Ramp Metering

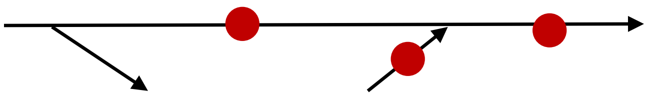
The application of control devices to regulate the number of vehicles entering or leaving the freeway, in order to achieve operational objectives.

Brief History

- 1963: First use – *Chicago; Eisenhower Expressway* – traffic officers would stand on ramp and release vehicles
- 1964 – 1967: Detroit and Los Angeles – (although no permanent meters were installed for a number of years thereafter)
- 1970: Minneapolis area – “fixed time, permanent” (including a bus bypass on some ramps to encourage transit use)
- 1972: Minneapolis area – the first “coordinated” meters were installed on multiple ramps on facilities
- 1980’s and 90’s: advancements towards “traffic responsive, dynamic” meters that would “self-regulate”
- 2000: Minnesota’s public “push-back” against meters
- Circa 2006: CALTRANS District 7 advanced “System Wide Adaptive Ramp Metering (SWARM)” to control whole freeway corridors automatically

Types of Ramp Metering

- Stand-alone (i.e., "time of day") 1960-70
  - *Often manually operated (switch on, switch off) or simple "traffic cop" management*
  - *An isolated, pre-timed location. Not much capability to adjust to traffic demand.*
  - *Problems: no way to clear congested queues; not responsive to upstream demand*
- Local Control 1970-80



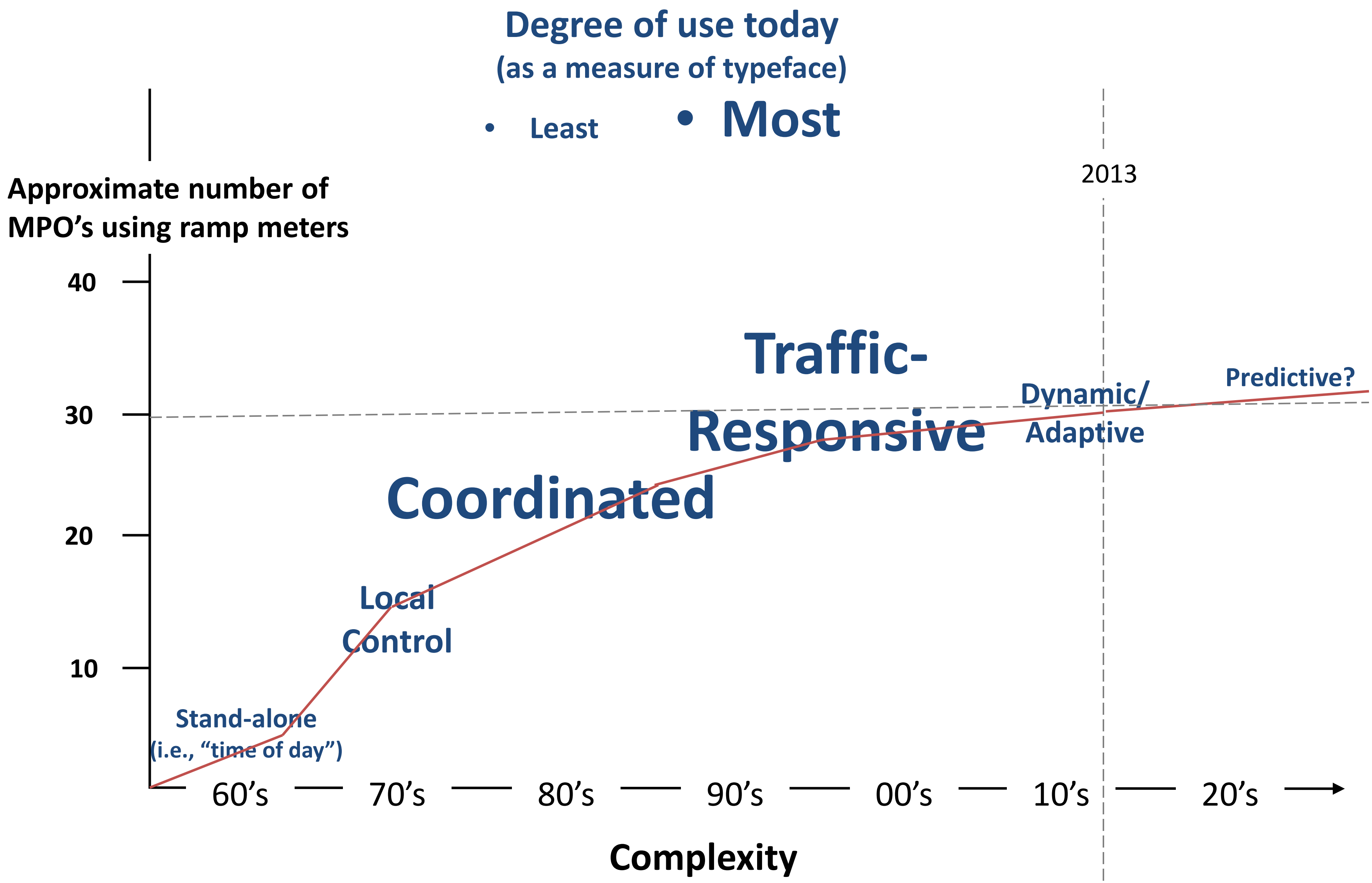
  - *Fixed segments of 'upstream+ramp+downstream' sections of highway using detectors to verify success*
  - *Problems: not responsive to downstream bottlenecks that would back up*
- Coordinated 1980-1990
  - *Improvements on local control; use of TMC's; greater sophistication*
  - *First use of algorithms (beyond just "timing patterns")*
- Responsive (i.e., "adaptive") 2000's
  - *At the most-congested MPO's; can understand multiple and dynamic bottlenecks.*
  - *Uses real-time data in 30-sec or 5-min intervals to readjust the algorithms*
- Predictive Future?
  - *In theory, would use upstream changes in traffic density to predict conditions and "forewarn" the meters how to operate*

Where are R-Meters used today?

Representative (not all-inclusive) as of 2012

- *Most Robust:* *(i.e., have the most installations, largest deployment)*
  - *So. Cal; NY-NJ; Chicago; San Fran; Minn; GA; San Diego; Seattle*
- *Others:* *(i.e., mid-sized cities and/or moderate # of ramps)*
  - *Miami; Phil-NJ; Houston; Phoenix; Portland;*
- *Small metro areas:* *(i.e., smaller regions or small # of ramps)*
  - *Cincinnati; Kansas City; Las Vegas; Columbus, OH; Salt Lake City; Denver*
- *Entire U.S.:*
  - *28 of 101* Metropolitan Regions
    - *12 of 15 "very large" . . generally 3M population or greater*
    - *11 of 32 "large" . . generally 1M to 3M in size*
    - *3 of 33 "medium" sized . . generally 500K to 1M population (Baton Rouge, Allentown, Fresno)*
    - *2 of 21 "small" sized . . generally 150K to 500K population (Madison WI, Provo UT)*

Evolution of Ramp Metering



Push Backs and Challenges

- Ramp meters were removed or deactivated after being installed in Dallas, San Antonio, and Austin, TX
- Other cities (e.g., St. Louis and Phil, et al) have removed some, kept others
- In 2000, MN legislature mandated a “recall’ of use of RM’s, resulting in a $650K study.

Push Backs and *Challenges*

- RM’s do a poor job in inclement weather and during special events
- Queue back-ups force “clears” or overrides that effectively restart the algorithms
- Challenges exist in properly staffing, training, and implementing RM’s
- Public acceptance is still an issue
- Agencies and peers have done a poor job of marketing the benefits and relatively high return on low investment

Results of 2001 study of Ramp Metering Effectiveness

In September 2000, all 430 ramp meters were turned off in the Twin Cities region in response to a mandate from the MN State Legislature, following citizen complaints and questions raised by State Senator Dick Day; namely, do ramp meters work?

Minnesota Ramp Meter Study -- 2001

Objectives

- To fully explore effectiveness of ramp meters; meter "wait time" was also a key concern
- **To respond to citizen's questions** and identify public perception of ramp metering
- To involve a citizens advisory board to ensure credibility of the study

Process and Findings

Cambridge Systematics was hired by MnDOT to perform the **3-month study**, inclusive of getting pre-study data and incorporating any/all citizen input and ensuring a transparent process. Five weeks of "before" speed and crash data, et al, was recorded. The ramps were shut off for a pre-determined "transition" period and then turned back on for five weeks of "after" data gathering.

- Without meters
  - A 9% reduction in freeway volume; a 22 % increase in travel times; a 26% increase in crashes (even after adjusting for prior seasonal rates)
  - **Most survey respondents believed traffic had worsened with meters off**
  - After the study: 20% wanted meters left off; 10% want them "returned"; 70% want modifications

Lessons Learned / Changes Implemented

- **Neither "all" nor "nothing" was deemed best**, but a new, modified approach was adopted:
- Fewer meters than before the study were turned back on (location candidacy was tightened and superfluous meters were removed)
- Hereafter, meters would wait no more than 4 minutes on local ramps or 2 minutes on freeway-to-freeway ramps
- Vehicles queued back to city streets will be "released" (meters temporarily shut off) and meter operation will better-respond to congestion-only times via improved use of detectors

Ramp Metering Benefits

Safety (Red) Congestion Mitigation (Black)

Location	
Portland, OR	43% Reduction in peak period collisions 17% in average travel speed
Minn., MN	24% reduction in peak period collisions 16% in avg. travel speed; 25% increase in peak period volume
Seattle, WA	39% reduction in collision rate 52% increase in avg. travel time; 74% increase in volume
Denver, CO	50% reduction in rear-end and side swipe collisions A 57% increase in average peak period travel speed and a 37% decrease in average travel time.
Detroit, MI	50% reduction in total collisions; 71% reductions in injuries An 8% increase in average travel speed and a 14% increase in traffic volume.
Long Island, NY	15% reduction in collision rate A 9% increase in average travel speed

Source: FHWA *Ramp Management and Control Handbook*, 2006

Recommendations for start-ups

- **Agencies should start small (one or a few ramps)**
  - Conduct pre-analysis to
    - ensure candidate locations and deployment exists
    - gather “before” data to compare to “after”
  - Instill public acceptance
  - Become “ramp meter smart” via training and experience before expanding the system
  - Make sure a strong deployment of detectors exists or will evolve