Transportation Decision-making –
*Principles of Project Evaluation and Programming*

**Visual Impacts Assessment**

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Contents of the Presentation

- Background
- Principles of Visual Performance
  - Performance Measures for Visual Performance Assessment
- Factors Affecting Visual Performance and Impact Mechanisms
  - Factors
  - Impact Mechanisms
- Methodology for Visual Impact Assessment
- Legislation
- Mitigation of Poor Visual Performance of Existing Facilities
- Visual Performance Enhancement – The State of Practice
1. Background

- The construction and operation of transportation facilities → profound aesthetic/visual impacts.

- Traditionally: transportation systems designed/built w/o aesthetics

- Emphasis on speed, safety, vehicle operating costs, and economic efficiency.

- 1966 - Historic Preservation Act changed all that
  - Since 1966 - Increasing attention to aesthetics in transp. project planning and design.
  - Initiatives by FTA, FHWA in context sensitive design (CSD)

- Need exists to:
  - understand principles of visual performance
  - identify factors affecting visual performance of transportation facilities,
  - discuss mechanisms by which factors enhance or degrade visual performance.
  - have a methodology for assessing the visual impacts of transportation projects.
  - mitigate visually-deficient transportation corridors and areas.
Terminology

- **Visual environment**
  - natural and man-made settings

- **Visual resources or inventory**
  - visual environment and proposed project, if any

- **Visual intrusion**
  - failing to blend in with the existing environment

- **Visual obstruction**
  - blocking the view of aesthetically pleasing features.

- **Visual response**
  - reaction to a specific visual stimulus

- **Visual sensitivity**
  - strength of viewer reaction to a visual stimulus
2. Principles of Visual Performance

- **Aesthetics** = visual performance = quality and character of visual experience.

- **Visual experience**: a compound of visual resources (proposed project, man-made & natural settings) and viewer response.

- **Visual environment**
  - Visual resources and
  - Visual characteristics

- **Visual performance impact** of transportation project: an interaction of:
  - resulting change in total visual resource +
  - change in visual response

- Negative visual performance impact (visual degradation) occurs as a::
  - visual intrusion
  - visual obstruction
Principles of Visual Performance

- **Aesthetics** = visual performance = quality and character of visual experience.

- **Visual experience**: a compound of **visual resources** (proposed project, man-made & natural settings) and **viewer response**.

- **Visual environment**
  - Visual resources and
  - Visual characteristics

- **Visual performance impact** of transportation project: an interaction of:
  - resulting change in total visual resource, and
  - change in visual response

- **Negative visual performance impact** (visual degradation) occurs as a:
  - visual intrusion, or
  - visual obstruction
Visual Performance Measures

- Visual experience is subjective
  - For each scene, VP varies across individuals
  - For each individual, VP varies across time, etc.

- Measures for assessing visual performance
  - Only a fair degree of consistency.

- Criteria for VP performance (next slide)
  - Smardon and Hunter (1983),
  - FHWA (1986), and
  - Ortolano (1997)
Visual Performance Measures

- Performance Measures
  - Overall Visual Character
  - Visual Pattern Elements
    - Color
    - Form
    - Line
    - Texture
    - Scale Contrast
    - Spatial Dominance
    - Diversity
    - Continuity
    - Variety
  - Visual Pattern Character
    - Unity
    - Vividness
    - Intactness
  - Visual Quality
Visual Performance Measures

Pattern Elements

These are the primary visual attributes of objects:

- **Color** – consistencies between facility colors, hues, values, and chrome with those of its environment;

- **Form** – virtual mass, bulk, or shape of an object,
  - refers to the compatibility between facility dimension and shape and its environment;

- **Line** – introduced by the edges of the facility or part thereof
  - refers to the compatibility of facility edges, bands, and introduced silhouette lines with its environment.

- **Texture** – apparent surface coarseness
  - refers to the compatibility between facility surface textural grain, density, and regularity of pattern.

- In some texts, an overall term *landscape compatibility* is used to indicate how well the new facility fits into the overall landscape from the perspectives of the visual pattern elements – color, form, line, and texture.

- Viewers’ appreciation of visual pattern elements can be influenced by their distance from the object.
Visual Performance Measures

Pattern Character

Is the visual contrast between a transp. facility and its environment (setting).

Two objects may have similar visual pattern elements but may exhibit very different visual characters.

Characters are:

- **Scale Contrast**: extent of facility blend into environment - size perspective.
- **Spatial Dominance**: similar to scale contrast but on a larger dimension
- **Diversity or setting contrast**: Extent to which facility visual pattern elements blends with existing natural or man-made background.
- **Continuity**: Is the uninterrupted flow of pattern elements in a landscape
- **Variety**: Is the richness/diversity of physical objects and interrelationships within the landscape.
Examples

Intactness and Unity

The above viewshed illustrates a fair degree of visual intactness and unity.

(Water transportation often offers a comprehensive viewshed of a city’s visual environment)
Examples

Form

Good visual form is reflected in harmony between horizontal and vertical alignment and the natural terrain.
Continuity

The visual continuity of the natural environment can be enhanced by a well designed highway.
Examples

Visual character

A transportation facility can be visually dominant when its pattern elements (form, color, line) are in significant contrast with its setting.
Examples

Scale

The visual scale of this highway is consistent with the scale of its rural setting due to the relatively gentle and grassy side slopes that merge into the setting.
Overall Effects …

**VISUAL RESOURCES (FACILITY/SETTING)**
- Elements of Visual Character
- Visual Quality
- Total Resource Quality

**VIEWER CHARACTERISTICS**
- Viewer Exposure
- Viewer Sensitivity
- Viewer Response
Overall Effects …

**VISUAL RESOURCES (FACILITY/SETTING)**
- Elements of Visual Character
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  - Total Resource Quality

**VIEWER CHARACTERISTICS**
- Viewer Exposure
- Viewer Sensitivity
  - Viewer Response

Overall Visual Effect of the Transp. Facility
3. Visual Impact Factors

- Transportation Facility Characteristics.
  - Facility type,
  - dimensions,
  - shape,
  - texture and
  - other features.

- Stage of the Transportation Development Process.
  - Completed facilities vs. partially constructed facilities
Visual Impact Factors

- **Extent of the Exposure.**
  - Greater exposure of unsightly transportation facility (bridge underpasses)
  - Greater the exposure of a visually-appealing facility to public view
  - Greater view of pleasing natural landscape from transp. facility

- **Viewer Sensitivity - Influenced by:**
  - viewer category (pedestrian, facility user, tourist, or resident),
  - age, gender, background,
  - frequency and duration of viewing,
  - type of activity that the viewer is engaged in while experiencing the scene in question (commuting, work, recreation, etc.).
  - proximity of the facility to the viewer
  - viewers’ level of aesthetic training or skills.
4. Visual Impact Mechanisms

- **Addition of sizeable new physical elements** on the visual landscape through construction of new transportation facilities or expansion of existing ones. These can either intrude or blend in with their surrounding environment.

- **Proximity to passing vehicles.** Communities adjacent to freeways, railways, or air terminals, etc. encounter views of passing transportation vehicles. Depending on viewer sensitivity, such views may either degrade or enhance viewing pleasure.

- **Blocking of existing features that are visually-pleasing or visually-repulsive**, natural or man-made (such as landmarks, open space, community features) (such as blighted areas) through new construction or expansion of transportation facilities.

- **Removal, during construction, of existing features** in ROW that are visually pleasing or repulsive.
Visual Impact Mechanisms

- **Addition of visual clutter** to the landscape due to provision of new transportation features such as road signs, overhead traffic sign posts and lines, etc.

- **Replacement of unsightly transportation infrastructure** with upgraded facilities primarily for reasons of capacity or safety enhancement but with aesthetic improvement as a secondary benefit.

- **Provision of visually pleasing features** as part of the transportation project, such as lighting (in urban areas), landscaping of the median and roadsides, etc.

- **Privacy.** Elevated railways or freeways can affect the privacy of people in houses and other buildings located below.
Framework for Visual Impact Assessment

1. Establish distinct visual analysis areas along the project corridor and conduct visual inventories.
2. Select a specific visual analysis area and define the area (the proposed facility and boundaries of its visual environment).
3. Select a transportation improvement alternative.
4. Identify the various simulation media to be used.
5. Use a selected simulation medium to present aesthetic impacts of selected transportation alternative.
6. Identify the level of detail of the assessment.
7. Use a selected instrument to estimate aesthetic impacts of simulated transportation alternative.
8. Identify the various estimation instruments to be used.
9. Repeat for all transportation alternatives.
Step 1 - Establish Visual Analysis Areas and Prepare Visual Inventories

- Identify distinct viewing settings at various points ...
  - along the project corridor (highway, railway, waterway)
    for above lineal facilities, use route inventory: the entire project must be decomposed into distinct segments
  - around the project node (airport terminal, transit terminal, or parking garage)
    for above nodal facilities, use area inventory. Distinct view settings may comprise the various perspectives of the facilities, particularly the areas that are frequently seen by the facility users (the most common being the facility’s front view).

- ¼ mile loci study area recommended except where scenic viewing points exist within farther distances.

- Topographic maps, aerial photographs (Google Earth), field survey descriptions, sketches, and ground-level photos, or video clips.
Step 1 (continued)

- Establish distinct **viewsheds** (views seen from a particular location)

- Features and components of visual inventory:
  - Natural
  - Man-made
Step 1 (continued)

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- Features and components of visual inventory:
  - Natural
  - Man-made

  ```
  visual character
  visual quality
  viewing conditions
  viewer sensitivity
  visual policies
  ```
Step 1 (continued)

- Establish distinct **viewsheds** (views seen from a particular location)

- **Features and components of visual inventory:**
  
  - **Natural**
  
  - **Man-made**

  - **visual character**
  
  - **visual quality**
  
  - **viewing conditions**
  
  - **viewer sensitivity**
  
  - **visual policies**

  - patterns
  
  - attractiveness
  
  - viewpoints from which the proposed project or its environment can be seen
  
  - level of concern exhibited by the likely viewers of the project
  
  - policies, guidelines or standards of agency or community
Step 2 - Identify the Transportation Alternatives

- Consider each transportation improvement alternative
- Aesthetic considerations alone may not sway the decision to adopt one transportation alternative over another

Exceptions:

- Where there are negligible differences in levels of other performance measures across the alternatives
- Where visual performance far exceeds all other performance measures in importance

Example, environments/facilities that inherently attract tourists or provide viewing pleasure due to their natural beauty or historical/cultural significance.
Step 3 – Establish Scope and Level of Detail of the Assessment

- Which issues require analysis for a specific project?
- Use visual scoping questionnaire
  - FHWA (1988)
  - California Department of Transportation
SCOPING QUESTIONNAIRE FOR VISUAL ASSESSMENT

CONSIDER EACH OF THE EIGHTEEN QUESTIONS BELOW AND SELECT THE RESPONSE THAT MOST CLOSELY APPLIES TO THE PROJECT IN QUESTION.

1. Project Characteristics
   A. What are the major project design standards (capacity, access, speed, geometry)? What are the Alternatives?
   B. What is the typical geometric profile (roadway, roadside slopes and drainage, right-of-way, guide-way)? What major structures and appurtenances will be required? What are the Alternatives?
   C. What other facilities (such as rest areas, maintenance yards or stations) are part of the project? What construction areas (borrow pits, spoil areas) will be needed? What are the Alternatives?
   D. What secondary effects (such as development at interchanges, stations etc. or conversion of land from rural to urban uses or from residential to commercial) may result from the project?

2. Visual Environment of Project
   A. What landscape components (landform, water, vegetation, and man-made development) are characteristic of the regional landscape and the immediate project area?
   B. From which locations are the project likely to be seen?
   C. What visually distinct landscape units can be identified within the immediate project area?
A. How would the project alternative affect the landscape components which are present within the visual environment?
B. What is the existing visual character of the project environment (e.g., form, line, color, texture and dominance, scale, 
diversity, continuity) and how compatible would project alternatives be with this character?
C. What levels of visual quality exist at the current time (may be evaluated using criteria such as vividness, intactness, and 
unity and other indicators), and how much would project alternatives affect these?

4. Significant Viewer Response Issues
A. What major viewer groups are likely to see the project?
B. What is the viewer exposure to project alternatives for different groups (numbers, distance, duration and speed of view, etc.)
   and how does each alternative affect important existing views?
C. How are viewer activity and awareness likely to affect the attention that different groups pay to the project and its visual 
environment? (Include both viewers from the road (such as vehicle operators) and off the road (such as pedestrians).
D. Are there any visual resources in the project environment that are particularly important to local viewers? Are there any 
districts, sites, or features that are regionally or nationally recognized for their historical/cultural significance?
E. Is the project thought to threaten or support expectations for the future appearance of any areas it traverses?

5. Visual Impacts and Impact Management
A. In summary, what significant visual impacts, if any, appear likely? (Include both adverse and beneficial impacts).
B. What alternative might avoid, minimize, or reduce any adverse visual impacts and by how much?
C. What actions might rectify or compensate for adverse visual impacts and by how much?
Step 5 - Presentation of the Existing Scene and Simulation of the Proposed Scene

Simulation media:
- Artist sketches
- Photomontage techniques
- Computer modeling (simulation software)

Factors affecting the selection of appropriate simulation medium:
- project scale
- physical environment
- number of alternatives
- availability of resources
- analyst’s familiarity with the techniques.
Facility Simulation
Artist Sketch - Examples

Coburn Intermodal Exchange Center, Australia
Facility Simulation
Artist Sketch - Examples

38th Station Transit Terminal, St. Paul, Minneapolis
Facility Simulation
Artist Sketch - Examples

Sandpoint Tunnel Project, City of Sandpoint, Idaho
Facility Simulation
Artist Sketch - Examples

ParkShuttle System, Schipol Airport, Amsterdam
Facility Simulation
Artist Sketch - Examples

Rail Transit System, Dubai
Facility Simulation
Artist Sketch - Examples

Alternative 1

Alternative 2

Stoke Road Junction, Devon, UK
Photomontage - Examples

Photomontage – A Transit Terminal

Source: Scott Page, for the Strategic Technology Collaborative, 2004
Photomontage - Examples

Photomontage of US 1 at NC 98 Bypass

EXISTING VIEW OF US-1 AT NC-98 BYPASS LOOKING NORTH

VIEW OF US-1 AT NC-98 BYPASS LOOKING NORTH WITH PROPOSED IMPROVEMENTS
Photomontage - Examples

US-1 at Gresham Road, North Carolina
Computer Simulation - Examples

Cincinnati Bus Rapid Transit (BRT) Project
New Strelasund bridge, Germany

(Computer-generated image superimposed on real image)
Computer Simulation - Examples

Sample computer simulation of a roundabout project (from FHWA)
Computer Simulation - Examples

Proposed integration of car and rail traffic on Buffalo, NY, Main Street

Source: Center for Computational Research (CCR), University of Buffalo
Step 4 (continued)

Simulation media:

- Artist sketches
- Photomontage techniques
- Computer modeling (simulation software)

Factors affecting the selection of appropriate simulation medium:

- project scale
- physical environment
- number of alternatives
- availability of resources
- analyst’s familiarity with the techniques.
Step 4 (continued) When to use Which?

- **Artist sketches**
  - When the transportation project is small and not complex
  - When there are few design alternatives

- **Photomontage techniques**
  - When time or resources are limited,
  - When the proposed change would add a new visual element to the street scene such as an elevated structure, when the change will block existing views of significant landmarks or green space in the area, or
  - When the character of the street scene will be altered (e.g., with an upgraded intersection).

- **Computer modeling (simulation software)**
  - When there is a large number of distinct alternatives
  - When there are adequate time and money resources for the evaluation
  - When it is sought to acquire viewsheds encountered as one travels along the transportation roadway/guideway (for lineal facilities) or as one moves around a nodal facility
Step 5 - Estimation of Visual Impacts

FOR EACH TRANSPORTATION ALTERNATIVE:

- Indicate **level of aesthetic desirability**, for each aesthetic criterion
  - Each respondent should assess the impacts based on a scale of increasing or decreasing appeal.
  - Responses may be categorical (high, medium or low appeal), or quantitative (on a scale of 0-10 or 0-100)

- Indicate **importance** of each aesthetic criterion
  - Ratings indicated by the responses can be adjusted by various influencing factors, such as the length of time each respondent typically would encounter the image on a daily basis,
  - Then all responses can be collated to generate a single rating index or value that represents the level of aesthetic appeal of the selected transportation alternative
Example: A survey of aesthetic experts yielded the following weights:
  Landscape compatibility - 0.5 (Color - 40%; Form - 30%; Line - 20%; Texture - 10%)
  Scale contrast - 0.3
  Spatial dominance - 0.2

Proposed design of retaining wall along highway near a university town, displayed publicly.

In a survey, students, commuters, and residents of the area, rated the design on the basis of the above aesthetic performance measures.

Determine the overall visual performance index for the design under consideration.
<table>
<thead>
<tr>
<th>Visual Element (Performance Measure)</th>
<th>Visual Sub-elements</th>
<th>Indicators/Clues</th>
<th>Sub-element Weight</th>
<th>Rating Score (from Scale)</th>
<th>Weighted Rating Score (WRS)</th>
<th>WRS for Performance Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscape Compatibility</td>
<td>Color</td>
<td>Consistency between facility colors, hues, values, chroma with those of its environment</td>
<td>0.4</td>
<td>8</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Form</td>
<td>Compatibility between facility dimension and shape and its environment</td>
<td>0.3</td>
<td>7</td>
<td>2.1</td>
<td>7.5</td>
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<tr>
<td></td>
<td>Line</td>
<td>Compatibility of facility edges, bands and introduced silhouette lines with its environment</td>
<td>0.2</td>
<td>8</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Texture</td>
<td>Compatibility between facility surface textural grain, density, and regularity of pattern</td>
<td>0.1</td>
<td>6</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Scale Contrast</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rating Scale</td>
<td>Excellent (Small object or scale of activity) - 10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Good (Significant object or scale) – 8</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Moderate (one of several major scales or major objects in confined setting) - 4</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Poor/Very poor (Major scale introduction/intrusion) – 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spatial Dominance (Landscape situation backdrop)</td>
<td></td>
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<tr>
<td></td>
<td>Rating Scale</td>
<td>Excellent (Object does not dominate) - 10</td>
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<tr>
<td></td>
<td></td>
<td>Good (Object is subordinate to some other natural feature) - 8</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Moderate (Object is co-dominant with a natural feature) - 4</td>
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<tr>
<td></td>
<td></td>
<td>Poor/Very poor (Object is very prominent is the composition of the landscape; dominates the landform, water or sky backdrops) – 0</td>
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</tr>
</tbody>
</table>
- The combined rating for the landscape compatibility performance measure is given by:

\[
VP_{LandCompatibility} = \frac{(0.4 \times 8) + (0.3 \times 7) + (0.2 \times 8) + (0.1 \times 6)}{0.4 + 0.3 + 0.2 + 0.1} = 7.5
\]

- The overall weighted rating for visual impact assessment is found as follows:

\[
VP = \frac{(0.5 \times 7.5) + (0.3 \times 8) + (0.2 \times 4)}{0.5 + 0.3 + 0.2} = 6.95
\]

- Thus, the visual performance rating is 6.95 out of a maximum of 10, which can be considered “good” visual performance.
Legislative Impetus for Visual Quality Assessments

- 1966 Historic Preservation Act
  Scenic roads and parkway views
  Precipitated the consideration of visual resource impact mitigation in the transportation planning process.

- 1966 Department of Transportation Act, Section 4(f)
  Established EIS
  Identified aesthetics as a human environment factor in determining the effects of highway or transit actions.
  Required development of techniques that appropriately weigh aesthetic values in transportation agency decision-making.

- 1969 National Environmental Policy Act (NEPA)

- Regulations from the Council on Environmental Quality.

- FTA/FHWA
  Introduced Context Sensitive Design
Effects of Visual Performance Enhancements

**COST**

- Inclusion of visual performance benefits in transportation project design
  - Higher cost of the facility
  - Cost often minimal compared to the overall cost of project.
  - 1\% of the overall project cost in Ohio DOT (Sipes, 2005).

- Funding support for aesthetic enhancement efforts by state and local agencies
  - Federal Transportation Enhancement Program (FTEP)

- FTEP geared toward effectively integrating transportation facilities into their surrounding communities and natural environment thereby increasing the value of a project and/or making it more aesthetically pleasing

**BENEFITS**

- Non-monetary: increase in well-being, community spirit, etc.

- Monetary: increased tourist revenue
Context Sensitive Design (CSD)

- Technical Professionals
- Local Community
- Interest Groups
- General Public

- Issues of concern
  - safety, mobility
  - historic and natural resource preservation
  - ...
  - aesthetics
  - environmental enhancements

- Connecticut, Kentucky, Maryland, Minnesota and Utah
Resources for CSD

- CSD: NCHRP 480
- FHWA: Roadway Aesthetic Treatments
- TXDOT: Landscape and Aesthetics Manual
- ODOT: Design Aesthetic Initiative
- MnDOT: Aesthetics Initiative Measurement System (AIMS)
Questions?