What is the Future of Traffic Control Devices?

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Our current system of traffic control devices (TCDs) originated in the early part of the 20th century as the amount of automobile traffic increased and it became necessary to control vehicle traffic for both safety and operational reasons. In the early days, there was a great deal of variability in TCDs. Signs were hand painted and took whatever appearance the creator thought appropriate. Pavement markings used whatever color provided contrasts and might be used only in limited locations. There were a wide range of traffic signal designs with various arrangements of lenses, colors, and shapes. The recognition of the need to create a uniform system of TCDs led to the publication of the first MUTCD in 1935. The national system of TCDs achieved uniformity as our surface transportation network matured between the 1930s and 1970s, largely due to the recognition of the MUTCD as the national standard for TCDs. The use of the network also grew during this time, increasing the travel between jurisdictions. In the 1970s and 1980s, there began an increase in the prevalence of tort liability claims involving TCDs and this led to the restructuring of the MUTCD, which was published in 2000. At the present time, the United States has a well-developed TCD infrastructure, which is highly standardized through the MUTCD and which has been relatively stable for over a quarter century. During this last quarter century, there have been numerous advances in traffic control, some of which have found their way into the MUTCD. Among these advances are:

- Brighter sign sheeting.
- Improved sign fabrication practices.
- Light emitting diodes (LEDs) in traffic signals and signs.
- Improvements in traffic signal controller technologies, which increase the signal phasing flexibility.
- Improvements in accessible pedestrian signals.

Also during the last 25 years or so, there have been other types of advancements that impact the MUTCD and TCDs. These include:

- The MUTCD has become a free, on-line document.
- Revisions to the MUTCD has shifted to the federal rulemaking process.
- The technology revolution in computers, communications, and materials have created expanded opportunities for the use and management of TCDs.
- Individual mobility has significantly increased, with much higher travel within and between communities.
- Vehicle technologies and safety features have improved dramatically.
- Tort liability claims related to TCDs have increased.

And during the last 5 years or so, the following trends have also impacted the MUTCD and the use of TCDs:

- A greater emphasis on accessibility and equality for pedestrian and bicycle issues.
- The introduction of new devices with new materials or advanced technologies.
An increase in the regulation of TCDs through more specific language in the MUTCD.

The sometimes politicalization of the TCDs decision-making process, either through legislation or direction by elected officials.

A reduction in public agency staffing levels and the resulting decrease in traffic engineering expertise.

The need to bring into uniformity diverse road operators or those entities which have an effect on travel safety in the U.S. such as: railroads, toll authorities, airports and private property open to public travel.

The increasing demand for various forms of advertising (both in-vehicle, out-of-vehicle) that effectively compete for drivers’ attention.

An enhanced need to “share” roadway, sidewalk and pathway rights-of-way among pedestrian (walkers, joggers, bike, wheelchair) and motorized vehicles (single-person vehicle, mopeds, autos, buses, trucks).

(Not sure if this is statistically true or not) Increase in red-light running, speeding above the posted speed limit and general disregard for traditional TCDs.

Given the recent advances and the expectation of even greater advances in the near future (Moore’s law predicts that the number of transistors that can be placed inexpensively on an integrated circuit doubles approximately every two years), there can be little doubt that the transportation system and traffic control environment will be radically different in 20-30 years from what it is today. It is likely that today’s professionals will tell their grandchildren the statements below and the grandchildren will stare in disbelief.

- We could drive on roads without paying tolls.
- We had to steer the vehicle with an actual steering wheel (it also had pedals for brakes and gas).
- Signs, markings, and signals told us what to do.
- We used paper maps to help us find our way (already a dated concept).

In the future, we may see some of the following trends occur:

- Increases in most modes of travel:
  - Bus,
  - Rail (light, commuter, heavy, high speed),
  - Pedestrians,
  - Bicycles,
  - Personal (skates, skate/long boards, single person vehicles), and
  - Share-a-car applications.
- Improvements in the traditional passenger vehicle:
  - Predictive cruise control,
  - GPS tracking (needed for vehicle-mile based taxes),
  - Vision enhancements (night vision, TCD tracking, vehicle and obstacle identification),
  - Driver and vehicle monitoring:
    - Driver drowsiness, distraction, and impairment,
    - Vehicle’s position with respect to lane lines,
Vehicle’s speed with respect to speed limit, Reduced reliance on fossil fuels, and Fully automated vehicles on selected major facilities.

- Changes in the characteristics of road users:
  - Increase in older drivers (the aging population of the U.S. will bring into increased focus the needs of the elderly and mobility-impaired individuals and their interface with larger and higher-performing road vehicles),
  - Decrease in younger drivers,
  - Increased diversity in driver language,
  - Demand for access to personal transportation despite limitations, and
  - Increase in demand for driver attention.
    - Increase distraction opportunities.

- Improvements to existing TCDs (current form likely to exist for another 15± years):
  - TCDs that communicate with vehicles,
    - Roadside TCDs that send active messages to vehicles,
    - In-vehicle TCDs that supplement the messages of roadside TCDs, and
    - Automated road systems that may eliminate the need for TCDs on those roads.
  - Enhancements to nighttime visibility (luminescent materials and LEDs in signs and markings, for example),
  - TCD operation associated with vehicle position (vehicles sending position and speed information to smart TCDs and/or signals controllers).
  - Active notification of violations,
  - Use of TCDs to dynamically manage pavement space,
  - Active warning of intermittent hazards, and
  - Reduction in use of traditional guide signs due to in-vehicle navigation systems.

- Issues related to the use of TCDs:
  - Shorter time frames for introducing new products and new devices,
  - Recognition of need for TCD expertise in making decisions,
  - Greater communication between agencies responsible for TCDs.
  - The MUTCD will need to be adaptable to changing technologies.

- Changes in the roadway environment:
  - Increase in toll roads; either flat or variable pricing (the increase in toll road relates to the issue of agencies and the public being willing to pay for advanced TCDs).
  - Increase in variable on-street variable parking pricing or downtown congestion pricing schemes (requiring need for new signing or communication w/drivers re: fees).

There are barriers to these and other advances in TCDs and related technologies. Among the barriers are:

- Funding:
  - Will agencies and the public be willing to pay for the improved capabilities of smart TCDs?
  - Maintenance demands of the advanced systems could be greater and require higher funding levels.

- Safety and liability:
Advanced systems will require a higher level of precision and accuracy than that currently used.

Who will be at fault when technology fails?

What is the failsafe mode when there is a power failure or other type of failure?

Accessibility:
- How do pedestrians and bicyclists fit into an advanced TCD system? Will they need tracking capability that is consistent with vehicles?

Institutional momentum:
- “We’ve always done it that way” attitude hinders innovation.

Privacy:
- Drivers may want to protect personal travel information.

Fleet turnover:
- Some of the advanced TCD systems could eliminate the ability of older vehicles to travel on some roads.

Turf protection:
- Agencies and industry has investment in the current system and may want to that investment rather than move to newer systems.

Changing the MUTCD through the rulemaking process is a time-consuming activity and limits the ability of the MUTCD to respond to changing technologies and innovation.
- Because of the slow pace of MUTCD change, the private sector may be on a second or third generation of technology by the time the first generation is adopted in the MUTCD.

Given the information described above, the MUTCD of the future should be a document that is adaptable to changing technologies in TCDs, vehicles, and user characteristics. The strategic planning effort should focus on overarching visions and goals and should not address issues related to specific TCDs.