Potentials of BMW Driver Assistance to Improve Fuel Economy

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Abstract:

With increasing computeraided analysis of the actual traffic situation and ongoing development of electronic vehicle systems, information is already available which allows us partly to extend the driver's visual horizon to an electronic horizon. By anticipating certain driving situations the system can recommend handling strategies to the driver. By means of the grouping, complex analysis and selection of all information, specific influences can be exerted on drive train management and driving strategies aimed at cutting fuel consumption can be derived. New driving strategies have been developed to utilise the above potentials. The results calculated from simulations indicate substantial cuts in fuel consumption for telematics systems already developed. Acceptance of individual strategies by drivers and traffic requires further intensive investigation.

Glossary:

ABS	Anti-lock Brake System
ACC	Active Cruise Control
ASC+T	Automated Stability Control + Traction
CARIN	Car Information System (BMW navigation system)
DAB	Digital Audio Broadcasting
DSC	Dynamic Stability Control
FCD	Floating Car Data
GPS	Global Positioning System
GSM	Global System for Mobile Communication
MMI	Man Machine Interface
NAV	Navigation System
RDS-TMC	Radio Data System–Traffic Message Channel
SAM	Situation Adaptive Drive Train Management
v	Velocity, Speed of Vehicle

Introduction

The number of concepts and systems of driver supportive systems has increased enormously over the past few years. Most of them either intend to increase drivers comfort, safety or traffic efficiency, with some positive side effects for the reduction of fuel consumption or emissions by a more harmonised traffic flow, by a reduction of traffic jams and by a reduction of traffic in search for a parking lot. Little emphasis has been paid so far to their application as to enhance fuel economy as their primary goal.

It is well known that the driving style of a driver has a very strong influence on the fuel consumption of her/his vehicle. Up to 50% of the fuel consumption can at least theoretically be saved, if an appropriate driving style is applied. The necessary driving style to exploit the full potential would surely be in conflict with today's manner of driving, it would annoy other traffic participants and would have little chance to be accepted by a wider driver population.

Thus an attempt to influence a drivers driving style has to overcome the barrier of driver's acceptance of such a system. What could lead to an acceptance level which allows the introduction of such a driver assistance functionality? It seems that the following premises are of great importance:

- The driver has the freedom to decide, if and when she/he wants to use the system.
- The system explains its behaviour to the driver in an easily understandable manner
- The system provides feedback to the driver on the results of the fuel saving driving style
- The systems behaves smooth and does not affect the dynamics of driving when needed
- The driver can always override the system recommendations

This paper describes an approach as developed by BMW research together with partners from the Fachhochschule München to influence the driving style of a driver by means of information and active support as to achieve a significant reduction of fuel consumption which meets the above mentioned acceptance criteria.

Driver's Requirements for Mobility

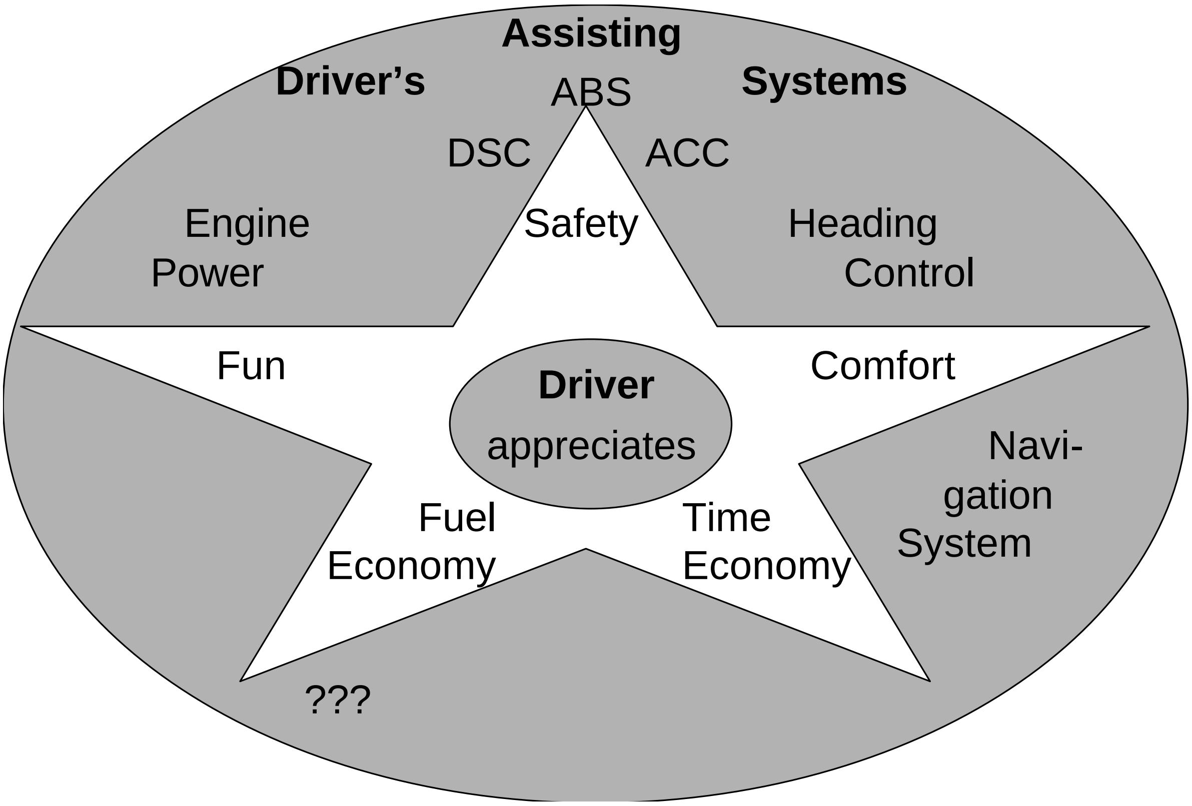


Figure 1: Driver's requirements for Mobility

Driver assistance can take many different forms according to the level of automation which is applied. The driver assistance systems can provide information or warnings, they can support the driver in the execution of a task, they can enhance his decision making and planning, they can take over parts of drivers role or even fully automate drivers tasks. BMW has always focused on those systems which leave the ultimate responsibility at the drivers.

The driver assistance systems can be applied to all levels of a drivers task in the vehicle stabilisation, guidance or navigation (*Figure 1*). Today a rather great variety of systems already exists for the support on the stabilisation task like ABS, ASC+T, DSC etc. Also in the area of navigation and planning systems are already introduced or will be introduced quite soon. The BMW navigation system CARIN is one example of such a system. Systems for an improved information on the traffic situation will follow soon like RDS-TMC or park-information. Whereas the assistance functions at the guidance level are still at their infants with the exemption of park distance control systems. The main eason for that is the difficulty to get a rather complete picture of the traffic and driving situation. The knowledge about the traffic and driving situation is of high importance for driver assistance systems, it shall contain a certain preview, an electronic horizon. The so-called electronic horizon of the vehicle is needed as to inform or react in advance to events which either are outside of a drivers visual range or whose continuos monitoring would pose an unnecessary burden on the driver. The electronic horizon can be derived from sensory information (Radar, Laser, Image Processing), which will be introduced for other driver assistance functions anyway, from telecommunication (RDS-TMC, DAB, GSM) and from the satellite-based vehicle positioning system (GPS) and the related navigation system with its more and more refined data base. The approach to city limits, the approach to road sections with speed limitations, to intersections with no right of way, to traffic signals and so forth are data a driver needs to know, when he wants to drive as to save fuels.

To influence a drivers driving style without leading to annoyance and discomfort the use of the haptic feedback channel seems to be the most appropriate form. BMW research has developed an active accelerator pedal which provides a subtle haptic feedback and can be overridden whenever the driver feels a need to do so. This pedal triggers rather intuitively suitable reactions of drivers as it was demonstrated when applied to an Active Cruise Control system (ACC). The basic functionality of the active pedal consists in a variable point of pedal resistance giving a clear indication on the appropriate pedal position which is felt and followed by the driver. Due to the on-going developments towards driver assistance functions for support in the longitudinal and lateral vehicle guidance the basic system elements exist already. These different system elements can be merged for an adapted longitudinal vehicle control to improve fuel economy.

Potential for improving fuel economy

Improving fuel economy is an important task in automotive engineering due to commitments to reduce global emissions of CO_2 and the likelihood of rising energy costs. For over 25 years, since the first world oil crisis, engineers have been fine tuning the efficiency of engines, transmission systems etc. In addition to these enhancements, aerodynamics have been improved and vehicle weight gradually reduced, pointing towards a future trend of lighter weight vehicles. In line with the increasing importance of fuel economy over recent years, test cycles have been established to measure and compare vehicles at defined load levels. All test cycles feature time-velocity specifications to compare different vehicle types and to evaluate the efficiency of the vehicle concept. The results of cycle testing, however, can only partially reveal the factors that affect fuel consumption. There are additional influences that are eliminated by the cycles in order to enable comparisons to be made. One factor is the driving behaviour of the motorist and another is the driver's choice of route. These factors, which have been more or less completely ignored by the engineers, play a considerable role in fuel consumption. Investigations show that up to 50% of fuel consumption is dictated by the traffic situation and driving behaviour [1, 2, 3].

The main objective is to minimise energy usage by the consumer in his daily driving tasks and not just to achieve low consumption levels in the test cycles. Taking this into account, there is considerable scope available to help the driver achieve higher levels of fuel economy during driving.

The essential question in discussions on fuel economy is not so much the technological possibilities but the economic tradeoff for the automobile manufacturer and the end consumer with regard to the effect on other important features such as safety and driving performance. Conventional methods used to reduce fuel consumption focus on enhancing the drive train by applying new engine technologies or transmission systems. Additional methods include the reduction of driving resistance by cutting vehicle mass, improving the aerodynamics and rolling resistance of tyres. The theoretical potential for improving vehicle fuel economy in the future using conventional methods adds up to around 30%. Exploiting this potential will cost billions, as efforts continue to satisfy consumer demands concerning safety, comfort, space and adequate acceleration and performance. Utilising these development trends will enable substantial cuts to be made in fuel consumption, but in the meantime potential on the driver's side should also be exploited.

Navigation systems are widely established in automotive applications to help optimise route planning and guidance in terms of time efficiency and to reduce the driver’s mental workload, in turn augmenting driving convenience. The next generation of navigation systems as they are announced will inform about congested roads and how to avoid them. These dynamic systems are the first step towards considering and eliminating aspects of energy wastage in route planning. It is possible to envisage a system which considers the shortest rather than the quickest route and which also takes into account road attributes such as hills, actual speed etc. to find the route with the lowest energy consumption requirements.

Even more potential is promised by the prospect of training the driver for high efficiency vehicle control. Several studies have been carried out, revealing significant cuts in fuel consumption (-30 to 60%) when people have learned to drive while anticipating traffic situations and applying the accelerator pedal efficiently [1]. *Figure 2* shows a comparison of theoretical areas of improvement.

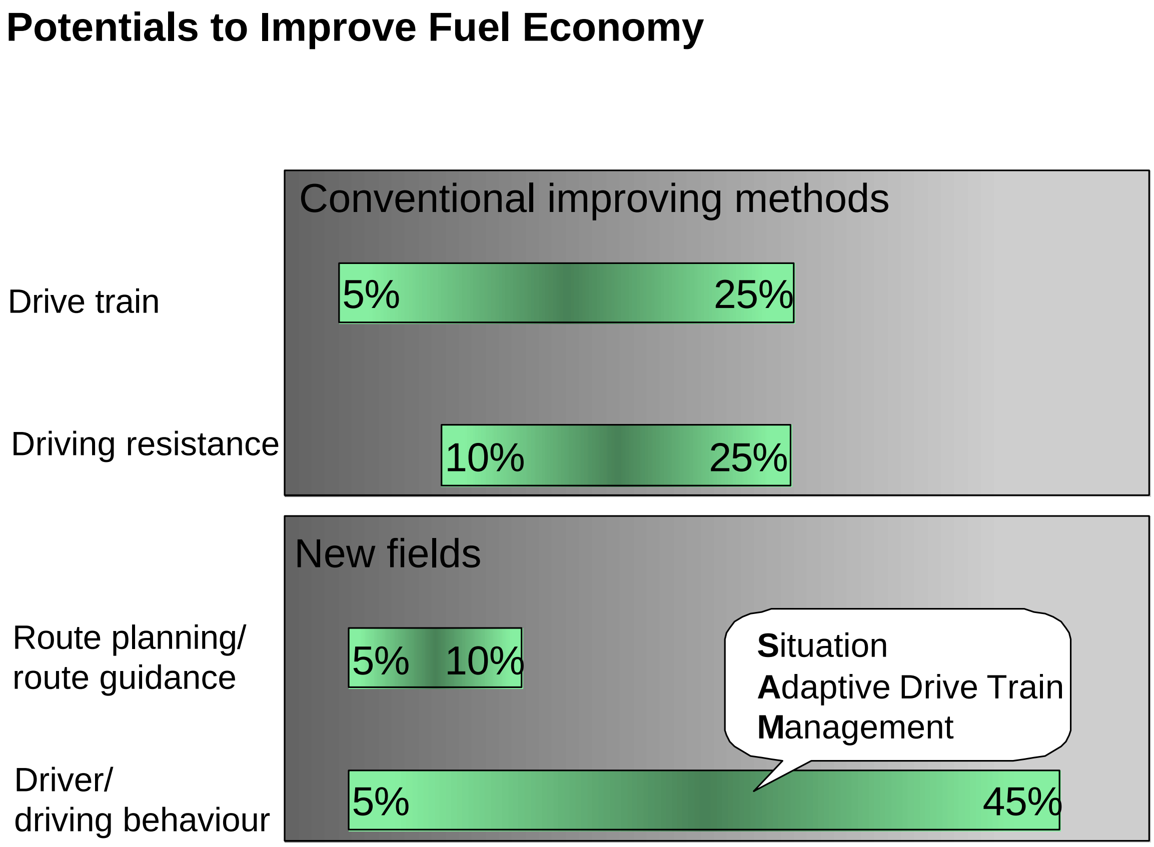


Figure 2: Potentials of improvement

If efforts to reduce CO_2 emissions (fuel consumption) are to be taken seriously, anyone with a driving licence would have to participate in an "Economic Driving" course. In order to exploit the potential fully, motorists would have to follow all the rules and regulations learned on such courses, adding an enormous additional mental workload. However, driving in crowded cities, on diversified main roads, and on high speed motorways is complex enough! What the driver needs is some form of online assistance to assist economic driving. The **S**ituation **A**daptive Drive Train **M**anagement (SAM) is one possible solution to help make driving more convenient and economic.

System for adapting longitudinal drive train control

SAM reaches a longitudinal driving decision similar to the way a driver would. The driver surveys his driving environment by taking in information with his various senses and evaluating the information. Observation of the traffic situation and the resulting necessary action is decisively influenced by the mood of the driver and circumstances such as safety considerations, time requirements, traffic and - last but not least - operational requirement. The driving strategy selected is implemented using actuators such as the accelerator and brake pedal to control the vehicle. *Figure 3* outlines the similarities between driver behaviour and drive train management.

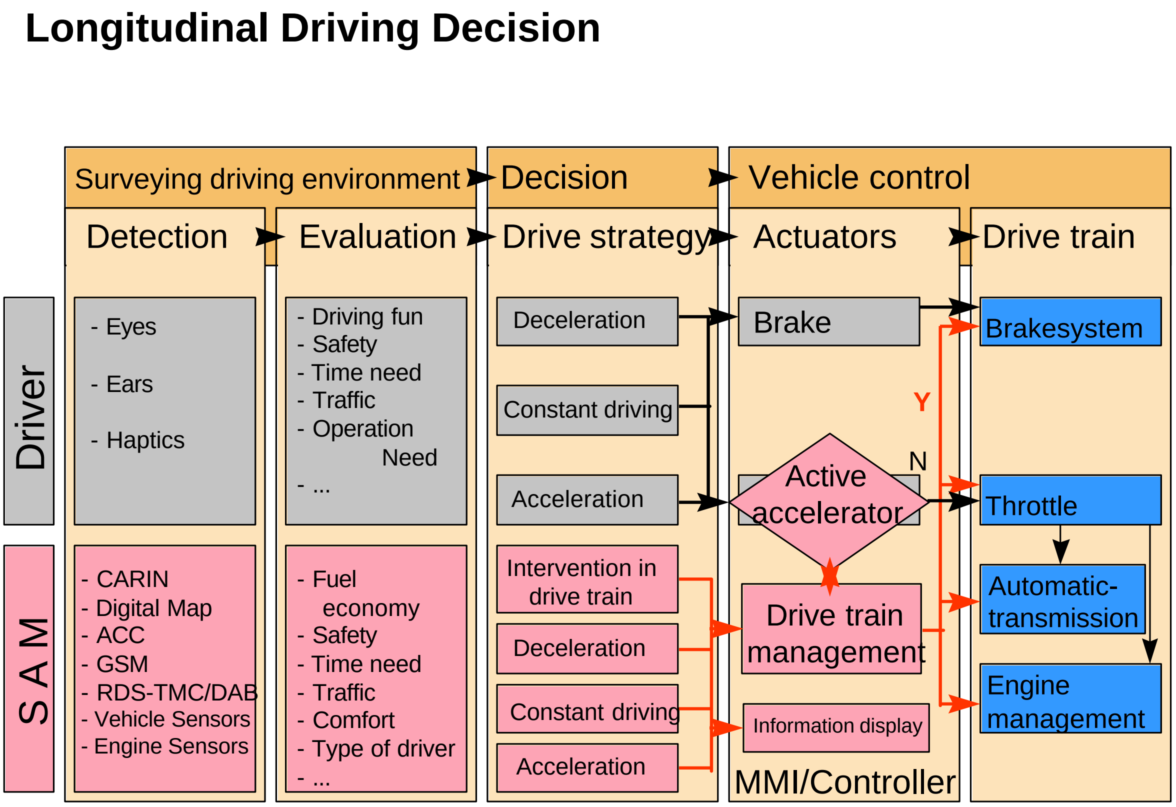


Figure 3: Comparison between driver and SAM-System

The SAM system continuously uses its data acquisition equipment to collect information from digitised road maps, navigation system, distance sensors and telematic instruments, for example GSM, RDS-TMC, DAB etc. This information and additional vehicle data is collated and used to anticipate driving situations in the future. These likely events are evaluated in respect of possible savings in fuel consumption, considering ancillary conditions such as safety, traffic flow, time requirement, driving comfort etc. Optimised driving strategies with possible interventions of the drive train are selected by recording and evaluating traffic situations. The SAM MMI control system indicates the vehicle handling strategy which has been selected to the driver. A so-called active accelerator pedal is mainly used for this purpose, in addition to optical indicators in the cockpit or navigation display. This accelerator can indicate an ideal pedal position to the driver with increased pedal resistance. The driver can sense this point of resistance in the pedal. If he wants to override the recommendation, he simply has to apply a greater force to the pedal, overcoming the „pressure“ point. In this case the vehicle reacts as normal.

If the system detects that the driver has accepted the recommended pedal position, the drive train management system reacts accordingly to make sure that the energy saving potential of the driving situation is fully exploited. Throughout the entire period that the SAM system is managing the drive train, the driver remains in complete control of all driving actions. He can override the automatic system at any time, reverting to normal driving control.

In conclusion, the driver assistance system "SAM" is designed to help the driver by anticipating driving conditions, providing him with an evaluated system reaction to traffic situations which will help to augment fuel economy. Last but not least, the drive train management system allows him to exploit some of the theoretical potential for savings in fuel consumption.

Situation detection as a main task

To permit a better understanding of information detection, it is necessary to classify traffic situations. It is obvious that certain objects trigger a corresponding traffic situation. It is therefore required to detect these objects using technical equipment and to understand what they mean. For example, objects such as traffic signs specifying a speed limit or inform the motorist that he is required to stop at a junction. These sort of signs prescribe a constant speed at all times. A traffic light acts differently. Either it calls for the motorist to adapt his speed if a red light is shown, or it requires no reaction if it shows green. In addition there is the complex factor of other road users.

These and other situations have to be detected by the system to foresee possible influences on the speed decision. As mentioned previously, two types of speed defaults have to be distinguished with a difference in the object location. *Figure 4* shows a portfolio with four areas of comparable features. The abscissa indicates the object location and the ordinate defines the objects according to speed information.

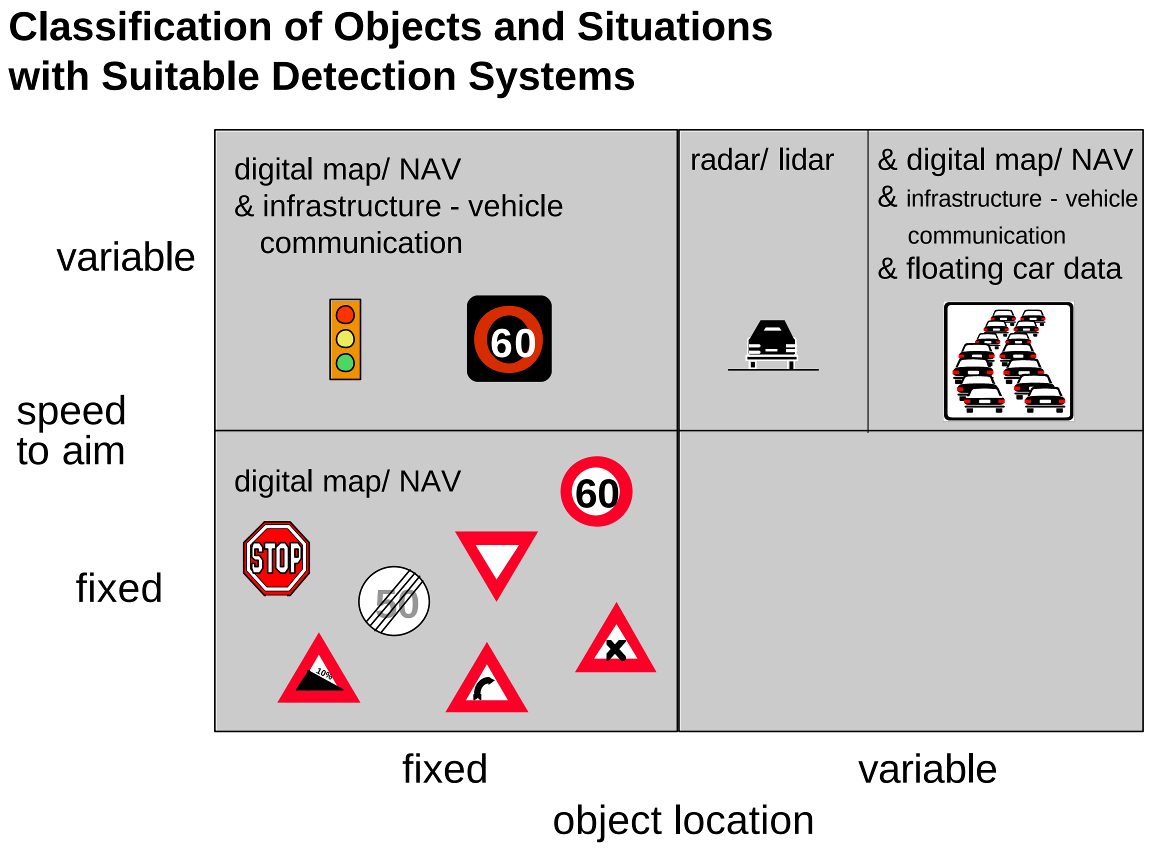


Figure 4: Classification of objects and situations with suitable detection systems

Beginning with the lower left-hand rectangle, we can see the least complex cluster of situations to detect and react to. These feature a constant speed default. Due to their fixed location on the road, information can be supplied by digitised road maps and navigation systems which read this information.

The other type of objects in the upper left-hand sector have a fixed location but may be variable due to special factors such as traffic flow, weather conditions or the colour of the traffic light. Additional equipment is required in order to detect this information properly. The digitised road map and navigation system give the location of the occurrence and the relevant speed information has to be extracted from an infrastructure vehicle communication system. It is important that a suitable correlation is found between the different information sources. The right-hand section of the portfolio shows situations with differing object location. These types of traffic influences are dictated by other vehicles with variable speed. As a result, the speed our vehicle has to adapt to avoid an accident must be variable as well. Vehicles which are directly ahead can be detected by vehicle radar systems, soon to be launched for ACC applications, whereby the secure detection distance is limited to about 150 metres. To capture the surrounding traffic beyond one or two leading vehicles, a capable short range vehicle communication system or observation system would be ideal. Also possible - and more realistic - is the use of floating car data (FCD) combined with infrastructure-vehicle communication and positioning systems. Completing this depiction, the lower right-hand section of this portfolio considers only exceptional traffic situations with fixed speed limits but with variable positions, such as lawn mowing machines on the motorway carrying a speed limit sign at the rear end of the truck. This structured consideration of traffic situations and possible detection systems also outlines the amount of work required to incorporate this situation in the overall strategy.

All these individual situations affect driving in some way, and many of them interact to create particular driving behaviour. The driver does an incredible job of dealing with all these different factors at the same time. So it is a demanding but necessary task to offer additional advantages to the driver using this system. The only way to do so is to extend the detection and situation processing facilities beyond the driver's visual horizon. The additional time to react to situations due to this "electronic horizon" and the precise knowledge of the characteristics of the drive train used to optimise fuel economy are the key benefits of this system. The driver can profit from this assistance.

Systematic investigation of driving strategies

The early detection of objects and situations on the electronic horizon is an essential requirement, allowing an early reaction with an optimum driving strategy. A strategy has to be selected which will use as little energy as possible. As already shown, driving is made up of four basic driving strategies:

- Acceleration
- Constant speed } Dynamic driving strategy
- Deceleration
- Standstill

The dynamic driving strategies can be actuated as a result of active intervention, for example pressing the accelerator pedal or applying the brakes, or as a result of passive influences. Passive influences include all aspects of driving resistance, for example rolling friction and environmental influences such as headwind or hills. The energy required for overcoming rolling, acceleration and air resistance as well as drive losses is non-usable energy, while the energy required for climbing and speed increase is converted into potential and kinetic energy which can be re-used for propulsion. The combination of active driving influences with passive effects can lead to both complementary as well as contradictory effects. It is important that all parameters are considered as a whole to ensure that energetic use of the given passive effects is guaranteed by active strategic driving reactions.

If we limit this to an ideal observation of driving strategies on the level, complex combinations with a view to driving up- and downhill and the effects of a headwind are omitted. In many cases it is necessary to consider topographical characteristics of the route. In this paper, however, we abandon this aspect and focus on presenting the basic features of the system.

Acceleration wishes on an open stretch are implemented at will by the driver using the accelerator pedal, and the gear is selected in line with the transmission control. This means that the engine produces the desired acceleration performance but does not automatically adopt an operating level with the most favourable fuel consumption levels. Potential for improvement is offered to the driver in the form of a recommended accelerator pedal position for optimum fuel consumption. This increase in efficiency - in line with the driver's wishes for vehicle performance - offers an improvement of several percent for the acceleration process. Further benefits as a result of advanced recognition of a possible acceleration phase are not given (*Figure 5*).

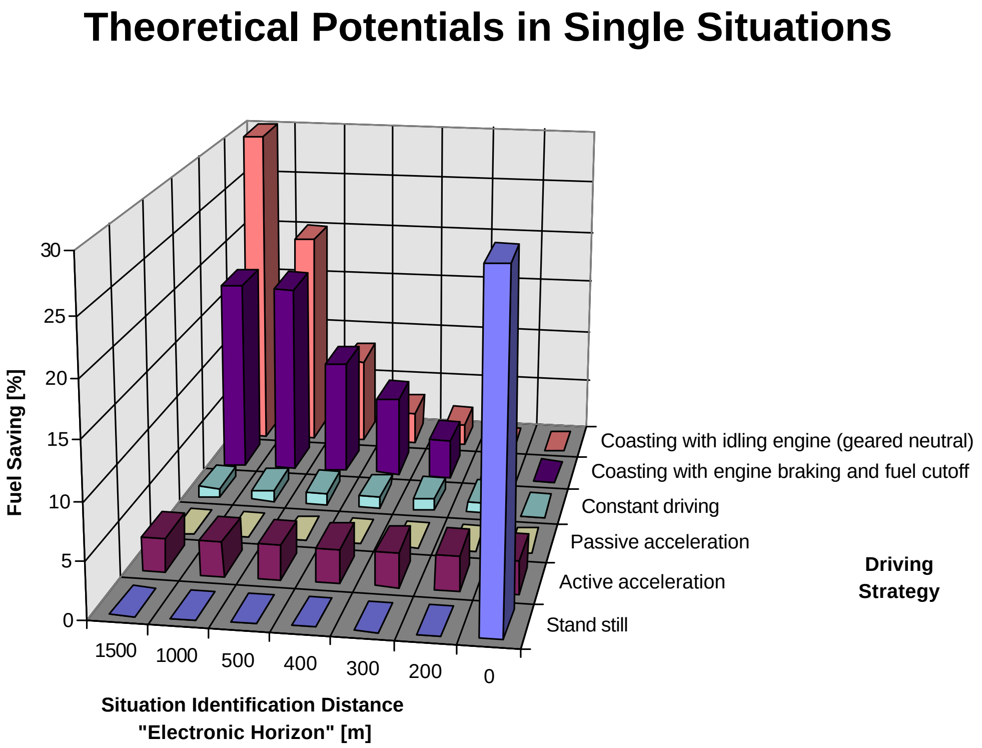


Figure 5: Characteristics of driving strategies and fuel saving

Similar factors apply to the constant speed driving strategy, which aims at maintaining the energy potential of the vehicle in the face of influences causing driving resistance. The early recognition of a section of the road which is highly likely to represent a constant driving speed for the vehicle does not increase the possible potential for saving energy. This is achieved by the optimum operating point being selected in the combustion engine by changing the ratio of the transmission. As a result of "looking into the future" using the "electronic horizon" these ratios can be utilised in a much more acceptable manner for the driver.

The deceleration strategy represents the type of driving strategy with the greatest possible potential for saving energy. With deceleration procedures, speed is reduced, i.e. the vehicle reaches a lower level of energy under the above-mentioned restrictions. The objective of an optimised deceleration strategy is to convert as little energy into heat as possible by applying the brake causing the energy to be lost. We can differentiate between two different types of deceleration on the level without active braking:

1. Freewheeling, i.e. coasting with the engine declutched or geared neutral
2. Engine braking, i.e. coasting with the clutch engaged, variable using different ratios

A freewheeling strategy exploits the energy invested in the vehicle to the maximum. The deceleration procedure from a speed v_1 to v_2 where $v_1>v_2$ encompasses the maximum distance to be travelled and signifies the lowest deceleration. Ideally, the engine would have to be switched off rather than being run in idle. This procedure allows the maximum energy-saving potential to be exploited. A critical requirement for this strategy, however, is the necessity of very early detection of the situation requiring complicated procedures and, subsequently, an equally early reaction to the situation. Coasting by declutching of the engine well ahead of the object or situation are often found to be unpleasant for the driver. The lack of success for concepts with freewheeling and engine cutout features demonstrates the lack of customer acceptance. The permanent energy-saving potential does, however, make this engine cutout system very interesting for lowering energy consumption levels [4]. It is more important to look at the reasons for this system not being accepted and to eliminate these with new concepts and components.

The second method of deceleration is the use of the engine brake linked with deceleration fuel injection cutoff. This strategy enables the desired vehicle speed to be adopted with "zero consumption" as a result of advanced deceleration, whereby deceleration is considerably higher and increases as lower gears are selected.

The main differences in the coasting strategies lie in the objectives with regard to energy-saving potential, the distances available and driver acceptance. While the freewheeling strategy offers greater potential for saving energy with extraordinary early reaction capabilities, the consistent use of engine braking with the deceleration fuel cutoff also allows later detection and reaction for good fuel savings.

It must be emphasised, however, that the driver assistance system SAM can only support the driver in certain predictable driving situations. For example, driver-motivated deceleration passes through the drive management system without any useful reduction in energy consumption. This also applies especially for standstill situations. Fuel economy improvement is only possible in the case of a non-driver-motivated - i.e. traffic-related - vehicle standstill. The concept covers, for example, switching off the engine when the vehicle comes to a standstill at a red traffic light, if the appropriate data is available.

Early situation detection allows a sustained reaction

As already mentioned in the context of the engine cutout, this driver assistance system offers the possibility of utilising new and well-established fuel economy methods with increased acceptance. Both from a point of view of drive development as well as data recording and processing, it appears to be the sensible thing initially to equip this system with functions that are already tried-and-tested. This data basis and the exclusive use of these functions is referred to as the "today" scenario. Fuel economy improving measures on the conventional drive train such as automated coasting and engine cutout systems in connection with expanded data recording make up the scenario "tomorrow". The vehicle and traffic simulation program PELOPS [5] developed for longitudinal dynamic tests was available for initial calculations for estimating potential as well as off-line simulations of the drive management system. All observations refer to a medium to large-sized vehicle with six-cylinder engine (2.5 liters, 170 hp), 5-speed automatic transmission and a total driving weight of 1700kg. This vehicle, controlled by a "standard driver" is modelled as a standard design in the simulation program. Another vehicle of the same type is additionally equipped with the SAM system for simulation purposes.

The following example (*Figure 6*)describes the driving course of a driver-vehicle unit as a regular vehicle compared with a driver-vehicle unit with SAM support in an approach situation. Both vehicles are driving at 100 km/h on a country road approaching a town. The driver sees the sign approximately 200 m away. He then lifts his foot from the accelerator pedal approximately 170 m away from the entrance to the town and starts to brake to achieve the 50 km/h speed limit approximately when he is level with the signpost.

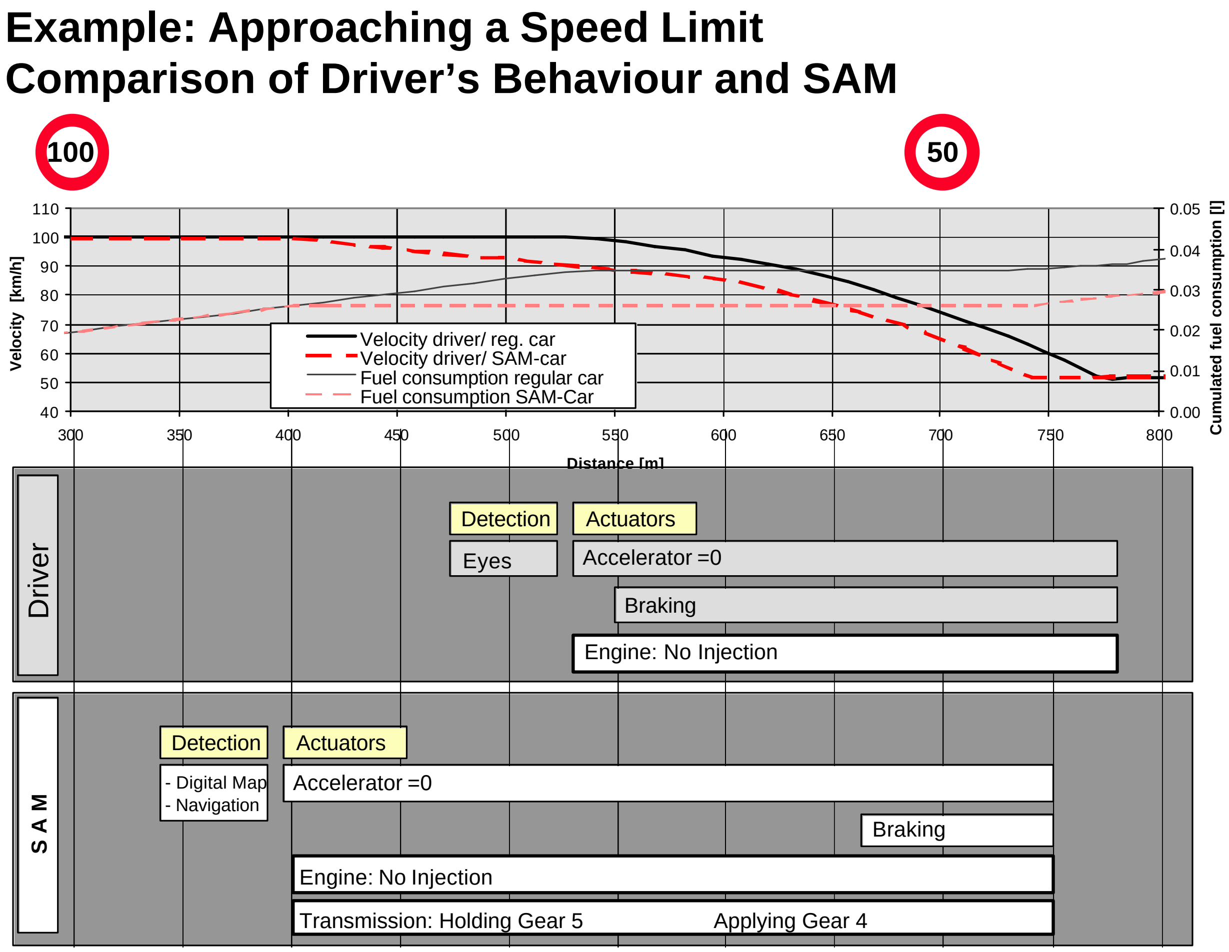


Figure 6: Comparison of driver and SAM-system when approaching a speed limit

The comparison with the SAM system is based on the characteristics of the "today" scenario, i.e. only functions are used which are already available in the vehicle today, or which will be available in the near future. The system is set so that the SAM system can give recommendations at a maximum of 300 m away from a relevant situation.

The SAM computer continually assesses data from the digital map concerning the route ahead. From the information on the remaining distance from the town signpost to the vehicle, SAM calculates at what point ahead of this "occurrence" the accelerator pedal should be released to allow the vehicle to approach the town with the lowest fuel consumption level possible. The driver can sense this process on the accelerator pedal. If he still wants to accelerate, however, he can easily override the pressure point on the accelerator pedal. If the driver follows the SAM recommendation, he will release the accelerator pedal approximately 300 m away from the town signpost, while the SAM drive management system makes sure that the engine function deceleration fuel cutoff remains activated.

The driver still has to apply the brake to slow the vehicle to the 50 km/h speed limit. According to the characteristics of human driving behaviour both vehicles are not cruising with the given speed limit right at the sign, but some way behind it.

The following *Table 1* shows a comparison of the driving values in this comparison test relating to a 1-km stretch of road:

Comparison in an individual deceleration situation	**Driver**	**Driver**	**Difference**
	Regular vehicle	**SAM vehicle**	**%**
Driving distance [m]	1000.83	1001.16	0.03%
Reaction distance before sign [m]	170.00	300.00	76.47%
Starting velocity [km/h]	99.65	100.20	0.55%
End velocity [km/h]	51.51	51.55	0.08%
Time [s]	46.00	47.50	**+3.26%**
Average speed [km/h]	78.33	75.88	**-3.13%**
Absolute fuel consumption [ml]	48.04	40.18	**-16.36%**
Average fuel consumption [L/100km]	4.80	4.01	**-16.38%**

Table 1: Simulation results for an individual deceleration situation

This overview underlines the considerable improvement in fuel consumption on the test stretch when there is an early reaction to the object/situation. The driving strategy with improved fuel economy correlates with a change in the average speed. This was reduced by a good 3% while fuel consumption was reduced by more than 16%.

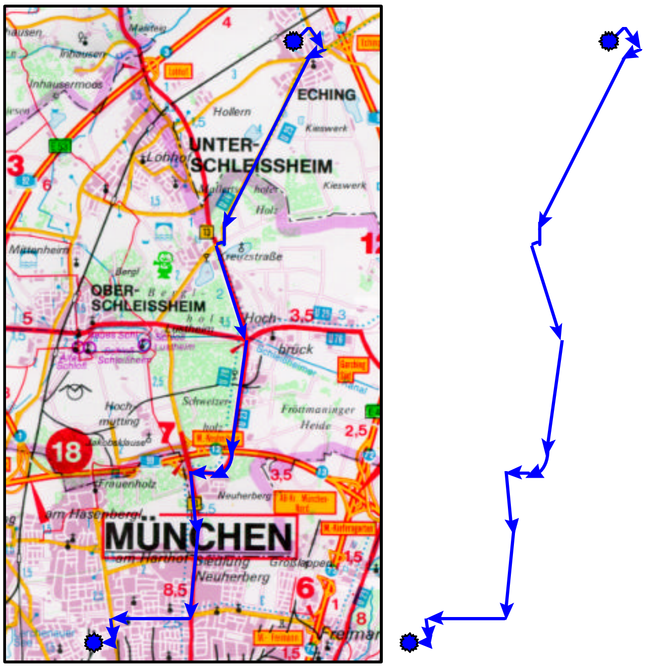
With all individual test situations there were similar relationships between possible savings in consumption exploited by the SAM system with resulting slight time delays. This compromise - with an additional time requirement of a few percentage points compared with savings in fuel consumption of several percentage points - appears to be thoroughly lucrative.

The conclusions that can be drawn on fuel economy potential shown here in individual situations are limited. Important is the frequency of the situations and the degree to which the driver follows the recommendations.

Tests using a number of different situations on several routes in the Munich area showed that a situation which is potentially relevant to the SAM system occurs approximately every 400 m.

As an example, we can take a 16 km stretch of road which can be seen as a typical journey to work. Along this route the driver finds various different situations which present the possibility of reducing fuel consumption (*Figure 7* [6]):

Example route from a suburban village to Munich



Distance: 16.0 km

Total number of situations: 37

Relevant situations: 20

Lower speed limits: 7

Give Way junctions: 1

Traffic lights: 7
Turns / traffic lights : 5

Figure 7: Example journey to work with several traffic situations

Although the driver has to pass 20 sets of traffic lights on the actual route, only 12 are relevant for SAM, as the others are very near to each other and are interlinked or can be passed without a reduction in speed as they all remain green in sequence. The savings in fuel heavily depend on the time at which the vehicle approaches during a traffic light sequence. With this estimate, a constant average value from various simulation phases was applied for all traffic lights in order to evaluate the savings potential.

The test stretch was driven along by a real vehicle with the fuel consumption and driving time being measured. For each relevant individual situation, the fuel savings and the additional driving time were simulated. These simulated values resulted in reduced total consumption and an extended driving time.

For a normal method of driving which is not supported by SAM, the reference vehicle requires an average of 11.0 l/100 km on the test stretch with a driving time of 20 minutes. If the driver is supported by the SAM calculations and if he follows all recommendations, his fuel consumption is reduced by 14.7 %, while his driving time is increased by 36 s, that is 3 %. This applies to an "electronic horizon" of 300 m. With an advanced view extended to 500 m, the simulation shows that SAM assistance can lead to fuel savings of 21% with a driving time increased by 5.4 %, over a minute, on this stretch of road. *Table 2* provides an overview of the results.

Comparison for an example route	**Driver** **Regular vehicle**	**Driver** **SAM vehicle**	**Difference** **%**	**Driver** **SAM vehicle**	**Difference** **%**
Driving distance [km]	16.0	16.0		16.0	
Reaction distance before situation [m]	**50.0-180.0**	**300.0**		**500.0**	
Time [s]	1200.0	1236.0	**+3.0%**	1265.0	**+5.4%**
Average speed [km/h]	48.0	46.6	**-3.0%**	45.5	**-5.1%**
Average fuel consumption [L/100km]	11.0	9.4	**-14.7%**	8.7	**-21.1%**

Table 2: Estimation for improved fuel economy based on simulation results

In this estimate, it is assumed that the vehicle is not influenced by other road users, but only by the traffic infrastructure. When taking into consideration the real traffic density, there are much more frequent occasions when SAM can provide the driver with a recommendation for saving fuel, whereby in these types of situations the electronic visibility is no greater than optical visibility. The savings potential for each situation is therefore reduced. All in all, the claim that the fuel consumption-conscious driver with SAM support can save 15% in fuel consumption using today's technology is very realistic.

Conclusion:

Based on the wide range of requirements that the driver has to deal with regard to his vehicle and mobility, a whole variety of systems have been born out of the development history of automobile construction. In today's climate of increasing pressure to protect the environment, the need for lower fuel consumption and fuel costs is all too evident, while other requirements, such as safety, comfort and good driving performance are not stagnating, and are certainly not on the decrease.

The driver assistance system for supporting predictive, low consumption driving which has been presented here takes all this into consideration. It provides the technical prerequisites for exploiting a considerable potential. The driver himself controls this tool for improving fuel economy for a driving distance from A to B.

Certain functions of this driver assistance system could already be implemented in the near future, whereby additional data systems are required for comprehensive use exceeding the research stage. These include, for example, extended digital maps with corresponding navigation systems and additional telematics data with detailed information on the infrastructure and immediate traffic environment. Developments in this field are advancing at a fast pace and corresponding prerequisites will be available in the coming years.

At the same time, there are an increasing number of low-consumption drive concepts in development, which no longer necessarily have the usual performance level and the range available today. This type of energy-optimising drive management system with an interactive interface to the driver may well increase the acceptance of such systems.

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