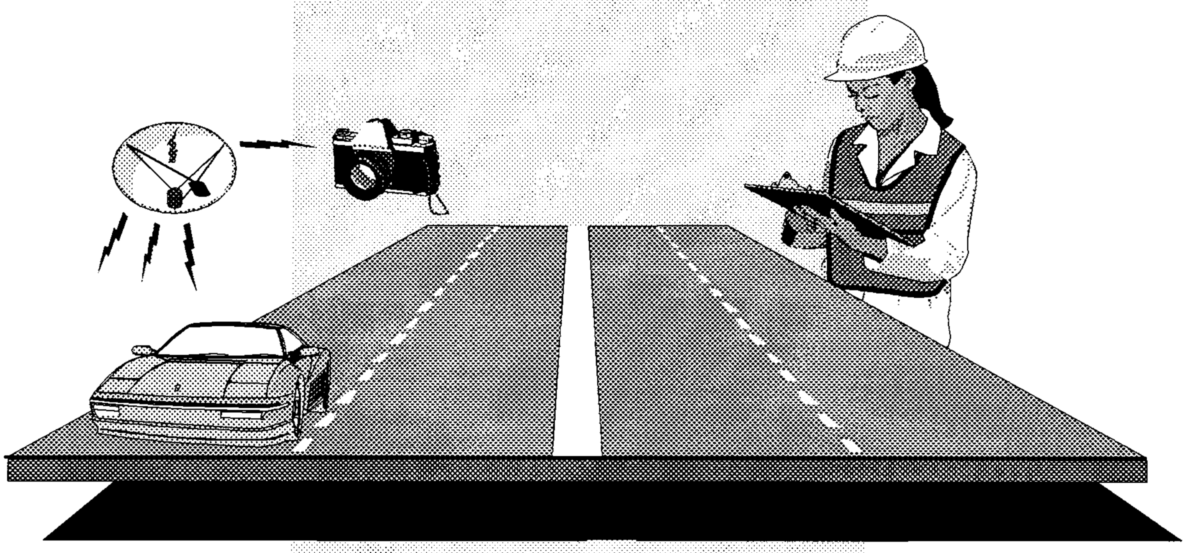
FINAL REPORT

CAPITAL BELTWAY PHOTO-RADAR DEMONSTRATION PROJECT: SITE VISIT REPORT



CHERYL W. LYNN
Senior Research Scientist

VIRGINIA TRANSPORTATION RESEARCH COUNCIL

FINAL REPORT

CAPITAL BELTWAY PHOTO-RADAR DEMONSTRATION PROJECT: SITE VISIT REPORT

Cheryl W. Lynn
Senior Research Scientist

(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

Virginia Transportation Research Council
(A Cooperative Organization Sponsored Jointly by the
Virginia Department of Transportation and
the University of Virginia)

Charlottesville, Virginia
August 1992

TABLE OF CONTENTS

CAPITAL BELTWAY PHOTO-RADAR DEMONSTRATION PROJECT: SITE VISIT REPORT

Cheryl W. Lynn
Senior Research Scientist

INTRODUCTION

Speeding on the Capital Beltway (Interstate 495 around Washington, D.C.) has long posed a traffic safety and incident management problem for local officials. As the Beltway expanded from 4 lanes to as many as 8 lanes, shoulder and median areas providing places for police officers to "pull over" speeding drivers were drastically reduced. As traffic volume on the facility increased, the ability of officers to safely stop single vehicles for speeding decreased. By 1989, both the Virginia Department of State Police and its Maryland counterpart abandoned traditional speed enforcement on the Beltway and began looking for innovative ways to enforce the speed laws.

Photo-radar, in use in Europe for over 30 years, was an obvious technology for study. Photo-radar equipment combines a camera and radar with electronic controls to detect and photograph speeding vehicles. The license number of the speeding vehicle is extracted from the picture and a citation sent to the owner. If the driver in the picture is not the owner, or if the case goes to court for any reason, the picture can be used to identify the driver.

In October 1989, the Virginia Department of State Police was awarded a grant by the National Highway Traffic Safety Administration to study the possible use of photo-radar on the Capital Beltway. The Virginia Transportation Research Council was enlisted to conduct the evaluation with the help of both the Maryland and Virginia State Police. This site visit report summarizes one part of this effort.

There were two locations in the United States where photo-radar was used for speed enforcement -- Pasadena, California and Paradise Valley, Arizona. These programs had been ongoing for several years. Site visits to these two cities were made between February 26 and March 5, 1990. Since photo-radar has long been used in Europe, four European manufacturers of photo-radar were visited -- Gatsometer in Overveen, The Netherlands, Multanova in Uster, Switzerland, Traffipax in Benrath, Germany, and Trafikanalys in Gävle, Sweden.

The trip reports for the European and American site visits are different in nature. In the United States, interviews concentrated on the users' experiences and their methods of deploying photo-radar, although the manufacturers' representatives were present. The interviews sought to discover how photo-radar applications in Pasadena and Paradise Valley could be applied to other American cities, and what had been learned about photo-radar program development, court liaison, and constitutionality. In Europe, however, representatives of police agencies generally declined to be interviewed. The European site visits centered on methods of manufacturing, testing, and quality control, and demonstrations of the equipment's capabilities.

Specifically, in the European site visits the Study Team could:

1. Discuss the equipment with the manufacturers. The manufacturers who initially developed and now produce the devices know the most about photo-radar equipment. Many manufacturers, especially those located overseas, contract with agents to market their products in the United States. Often these agents are experts in sales and distribution, who have little technical training. Manufacturers' agents lacking in technical expertise often provided the Study Team with inaccurate information. By dealing with the manufacturers directly, the Study Team could ascertain the real capabilities and idiosyncrasies of the equipment, and ensure that the manufacturers knew the testing criteria for the Virginia/Maryland demonstrations.

2. Observe the photo-radar equipment in use at locations where the manufacturers felt it had been successful. The Study Team believed the manufacturers to be uniquely qualified to judge the "successful" use of their products. Also, the team was often able to discuss the equipment with the technicians and police officers who worked at the photo-radar sites.

3. Evaluate the equipment's design and the manufacturers' claims about photo-radar use on high-density urban expressways. Most locations in the U.S. where photo-radar has been used successfully are city streets and residential areas. During the interviews, the team members noted problems, such as "screening," that affect use on high-volume, high-speed expressways like the Beltway. (Screening occurs when one vehicle blocks the radar signal or the camera's view of another vehicle.) The U.S. demonstration phase of the project was designed to test for these problems.

The manufacturers provided the study team with detailed information on their equipment, and demonstrated the photo-radar units and their accompanying peripherals (computer interfaces, software, photograph enhancement capabilities, speed display signs to inform drivers of their speeds, slave cameras for front and rear plate photography, and nighttime operation enhancements).

SITE VISITS IN THE UNITED STATES

Pasadena, California

Pasadena is a city of approximately 130,000 just northeast of Los Angeles, California. The impetus for the Pasadena photo-radar program came from the community, when residents in several neighborhoods asked the Department of Public Works to install speed bumps. Pasadena was plagued by high-speed commuter traffic using the city streets as a corridor to other cities.

Results of Interviews with Police Officials

The Pasadena Public Works Department either had to install speed bumps, which they opposed, or suggest another countermeasure. One of their traffic engineers, Chuck Eckerston, had heard about the Texas photo-radar project using Orbis equipment (the precursor to Traffic Monitoring Technologies, or TMT). After extensive deliberations, David Barnhart, the Engineering and Planning Manager, and Police Chief James M. Robenson approached the Pasadena Board of Directors in August of 1987 to ask the City to enter into an agreement with TMT for a 30-day trial of the equipment. TMT demonstrated the equipment on September 25th, receiving considerable media attention. The Board agreed to a test period beginning November 10th, 1987 and ending December 18, 1987, during which time warning letters were sent to violators along with a questionnaire. The City paid TMT $27,500 for providing the radar equipment, vehicle, training, photo processing, warning letter generation, stationery, postage, mailing services, and employee travel during the 30-day trial period. The results of the trial were as follows:

Vehicles monitored	21,719
Violations recorded	3,317
Notices mailed to city residents	362 (25.5%)
Notices mailed to non-residents	1,058 (74.5%)

Almost 75% of the warning letters were issued to non-residents, confirming the assumption that commuter traffic accounted for much of the speeding problem in Pasadena. Of the 1,400 questionnaires mailed out with the warning letters, about 400 were returned, with 53% in favor of the use of photo-radar. The violators' sentiments about the potential program were remarkably similar to the general public's.

During the trial period, the public had several opportunities to observe the use of the equipment. Data suggested reductions in speed after only a month of operation. After the trial period, an agreement with Traffic Monitoring Technologies was negotiated. Full scale operations began in June of 1988. The City targeted 53 sites where travel speeds were hazardous. In agreement with the Chamber of Commerce, no sites were in commercial areas.

In Pasadena, photo-radar has been used to scan up to three lanes of traffic, but the third lane yields few usable photos, in the opinion of the police. At a 22 degree angle, the third lane is 55 feet from the camera housed in the back of the police vehicle. If the vehicle has no front license plate, the officer manning the equipment takes a Polaroid picture of the back of the offending vehicle as it passes. The equipment is not used in the rain or other inclement weather, but is used until 8:00 p.m, adding a red filter to the strobe. The Pasadena equipment operates in the KA band, 34.6 gHz. TMT is responsible for the FCC permits. The Pasadena police believe that only two brands of radar detectors can detect the photo-radar in operation, and only after drivers are too close to take evasive action. (In Paradise Valley, Arizona, police found three brands that can detect the photo-radar, but only the "Gull" gave the driver sufficient warning). Once a session is completed and the equipment returned, or as soon as all 80 exposures in the cartridge have been used, a TMT representative unloads the film and has it processed. A police representative stands by to maintain custody of the evidence. After the technician screens the negatives and collects pertinent data, the negatives are sent to TMT in Houston where the pictures are printed and screened again. Meanwhile, DMV driver files are searched for the name and address of the owner, who is then sent a citation.

Once the citation is sent, the owner can pay the fine by mail. Alternatively, the owner can come view the photograph in the Prosecutor's Office. No one may see the photograph but the individual cited. If the gender of the driver does not match the gender of the owner, the case against the owner is dismissed and the owner is asked to identify the driver by signing a release of liability form. If the gender is the same but there is reasonable doubt that the owner was the driver, or if the owner has sold the vehicle but it has not been retitled, the case is also dismissed. If the citation is sent to a business, the fleet manager is asked to identify the driver. If the citation is sent to a rental car company, the company researches its rental agreements to identify the driver. If the driver wishes to contest the case, TMT produces an 8" by 10" version of the photo, and the police sergeant in charge of the program prepares the court packet, including the 3" by 5" and the 8" by 10" pictures, the summons, the DMV readout, speed survey information from the Traffic and Transportation Engineer, the declaration of the custodian of records, the photo-radar calibration materials, and the photo-radar site information.

Adjudicated cases are rare. In these cases, the officer manning the equipment testifies in court that the equipment was calibrated and set up properly. The equipment is self-calibrating, but the police also check the calibration at the beginning and end of each session by running a patrol car through the site and comparing the speedometer and the photo-radar equipment. The officer also testifies that the equipment was not tampered with or vandalized. In a typical month, the disposition of cases was as follows:

Cases Dismissed by the Court	7.4%
Cases Opting for Traffic School	31.6%
Cases Paid	44.5%
Cases Outstanding After a Month	16.5%
Total	100.0%

The City's agreement with TMT provides that the Company is responsible for providing and maintaining the equipment and the vehicle housing the device, training the police officers, screening and processing the photographs, researching DMV records, preparing citations, and providing special photographic evidence and expert testimony for trials. The City allows the TMT staff access to DMV terminals and mails the citations with a City postmark. In return for these contractual services, TMT receives $20 per paid citation or the amount of the fine that reverted back to the city, whichever is less.

During the first year of operation, the fine schedule was as follows:

Speeding Over The Safe Speed[a]	City Share	TMT Share
1 to 5 mph	$0.00	$9.10
6 to 10 mph	$0.00	$9.10
11 to 15 mph	$0.00	$18.20
16 to 20 mph	$7.30	$20.00
21 to 25 mph	$25.50	$20.00
26 to 30 mph	$34.60	$20.00
31 to 35 mph	$52.80	$20.00
36 and over	$71.00	$20.00

a. California has a prima facie speed system, where the officer decides on the safe speed for the roadway at the time of the offense, based on speed surveys and prevailing conditions. This safe limit is enforced, not the posted limit. The difference between the posted limit and the safe speed is generally no more than 5 mph in Pasadena. The maximum posted speed in the city is 50 mph. It should be noted that the use of radar on state roads in California is expressly forbidden. Hand-held radar, if purchased by municipalities, may be used on city streets only).

The City received $8.90 for each person attending driving school, all of which went to TMT. During the first seven months of operation the City collected $39,431.50, based on 64 hours of photo-radar use per month, and paid TMT a guaranteed $10,000 per month for the fourth through the seventh months, or $40,000. In April of 1989, the city increased the intended hours of use to 160 in an attempt to "break even." In addition, TMT agreed to hold the next two years' minimums in trust and to cancel the City's liability if another agency began using the equipment during that time (for instance, if Peoria, Arizona began using the equipment before April 1991, the City would be reimbursed $240,000).

When interviewed, the finance department revealed that the program had yet to break even, excluding hidden costs such as increased police time and increased expenses in the Prosecutor's Office and the courts. The police attributed this to increased numbers of persons going to traffic school, for which the city received less reimbursement. However, since the monetary difference between these two outcomes was often only $.20, and in almost all cases was less than $10.00, this should not have created such a problem. A new, higher fine schedule is now in place in California, but the local judges and commissioners have not been adhering to it. Finally, since the threshold for citing violators remains 11 mph over the prima facie safe speed, the number of citations issued has fallen dramatically as the program did exactly what it was intended to do — reduce travel speeds. The city has also added 16 additional motor patrolmen, a sergeant, and a lieutenant to staff the program.

Of the first 18,000 citations issued, only 284 actually went to court, far fewer than originally predicted. One case caused the City considerable problems early in the program when it was pointed out that the photo-radar vehicle did not conform to California standards for police vehicles. The case was dismissed and the City was forced to refund all fines collected up to that point, representing around 3,000 violations. While no appeals have been heard by higher courts, appeal motions have included due process and timeliness issues.

About 16% of all persons issued photo-radar citations ignored them. Cases were not prosecuted when individuals ignored their citations, and several interviewees thought that this threatened the program. No city ordinance specifically dealing with photo-radar existed. Existing ordinances were meant to apply to ordinary traffic stops, where a warrant could be issued immediately if the violator ignored the citation because the violator had to sign the citation. When a driver ignored a photo-radar citation, the investigation required sending for a fax of the driver's license picture to compare to the photo-radar photograph, and a warrant could be issued only if there was a match. This costly procedure required a license search (often unsuccessful, since it was a name search only), the reproduction of the license photo, and time for the police to make the investigation. A letter threatening to investigate the case was sent, but in reality the case would be held in limbo, awaiting an investigation the program could not afford. If this became common knowledge, the percentage of "scofflaws" could increase, and possibly create a "fairness" issue in the courts. One such case was developing in Pasadena while the Study Team was there, in which a television reporter had been cited by photo-radar and subsequently learned that scofflaws were not necessarily prosecuted.

Interviews with Other Town Officials

Commissioner Warren Haas

Commissioner Haas, like all California Commissioners, was essentially a temporary judge. Commissioner Haas felt that all of the legal issues of photo-radar except for the "fairness" issue had been answered in court proceedings. However, none of these cases had been appealed. The due process argument ("How can I remember what I was doing that long ago?") was addressed by requiring that the defendant be notified of the offense within 30 days and that the citation be sent within two weeks of the offense. Also, road signs announcing that the driver has just travelled through a photo-radar site, and a visible strobe, made drivers aware that they were "apprehended." The right to confront the accuser was protected by having the officer manning the equipment testify. Commissioner Haas did not feel that privacy was an issue in these cases, since anyone can stand on a street corner and take a picture of the occupants of a car. Also, photo-radar photographs were available only to the individual receiving the citation, thus ensuring confidentiality. The Commissioner felt that having 16% of the apprehended drivers ignore the citation was the gravest threat to the program, and could bring it to a halt.

The Commissioner also clarified the relationship between TMT and the Police Department. Since the police yield virtually all discretion in prosecution to TMT, several Study Team members felt that the public might think there was something wrong with turning law enforcement over to a private commercial firm. This apparently was not much of an issue in California. State law limits the number of staff persons per judge, so many courts were already using private vendors for clerical services, such as generating summonses. There was precedent in California for the type of relationship existing between TMT, the police, and the courts.

Commissioner Haas recommended screening the photographs better, to help the citations stand up in court. The Prosecutor's Office declined to prosecute 5 to 10% of the cases received, and had a 70 to 80% conviction rate. Interestingly, the staff of the Department of Finance made the opposite recommendation. They felt that for the program to maximize its income, a citation should be sent to every owner whose vehicle can be identified, whether or not the photo established the identity of the driver. Since many people pay fines without viewing the photograph, this could increase revenues.

Courtland Crabtree

Mr. Crabtree was a police sergeant for many years prior to taking his law degree and transferring to the Prosecutor's Office. He also served for a year as a traffic court judge, so he had an unusually broad perspective on law enforcement.

Originally the Prosecutor's Office felt that the use of photo-radar equipment would increase its workload significantly. Once it was found that few cases were actually adjudicated, the Prosecutor's Office simply absorbed the increased burden of photo-radar cases. However, since prosecutions have increased 25% each year, Mr. Crabtree felt he needed additional staff (1.5 FTE's) to fulfill court responsibilities. If his office was called on to assist in the investigation of scofflaws more help would be needed, especially if more defendants pursued their right to have the case tried at the county seat. California law permits defendants to have their cases heard at the courts closest to their places of employment or residence. In these cases, Mr. Crabtree has to go to Los Angeles.

Mr. Crabtree noted that accident statistics had not changed, possibly because there really was no speed-related accident problem in the city. However, the program increased the City's ability to respond to individual complaints. When the Police Department, Public Works or Prosecutor's Office received a citizen complaint, a photo-radar operation could be set up at that location, resulting either in many citations and slower traffic, or at least a public perception that the City was doing something about the speeding problem. Mr. Crabtree agreed with Commissioner Haas about the threat of ignored citations. He too felt that privacy was not an issue. Mr. Crabtree cited a case deciding that an officer has a right to shine a flashlight into a car at night.

Mr. Crabtree felt that unmanned photo-radar equipment or equipment operated by civilian employees would become possible at some later date. Even though the machine was calibrated every 30 days, and checked at the beginning and end of each session, courts would not yet assume that the machine operated properly between checks, making the presence of an officer during the commission of the offense a necessity.

When the program began, Mr. Crabtree handled all the photo-radar cases himself, talking personally to violators about the program and ensuring that officers met a number of criteria in pursuing each case. As a result, the office had a 90% conviction rate. After he delegated responsibility to his assistants, who did not follow this practice, the conviction rate declined to between 70% and 80%. Mr. Crabtree would prefer a system similar to Arizona's, where some speeding offenses are civil cases with a lesser burden of proof. In Arizona, speeding less than 20 mph over the limit is a civil violation, while speeding 20 mph or more over the limit is a criminal offense.

Norman Carter, Deputy Director of Finance, Jack McCool and John Ostrowski

Mr. Carter said that the TMT agreement created a strong incentive for TMT to keep the equipment in working order and to "make" as many cases as possible, much to the City's benefit. However, the $10,000 per month guarantee was something of a disincentive. He felt that the equipment was not on the street long enough to generate the necessary $10,000 each month. He also felt that meeting a minimum number of cases to break even could be interpreted by the public as a quota. It was Mr. Carter's understanding that TMT would give the City a rebate if another locality began using the equipment, but he thought it was based on a percentage distribution per citation issued in the other locality. He said that the traffic school option "subverts the revenue stream," making it more difficult to break even. There were hundreds of traffic schools in the Pasadena area, some including incentives in their curriculum. One school taught the Defensive Driving program on a round-trip bus ride to Las Vegas. Another was billed as a "comedy school" and taught DDC accompanied by stand-up comedy. Since the incentive to take DDC was strong and since the City was reimbursed less, the traffic schools pulled potential photo-radar funds out of City coffers. The photo-radar program was not self-supporting in its relationship with TMT, and did not pay the prosecutor's costs for preparing cases, the cost of automating the prosecution files for use in photo-radar cases ($50,000), or other hidden costs, such as additional police work-hours and police court costs. Mr. Carter also said that the traffic school option was becoming increasingly popular because insurance companies have begun tapping into driver history files and sometimes doubling rates as a result of speeding violations. Mr. Ostrowski attributed $75,000 in lost revenue to traffic schools.

Paradise Valley, Arizona

Paradise Valley, Arizona is a 16-square-mile suburb of Phoenix, with a population of approximately 14,000. Because of its location, Paradise Valley receives approximately 1.5 million visitors per year. The Town Manager felt that despite being a conservative community resistant to "governmental interference," Paradise Valley was largely in favor of photo-radar. The basic motivation for the photo-radar program was similar to Pasadena's. Crosstown commuters were exceeding the speed limit on city streets. Some city streets, especially those connecting Phoenix and Scottsdale, had an average daily traffic of 100,000 vehicles.

Results of Interviews with Police Officials

In 1987, Paradise Valley police noticed that speed-related injuries were increasing. The residents began to complain about the town's speeding problem. With a relatively small police force (30 officers and 10 civilians), Paradise Valley could not devote extra patrolmen to speed enforcement. After considering several alternatives, police officials attended a demonstration of TMT equipment set up by the Arizona Department of Transportation. Impressed, the police approached the Town Council with the idea.

The Council facilitated prosecution of photo-radar cases by passing an ordinance creating a rebuttable presumption that the driver of a vehicle photographed by photo-radar equipment is in fact the owner. The Town already had a history of citing some speed violators by mail. For instance, if a doctor claimed at the time of apprehension that he was speeding because of a medical emergency, the officer would take down the specifics and then check to see if an emergency in fact existed. If not, the doctor would be cited by mail.

According to the police, photo-radar has generated 19 times more citations than mobile patrols would. Total speeding citations have doubled since program inception.

Paradise Valley's photo-radar operation is similar to Pasadena's. The police set up the unit, filling out the same information sheet used in Pasadena, indicating the time and physical aspects of the location and equipment, the weather conditions, the speed threshold, etc. The equipment is used by day and at night until about 8:00 p.m. with a special infrared lens. A calibration check is conducted by driving a patrol car past the site and comparing the speedometer to the photo-radar. At the request of the Department, the equipment can also be calibrated with a tuning fork, the way ordinary radar devices are. Signs are posted to inform drivers that they have passed through a photo-radar site. Warning signs are also posted at the town limits. Since only a rear license plate is required in Arizona, both a front and rear photo are taken, one to identify the vehicle and one to identify the driver. The camera photographing the rear is triggered by the strobe flash of the camera photographing the front. A digital sign displaying the violator's speed (the Lozier Speed Display) is mounted downstream from the site. Once the photo-radar sessions are ended for the day, the TMT representative removes exposed film and has the negatives processed. TMT personnel in Houston screen the photographs and decide which provide identifying information on the vehicle and owner. The pictures are returned to Paradise Valley within two days. About 75% of the photographs are of sufficient quality to identify both the license plate and the driver (glare tends to be a problem). A town employee then searches DMV records for information on the vehicle's owner.

Initially, since DMV files are public records, DMV had agreed to give TMT a tape copy of the file. However, this raised a privacy issue since criminal files are stored in the same database and can be accessed from the same terminals. This was resolved by having TMT reimburse a town employee for accessing files during the lunch hour. A citation is issued by TMT and mailed from Paradise Valley within two weeks of the offense. The owner can pay the fine or contest the case. While 75% of the drivers charged with photo-radar violations in Pasadena are non-residents, 98% or more charged in Paradise Valley live elsewhere. About 60% of all persons cited do not request to see the photograph.

In cases where defendants go to trial, TMT prepares an 8" by 10" photograph for use by the prosecution. This photograph may only be viewed by the person cited for the offense. If the owner was not the driver, the owner is asked to fill out a release of liability form identifying the driver. In some cases the owner will not (or cannot) do so. In these cases, the court could hold the owner in contempt, but this has been avoided for the sake of public relations. Also, in cases of joint ownership only the first owner's name appears in the DMV file. The joint owner could be the driver and not be cited. As in Pasadena, most businesses and rental car agencies will identify the driver. Once an individual has been identified, the reissuance of the citation in that person's name must still take place within 30 days of the offense to satisfy due process requirements. The officers in Paradise Valley testify in court like the Pasadena officers. Although TMT representatives gave expert testimony during early cases, the judiciary now treats uniformed officers as photo-radar experts.

Ignored citations were not considered a serious threat to the program in Paradise Valley. If the violator does not appear in court or pay by mail, a summons is issued. If the summons is ignored, a warrant is issued. If the warrant and the summons are ignored, the driver's license is suspended indefinitely. The percentage of photo-radar tickets ignored is about 10%, the same as for regular patrols. Those who ignore the repeated warnings are not actually sanctioned when the prosecution does not know the license number. It takes approximately 12 minutes per search for a license number and many searches are unsuccessful, so this is not considered a viable option. In cases where the license number is known, the citation is appended to the driving record, and when the violator tries to take any licensing action, such as renewal, he is cited and has to respond in order to clear his license status.

As in Pasadena, the chain of custody and police discretion issues were not considered to be problems in Paradise Valley, despite some concerns at the beginning of the program. The policy for mobile patrol officers in Paradise Valley allows officer discretion if the individual is traveling 11 or fewer mph over the limit, even though the Department prefers that persons going that fast be cited. Citations must be issued for speeds 16 mph over the limit. The photo-radar equipment is, by policy, set at 11 mph over the posted limit, except in school zones (3 mph over) and residential districts (8 mph over). The police felt that photo-radar resulted in more uniform speed enforcement. There was some concern at first over the loss of officer discretion in screening photographs, but after several years of operation the police are satisfied with the TMT screening process. The negatives sent to TMT for printing are returned within two days, and the software prepares a list of names of those apprehended and cited, which the officer signs as an affidavit. The Town Attorney is satisfied with the screening of photos by TMT.

The contractual relationship between Paradise Valley and TMT is similar to Pasadena's. The agreement includes several interesting stipulations. TMT is obliged to replace equipment within seven days if it cannot be repaired in a timely fashion. TMT is also responsible for insuring and repairing the vehicle housing the equipment (the vehicle has been in the shop five days in the last two years, and the equipment has been down a total of two to three weeks in the same period). A probationary period of 180 days was written into the agreement, during which time the agreement could be cancelled on 30 days notice. TMT may cancel anytime, with 30 days written notice, if the Town does not operate the equipment 30 hours per week.

Paradise Valley agreed to pay TMT $20.00 per citation going to final disposition within 15 days of disposition. No minimum monthly payment was written into the Paradise Valley agreement. There was no incentive to have other localities begin using photo-radar. Also, TMT was expressly required to produce a set number of reports for use in Paradise Valley.

Unlike the Pasadena program, which was losing money, the photo-radar program in Paradise Valley was actually making money for the community. The fine schedule was the major difference between the two programs. Pasadena received either $9.10 or $18.20 for most citations, which was paid to TMT. Paradise Valley received considerably more. In particular, if the defendant attended a Defensive Driving Course, the Town's share was greater than if the fine had been paid. The breakdown of fines and fees follows:

	$60.00 Speeding Ticket	$75.00 DDC Fee
To the State	22.00	15.00
To TMT	20.00	20.00
To the School	—	15.00
To Paradise Valley	18.00	25.00

Photo-radar generated about $325,000.00 for the town, from which they added two full-time court clerks, one court day (court reporter costs), and one photo-radar Hearings Officer for the civil cases. The City also used the money to pay the overtime for the police officers manning the equipment. Given all this, the program still netted $25,000 for the Town last year, a profit (according to the police) of $0.58 per citation.

The program improved as the police became increasingly efficient at photo-radar use. When the first nine months of 1988 were compared to the first nine months of 1989, the officers had deployed the radar for fewer hours, apprehended more violators and made more of their photographs readable. The number of violations per 1000 vehicles went up, indicating improved targeting of photo-radar sites. Of the 17,773 citations sent in 1988 and 1989:

- About 32% pleaded guilty and paid their fines.
- Under 1% went to trial, with 82% of those being found guilty.
- About 40% attended DDC.
- Slightly more than 23% were dismissed by the court, mostly in cases where the owner was not the driver or where the pictures were not good enough for identification.
- Just under 10% ignored their citations, and thus required additional attention from the Court (compared to 16% in Pasadena).

According to Chief Lozier, speeds on most roads have been reduced by about 8 mph. Because speed enforcement is largely done through overtime photo-radar hours, DUI enforcement has been doubled. Photo-radar has reduced the need for high speed chases, improving traffic safety in general. A plan was developed for scheduling court dates and cases to avoid the havoc generated by so many additional defendants.

Program materials generally claim a 40% reduction in accidents as a result of the use of photo-radar. This claim is slightly misleading. Although the numbers are necessarily small, the total number of accidents decreased from 460 in 1986 to 278 in 1989, a 39.6% decrease. However, the program was instituted because injury accidents were on the rise. Injury accidents decreased in 1987 and 1988, but increased in 1989. The percentage of total accidents involving injury increased from 24.8% in 1986 to 34.9% in 1988, and to 39.9% in 1989. Thus, total accidents were reduced while injury accidents increased. Also, the reduction in total accidents was not necessarily caused by the photo-radar program.

Community and judicial support was cited by Paradise Valley police and government officials as the most necessary factor for the successful start-up of a photo-radar program. In an Insurance Institute study, 58% of the residents polled approved of photo-radar and 75% supported additional use of the equipment. Police officials in Paradise Valley thought that the original prosecutor in Pasadena had not supported the program, causing the rough start-up period in California. Media support during the start-up period kept the public from feeling that speed traps were being set up without their knowledge. The police also felt that programs started for reasons other than traffic safety would not be likely to succeed. The officers mentioned three common complaints about the program: (1) that it represents too much government interference (a common complaint about most government programs in conservative Arizona), (2) that it does not allow defendants to confront their accuser, since the accuser is a machine, and (3) that it is more a money-making scheme than a traffic safety program. While these arguments have largely been laid to rest in Paradise Valley, they are likely to be re-argued with regard to photo-radar in Maryland and Virginia.

Interviews with Other Town Officials

Charles Ollinger

Mr. Ollinger, the Town Attorney, discussed prosecuting photo-radar cases. About a dozen cases have been appealed. In all cases, the owner and driver were the same person. There were no appeals where the owner of the vehicle identified someone else as the driver. Very few of these "secondary defendants" have even taken their cases to trial. Because obtaining a secondary identification takes time, a number of those cases have been dismissed on account of the delay. While Mr. Ollinger has been tempted to take court action against persons who know but refuse to identify the driver, he has not done so, and has made every attempt to protect the program from frivolous appeals. According to Mr. Ollinger, about 25% of the dismissals (or about 1/12th of all cases) result from the owner not knowing who the driver is.

Several of the appeals argued the "reasonable and prudent" prima facie speed limit of the civil speeding offense (less than 20 mph over the limit). These cases were largely argued unsuccessfully. The due process argument has been used, where the defendants cannot remember what they were doing on the date they were apprehended by photo-radar. However, one explanation why these persons cannot remember why they were speeding may be that they habitually drive faster than the posted limit. There is latitude in the trial for mitigating circumstances, but the driver has to be able to remember them, and the police do check the reasons out. Several cases have attacked the chain of custody, but with TMT expert testimony, such challenges have been fended off. The enhancement of night photographs by making prints using a special contrast filter has not been challenged, since the enhancement is not needed to identify the license number and is only produced for the benefit of the court. There have been several challenges to the technology, but Mr. Ollinger has argued that since the use of each of the components has been accepted by the courts for speed enforcement (computers, radar, cameras, etc.), the device should be accepted. Again, the expert testimony of TMT and the officer manning the equipment have helped in these cases. The right to privacy has not been an issue, although Mr. Ollinger thought that a privacy argument ended the Orbis program in Arlington, Texas. The pictures are available only to the individual cited and are kept by the court about 6 months, except in cases that are likely to be appealed, or when the individual has ignored the citation. TMT keeps the negatives indefinitely.

Mr. Ollinger also felt that the program was instituted for rational reasons and did not violate equal protection requirements. He did not think the use of photo-radar shifted the burden of proof from the state to the defendant, since the state still had to prove all of the usual elements establishing the defendant's guilt. Photo-radar simply made such proof easier. Also, given the argument that the defendant has to prove that "the picture isn't of me," Mr. Ollinger noted that the state was providing the very information (the picture) that could definitively prove the defendant not guilty.

Mr. Ollinger did cite a "fairness" issue in Paradise Valley regarding the non-prosecution of scofflaws. Mr. Ollinger felt that the scofflaw has always put the burden on the good citizen, regardless of the type of law involved. Mr. Ollinger also felt that most citizens will pay their fines regardless of a well publicized "way out."

One photo-radar case in Arizona was appealed from the Hearings Officer directly to the State Supreme Court. In Arizona, there is no such thing as a trial de novo. All appeals must be founded on an error in law in the original trial. The court decided in this case that the petitioner had no standing to challenge the city ordinance, since the defendant was charged under the Arizona speed laws and the city ordinance simply allowed the initial assumption that the owner is the driver. The Court denied jurisdiction. One of the judges, according to Mr. Ollinger, was violently anti-radar and wrote a dissenting comment. This case was nominally backed by the ACLU, because Manual Fuestes contacted them and had them lend their name to the appeal.

Manual Fuestes (TMT) and Lt. J. G. Gragg (Peoria, Arizona Police Department)

The final interviews collected information about new equipment, which was demonstrated. In discussing the relationship between TMT and Multanova, Manual Fuestes said that the Multanova apparatus had worked well in the TMT setup and that it was fine equipment, but that the manufacturer had been unwilling to help develop the necessary software. TMT built its own equipment improving on the Multanova design. TMT developed its own radar, using a narrower beam, and feels that it is more reliable than the doppler radar used by regular patrols and by Multanova. TMT began using a 70 mm Hasselblad camera that takes 3200 speed film, added a solid state cooler to the system and reduced the photographic recovery time to one second.

Lt. Gragg said that Peoria has the same commuter traffic problem as Pasadena and Paradise Valley and planned to use photo-radar in the same way. His officers had just been trained and had just run their first site. Mr. Fuestes said that Scottsdale and Glendale were considering participating.

SITE VISITS IN EUROPE

The European site visits differed in structure from site visits in the United States. Fewer actual users, particularly police officials, were available for comment, and less information about court proceedings was available.

The attitude toward photo-radar in The Netherlands, Switzerland, and Germany differs from that in the United States, partly due to the long history of photo-radar use and partly to different attitudes toward the police. The study team noted that European interviewees trusted and esteemed law enforcement officials. The U.S. legal system is designed to protect the individual from false accusation by the police, but this was not feared by those interviewed abroad. Interestingly, attitudes toward photo-radar in Sweden, where the equipment has been used for only a few years, more closely paralleled those in the U.S.

Gatsometer BV

2050 AA Overveen, The Netherlands
Tel: 31-23-255050
FAX: 21-23-276961

Gatsometer is one of the oldest companies in Europe specializing in the manufacture and distribution of radar and photo-radar products. The company was founded by Maurice Gatsonides, the father of the current head of the company. After a career as an aircraft engineer, and after working with the Dutch resistance during WWII, Maurice Gatsonides became a race car driver, participating in road rallies all over Europe. As part of the Gatso team's winning strategy, Maurice Gatsonides included a number of electronic "gadgets" in his vehicles, including some of the first precision speed measurement devices adapted for motor vehicle use. In 1959, Gatsometer BV offered its first speed measurement product for sale. This equipment used pneumatic tube detectors similar to the pneumatic tubes used for data collection today. In 1966, cameras were combined with the tube system to product pictures of both the front and rear of selected vehicles, and were used to apprehend speeders and vehicles running red lights. In 1968, doppler radar units were first used as part of Gatsometer speed detection. These radar units were a redesign of early British units originally developed for use in WWII, and had to be completely reworked for the purposes of traffic law enforcement. In 1982, Gatso Micro Radar with Automatic Traffic Camera was available with its own power supply for use on the roadside or in a moving vehicle. Additional refinements are constantly being made to the Gatso equipment. Gatsometer has three researchers on its staff and the researchers work closely with the production staff.

The firm has about 20 employees and produces about 200 photo-radar units per year. Gatsometer has units in operation in Australia, Great Britain, and continental Europe. At the beginning of the interviews, Tom Gatsonides, co-director and current head of the company, mentioned that Gatsometer was not necessarily interested in developing a U.S. market. According to Mr. Gatsonides, product liability issues in the United States are quite different from those applying in The Netherlands and the rest of Europe. Possible judgments against a small firm like Gatso could endanger its very existence. However, Mr. Gatsonides said that by marketing the product through an agent's corporation—in this case Gatso-Export, or GTEL—their liability can be limited. The Gatsonides family worries that their company could expand too fast and jeopardize the integrity of their product. The company prides itself on being service-oriented, a feature that might suffer from rapid growth. If the company stays small, the Gatsonides family can act as the sales staff, and provide complete and accurate information to customers. Once they expand beyond current markets, they must be represented by agents.

The Product

The backbone of Gatso photo-radar is the Gatso Type 24 Micro Radar. Unlike its counterparts, the Gatso Type 24 uses a slotted wave guide antenna instead of a parabolic antenna. The Gatsometer staff felt that the slotted wave guide antenna tended to produce a more two-dimensional radar beam rather than the more elliptical beam emitted by the parabolic antenna. The Gatso beam extends 22 degrees in the horizontal direction and only 5 degrees in the vertical direction. The radar operates at 24.125 gHz or at 13.5 gHz and the beam is constant and aimed at an angle of 20 degrees from parallel to the roadway. The radar's accuracy is listed as ±2 km/h (±1.3 mph) for speeds up to 100 km/h (62.1 mph), and as ±2% at speeds above 100 km/h. This particular radar unit is also used in the Traffipax photo-radar equipment, as part of a long-standing agreement between Gatso and Zellwege/Robot Foto Und Electronic, the parent company of Traffipax. Gatso uses the Robot camera in its equipment and Traffipax uses the Gatso radar. The unit is guaranteed at temperatures from -20° C (-4° F) to 60° C (140° F).

All photo-radar units operate in one or more of the following modes: (1) stationary mode, at a fixed position on the roadway, (2) stationary mode, mounted in the back of a vehicle or on a tripod, so the equipment can be moved from site to site, or (3) mobile mode, mounted in a vehicle and designed to be used while the vehicle is in motion. In the stationary unit, the Gatso unit is mounted either in a cabinet, on a hinged pole (the hinged pole allows the police to retrieve film easily) or an overhead structure, on a tripod, or in a parked vehicle. About 5% of the Gatsometer units are used on hinged poles. The other 95% are used mainly in stationary or mobile vehicles.

In the mobile mode, the antenna is fixed behind the front grill of the vehicle, with the electronics installed inside the vehicle and the cameras installed on the dash and/or rear platform. The speed of the equipment-bearing vehicle is measured using an optical coupler in the gear box, and considered in determining the true speed of the target vehicle. In mobile mode, the equipment can be used to pace and pursue speeding vehicles and to detect speeding vehicles in receding traffic. The equipment cannot be used in mobile mode to detect speeding vehicles in approaching traffic. According to Tom Gatsonides, no photo-radar equipment on the market can adequately measure the speed of approaching traffic. In his opinion there simply is not enough time to receive a sufficient number of doppler cycles before a picture would have to be taken. The Gatso unit can also discriminate between passenger vehicles and trucks, and allow for different speed limits and tolerances to be applied to each vehicle type.

The Robot camera employed in this unit uses standard 35 mm, 200 to 400 ASA film. Cartridges with as many as 800 frames are available. For photo-radar, a 90 mm lens is recommended, whereas the red light camera typically uses a 45 mm lens. (For more information on the Robot camera, please consult the Traffipax portion of this report.) Front and rear photographs are possible, and a unit displaying the offender's speed at the site is available. The location, time, date, and speed of the offending vehicle are superimposed on the upper right-hand corner of the frame. A slave flash unit is used for nighttime photography. The unit can operate adequately in the rain, but reflections in the snow were reported to significantly reduce the quality of the photographs. Although the units have two settings, one for 2 lane scanning and another for 4 lane scanning, Mr. Gatsonides felt that since the camera could only use one lens at a time, better pictures would be available using the unit at the outside edge of the road to scan the outside two lanes and in the inside median to scan the inside two lanes. This would also reduce the problem of having more than one vehicle in the radar beam at the same time. A template, or transparent overlay, is available to show where the radar beam is, and thus which vehicle was speeding when the picture was taken. In The Netherlands, cases where more than one vehicle appears in the photograph are not pursued, so no template is needed there, although one is included in their manual for use outside The Netherlands.

The units are calibrated before they are shipped from the factory. They are self-calibrating, requiring no tuning forks. In Holland, the units are re-certified once a year. The Dutch Bureau of Standards recognizes Gatsometer as a valid testing agency, so its units are returned to the factory annually for certification. Gatsometer does not recommend on-site calibration and does not impose any preventive maintenance requirements. They do suggest that the camera be overhauled every three years since the camera contains moving mechanical parts. All of the equipment is enclosed in nickel-plated sheeting to shield it from radio frequency interference. Gatsometer guarantees 24-hour turnaround service in Holland, but in other European countries the quality of service depends largely on the Gatso agent serving that country. Most users in other countries try to have the equipment repaired locally. Gatsometer will replace a critical component and recalibrates the apparatus (the antenna, the oscillator and the mixer), but this may or may not be done for equipment in use outside The Netherlands.

The radar portion of the Gatso equipment costs around $10,000, with the other equipment costing about 20% to 30% more. At the time of this writing, the full photo-radar package was estimated to cost $25,000 to $40,000 in the United States. Also available is a unit for card storage of all data collected. Although the data-processing software was not demonstrated, these programs reportedly produce both ASCII files and summary tables.

Photo-Radar Use in the Netherlands

According to Tom Gatsonides, about 200 policemen are involved in traffic duty in Holland. In The Netherlands, police departments retain the fines collected from enforcement in their jurisdiction, so photo-radar can produce local revenues as it does in the U.S. Police officers receive the 60-page operating manual along with 3 hours of training on the equipment at the police academy. About 50% of the 100 municipal police use radar. All of the state police use the equipment. However, state police officers are not allowed to stop offending vehicles on the roadside. Photo-radar is one of the few ways that speed laws can be enforced outside the municipalities. For instance, the police had documented a speed-related accident problem in an area between Overveen and The Hague. To combat the problem, the speed limit was reduced from 100 km/h (62.1 mph) to 70 km/h (43.5 mph) and six fixed-post cabinet installations were placed on a five mile section of roadway. Only one box contained photo-radar equipment at any one time, and the equipment was actually on the roadway only one day per week. These "placebo" boxes had a deterrent effect on the entire stretch of roadway at all times. At the beginning of this particular program, approximately 800 pictures of speeding vehicles were taken in a 4-hour period, indicating the extent of the problem. No data were released by the Government or SWOV (Institute for Road Safety Research), but the study team was told that significant reductions in speed were achieved.

In addition to pole-mounted photo-radar units, Gatsometer has also tried fixed-position overhead installations, with mixed results. The police can generate a large number of tickets in this configuration, but the equipment seems to provide little deterrence except when the media provides heavy press coverage of the unit.

According to Tom Gatsonides, photo-evidence is controversial in Europe, as it is in the United States. New laws in The Netherlands made the owner of the vehicle responsible for all vehicular violations. A similar law was being considered in Germany.

Mr. Gatsonides said that about 90% of the installations using Gatso equipment are manned and 10% are not. In unmanned installations, vandalism is a problem even though the cabinets are constructed from double-plated stainless steel. Whether the equipment is manned or not makes no difference in court in The Netherlands, where the equipment has been established as "fail-safe" by long use. He thought that in the United States, as in Holland, judicial habits have to be established slowly until the accuracy of the equipment is generally accepted. In Holland, the use of the red light camera paved the way for acceptance of photo-radar. The courts were accustomed to photographic evidence from red light prosecution, and photographs taken by photo-radar equipment were readily accepted as evidence.

Police Experience in The Netherlands

In all of the countries visited, the Study Team requested interviews with the local police using the equipment. The Netherlands was the only country where the police agreed to have the team visit the station and discuss the equipment. (In Sweden, the police met the team at a photo-radar site. In Switzerland, the police commissioner met briefly with the study team. No police input was available in Germany.)

In Holland, the team visited the Wassenaar Town Police, and talked with Officer Smit. Wassenaar is between The Hague and Leiden. Interestingly, the use of photo-radar in Wassenaar closely paralleled Pasadena and Paradise Valley -- an affluent community with cross-town commuter traffic. Local speed limits are normally 50 km/h (31 mph), and "special" city roads are set at 70 km/h (43.5 mph). Local police generally allow either a 3 km/h or a 3% tolerance over the limit. Speeding violations are separated into two categories: traffic violations (less than 30 km/h over the limit) and criminal violations (over 30 km/h over the limit). Offenders who receive three criminal tickets in one year lose their license for 3 months.

The film from the photo-radar and red light cameras is retrieved by police officers and developed at the central police headquarters in The Hague. The negatives are then read for the license number and driver identification (if needed) using a standard microfilm reader, avoiding printing costs. Unlike the United States, in many parts of Europe driver identification is not required to prosecute a photo-radar case. There are some problems with reading negatives this way. Red plates do not show up well in black-and-white negatives and overhead pictures are often distorted by reflections. The police do not use special enhancements and they do not generally use a template to identify the speeding vehicle in a multi-vehicle picture, since they have enough uncomplicated photographs to keep them busy. In small townships, the police process about 400 photographs per day of photo-radar use. In the last year, one red light camera and one photo-radar unit yielded about 12,000 tickets.

The owners of the vehicles cited by photo-radar for speeding have six weeks to respond to their summons, either by paying the ticket, naming the offending driver, or showing evidence that the vehicle was sold before the offense. The officer does not have to appear in court. About 95% pay right away. Only about 1-2% actually go to court, since fines issued in court tend to be higher. When drivers from other countries are cited, an official report is issued through Interpol. Generally, no action is taken as a result of this report; or if action is taken in the other country, no information filters back to The Netherlands.

Research in The Netherlands

As part of the site visit, the study team visited the SWOV Institute for Road Safety Research. SWOV was established in 1962 and is administered by a Board of Governors appointed by the Minister of Transport. The agency researches traffic safety almost exclusively. Traffic safety in The Netherlands is to some extent dependent on the demographic characteristics of the population. Of the 14.5 million people in Holland, 5.2 million are under 25 years of age and 1.8 million are over the age of 65. As in other countries, these two age groups are more likely to be involved in accidents, and the size of the groups exacerbates traffic safety problems. There are only 98,000 km of roadway in The Netherlands, but 5.2 million registered vehicles and 11.4 million bicycles. There were 969 fatal accidents in 1988. By comparison, Virginia has 66,900 miles of roadway and had 929 fatal accidents in 1988. Accident characteristics in Holland reflect their dependence on bicycles — 282 of the fatal accidents in Holland resulted in the death of a cyclist.

Anita van der Vorst, Head of the Public Information Department of SWOV, discussed the organization and the type of work currently underway. The Institute employs 40 researchers and 30 support staff in three areas: information control, contract administration, and research. Most SWOV research deals directly with safety problems, and the remainder is classified as behavioral or technical. As noted by Liem Oei of the research staff, several ongoing studies are speed-related. There is little data about photo-radar use in The Netherlands. Using small urban areas, staff at the University of Delft noted a 20% drop in the mean speed following the installation of photo-radar, with the percentage of speeders dropping from 80% to 20%. Similar results were found in Norway. However, after drivers became aware of the location of the devices, the percentage of speeders rebounded.

Multanova Multanova/RPJ, Inc.

(Multanova AG, Zellweger Uster LTD.)
Seestrasse 108
CH-8612 Uster 2/Schweiz
Switzerland
Tel: 01/9406161
Fax: 01/9404530

Multanova AG, a small company located in Uster, Switzerland, is an independent subsidiary of Zellweger Uster Ltd. Zellweger bought Multanova in 1964, about 8 years after Multanova produced its first radar unit. According to Martin Schaufelberger of Multanova, the relationship between Multanova and Zellweger allows Multanova the flexibility needed for research and development, especially regarding the speed with which they can develop new products or meet large orders. According to Mr. Schaufelberger, they can go from prototype to production in about 5 months. Unfortunately, Multanova is constantly understaffed, because staff members are hired away by Zellweger as soon as they become well-trained and productive. There are occasional problems when the parent company has rush orders.

The Product

The Multanova equipment uses a parabolic antenna similar to those used in radar in the United States, rather than the slotted wave guide antenna. In other ways Multanova units are similar to the Gatsometer. The Multanova radar operates at 35 gHz (or at 24 gHz, since some countries reserve 35 gHz for the military). The angle of operation is set at 22 degrees, like the Gatso equipment, but there are sensors in the Multanova equipment to detect when this angle is violated by more than 1 degree. When this is the case, the photographs are nullified. The radar's accuracy is listed as ±1 km/h for speeds up to 100 km/h (62.1 mph), and as ±1% at speeds above 100 km/h. The buyer has a choice of cameras: either the Jacknau Recording camera or the Robot-Motor Recorder 36 DET. The cameras operate on aperture priority, with the Robot camera set at 1/750th of a second and the Jacknau set at 1/500th. Without a flash unit, both cameras can take two pictures a second. The recycling time for the flash is one second. However, cameras with multiple flash units can recycle in less time. The accuracy and proper operation of the unit is guaranteed at temperatures from -25° C (-13°F) to 60° C (140°F).

The camera employed in this unit uses standard 35-mm film, available in cartridges of 450 frames. For color film, 200 ASA is used, while 400 ASA is used for black and white. Both films can be pushed to 3200 speed, if needed. For photo-radar, an 85-mm lens is recommended. Front and rear photographs are possible. The location, time, date, and speed of the offending vehicle are superimposed on the upper right-hand corner of the frame. A flash unit is used for both daytime and nighttime photography. Two flash units may be used—a regular unit in the rear of the equipment vehicle and an angled flash in the front. Battery chargers are included with the equipment. The equipment is designed to scan up to four lanes of traffic; however, Martin Schaufelberger thought traffic density was a problem when scanning more than two lanes. He agreed with Tom

Gatsonides that scanning the outside lanes from the shoulder and the inside lanes from the median would work better.

Like Gatsometer, Multanova photo-radar can be used in both stationary and mobile mode. Unlike the Gatso equipment, however, Multanova photo-radar can detect speeders in approaching traffic. Some restrictions are placed on the Multanova equipment when used in mobile mode. Readings are judged to be unreliable and no picture is taken if the speed of the offending vehicle or the equipment vehicle changes by 3% or more while in the radar beam. Also, pictures are not reliable where the curvature of the roadway exceeds 3 degrees. These limitations were not mentioned by other manufacturers offering mobile equipment. It is not known whether these limitations apply only to Multanova equipment.

Photo-Radar Use in Switzerland

In stationary mode, the equipment can be used on a tripod (with an optional 60 foot cable attachment to a power source so that the device can be used from the median), in a vehicle parked on the roadside, in a cabinet on the roadside, on overhead signs, or on a fixed pole. Multanova uses a motorized flex pole that lowers the equipment to the operator, rather than the hinged pole configuration used by Gatsometer. The cabinets are extraordinarily over-designed. Originally, the cabinets were made of bulletproof steel. Vandals, however, were knocking the cabinets over with four-wheel-drive vehicles. The design was changed and the cabinets were made of reinforced concrete on a concrete base. However, the ventilation louvres on the concrete cabinets pointed upwards, and vandals began pouring gasoline into the cabinets and blowing the equipment up. The latest design has the louvres pointing down.

In the mobile mode, the antenna is fixed behind the front grill of the vehicle, with the antenna opening next to the driver-side headlamp. The electronics are installed inside the vehicle, and the cameras are installed on the dash and/or rear platform, depending on their anticipated use. The speed of vehicle in which the photo-radar equipment is mounted is measured using an impulse generator with a coupler in the gear box.

Whenever a permanent installation is made, the National Bureau of Standards in Switzerland requires special testing. The accuracy of the system must be validated using a second type of measurement, with data provided for at least one half hour. Multanova lays down a "carpet" 46 meters down the roadway. The carpet has distances marked, and time/distance studies are done to corroborate the radar findings. This calibration procedure is also used to make a template specific to the location, which identifies which vehicle in a picture is speeding.

Switzerland and The Netherlands use a similar procedure to prosecute photo-radar cases. After a stationary or mobile photo-radar run, the police recover the film, process the negatives, take the registration data, recover the owner information, and send a citation to the owner. In Switzerland, however, the owner must pay the fine regardless of who is driving. For the offense to contribute toward a license suspension, the identity of the driver must be established. This creates two classes of offenses: an administrative offense resulting in a fine, requiring less proof, and a criminal offense that results in license suspension. In Switzerland, owners need not identify family members who happen to have been driving when the offense was photographed. Very few photo-radar cases, about 2 in every 1,000, actually go to court. Most offenders simply pay the fine.

For cases requiring identification of the driver, Multanova offers equipment to enhance the quality of the pictures. The Multascope consists of a video camera and lens, a Sony photographic printer, and electronics for special printing. Using this system, the contrast on part or all of the picture may be increased or decreased. It is possible to zoom in on a part of the picture, such as the driver's face, alter the contrast, and print only that. It is also possible to mask out parts of the picture, such as a passenger. These enhanced pictures can then be presented in court. The cost of the viewing system is about $40,000. There is a separate special attachment for viewing reflectorized license plates. Since the flash position cannot be re-aimed when weather and lighting conditions change, there is often too much light to identify the license number on reflectorized plates. The special attachment enhances the plate number.

The equipment also comes with card storage and data-processing software. As the officers lift the registration information from the photographs, they add the license plate information to the data file, creating a catalog of offenders and a database for case tracking. The file with the vehicle license numbers can be sent directly to the authorities to solicit the owners' names and addresses. Interestingly, like other sites studied, about 95% of the drivers apprehended in Switzerland did not live in the municipality in which they were charged.

Police Experience in Switzerland

Switzerland has 6.5 million inhabitants and over 3 million registered vehicles. Some 60 million foreign vehicles enter the country each year. Between 1970 and 1983, the number of vehicles registered in Switzerland more than doubled, and continues to increase. Over 30,000 injury accidents and more than 1000 fatalities are recorded each year. Speeding is the second most common cause of accidents and the foremost cause of fatal accidents.

In the early 1970's, the Swiss installed 142 Multanova photo-radar units at 105 sites and purchased additional units for mobile use. At most stationary installations, accidents were reduced by approximately 50%. According to a Multanova publication, the public reaction to the stationary units was neutral to positive, but the reaction to the mobile units, often used in unmarked cars, was negative. Now, the officers often use the radar camera as part of normal enforcement. After taking the picture, they pull the offender over and issue the citation on the spot. The picture then becomes evidence in a normal speeding case.

On roadways signed for less than 80 km/h (49.7 mph) in Switzerland, the photo-radar equipment is set at 5 km/h over the limit. On roadways with limits higher than 80 km/h, the equipment is set 8 km/h (4.9 mph) over the limit.

Multanova equipment is used in other countries. The Autobahn in Elzerberg, Germany was targeted for special attention in response to high accident and fatality rates. In 1970, when the road was reconstructed from two lanes to three, the number of accidents decreased from an average of 294 to 199. In April of 1972, special large speed limit signs were installed above each lane, but accidents decreased only slightly. In May of 1973, stationary photo-radar was installed above each lane, manned by officers sitting behind overhead signs. Since then, no more than 84 accidents have occurred in any one year. The speed limit on the Autobahn is 100 km/h. The photo-radar units were set at 111 km/h. These units were staffed so speeders with foreign license plates could be identified and stopped downstream by the police in order to collect the fines on the spot. During the first year of operation, more than 134,382 violations were processed. Subsequently, the number processed each year varied from 22,000 to 79,000. The Elzerberg photo-radar units paid for themselves in one month's time and accident rates were reduced.

Traffipax-Vertrieb GMBH

Hildener Str. 57
P. O. Box 13 07 26
D-4000 Dusseldorf 13
West Germany
Tel: 211 7110502
Fax: 211 7110569

Traffipax-Vertrieb GMBH is a subsidiary of Robot Foto Und Electronic. Robot has been producing cameras for professional applications for over 60 years. Originally, Robot made cameras for professional and amateur markets as well as specialty cameras for scientific applications. Robot made the first auto-shutter camera in 1934 and specialized in both very fast stop-action photography and telescopic photography. Robot cameras were used during World War II by the German Air Force to verify "hits" during bombing runs. Later, Robot abandoned its amateur market to concentrate on scientific applications. Traffipax was created in response to the need for electronic help in traffic law enforcement. In 1955, Traffipax began manufacturing a camera that was mounted in a police car and took pictures of violators. However, a picture alone was insufficient evidence for conviction. Additional data corresponding to the picture was required. In 1970, a unit combining speed-measuring radar with a camera was introduced. The current version is the Traffipax Speedophot.

The Product

The Traffipax Speedophot uses the Gatso Type 24 Micro Radar, including the slotted wave guide antenna, which emits a narrower beam than ordinary parabolic antennas. The beam extends 22 degrees in the horizontal direction and 5 degrees in the vertical direction. About 1,500 measurements of speed are taken for each passenger vehicle as it passes through the radar beam, and 2,500 measurements on trucks. The software used to analyze these Gatso radar measurements was developed by Traffipax. The measurements are averaged to obtain the speed reading, which determines whether a picture will be taken. According to Traffipax, the French manufacturer Mesta has developed a new circular antenna, but little is known about the design. The Traffipax staff likes the Gatso radar unit and have used it for years, but are not "wed" to it and may change.

The radar operates at 24.125 gHz (or at 13.5 gHz) and the beam is constant and aimed at an angle of 20 degrees from parallel to the roadway. The staff prefers lower frequency operation since weather and other factors affect the accuracy of readings more at the higher frequencies. The radar's accuracy is listed as ±2 km/h for speeds up to 100 km/h (62.1 mph), and as ±2% at speeds above 100 km/h. The accuracy of the radar unit is guaranteed at temperatures from -20° C (-4° F) to 60° C (140° F). The Speedophot unit with electronics and camera is guaranteed to run at temperatures from -10° (4° F) C to 60° C. In the stationary unit, the slotted wave guide antenna is mounted in a cabinet, with the camera and electronics on a tripod. In stationary mode, the distance between the aerial and the road edge must be between 1.5 and 3.5 meters (about 5 to 12 feet). In a stationary vehicle, the unit operates on a turntable to allow use from either the right or left side of the roadway. When the unit is locked into right hand position, the right margin of the photograph runs parallel to the road edge. If the unit is mounted on a tripod, the radar antenna must be aligned with the help of a viewfinder to ensure that the aerial is placed at a right angle to the road verge. If mounted in a vehicle, the unit automatically switches into mobile mode when the vehicle begins moving.

In the mobile mode, the antenna is fixed behind the front grill of the vehicle, with the electronics installed inside the vehicle and the cameras installed on the dash and/or rear platform. The speed of the photo-radar-equipment vehicle is measured by a digital tachometer. Periodic pulses proportional to the speed of the radar-equipment vehicle are sent to the control box of the unit from a pulse generator built into the tachometer drive. In the case of an inductive pulse generator, there are 6 pulses per each rotation of the tires. The equipment can be used to pace and pursue speeding vehicles and to detect speeding vehicles in receding traffic, approaching traffic, or both at the same time.

The camera employed in this unit is the Robot-Motor-Recorder 36 DFT, which uses standard 35 mm, 400 ASA film; however, as an option, ISO 25 to 1600 speed film can be accommodated. The camera can be adapted to use a cartridge of 800 frames. For photo-radar, a 75mm Schneider-Tele-Xenar lens (f/3.8) is used, although a 90 mm lens may be substituted. For operation on two lane roads, a 150 mm lens is available. Front and rear photographs are possible, and a unit displaying offenders' speeds is available. A flash unit is used for nighttime photography and for daytime photographs if light levels or shadows interfere with the image. The flash will carry up to 45 m (147.6 ft), or across 4 lanes of traffic. In default mode, the camera runs on aperture priority setting, with 1/1000th of a second as the set shutter speed; however, the aperture can be set manually. The camera can expose two frames per second but the recycling time for the flash unit limits the speed to one frame per second. A video system is also available to accompany the still camera. Like other manufacturers of photo-radar, Traffipax produces a red light camera setup. A template is available to determine which vehicle in a photograph is speeding. A recent German law makes the owner responsible for traffic offenses involving the vehicle; however, some states in Germany still require identification of the driver in photo-radar cases, so a front photo is needed.

Some photo-radar equipment records the data corresponding to the photograph (date, time, location, photo-radar speed setting, direction being measured, frame number, vehicle speed) within the frame of the photograph. The data can occasionally obscure part of the picture. The Speedophot solves this problem by transmitting the data after the picture of the offending vehicle is taken but before the film advances in the camera. The data are written by an automatic light pencil on the film edge, just below the exposure number, rather than inside the photo. Two 120-

character lines can be displayed. Data are also encoded onto memory cards for later use. An optional handset for in-vehicle use is available with this unit (and with the Multanova unit). The handset provides a readout on all data functions in both mobile and stationary modes, and allows the operator to disable the equipment. The radar units are calibrated before they are sent out of the Gatso factory, and they are self-calibrating, requiring no tuning forks. All equipment is shielded in nickel-plated sheeting to protect the unit from radio frequency interference. The equipment has received the approval of the German Federal Bureau of Standards. Traffipax recommends that units be serviced only by authorized service representatives or at the factory and that only genuine parts be used. All parts, with the exception of the radar components, are made at the Traffipax/Robot factory.

The Traffipax Speedophot costs about 65,000 Deutsche Marks, or between $40,000 and $45,000 in U.S. currency. Also available is a unit for card storage and software to display the data in various ways. The data can be converted to an ASCII file for use with other software products. Traffipax also markets several film readers, from the simple microfilm reader generally used in Holland to a system similar to the Multanova image enhancing reader.

Photo-Radar Use in Germany

Speedophot equipment can detect and photograph speeding vehicles that are approaching the equipped car, even though the Gatso radar is used. Traffipax electronics take the first 164 readings from the approaching vehicle to determine the likelihood that it is speeding, and then take the picture. After the picture is taken additional readings are made. If the average speed including the additional readings indicates that the vehicle was not speeding, the picture is voided. This wastes some film but allows the apprehension of oncoming vehicles. By using the handset when the angle of the roadway prohibits the accurate use of the photo-radar, the operator can temporarily stop operations. The Speedophot differentiates between cars and trucks in the radar beam, and allows the police officer to enter a passenger vehicle speed limit and a truck speed limit. The equipment then photographs trucks traveling over the truck speed limit and cars traveling over the passenger car limit. Traffipax claims that Speedophot Equipment is more sophisticated than Multanova equipment and that some of the errors that would invalidate Multanova readings do not affect Speedophot. The error summary appears below:

Mobile Errors	Gatso	Multanova	Traffipax
% Change in Speed in Beam (Either Vehicle)	Possible, but Not Mentioned	Problem	Not a Problem
3% Curvature in Roadway	Possible, but Not Mentioned	Problem	Problem
Weaving by Speeding Vehicle	Possible, but Not Mentioned	Problem	Problem
Vehicle Movement (bouncing of Either Vehicle)	Possible, but Not Mentioned	Problem	Not a Problem

Whether these conditions affect the accuracy of readings in mobile mode is difficult to say. Though these sources of error were not mentioned during the Gatsometer site visit, they may still be a problem. The Study Team did not directly inquire about these potential limitations, and the staff may not have thought it necessary to mention them. Though these problems were explicitly discussed during the Multanova site visit, only some of the problems cause the equipment to automatically invalidate the photographs. In other cases, the user must manually invalidate the photo. Finally, in the case of Traffipax, there is no concrete proof that those factors that "do not apply" really have no influence.

Discussions with Traffipax revealed a problem with the stationary mode that may or may not apply to other manufacturers' equipment. A vehicle installation of Speedophot used in stationary mode must be parallel to the roadway within a tolerance of 15 cm (about 6 inches) from the front to the back of a standard compact vehicle. That is, one end of the vehicle cannot be more than 15 cm closer or further away from the edge of the road than the other end. On the Traffipax vehicles, the front and rear windows were marked to help the operator line up the vehicle by sight. This problem was not mentioned by any other manufacturer.

TRAFIKANALYS AB

Utmarksvagen 33
Box 965 S-801
33 Gävle
Sweden
tel: 46 26 17 23 05
fax: 46 26 17 23 07

Unlike the other companies visited, Trafikanalys is a relatively new concern. All of the principals in Traffikanalys (and most of the engineers) worked for different companies housed in a major office park in Gävle, Sweden. This group met regularly at lunch in the park's cafeteria and, after months of discussion, decided that they were unable to do the research and development work they wanted to do on photo-radar in their respective companies. Lars Felth, a lawyer whose firm was located in the same area, saw the potential of photo-radar and helped organize the group and raise funds for the venture. The firm produces photo-radar equipment, and also works on several other projects. Trafikanalys engineers are working on a system for BMW to gauge the vehicle's own speed directly using radar, rather than using a device in the gear box susceptible to the same types of error as a speedometer. BMW is also funding work on in-vehicle crash avoidance devices. Trafikanalys engineers are working with laser radar and light barrier data collection systems, and systems to classify vehicles by size and pick up information encoded directly on vehicles. They have been involved with Project Prometheus, developing in-car sensors and on-road sensors under the intelligent vehicle/highway systems umbrella. The week before this visit, staffers from General Motors visited Trafikanalys to look into their in-vehicle sensor system and get an overview of their research program. Trafikanalys has also done weapons navigation work for the Swedish Organization for Defense Investigation by creating radar that can detect small, round targets (like bullets) that are hard to detect since they have so little mass and surface area.

Trafikanalys currently has two photo-radar units, one in production and one in development. The Astro 110 is being used by the police in Uppsala, Sweden, in stationary mode, mounted on a pole. This cabinet-mounted equipment can also be mounted on a tripod, but is too bulky to use in a vehicle. The next generation of their equipment, the Astro 220, is currently under development, and will operate in both stationary and mobile modes to detect oncoming and receding traffic at the same time. Trafikanalys and its equipment differ from other manufacturers by their heavy reliance on probability and statistics in the development of their radar model, and particularly their use of sampling theory in building the photo-radar system.

The Product

The unit consists of the radar equipment, camera, flash (with red filter), electronic unit to write speed information to the film (like Traffipax's system), electronic controller and software, and laptop computer. A film viewer with the capacity to create a hard copy of the image is available. The data are written directly to the computer rather than to a memorycard, similar to the approach of Traffic Monitoring Technologies in the United States. Like the Multanova equipment, additional fields can be added to the database as additional information is received. The unit also comes with a heater, since Sweden is cold and the unit must run at sub-freezing temperatures. The housing for the unit is bulletproof. The laminated glass in front of the camera is 20 mm (0.78 in) thick. The radar unit operates at 10.530 gHz. Between 20 and 250 km/h (12.4 and 155 mph), the unit is accurate to ±1 km/h. Between 100 and 250 km/h, the unit is accurate to ±1%. The radar is parabolic with a beam width of 12 degrees.

According to Trafikanalys engineers, the radar system is different from other units. Rather than using pulse radar, the Trafikanalys unit modulates continuously, with less power use overall and theoretically less detectability by radar detectors. The location of a vehicle is determined using three different signals — one carrier, one 100 kHz off the carrier, and one 500 kHz off the carrier. These signals are registered every 6 msec, and the vehicle's speed is calculated every 32 msec. Up to eight vehicles can be tracked at a time, with the speed, direction, identification number, time, and distance between the vehicle and the unit calculated for each. If the unit can successfully complete 6 of the 32 msec calculations in 192 msec, then one set of data is recorded by selecting and averaging the four most complete calculations. A moving average of the last six measurements taken is calculated continuously while the vehicle is between 10 and 200 m (32.8 and 656 ft) from the unit. The actual reading is based upon continuous measurements and is taken at 75 m (246 ft). The picture can be taken as close as 18 m (59 ft) from the unit.

This system is designed to overcome several drawbacks of conventional radar. First, with conventional radar the closest target is usually the only one identified and measured, and all others escape (except when a vehicle of larger mass is behind the closest vehicle). The Astro system amplifies and linearly transforms the signals to identify each vehicle.

The camera used is a Hasselblad, with a 6 by 6 format for extra data documentation. Generally, 400 ASA film is used at an exposure of 1/500 of a second and an aperture setting of f8. The recommended lens is a Zeiss planar 100 mm lens (CF 3.5) or a 140 mm with long focal length. The camera can expose two frames per second, and cassettes of 400 frames are available. Trafikanalys produces the only unit that requires that the flash be offset from the camera by a particular number of meters to avoid creating glare on the windscreen or extra reflectivity on the license plate.

Interestingly, this is the only equipment recommended by its manufacturers for bad weather. According to the engineers, the equipment works well except during periods of very heavy snowfall, when the snow reflects the strobe and distorts the picture somewhat. The offset flash helps overcome this problem.

Photo-Radar Use in Sweden

The equipment can be used in manned or unmanned mode. In Uppsala, the police make this determination. Since the company is only a few years old, few localities use Astro units compared to other brands of equipment.

In Sweden, the idea that individuals would be allowed to violate speed laws without being pulled over was disturbing to many officers. The police would rather stop crime as it happens than penalize the behavior after the fact. At first, the police actively campaigned against the use of photo-radar. A compromise was reached, stipulating that a two-year study would be conducted in the Stockholm area to evaluate the equipment. This evaluation involved the random sampling of locations in Stockholm, the installation of photo-radar, and the measurement of the equipment's ability to slow traffic and reduce accidents. Some officers interviewed by the Study Team were still disgruntled and openly critical, saying that the apparatus was too large and that the pictures were not very good.

The Trafikanalys equipment was being used only on city streets in stationary mode. According to Dick Iverson, an official at the Swedish road safety agency, this conformed to the "black spot" theory, where equipment would be installed at locations with dismal safety records, and if the situation improved then the equipment would have achieved its purpose. However, the engineers feel that as drivers become aware of the equipment, the ''black spot" simply moves. They would prefer in-vehicle use, or use with placebo boxes. Since the Astro 110 is too bulky for use in a vehicle, the staff is developing a much more sophisticated photo-radar unit, the Astro 220.

The Astro 220

The Astro 220 unit will be smaller than the Astro 110, and will be mounted in a vehicle and used in mobile mode. The speed of the equipment-mounted vehicle will be gauged by the method developed for BMW. The engineers are planning to retain the air traffic control-type radar algorithm, adding some additional features such as video. They feel that video will satisfy police complaints about image quality. They also hope to improve photographic quality by digitizing the image and transmitting and storing it electronically, bypassing film altogether. This would make storage of photographic evidence for vast numbers of cases possible. (In Pasadena, for instance, TMT photographs are discarded after 6 months, to save storage space.)

The Astro 110 and 220 use a unique method to identify vehicles. Most units track vehicles the way standard Doppler radar does, one vehicle at a time. ''TRACKMETHOD" assigns an identification number to each vehicle and then tracks it through the photo-radar site regardless of the vehicle configurations surrounding the target and regardless of the maneuvers the target makes. The vehicle is identified by sending multiple distinct radar signals, and the lane location is determined by triangulation and the use of an auxiliary radar unit offset from the main photo-radar unit. In order to be as accurate as possible, the algorithm used by the radar introduces a conservative bias, which means that if a mistake is made, it will favor the driver. The unit identifies each vehicle as the unique combination of three separate signals, with the A channel reflecting speed and the combination of the B and C channels reflecting distance and direction. As each new set of measurements on multiple vehicles is received, the measurements are categorized as belonging to a particular vehicle or as being a new vehicle, based upon a strict set of criteria and within a given statistical probability. The Astro radar maps the vehicles in three-dimensional space as air traffic control radar does, rather than the two-dimensional space used by conventional radar. The military also uses this type of system to prevent hostile "jamming." The radar installed in the Astro 220 system is supposed to be much faster than the Astro 110 and is supposed to overcome the problem of multiple vehicles within the radar signal. The real physical limitation to the system is the photograph. Even though a vehicle can be tracked behind other vehicles, the camera must have a clear shot to get a usable picture. The Astro 220 will also be able to distinguish between vehicles of differing sizes by essentially determining the distance between the unit and the vehicle and counting the "pixels" or data points involved.

ADDITIONAL INFORMATION

This report describes site visits to users and manufacturers of photo-radar equipment, but does not include the many documents and pictures supplied to the study team on-site. For more information, the reader is urged to contact the authors, the manufacturers, and the users interviewed as part of this study, or the manufacturers' sales representatives. At the time of these site visits, these representatives were:

Gatsometer
Mr. Michael Solow
Ms. Barbara Lee
(302) 652-4835

PhotoCop
Mr. Manual Fuestes
Mr. Eric Johnson
Mr. David Jackson
1-800-888-4049

Multanova
Mr. Peter A. Umbdenstock
800-237-6713

Traffipax
Mr. Bernd Rind
(516) 227-2217

Trafikanalys
Mr. Mike A. Kahn
011-44-4626-172305
011-44-4479-3814572

This report is not an evaluation of photo-radar use. For information on the accuracy, operational feasibility, and impact of photo-radar use, please refer to the companion document, "Automated Speed Enforcement Pilot Project for the Capital Beltway: Feasibility of Photo-Radar."