-bridge space more inviting.
#6 Pier Shape

- Proportions of framed piers need to be carefully considered

Pier cap appears to be far too massive relative to the columns that support it.

Cantilevers appear out of proportion to total cap width.
Wall type piers offer a wide range of visual expression.
#6 Pier Shape

- Integral pier caps result in continuity and minimize substructure mass
#6 Pier Shape

- Combining pier types and shapes results in visual discord. Be consistent
#7 Abutment Shape

- Articulated tall abutments with wrap around wing walls visually anchor the bridge ends and define a portal
#7 Abutment Shape

- Front faces of abutment walls may provide opportunities

Urban bridge with pedestrian traffic beneath. Articulated abutment surface and ceramic tile on abutment face provide visual interest.

Gateway bridge incorporates pilasters into abutment face. Strong shadows break up wide abutment surface.
#7 Abutment Shape

- Consider proportions and scale of abutments and how they relate to the superstructure.

Abutment pilasters define the ends of the crossing and provide human scale features for pedestrians. Scale of pilasters is appropriate.
• Is relatively inexpensive
• Is subjective
• Is much more complex than most people realize
#8 Color

- Issues to consider
  - Durability and maintenance of coatings
  - Graffiti resistance
  - Application over large areas /uniformity
  - Appearance during different seasons
  - Site Physical Context
    - Vegetation and soils /rocks in rural environments
    - Building materials in urban environments
#8 Color

- Blend with the environment
- Contrast with the environment
#8 Color

- Color has a cultural dimension

New Mexico bridges
#8 Color

- Color can influence our perceptions

"Purple People Bridge"

"Big Mac"
#9 Texture, Ornamentation and Details

- Values and attitudes related to ornamented bridges have changed over time

Photo: Carnegie Library, Wikimedia
During the late 20th century, the prevailing approach was to eliminate ornament. “Form follows function” also accommodated need for economy and rapid construction.
#9 Texture, Ornamentation and Details

- Avoid using structural forms as ornament

Decorative arches attached to conventional highway overpass bridges as ornament. These arches obviously do not support these bridges.
Avoid using false structural members to mimic structure.

Decorative truss members attached to conventional prestressed girder bridge to create landmark bridge. Have long term maintenance requirements been considered?
• Consider proportions and scale of ornament, and how it relates to the bridge structure

Brick parapet and ornamental lighting overwhelms the simple concrete bridge beneath. Is this a bridge or a wall with openings?
#9 Texture, Ornamentation and Details

- Be careful in using formliners

Formliner pattern suggests an unstable detail in masonry construction

Photo: Federal Highway Administration

Would a fieldstone wall span this road?
#9 Texture, Ornamentation and Details

- Pilasters or monuments visually define the ends of bridges or mark one’s position within the bridge length

Photo: Historicbridges.org
#10 Lighting, Signing and Landscaping

- Emotional Impact of Good Lighting

Before

After
#10 Lighting, Signing and Landscaping

- Lighting Considerations
  - Maintenance
  - Lamping and Energy
  - Physical Constraints
  - Color Rendering
  - Wildlife Concerns
  - Light Pollution
#10 Lighting, Signing and Landscaping

- Terracing and landscaping visually softens the connection between a bridge and its site
#10 Lighting, Signing and Landscaping

- An alternative approach is to use landscaping to reinforce a strong visual “anchor” at the bridge ends.
Bridge Aesthetics

It so happens that the work which is likely to be our most durable monument, and to convey some knowledge of us to the most remote posterity, is a work of pure utility; not a shrine, not a fortress, not a palace but a bridge.
— Montgomery Schuyler, 1883, writing about John Roebling's Brooklyn Bridge

This is the home of the Bridge Aesthetics Subcommittee of the Transportation Research Board.

The Subcommittee on Bridge Aesthetics is a subcommittee of the Committee on General Structures (AFF10) of the Transportation Research Board, which is part of the National Academies, "advisors to the nation on Science, Engineering and Medicine". The site has two target audiences, transportation agencies and their consultants, and members of the general public who would like to see better looking bridges in their own locales.

Purpose and Goals

The aesthetics of large bridges often receive much attention because of their size and prominence in the landscape. However, the numerous “everyday” bridges, such as highway overpasses and small river crossings are usually approached as purely technical problems, with little thought given to their appearance. The public has begun to realize that these bridges, taken together, can have a greater influence on the visual quality of the transportation environment than the landmark bridges. They are insisting that transportation agencies improve the appearance of their everyday bridges.

In response to this interest the General Structures Committee of the Transportation Research Board (TRB) and the Subcommittee on Bridges and Structures of the American Association of State Highway and Transportation Officials (AASHTO) established the Subcommittee on Bridge Aesthetics.
Get it here:

[Image: Draft Bridge Aesthetics Sourcebook]

You are welcome to [provide feedback concerning the Sourcebook](#).
Bridge Aesthetics Presentations

2009

The Federal Role in Highway Design and Aesthetics: A Historical Perspective
Bruce E. Seely, Michigan Technological University

Cost of Bridge Aesthetics from a Department of Transportation Perspective
Dean Van Landuyt, Texas Department of Transportation

Context-Sensitive Sustainable Solutions Meet Economy, Efficiency, and Elegance in Bridge Design
Robert J. Shulock, Hatch Mott MacDonald

Route 52 Viaduct: Ribbon in the Sky
Robert Hevilaqua, Michael Baker Jr., Inc.

Defining Subjective Context of Bridge Designs
Joe Tognoli, T.Y. Lin International

Connective Sensibilities: Pedestrian Bridge Design Concepts
Tom Sceurbo, HNTB Architecture

Bridge Architecture of the 21st Century: A Bridge Architect’s Perspective
Paul D. Kinderman, Washington State Department of Transportation

Contextual Bridge Design
Thomas Pietrowski, AIA, SARP, H2L2 Architects | Planners LLC

2008

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Bridge Aesthetics Sourcebook

- “Practical Ideas for Short and Medium Span Bridges” Draft developed by AFF10(2) on March 2009
- [http://bridgeaesthetics.org/](http://bridgeaesthetics.org/)
- Endorsed by AASHTO SCOBS in 2010
- “AASHTO Bridge Aesthetics Sourcebook, First Edition”
How much does it cost?

• “It is unwise to pay too much. But it is worse to pay too little. There is hardly anything in the world that can’t be made a little worse and to sell a little cheaper” - John Ruskin

• “At the opposite extreme, increasing project costs does not necessarily result in a better design. A common idea.. is that a bridge which is attractive in appearance must be more expensive than one which is not. There is no evidence that this is so. In fact, a good looking bridge is likely to have had more thought devoted to all aspects of its design; it will probably be more fully an integrated design and could even cost less to build.” - WJR Smyth
Thank You
POLL RESULTS OF NEW JERSEY ENGINEERS
Who cares about bridge aesthetics?

Question No. 1

Do you think it is important to consider aesthetics when designing bridges?

- Yes
- Somewhat
- No
Who cares about bridge aesthetics?

Question No. 2

What percentage of bridge construction cost should be made available for bridge aesthetics?

- < 1%
- < 5%
- < 10%