NEW STRATEGIES AND METHODS FOR SPEED MANAGEMENT IN NORWAY

Stein Johannessen

Department of Civil and Transport Engineering
NTNU - Norwegian University of Science and Technology
N-7491 Trondheim, Norway
Phone: +47 735 94676 (work), +47 918 97151 (mob)
e-mail: stein.johannessen@bygg.ntnu.no

ABSTRACT

The Norwegian Public Roads Administration (NPRA) has implemented important instruments for speed management on the Norwegian state road network:

1. Automatic speed control (ATC) by use of standard wet-film speed cameras, which will now be replaced by new digital cameras.

2. Permanent and mobile roadside speedometers giving feed-back to the individual drivers about their speed.

Speed control with ordinary cameras has been carried out since 1988 in Norway. Use of the new digital cameras raises new questions about technical and political matters, including security for the individual driver, especially related to a possible detection of individual speed over longer road sections.

Use of the other measure, roadside speedometers, which seem to give rather promising results, has also lead to discussions among researchers, practitioners and politicians.

This paper describes the two measures, their application in Norway and the results so far. The first measure, ATC, is described rather detailed, while the experience with the other one, the roadside speedometers, is described in a more summarised way. Important points of view from the Norwegian scene are presented for further discussion at this workshop.
1. INTRODUCTION

The Norwegian Public Roads Administration (NPRA) has implemented two important instruments for speed management on the Norwegian state road network:

- Automatic speed control (ATC) by use of standard wet-film speed cameras, which will now be replaced by new digital cameras.
- Permanent and mobile roadside speedometers giving feed-back to the individual drivers about their speed.

Both measures have lead to discussions among researchers, practitioners and politicians about technical matters, potential for speed reduction, transport policy related questions and even political questions related to the security of the individual driver. Some of the discussion points are based on legal and transport related practice which differs from other countries. This makes it interesting to present these measures and some of the discussion points about them for this international workshop on “Speed management”.

This paper describes the two measures, their application in Norway and the results so far. ATC is described in detail, while the experience with the roadside speedometers is described in a more summarised way. Important points of view from the Norwegian scene are presented for further discussion at this workshop.

2. AUTOMATIC TRAFFIC CONTROL (ATC) WITH SPEED CAMERAS

2.1 Background

Speed cameras have been used to record speeding in Norway since 1988. Today, more than 250 sites with equipment for automatic speed control are established.

Three criteria have to be fulfilled for such application:

- The accident rate (injury accidents per million vehicle-km) must exceed the average level for similar road sections (4 year period)
- The accident density must exceed 0,5 injury accidents per km per year, over the last 4 years
- Speed level: The average speed must exceed the speed limit

The effect of this measure on accidents has been rather convincing. The Norwegian Traffic Safety Handbook (Elvik & al 1997) summarises the overall effect on injury accidents to a significant 17 % reduction on average. Further, cost/benefit analysis based on the Norwegian application of this measure, suggested a benefit/cost ratio around 9.

The knowledge about the effect on speeds was more limited. Speed reductions up to 6 km/h were found, but these results were based on quite uncertain data. And, more worrying, a tendency to “cangaroo driving” (sudden braking in front of the camera, followed by acceleration) and a slight increase in rear-end collisions were found.

An important conclusion from these results and indications, was an obvious lack of real knowledge about the change in driver behaviour following the implementation of ATC; there
was a missing behavioural link between the measure in one end, and the resulting accident reduction in the other end.

### 2.2 TØI investigation

On this basis, TØI was commissioned in 1999 by the Ministry of Transport and Communications and the Police Directorate to carry out a study to evaluate the effect of speed cameras on driving speeds. The project consisted of two parts:

- Before and after analysis on ATC sections based on automatic measurements
- Measuring speed at the ATC speed camera site using a laser pistol

The results of this study are shortly summarized here, based on the TØI report (Ragnøy 2002) and an electronic version of figures and tables kindly made available by the author himself.

The before and after analysis is based on results from the Norwegian Public Roads Administration (NPRA) during one year before and one year after the implementation of ATC equipment (hourly averages). Measurements on reference sections are applied in order to correct for other possible influencing factors.

Three road sections were chosen:

- **E6 Østfold county** (8400 m road section, AADT 10000 veh/day, speed limit 90 km/h, 10 ATC sites)
- **E18 Østfold county** (10800 m road section, AADT 10000 veh/day, speed limits 70 and 80 km/h, 10 ATC sites, see figure 1)
- **E6 Hedmark county** (26000 m road section, AADT 10000 veh/day, speed limit 90 km/h, 4 ATC sites)

On E6 Østfold county, speed measurements of individual vehicles were carried out using a laser pistol, in the vicinity (+/- 200 m) of three ATC sites – at the first site, at the last site, and between the two sites.

---

**Figure 1  Example from E18 Øsfold county (Ragnøy 2002)**

![Figure 1](image1.png)

**Figure 2  ATC section E18 Øsfold county between Fosshellinga vest and Rom.**

Counting points ("tellepunkt") and ATC boxes. Distances between points in meter.
2.3 Results

Table 1 shows the weighted result of the effect of ATC on the three road section, by direction of traffic and speed limit. The net effect (corrected for reference measurements) varies between -6.16 km/h on E6 Hedmark, to -4.18 km/h on E6 Østfold.

Corresponding calculations of the net effect of ATC at each of 20 individual ATC sites where there are reliable speed data, showed reductions in speed at all sites, varying from – 1.38 km/h to -7.10 km/h.

Table 1  ATC effect on speed

<table>
<thead>
<tr>
<th>Speed limit km/h</th>
<th>Traffic direction (towards)</th>
<th>No of points</th>
<th>No of vehicles BEFORE</th>
<th>Hourly av. speed BEFORE km/h</th>
<th>No of vehicles AFTER</th>
<th>Hourly av. speed AFTER km/h</th>
<th>Observed Change km/h</th>
<th>Change reference points km/h</th>
<th>Estimated net effect ATC km/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>E6 90 Hedmark</td>
<td>Sweden</td>
<td>4</td>
<td>1586944</td>
<td>89.72</td>
<td>3070893</td>
<td>80.61</td>
<td>-5.11</td>
<td>-1.28</td>
<td>-3.83</td>
</tr>
<tr>
<td>Østfold</td>
<td>Oslo</td>
<td>4</td>
<td>1544490</td>
<td>89.37</td>
<td>3411744</td>
<td>83.32</td>
<td>-6.05</td>
<td>-1.31</td>
<td>-4.74</td>
</tr>
<tr>
<td>Total (average)</td>
<td></td>
<td>8</td>
<td>3131434</td>
<td>87.52</td>
<td>6482637</td>
<td>82.04</td>
<td>-5.48</td>
<td>-1.30</td>
<td>-4.18</td>
</tr>
<tr>
<td>E18 80 Østfold</td>
<td>Sweden</td>
<td>2</td>
<td>327624</td>
<td>74.24</td>
<td>169530</td>
<td>68.88</td>
<td>-5.36</td>
<td>0.26</td>
<td>-5.62</td>
</tr>
<tr>
<td>Oslo</td>
<td>3</td>
<td>517687</td>
<td>75.58</td>
<td>149234</td>
<td>70.65</td>
<td>-5.71</td>
<td>0.11</td>
<td>-5.82</td>
<td></td>
</tr>
<tr>
<td>Total 80</td>
<td></td>
<td>5</td>
<td>845311</td>
<td>75.06</td>
<td>483764</td>
<td>69.52</td>
<td>-5.54</td>
<td>0.19</td>
<td>-5.72</td>
</tr>
<tr>
<td>70</td>
<td>Sweden</td>
<td>2</td>
<td>386804</td>
<td>65.11</td>
<td>291593</td>
<td>60.65</td>
<td>-4.46</td>
<td>0.26</td>
<td>-4.72</td>
</tr>
<tr>
<td>Oslo</td>
<td>2</td>
<td>384790</td>
<td>66.97</td>
<td>292922</td>
<td>61.72</td>
<td>-5.25</td>
<td>0.11</td>
<td>-5.36</td>
<td></td>
</tr>
<tr>
<td>Total 70</td>
<td></td>
<td>4</td>
<td>771594</td>
<td>66.04</td>
<td>584515</td>
<td>61.19</td>
<td>-4.85</td>
<td>0.19</td>
<td>-5.04</td>
</tr>
<tr>
<td>E6 90 Hedmark</td>
<td>Hamar</td>
<td>2</td>
<td>1524431</td>
<td>89.06</td>
<td>1447722</td>
<td>84.28</td>
<td>-4.78</td>
<td>1.10</td>
<td>-5.88</td>
</tr>
<tr>
<td>Oslo</td>
<td>1</td>
<td>525196</td>
<td>90.18</td>
<td>479849</td>
<td>85.66</td>
<td>-4.52</td>
<td>1.76</td>
<td>-6.28</td>
<td></td>
</tr>
<tr>
<td>Total (average)</td>
<td></td>
<td>3</td>
<td>2049627</td>
<td>89.35</td>
<td>1927571</td>
<td>84.62</td>
<td>-4.73</td>
<td>1.43</td>
<td>-6.16</td>
</tr>
</tbody>
</table>

Table 2  Observed and estimated speed change before and after ATC, by speed limit and traffic direction at three sites

An important question was whether the speed was reduced only at the ATC sites, and not between or after the ATC sites.

Figure 2 on the next page shows that a speed reduction is recorded at a site without ATC between the ATC sites on E18 Østfold. All speed reductions are significant.

Figure 3, describing the speed profile on E6 Hedmark, shows that speed reductions are recorded both between camera sites, and after the camera sites (related to driving direction).

Some of the measurements indicate that the ATC sites also seem to work like a speed camera in the opposite direction of traffic (where no picture can be taken). The result at Skavabakken on Figure 3 is an example of this possible effect.
Figure 2  Speed profile along E18 Østfold (Ragnøy 2002)

Figure 3  Speed profile along E6 Hedmark (Ragnøy 2002)

Figure 9  Speed profile along E18 Østfold. Estimated speed before and after ATC in km/h. Change of speed in km/h (corr. for change in ref. points)

Figure 10  Speed profile along E6 Hedmark. Speed limit 90 km/h. Estimated speed before and after ATC in km/h. Change of speed in km/h (corr. for change in ref. points)
Some other interesting results or points of discussion can be mentioned:

- Figure 2 and Figure 3 show that the speed reductions at the ATC sites are greater than the reductions between and after the camera sites. It can therefore be claimed that speed cameras contribute to increased longitudinal variation in speed on the road sections studied. It can not be concluded, however, that road users compensate for the speed reduction at ATC sites by increasing speeds between and after the ATC sites, which was a worry on beforehand.

- Speed cameras seem to have a lasting effect. At the speed camera at Skavabakken E6 Hedmark, a clear effect of ATC has been demonstrated both a half year (-8,10 km/h) and 1,5 years (- 8,30 km/h) after the speed cameras were installed. This indicates that the effect is relatively stable over time.

- At one site, Skavabakken on E6 Hedmark, the speed distribution based on speed measurements for individual vehicles were studied before and after the installation of ATC equipment. Figure 4 shows the results from comparable periods of 3 days before (September 1999) and after (September 2000), based on 15000 vehicles in both periods. Interesting results are:
  - the average speed is reduced (leftwards shift of the distribution)
  - the reduction of high speeds is very strong (steep right side of the distribution)

**Figure 4 Speed distribution, individual vehicles, before and after ATC (Ragnøy 2002)**

<table>
<thead>
<tr>
<th></th>
<th>Before ATK</th>
<th>After ATK</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Av. speed</td>
<td>91.18</td>
<td>85.42</td>
<td>-5.76</td>
</tr>
<tr>
<td>Stdv km/h</td>
<td>8.39</td>
<td>5.87</td>
<td>-2.51</td>
</tr>
<tr>
<td>% over 90 km</td>
<td>49.3</td>
<td>16.9</td>
<td>65.7</td>
</tr>
<tr>
<td>No of vehicles</td>
<td>15278</td>
<td>14510</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 7 Driving speed before and after ATC in km/h. Distribution in %. Single vehicle speed measurements at Skavabakken, E6 Hedmark**
• Road users adjust their speed in the direct vicinity of the speed camera. Using a laser pistol connected to a laptop PC, measurements have been taken of the speed and position of vehicles in the direct vicinity of speed cameras. Figure 5 shows the results of this type of calculation made for the first speed camera of a series of 5 (based on 4000 “laser shots” at 302 vehicles). Both the actual measurement results and a mathematical “smoothing” of the measured speed profile are shown.

**Figure 5 Speed profile around ATC box on E6 Østfold (Ragnøy 2002)**

![Speed profile around ATC box on E6 Østfold (Ragnøy 2002)](image)

**Figure 12**
Speed profile around ATC box at Ingedal E6 Østfold. Traffic direction from Sweden. Driving speed in km/h vs distance between ATC box and vehicle in meter.
First ATC box of 5. N=302

### 2.4 Increased use of automatic speed control and manual police control in Norway

In connection with a lot of serious “summer accidents” (especially MC accidents) in Norway this summer, the Transport Minister has discussed possible “strong ad-hoc measures” with the police department, ”Trygg Trafikk” (the Norwegian Road Safety Organisation) and the Public Roads Administration. The result of this discussion is a decision about a significant increase in automatic and manual speed control, starting this autumn.

The positive results from the former accident studies, and the recent referred “speed study”, have been important inputs to this decision.
2.5 Digital cameras to replace todays “wet-film” cameras in Norway

On a more longterm basis, the number of ATC sites in Norway will be increased from around 250 today to 350 sites. It is also planned to replace the existing ATC cameras with new digital cameras. This provides some important new opportunities:

- a picture of car and driver offending the speed limit can be transferred immediately to the speed control centre (avoids some damage of ATC sites observed today in order to prevent transfer of picture)
- choice of time and place for automatic speed control can be managed from the speed control centre. Today wet-film has to be installed and collected manually.
- automatic recording of speeds over longer road section between ATC sites is possible

A technological challenge during the development has been to develop cameras which can take sufficiently reliable photos of both the licence plate and the face of the driver. In Norway, only the driver can be prosecuted, and there is no way to give a fine to the owner of the vehicle if he (or she) is not recognised as the driver.

The practice in some other countries are different, and it would be interesting to hear about other experience and practice from participants at this workshop.

The new cameras and the new possibilities have raised important questions of political and technological kind:

- One restriction is that the picture sent from the ATC must be unreadable for possible "hackers" in order to prevent improper use or manipulation of individual, personalised speed data
- Should the rules be changed so that the owner of the vehicle is responsible for providing information about the identity of the driver?
- If section speed is to be recorded, how can one handle pictures of “legal” drivers at the first ATC site? The Norwegian law does not allow use of such pictures when no traffic offence has taken place. Use of infrared flash and camera, creation of artificial “images” of the first picture (used for “de-individualised” recognition and speed calculation at a following ATC site), and limited storage time, might be a possible solution.
- the police has asked for a possible data link from the ATC equipment to a manual roadside police control post. So far this wish has been rejected.

The international and national answers to such discussion points depend on differences in speed control practice, differences in traffic related laws and differences in “traffic culture” from one country to another.

It will be of great interest if the workshop participants would bring forward views and information related to these topics.
3. PERMANENT AND MOBILE ROADSIDE SPEEDOMETERS

3.1 The 1994 experiment

A roadside speedometer, permanent or mobile, measures the speed of individual vehicles before presenting it back on a display readable to the passing drivers.

The first experiments with a mobile speedometer in Norway were carried out on two road sections, E18 (speed limit 80 km/h) and State Road 310 (speed limit 60 km/h) in Vestfold county in 1994, and is described in (Vaa & al 1994). On E18 a warning sign stating “Speed measurement 500 m” was used. Actual speeds were displayed to the drivers up to the speed limit plus 10%. The experiment lasted only a few weeks.

The results from this experiment were:

- The average speed was reduced on both sections (-1.2 km/h to – 6.8 km/h)
- Statistical analyses gave evidence of drivers generally reducing their speed over some distance – i.e. there are some “generalisation in space”
- The warning sign seemed to give some effect in itself
- The duration of the experiment was too short to study any long-term effect
- There was no clear evidence of “generalisation in time”, as the speed reductions seemed to disappear when the speedometer was removed.

3.2 The 2001 evaluation

Since 1994, more than 20 permanent or mobile roadside speedometers are implemented in Norway at sites where the average speed over 1 week exceeded the speed limit. Unsystematic speed measurements had indicated speed reductions at nearly all sites, but a reliable evaluation had not been carried out. This was the background for a project carried out by a student at NTNU (Norwegian University of Science and Technology, Trondheim) during the summer and autumn 2001 in Rogaland county (Budalen Hansen 2001).

A mobile roadside speedometer (Figure 6) was moved around to 4 different sites. The experiment period lasted 2 – 3 months at each site.
The general results from these experiments are shown on Figure 7:

*Figure 7  Average change in speed at the four test sites the 1st week after implementation, the last week before removal, the first week after removal, and the 4th week after removal. Left column is for the drivers viewing the speed sign, right column for the opposite direction. (Budalen Hansen 2001)*
The results to be seen from Figure 7 are:

- The first week the speed was reduced by 3 – 4 km/h. This is equivalent to the effects of a reduction of the speed limit by 10 km/h. A reduction in the opposite direction is also observed (due to curiosity?)
- The long-term effect (2 months later, week before removal) is slightly lower, but still obvious and highly significant
- Even some weeks after the removal, a speed reduction can be seen

3.3 Conclusions and points of discussion

Main results:

- The studies carried out so far show that the roadside speedometers have proved to give significant speed reductions when they are operative, even after 2 – 3 months.
- The speed reduction is of the same order as the effect of a speed limit reduction of 10 km/h.
- This measure is regarded by the drivers as a positive and informative measure from the road authorities (includes a chance to check the car speedometer)

Points to be discussed:

- The main point of discussion is whether to give a message to the driver of a speed exceeding the speed limit – is this a recognition of such speeds? The two main views are
  - show speed only up to the speed limit
  - show speeds up to speed limit plus 10%
- How do the drivers react when they see that the car speedometer shows lower values than the correct speed (usually 5 to 10% lower). Do they increase their general speed level because of this, and does this imply a traffic safety risk? Or, does this prevent drivers from driving 5 – 10 km/h below the speed limit, which make other drivers carry out more dangerous overtaking?

Views and documented experience from the workshop participants are welcome!
# REFERENCES

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Title</th>
<th>Location and Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budalen Hansen A B (2001)</td>
<td>Roadside speedometer in Rogaland. Effect on speed</td>
<td>&quot;Norwegian text&quot;</td>
</tr>
<tr>
<td></td>
<td>Fartsmålingstavle i Rogaland. Innvirkning på fart.</td>
<td>Prosjektoppgace, NTNU, Dept. og transport Eng., Trondheim, November 2001</td>
</tr>
</tbody>
</table>