What Is a "Bicycle Facility"?

- Bicycle Facility: Improvements and provisions to accommodate or encourage bicycling

- Any roadway not specifically prohibited to cycling is a bicycle facility
However...

- Not all existing roadways necessarily make good bicycle facilities
- How can we improve conditions for bicyclists?
Operating Characteristics

- Bicyclists are not pedestrians
- Bicycles cannot turn instantly - turning radius is based on speed
- Bicycles are only 2 feet wide - but require 4 to 6 feet of clear width (for "shy distance")
- Bicycles cannot stop instantly - stopping distance is based on speed
Bicyclist Characteristics

- Skilled Cyclists
- Basic Cyclists
- Child Cyclists

When accommodating less skilled cyclists, do not make conditions more difficult for skilled cyclists.
Where are real dangers?

- Motor vehicle/bicycle crashes can have high severity
  ...but comprise less than 1/3 of all bike crashes

- Facilities that are perceived to be safer can actually increase overall crash risks for cyclists
FHWA Crash Studies

Injuries to Pedestrians & Bicyclists: An Analysis Based on Hospital Emergency Department Data
http://www.tfhrc.gov/safety/pedbike/research/99078/contents.htm

Bicycle Crash Types: A 1990's Informational Guide
Bicycle Crash Types

- All non-MV related bike crashes - 69%
- Bicyclist failed to yield - 9%
- Motorist failed to yield - 7%
- Bicyclist turn/merge into motorist - 2%
- Motorist turn/merge into bicyclist - 4%
- Motorist overtaking bicyclist - 3%
- Other circumstances - 6%

All other non-motor vehicle related bike crashes

Source: Federal Highway Administration
- Bicycle Crash Types: A 1990s Informational Guide
- Injuries to Bicyclists & Pedestrians - An Analysis Based on Emergency Department Data
Non-Roadway Crashes

Almost 2/3 of non-roadway bicycle-motor vehicle collisions occurred on sidewalks typically at driveway & parking lot entrances/exits

Most remaining non-roadway bicycle-motor vehicle collisions occurred in parking lots
Non-Motor-Vehicle Crashes

- 31% of injury crashes happened in non-roadway locations
- 55% of on-road bicyclist injuries did not involve a motor vehicle
Non-Motor-Vehicle Crashes

- Half of bicycle-only non-roadway crashes occurred on sidewalks
- 1/4 on trails or paths
- 2/3 of bicycle-bicycle collisions occurred on the roadway
  - most of the remainder on trails/sidewalks
Non-Motor-Vehicle Crashes

- Bicycle-Pedestrian Crashes:
  - 40% on roadway
  - 60% on sidewalks
Good Bicycle Facility Design:

- Treats bicyclists as operators of vehicles
- Encourages operation in accordance with traffic flow and traffic law
- Connects destinations in a continuous network
- Accommodates cyclists without inconvenience or extra travel distance/time
Good Bicycle Facility Design

DOES NOT:

- Treat bicyclists like "wheeled pedestrians"
- Require bicyclists to operate in an unpredictable, unexpected, or unsafe manner
- Encourage bicyclists to violate traffic laws
Design References

- AASHTO Guide to Development of Bicycle Facilities
- Manual on Uniform Traffic Control Devices (MUTCD), Part 9
- Other References
AASHTO Guide

- Considered the "definitive" US guideline
- Consensus-based development process
- Only includes accepted best practices
- Consistent with MUTCD
- Thoroughly reviewed by several AASHTO subcommittees
AASHTO Guide

- Most recent edition: 1999
- Sections on:
  - Planning
  - Design
  - Operation
AASHTO Guide Update

- NCHRP Project 15-37
- Contractor will develop content
- Based on:
  - Changes & improvements in current accepted practice
  - New & ongoing research
AASHTO Guide Update

- Panel will review content & progress
- AASHTO committees will review & vote on draft final document
  - Geometric Design
  - Traffic Engineering
  - Non-Motorized Transportation
- Approval by AASHTO after (successful) balloting sometime in 2009-2010
MUTCD

Manual on Uniform Traffic Control Devices

Applies to all public roads in US

Defines standards & guidelines for:

- Signs
- Markings
- Traffic signals
- Work zones & other temporary controls
- Railroad crossings
Manual on Uniform Traffic Control Devices

Ensures similar situations are treated in similar manner for all road users

- Improves traffic flow
- Improves safety
- No "surprises"!

MUTCD defines uniformity of

- Color
- Shape
- Legend
- Placement
Parts of MUTCD

1 - General
2 - Signs
3 - Markings
4 - Traffic Signals
5 - Low Volume Roads
6 - Temporary Traffic Control
7 - School Areas
8 - Railroad Crossings
9 - Bicycle Facilities
10 - Light Rail
MUTCD Part 9 - Bicycle Facilities

- Section that deals specifically with bicyclists
  ...although the rest of the MUTCD still applies to bicycle traffic as well

- Covers:
  - Shared roadways & bike routes
  - Bike lanes
  - Shared-use paths
MUTCD Experimental Process

- Outlined in MUTCD Section 1A.10

- FHWA approval required for:
  - New symbols or combination of symbols
  - New colors or application of colors
  - Non-compliant devices

- Advantages of FHWA oversight:
  - Protection from liability
  - More likely for FHWA to accept results
  - Expert review / oversight
MUTCD Update Process

- 5 year cycle (approximately)
- Proposed changes published in Federal Register and on MUTCD website
- 6 month public comment period
- FHWA collects, reviews, & analyzes comments (12-18 months)
- Final Rule published in Federal Register
- States have 2 years to adopt
Next MUTCD

- All content to FHWA by February 2007
- Draft MUTCD out for review in late summer or fall 2007
- Public comment for 6 months (fall 2007 - spring 2008)
- Next edition published sometime in 2009
NCUTCD

National Committee on Uniform Traffic Control Devices

- Nonprofit corporation
- Provides expert input to FHWA on MUTCD
- Nearly 300 technical members from across US

http://www.ncutcd.org/
39 voting members from 21 sponsoring organizations

American Association of State Highway & Transportation Officials (8 seats)
Institute of Transportation Engineers (8 seats)
National Association of County Engineers (3 seats)
American Public Works Association (3 seats)
Advocates for Highway & Auto Safety
American Automobile Association
American Association of Motor Vehicle Administrators
American Highway Users Alliance
American Public Transportation Association
American Railway Engineering & Maintenance of Way Association
American Road & Transportation Builders Association
American Traffic Safety Services Association
Association of American Railroads
Human Factors Resources
International Association of Chiefs of Police
International Bridge, Tunnel, and Turnpike Association
International Municipal Signal Association
League of American Bicyclists
National Association of Governors’ State Highway Representatives
National Committee on Uniform Traffic Laws & Ordinances
National Safety Council
NCUTCD Technical Committees

- Regulatory & Warning Signs (RWSTC)
- Guide & Motorist Information Signs (GMITC)
- Markings (MTC)
- Signals (STC)
- Temporary Traffic Control (TTC)
- Railroad & Light Rail Crossings (RRLRTC)
- Bicycle (BTC)
NCUTCD Process

- Technical Committees develop proposed devices & application language
- Sponsor organizations review proposals & provide comments & input
- Committees revise proposals based on input
- Council votes on revised proposal
- If approved, proposal is forwarded to FHWA
- FHWA then includes proposed device in next MUTCD (usually…)


NCUTCD-Recommended Items
For Next MUTCD

- Signs for skaters and equestrians on paths
- Signing improvements for multi-state bicycle routes
- M1-8a Numbered Bicycle Route Sign with logo
- Revision of W5-4a Sign
NCUTCD-Recommended Items For Next MUTCD

- Reference Location Signs (mileposts) for paths
- Revision of use of Bike Lane signs (no longer mandatory)
- New Route Marker Auxiliaries for bicycle facilities
NCUTCD-Recommended Items For Next MUTCD

- Bicycle-specific direction & distance signing
- Sign height & offset changes for paths
- Shared Lane Marking
Other Design References

http://www.bicyclinginfo.org

- "Official" site for FHWA bicycle info
- Quality of information varies widely
  - Some recommendations are inconsistent with established standards & guidelines found in MUTCD & AASHTO Guide
  - Some design recommendations have not been fully tested or evaluated
Other Design References

ITE publications:
- Traffic Control Devices Handbook
- Traffic Engineering Handbook
- Innovative Bicycle Treatments

TRB publications:
- Transportation Research Record
- State-Specific Guidelines
Critiques & Evaluations

http://www.bikexpert.com

Looks at reports & facilities from an experienced point of view

Not afraid to go after a few "sacred cows"
Facility Types

Two basic categories:

- **On-roadway**
- **Off-roadway**
On-Roadway Facilities

- Travel Lanes (narrow or wide)
- Shoulders
- Bike Lanes
- Bicycle Boulevards

Sidewalks should never be considered to be an acceptable alternative to on-roadway accommodations.
Off-Roadway Facilities

- Pathways
  Typically improved & paved facilities

- Trails
  Typically unimproved & unpaved
Facility Selection Factors

- Expected user types
- Expected user volumes
- Traffic Generators
- Barriers & impediments
  - Busy streets / highways / freeways
  - Rivers / canals
  - Mountains, canyons, other topography
Facility Selection Factors

- Available corridors
  - Railroads (active or abandoned)
  - Utility corridors (power lines, pipelines)
  - Rivers/canals
  - Roads & streets (for on-street facilities)

- Built environment & landscape may limit or dictate options

- Politics shouldn't - but sometimes does
On-Roadway Facilities

- Travel Lanes (narrow or wide)
- Shoulders
- Bike Lanes
- Bicycle Boulevards
On-Road - For All Users?

Some less confident bicyclists may not feel comfortable riding on roadways.
May prefer sidewalks or parallel paths.
...especially on higher-volume streets.

However, studies indicate on-street facilities are safer overall than sidewalks or parallel pathways.
Applies to all user types.
Shared Travel Lanes

- Simplest, cheapest option
- Treats cyclists like other road users
- Serves greatest number of destinations
- Under higher speed & higher volume conditions, less confident cyclists may be reluctant to use the lane, and may instead use the sidewalk
Narrow (Non-Shareable) Lanes

- Lanes less than 13-14 ft wide typically do not allow for side-by-side operation in the same travel lane.
- Faster traffic must wait until safe overtaking opportunities exist.
- Opposing traffic, sight distance constraints, and no-passing markings can complicate matters.
Narrow Lanes

Narrow travel lanes can still accommodate bicyclists in many situations, *depending on conditions*

Examples:
- Low-volume urban streets
- Higher-volume but low-speed streets
- Low-volume rural roads
Wide (Shareable) Lanes

- Typically 14-16 ft wide from lane line to face of curb
- Allows more convenient overtaking by faster traffic
- More 'comfortable' for many bicyclists
Wide (Shareable) Lanes

- Eliminate channelization problems at intersections (such as inherent in bike lanes or shoulders)
- Less-confident bicyclists may not feel comfortable sharing a lane, even if wide
Shoulders

- Create a place for cyclists to operate adjacent to travel lanes
- Provide safety benefits to all road users
- 4 ft minimum clear width recommended for bicycle use
- Usable by bicyclists on a wide variety of roadways - even rural freeways
Shoulders

- Not typically used in urban areas
- Can accumulate debris, parked vehicles, etc.
- Can create conflicts between cyclists and turning vehicles
- Striping changes at right turn lanes to reduce shoulder to right of turn lane & add "buffer zone" to left can mitigate turning conflicts (similar to through bike lanes)
Shoulders & Rumble Strips

- Rumble strips can affect bicyclist travel
- 3/8" or less rumble depth is much less jarring to bicyclists than 1/2" depth
  - Still provides effective rumble
  - Used by several states
- Gaps in rumble pattern can allow for easy crossing by bicyclists
Bike Lanes

- Typically used in urban & suburban areas
- Create defined road space for cyclists
  - More "comfortable" for some cyclists than shared travel lanes
- Can reduce sidewalk & wrong-way riding
Bike Lanes

- Can accumulate debris & gravel if not frequently swept & cleaned
- Prone to cracking & displacement
- Should not be placed in "door zone" of parked cars
- 4 ft minimum clear width
- 5 ft or greater width preferable
  - 3 ft minimum outside gutter pan
Bike Lanes

- Signs & markings for bike lanes defined in MUTCD
- Widths, offsets, other details defined in AASHTO Guide
- Be familiar with both these references!
Bicycle Boulevards

- "Bike-friendly" streets parallel to major travel corridors
- Provide convenient & continuous route of travel
Bicycle Boulevards

- Intersection designs discourage "cut-through" traffic, but encourage through bicycle travel
- Bike-specific signing & trailblazing provided for cyclist guidance & information
Roadway Retrofit Example

- Existing roadway: urban arterial
- 60 ft wide + 2 x 2 ft gutters
- Existing striping: 5 x 12 ft lanes
  2 lanes in each direction + TWLTL
- Problem: 25% of all crashes on corridor involved bicyclists (75 out of 300 in 5 yr)
- High percentage of wrong-way & sidewalk riders
Roadway Retrofit Example

Question: How to encourage on-street bicycle operation in constrained width?

Proposed solution: Lane width reassignment

AASHTO Green Book allows use of 10 ft or 11 ft lanes in urban areas

Restriped to create wide outside lanes
Roadway Retrofit Example

Before:

12' travel lane  12' travel lane  12' TWLTL  12' travel lane  12' travel lane
Roadway Retrofit Example

After:

14' travel lane  11' travel lane  10' TWLTL  11' travel lane  14' travel lane
Roadway Retrofit Example

Other Possible Options:
Off-Street Facilities
Paths & Trails

- Preferred by recreational cyclists
- Serve pedestrians and other users
- May be scenic and esthetically pleasing
- Can form valuable links in a transportation network when placed on independent alignments
Critical Design Issues
Bikes & On-Street Parking

- Misperception of risks
  Bicyclists "shy away" from moving traffic
  Result: ride too close to parked vehicles
- Bicyclists can't reliably see inside vehicles
  Larger vehicle types
  Headrests
  Tinted windows
Bikes & On-Street Parking

- Car door opens in 3/4 second
  Too fast for human reaction

- "Door zone" crashes can have severe or fatal results
Bike Lanes - Mitigating "Door Zones"

- Wider bike lane
  - Bicyclists may still ride too close to parked vehicles
- Buffer between bike lane & parking
  - More expensive to stripe/maintain
  - May not be understood by cyclists
Bike Lanes - 
Mitigating "Door Zones"

- Wider parking lane
  - Vehicles still park close to curb
  - Leave more clear room on left side

- Parking "crosses" (extended Ts)
  - Promising results in recent study
Bike Lanes & Intersections

- Typically not a good idea to stripe a solid bike lane all the way to intersection
  Encourages "cutting-off" movements
- Recommend dashed (or dropped) bike lane 50-200 ft in advance of intersection
Bike Lanes & Intersections

2003 MUTCD:
A through bicycle lane shall not be positioned to the right of a right turn only lane
Bike Lanes & Intersections

Bike lane should be continued to the left of all right turn only lanes
Bike Lanes & Intersections

"Trap" right turn lanes:

- Cyclists should be encouraged to merge to left of turn lane
- Best merging location will vary based on traffic volume, speed, platoons, etc.
- Don't mark a single merging path veering across lane
- Use "parallel lane" striping
Bike Lanes & Intersections

Multiple turn lanes:

- There may not be any single best travel path through this intersection
- Skilled cyclists will merge over & use center of thru/right lane
- **MUTCD**: Don't use this where bikelanes exist unless justified by capacity analysis
Bike Lanes & Roundabouts

2003 MUTCD:
Bicycle lanes shall not be provided on the circular roadway of a roundabout intersection
Signal Actuation Sign/Symbol

- In MUTCD (as of 2003 edition)
- Indicates best location to actuate signal detector
- R10-22 sign can be used to assist / educate
Pathway Issues

- Conflicts between different user types
- Users may be less attentive
- Crossings of roadways may cause problems
- Pathways parallel and adjacent to roadways create severe intersection and driveway conflicts
Good Pathway Design

- Place on independent alignment
- Provide adequate width for all users to "share nicely"
- Provide good sight distance
- Install all obstructions clear of traveled way
- Route roadway crossings away from other intersections
Don't install posts or bollards in traveled way of path unless there is a documented history of vehicle intrusion

Can cause severe crashes & injuries, even if marked or reflectorized
Path-Roadway Intersections

- Path shouldn’t always have to yield to road
- Priority should be assigned based on:
  - Relative speeds - path vs. roadway
  - Relative volumes - path vs. roadway
  - Relative importance - path vs. roadway
- It’s appropriate to give right-of-way to a high-volume path crossing a low-volume street
- STOP signs should not be used where YIELD signs would be acceptable
Pathway Design

"Sidepaths" (pathways parallel & adjacent to roadways) can be very problematic

Why?

- Intersections
- Driveways
Sidepath Issues

- Offset between path and adjacent roadway does not ensure safety
- Requiring cyclists to yield at intersections and driveways or operate at pedestrian speeds may not be feasible or reasonable
- Two-way path on one side of street encourages wrong-way operation
Are Sidepaths Safer?

- Unless grade-separated, pathways still have intersection conflicts - often severe
- 70% of bicycle/motor vehicle crashes occur at intersections and driveways
- Very few bicycle crashes involve overtaking vehicles
- Children are still at greater relative risk at intersections & driveways
Legal Issues - Sidepaths

If we tell cyclists that it is not OK to ride against traffic here...

...then how can we say it’s OK to ride against traffic here?
Wrong-Way Cycling Hazard - Left Turn From Parallel Road
Wrong-Way Cycling Hazard - Right Turn From Cross Road
Wrong-Way Cycling Hazard - Left Turn From Parallel Road

- Correct bicyclist is easily seen.
- Driver’s focus of vision.
- Wrong-way bicyclist can’t be seen until just before impact.
- Driver’s focus of vision.
Other Cycling Improvements

- Guide & Informational Signing
- Bicycle Parking
- "Bikestations"
- Education
- Enforcement
Guide & Informational Signs

- Low-cost, high-value improvement
- Typically not done (well) in US
- Signing can be provided for destinations frequently visited by cyclists
  - Local
  - Long-distance
Guide & Informational Signs

- Can use BIKE ROUTE + info signs

- New series of signs proposed for MUTCD
Bicycle Parking

- Lack of available parking can greatly discourage bicycle use
- Parking should be:
  - Convenient
  - Secure
- See www.apbp.org for recommendations
'Bikestations'

Central location for:
- Secure parking
- Minor service
- Clean-up/wash-up

Either privately or publicly owned & operated
Education

- Education can be far more effective in improving behavior and safety than any facility type or traffic control device.
- Education programs can be far cheaper than signs, markings, asphalt, & concrete.
Education

- Education can be effective in reducing high-risk behaviors:
  - Wrong-way cycling
  - Sidewalk cycling
  - Nighttime operation without lights
Education

However, most cyclists do not take advantage of education, even if available

Widespread perception: "I know how to pedal & stop - what else is there?"
Education Resources

League of American Bicyclists

- Targeted programs for adults, kids, motorists, commuters
- Certified instructors
- Peer-reviewed national curriculum
- Classroom & "hands-on" modules

http://www.bikeleague.org/
Enforcement

- Enforcement can be very effective against high-risk behavior patterns.
- Targeted enforcement sweeps at high-ridership times & locations can have significant "halo effect."
- Warnings (followed by citations if needed) can be effective without causing backlash.
Enforcement

'Useful' enforcement:
- Wrong-way riding
- Failure to yield (running stop signs / signals)
- Unlit operation at night

'Not-So-Useful' Enforcement:
- Failure to make a full stop (but yielding)
- Registration violations
Enforcement

- Build a good relationship with your local enforcement agency
- Try to overcome misconceptions & assumptions
- Focus on intercepting high-risk behavior
So, Finally...

- There are many ways to accommodate bicyclists
- It's extremely important to accommodate cyclists in reasonable, convenient, and safe ways
- Select the correct type of facility, then design it properly