BE SEEN AND BE SAFE

Motorists have a difficult time detecting and recognizing pedestrians and bicyclists in a visually complex urban environment. The special problems associated with motorists' night vision and low light conditions, the physiology, physics, and psychology of *seeing* will be discussed. Vision is a combination of physics, physiology, and psychology. To understand seeing you must know all three elements and how they work together. There is a need to better light both the bicycle and the rider so you will learn about the needs for high contrast, fluorescent and retroreflective clothing, and the roles played by glare, aging, disease, speed and specific environmental conditions.

VISUAL PERCEPTION: SEEING AND BEING SEEN

MOTORIST FAILS TO SEE PEDESTRIAN OR BICYCLIST

In up to 60% of all crashes the motorist failed to see the pedestrian or bicyclist prior to impact. Annually, 56% of bicyclist fatalities and 60% of pedestrian fatalities are in low/night light. Up to 70% of all motorists driving day and night claim to have not seen the pedestrian or bicyclist until it was too late or not at all.

PEDESTRIANS AND BICYCLISTS ASSUME THEY ARE SEEN

Nearly 100% of pedestrians or bicyclists hit assume that the motorist or bicyclist saw them. This strong disparity between what the pedestrian or bicyclist thinks the motorist sees and what the motorist actually sees must be addressed. If not, very little change will occur in serious crash levels.

WRONG MESSAGES

For years everyone has been taught to wear white at night or have reflectors on the back of their bikes. Some people respond to this information - most do not. Studies have proven that white alone is not enough and a single red reflector gives too little information too late. Anyone traveling at night should make sure to carry or wear retroreflective items.

PEOPLE ARE NOT TRAINED WHERE TO LOOK

Most literature says "Look Both Ways." The message is incomplete and incorrect. A good visual search requires that you **"Look Left - Right - Left *and* Keep On Looking."** The correct scanning procedure also requires one to look over their shoulder for a turning motorist when crossing at an intersection.

PEOPLE ARE NOT TRAINED WHAT TO LOOK FOR

Even when looking in the correct general direction, what are you looking for? Most motorists are looking only for cars, trucks, buses, and, at times, motorcycles. Rarely are they looking for the pencil thin profile of a pedestrian or bicyclist. These people are often hidden on sidewalks, in shade, by parked cars, or other visual barriers. Sometimes they even ride or

walk from directions where motorists never search, such as riding against traffic, on a sidewalk or a street.

PEOPLE CANNOT SEE

This is especially true at night or low light conditions, when the motorist has been drinking or when the cumulative effects of age have reduced night vision. It is also true under certain glare conditions, fogging, icing, bad weather, low angles of the sun, when color is eliminated and when the pedestrian or bicyclist is screened by parked cars, shrubs, other traffic or by being hidden in a blind spot along the vehicle.

CARS HAVE LIMITATIONS

Cars were designed to (more or less) get motorists through a lot of tough conditions. For instance, a motorist cannot improve headlamps to see more than 229 feet on low beams under ideal conditions -- and only objects with the highest possible target contrast will be seen. When a car is traveling at night at 60 mph, the brain must do a lot of quick calculating to pass a bicyclist under the best of conditions. Much can be done to improve the physics of driving and information sharing, but far more can be done to train motorists, bicyclists, and pedestrian.

CONSPICUITY

Pedestrians and bicyclists should do all they can to make certain the motorist sees them To do this they must increase their *conspicuity* -- they must attract the motorist's attention, by becoming more conspicuous. Individuals can improve their chances of being seen by wearing bright clothing, fluorescent by day, retroreflective by night, bright helmets, or by using spacers or moving flags on bikes.

PHYSICS, PHYSIOLOGY, PSYCHOLOGY - HOW DO WE SEE?

When man does not understand nature he is liable to make long-term mistakes. For instance, traffic engineers laid down quite a number of rules early this century without understanding the properties of light. We have all been paying the dividends of that oversight. Here are the most common problems, beginning with the physics.

VISION IS BASED ON REFLECTED LIGHT

Pigments hold onto certain wavelengths of light energy, bouncing back those they do not retain, creating color. Many people cannot see certain critical traffic colors. No important life forms emit their own light at night so only reflected light will give visual information. For high speed traffic conditions only the best reflected colors and substances will work.

RED IS A BAD COLOR

Overused in signals, signs, taillights, and emergency equipment - red is at the far end of the wavelength light spectrum. It fades into black at night, cannot be seen by a high percentage of males, and becomes a problem for the aging driver and pedestrian.

CERTAIN COLORS NOT SEEN WELL IN LATER LIFE

Yellowed eye lenses filter Blues and several other colors. This weakens color detection, especially in certain wavelength spectrums as a person ages.

LOSS OF CONTRAST PERCEPTION AS WE AGE

The eye loses the ability to see contrast as it ages, making it difficult to see low contrast items. Only high contrast will work in an aging population.

SUPER SATURATED COLORS

Fluorescence sends out more reflected light than it absorbs - and thus, has the property of being the brightest color around. Does fluorescent work at night? "No." Fluorescent colors need lots of light and are perceived as black at night.

FLUORESCENT COLORS

Lime green, yellow, orange, pink, then natural yellow and orange are the most visible colors. These are near the center of the visual spectrum and are visible to most people throughout their lives. These colors stimulate more nerve endings and are strongly recorded in the brain.

RETROREFLECTIVE BEST FOR NIGHT

Although white is the most reflective natural color since it bounces back the highest percentage of wavelengths, it is not nearly enough. Fluorescent colors appear black at night. The use of retroreflective materials provides needed levels of visibility. These materials use tens of thousands of tiny glass beads embedded in paint or ink, which are then applied to fabric, signs or other materials.

PHYSIOLOGY OF THE EYE

Once we understand the physical properties of light, the physiology of the human eye can be better understood. The eye is an instrument that takes wavelengths of light, inverts and focuses them on the retina or backside of the eye. The retina is made of many nerve endings called rods and cones. The rods and cones are receivers that convert the power of the incoming light waves into a simple electrical charge, which travels over neurons to the brain--which then figures out what the signals mean.

RODS RECORD CONTRAST AND MOTION

Rods are excellent detectors of motion, but not color or detail. They have no sharpness, everything to a rod is soft and fuzzy. Most of the rods are on the outer banks of the retina and make up most of our peripheral vision and there is little color reception in the periphery.

Rods:
- Are used for night vision
- Make up 95% of visual field
- Pick up motion, suggesting that the brain move the eye in a given direction to see detail and color.

CONES RECORD COLOR AND DETAIL

Cones do not detect motion, require very strong wavelengths and are virtually useless at night. Most motorists who are able to see bright head and tail lights assume they see what is out there. However, critical information, such as unlit pedestrians and bicyclists are going undetected because the visual information to weak for the brain to detect.

Cones:
- Only detect bright night lights
- Have only 5 degrees of visual field, like a spotlight
- Require constant head motion to be effective in picking out detail

AGING DRIVERS

As we age we lose:
- Night vision after age 45 - 50
- General vision after age 65, with a more dramatic drop after age 75

Many older drivers are dependent on driving for their mobility and continue to drive long after it is safe to do so. The risk to low profile objects such as pedestrians and bicyclists is obvious.

EYES AGE

Aging eyes lose the ability to focus, transmit light and may be prone to disease due to poor circulation. We lose half of our night vision every thirteen years and it takes longer to focus from near to far every year we age because eye muscles are weakening. Eye lenses fill with sloughed off and dead cells, filtering the colors. Cataracts may develop.

VISUAL PURPLE - RHODOPSIN

This substance provides you the chemical key to night vision. If you work or play outdoors, yours is burned out for many hours each day. As you age, it takes longer to regain this important substance to transfer night vision information.

MORE AND MORE - YOU SEE LESS AND LESS AT NIGHT

At night it takes from 16 to 32 light bulbs for a person in his/her seventies to see what a teenager sees with one light bulb.

GLARE IS AN INCREASING DISCOMFORT AT NIGHT

This is due to the constant scratching and scarring of your lens by things like wind, rubbing your eyes and natural aging effects. Glare greatly reduces the ability to see critical elements in traffic.

VISUAL ACUITY DROPS

As you age you lose the ability to see 20/20 at night. This is not a correctable condition.

VISUAL FIELD NARROWS BY ONE-THIRD

Reduced peripheral vision and the difficulty of turnings one's head at an older age make it difficult to see thing that were once detected quickly.

PUPILS DO NOT DILATE FULLY

Less light enters which further affects night vision and night driving.

MEDICATIONS AND ILLNESS

As we age we tend to be sick more often. The average Medicare patient may be taking 7 - 12 medications at any one time. Illness and drugs are known to influence vision, sometimes dramatically.

EYE DISEASE

There are a number of dramatic reductions in vision due to eye disease, most of which become more pronounced in old age. These include glaucoma, cataracts, and macular degeneration. Many people drive in the early stages of disease degeneration without awareness of their reduced seeing ability. Some know the effects and "drive more carefully." Combined with other aging effects, disease related loss of vision is very harmful to the driving task. Big objects may be seen, but not smaller, low profile items.

PSYCHOLOGY

Assuming you have not been dealt a blow by the physical properties of light, or the physiology of the eye, your brain now takes over and tries to figure out what is up and down, what is relevant (or not), what is something that looks like - therefore it must be, those kind of things. It is a very complicated process. For instance, the brain must process the following so you can properly pass a pedestrian or bicyclists at night.

DETECT

There are a lot of lights at night, of which only a few have any importance. The brain must determine from this jumble that something is out there worthy of focusing on. The brain tells the eye where to focus.

SELECT

Next the brain must select an item far more significant than all others - focus on the object to see if there is strong enough visual information to select the object for further study before going on to the next task. If the brain has lots of experience with night, traffic and like conditions it will select the right object to study. There may be added time in focusing and screening to find the important items.

RECOGNIZE

The brain now studies its library of items that look like this, sorting through all sorts of memory cells that should be triggered from experience, and voila! ... it's a bicyclist. "Better start to move over or slow down or we are in trouble."

LOCATE

The final task is to calculate speed and distance to avoid a crash.

INCREASING CONSPICUITY

IMPROVING MOTORIST VISUAL PERFORMANCE

Motorists can learn to see pedestrians and bicyclists. One effective technique is to try this activity. When leaving for work one morning ask yourself how many bicyclists or pedestrians you will see on that trip. Record the number. Then consciously look all the way for bicyclists or pedestrians. When you get to the office note the number. It may be five or ten times as many as you expected. Do this in a number of locations and settings. After a while your brain decides this is fun, opens new pathways to detect pedestrians and bicyclists and starts doing a better job.

IMPROVING MOTORIST RESPONSE TIMES

Motorists tend to not only overdrive their headlights at night (any urban night speed over 20 mph), but they fail to prepare themselves fully for likely events in a normal traffic context. For instance, a motorist following a 9 - 12 year old child down the street should know that a bicyclist this age is quite likely to suddenly swerve into their path. By learning to improve their readiness, response time can be cut from six seconds to .75 seconds.

IMPROVING PEDESTRIAN AND BICYCLIST CONSPICUITY

Pedestrians and bicyclists can greatly increase their chances of being seen at critical moments by doing each of the following:

- Wear bright, conspicuous clothing, fluorescent colors, wild designs. A bright lime green helmet can be seen for great distances.

- Wear retroreflective clothing at night on the torso and moving legs.

- Signature value. Pedestrians and bicyclists can help the motorist detect them more quickly by using materials and shapes that form a strong, definite signature. A signature is any visual information that always is "X". A car has two bright taillights with a third braking lamp in the middle. A stop sign is always red, octagonal and has letter-spelling STOP. These are very powerful signatures and leave no chance of confusion. The bicyclist or pedestrian can form a signature by using retroreflective outlines showing the body form and a band on a leg that has a distinct pumping action. There is no confusion when multiple visual messages are sent.

TEACHING VISUAL SKILLS TO CYCLISTS

Traffic experience has proven the need to scan to read downstream conditions twelve seconds ahead. You can train a bicyclists to look for specific things.

Surface hazards - Cracks, loose gravel, ice, water, potholes, railroad tracks, and others.

Stationary hazards - Fire hydrants, parked cars, buildings, high rails fences, and others.

Moving hazards - Pedestrians, other bicyclists, motorists, loose dogs, and objects blowing in the wind.

Visual hazards - Objects that screen important visual information -- mail boxes, vegetation, buildings, walls, parked cars, fences, controller boxes, advertising signs, and others.

You can use slides, video, and other media to teach pedestrians and bicyclists how to determine quickly whether certain information is important or not. This has been done to good effect with fighter pilots and ground based firing teams so they can quickly pick out the planes that are "ours" vs. "theirs."

THREE TYPES OF INCONSPICUITY

There are three ways to stay hidden. All can be improved to where detection is likely.

Invisible	Dark, low light, glare
Obstructed	Bushes, parked cars
Visible, Not Seen	Blend into strong urban visual soup, wrong way riding, motorist not looking

By knowing how inconspicuity occurs, pedestrians and bicyclists can improve their survivability.

Lighting conditions - If children know when rain, fog, low light, glare and other conditions hide them they can be far more cautious and watchful.

Wrong Way Riding - The most dangerous thing about wrong way riding is that the bicyclist is tricking the motorist by coming from an unexpected direction.

Parked cars, sidewalks - Children need to know, even though the sidewalk is where mom and dad want them to ride at that stage in their life, many people will turn or back over their path or pull through an intersection.

NIGHT CONSPICUITY

Headlights - Range on low beam is 229 feet, 445 feet for high beams, and 721 for halogen. 90% of driving is on low beams, particularly in urban settings.

Rain - Cuts visual detection by up to 50%. Bug screens, often used to cover grills are often designed to cover the headlamps as well. This reduces visual information to 1/2 to 1/4 in the rain.

Solar Screens - Many cars have packages that tint windshields, thus cutting down on visual information at night, which further the problems of the aging driver.

Headlight Aim - Many car lights are not aimed correctly. States that do not require inspection often have a 60-70% out of compliance rate.

Other factors - Many other factors reduce night vision through the vehicle. This includes having weight in the trunk, smoking film on the windshield and instrument glare.

BICYCLISTS NOT VISIBLE

Although most bicyclists assume they are visible to the motorist, most are not. Only 5% of bikes ridden at night have legal night lighting. Even those with legal lighting may be sending too little information for the average motorist.

Reflectorization Not Correct - Check the schoolyard before you go in. About 1/3 of all bikes will not have a rear reflector or it will be covered with mud, bent in the wrong direction, broken ore event the wrong color.

Bicyclists Hidden - Many bicyclists who sneak by (literally) in the day may be clobbered at night, riding against traffic, or in an unusual location - perhaps coming right at the motorist in their lane.

Side Reflectors Do Not Work - Bicyclists who assume from the ads that their side reflectors allow a motorist to see them cross their path are wrong. Think about it. A motorist can only see reflected light. When driving more than 20 mph a car headlamp, which has narrow cone, will only pick up items in a direct unavoidable crash path.

Pedal Reflectors - These reflectors have probably saved more lives than life vests. Yet these should not be overly depended upon. Shoes with heels, mud, too low of a seating angle and a broken lens are just a few of the reasons motorists may not see a pedal reflector.

Target Contrast - Dark clothing greatly reduces the motorist's ability to see bounced light off of a bicyclist. White improves detection dramatically, but still is not enough even when sharing the road with sober motorists at speeds above 20 mph.

Head and Tail Lamps A Must - Bicycles ridden at night, in addition to reflectors, should have head and taillights. Active taillights are essential for motorists driving in low light without lights, who are rounding a bend and in certain atmospheric conditions.

Bigger Tail Reflectors - Reflectors can be purchased that are 2-10 times bigger and brighter than those legally required on a bike. Yellow is better than red for detection.

Laws on Night Riding Not Adequate - No bicyclist should be led to believe that the night lighting laws alone are giving them adequate protection. No law currently comes close. Make sure your literature and messages emphasize this oversight.

Good Head Lamps Not Enough - There are conditions, such as rain, fog, mist and ponding water on the roadway, where even the very best bicycle head lamps are inadequate to point out the critical surface condition. Many bike lights are only adequate.

CLASSROOM ACTIVITIES

Using black paper and neon "glo" paint, have students design imaginative high visibility clothing and helmets that help bicyclists and pedestrians advertise their presence to motorists. Display the results on a bulletin board.

Ask students when a motorist might not see a bicyclist or pedestrian approaching at an intersection. Point out some of the following situations:

- Little available natural light (dusk, dawn, night, or a foggy or cloudy day).
- Glare on a motorists' windshield from the sun or other vehicles' headlights.
- Obstructed vision from shrubs, traffic or other blind spots,
- Poor figure/ground contrast (pedestrian and bicyclist's clothing and bicycle blend into the background).

Students can write a brief story about each situation and formulate a plan that could correct the problem.

Collect news stories on bicycle and pedestrian crashes from local papers. Have students analyze the stories and ask what might have prevented the crash. Was the pedestrian/bicyclists wearing clothing that enhanced his/her visibility. Was the bicycle properly equipped?