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Together for rider safety

One of the main challenges for motorcycling is safety - the accident statistics are of great interest to many, the road authorities, the motorcycle riding community, the individual riders, and the motorcycle industry.
In the last decade, the number of Powered Two-Wheeler rider fatalities in the EU decreased by 25%, from 5,216 in 2011 to 3,891 in 2021. The majority of these were motorcyclists.
The number of all other fatalities decreased by 33% over the same period. (Source: ETSC)

The probability of getting involved in an accident is highest for motorcycles among the motorized vehicle types.
In-depth accident causation investigations, based on the European-funded MAIDS project (Motorcycle Accident In-depth Study), have revealed that in 51% of cases, the accident was caused by the Other Vehicle, and that in 72% of these cases, the accident is caused by a perception failure. Simply worded: “Sorry, I did not see you”.

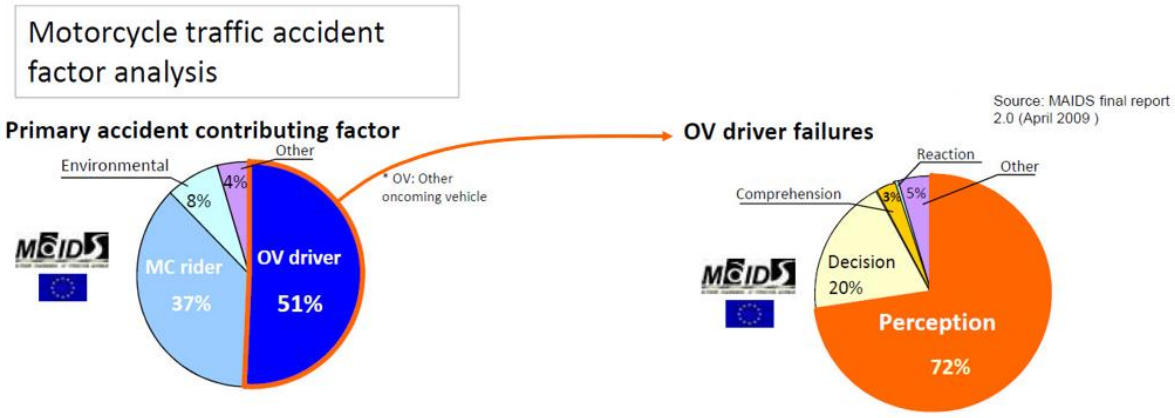

Figure 1 – MAIDS accident causation data – perception failures

Connectivity & ADAS improve Motorcycle Safety

Cooperative communication systems and ADAS (Advanced Driver Assistance Systems, mainly in cars) offer new opportunities, which can make motorcycling significantly safer.
Since motorcycles differ from cars in design, driving dynamics and driver behaviour, car systems cannot directly be transferred and adapted to motorcycles. This applies to driver assistance systems in general but also to cooperative communication systems.
Motorcycles require principle-based adaptations to the applications as such (i.e., motorcycle-specific use-cases), but also hardware and software-side adaptations to the position accuracy, triggering algorithms, antenna positioning and to the human-machine-interface.
Recognizing these challenges, the world's leading motorcycle makers founded the "CMC - Connected Motorcycle Consortium" (www.cmc-info.net).

Digital Conspicuity

Motorcycles are often not seen or recognized by other vehicle drivers, as mentioned above. The catchphrase 'Digital Conspicuity' describes recognition of PTWs by means of exchanging messages to make the other vehicle drivers aware of motorcycles in their vicinity.

To address these perception failures leading to accidents involving motorcycles, the motorcycle industry joined forces and conducted research on Vehicle-to-X communication.

By the very nature of C-ITS systems which require interoperability across vehicle brands, vehicle types, and between vehicles and infrastructure. Vehicle-to-X communication can only be realized successfully if all relevant players cooperate and coordinate their activities.

Initially, such vehicle-to-vehicle research projects focused on passenger cars and are commonly described as Car2Car or Car2X communications. To ensure that motorcycles could equally communicate with cars and be considered into the future connected car system, it was a prerequisite to get involved in the relevant research projects and to actively work together with the car industry.

If motorcycles would communicate on the same frequency, and exchange the same standardized data messages, and comply to the same system requirements, hence ensuring interoperability among vehicles of different vehicle brands, this would allow cars to pick up the approaching motorcycle signal. In addition, identify them as such and potentially generate advance information or warnings to the Other Vehicle driver in case the system calculates that both vehicles are on a collision course.

CMC 1.0: Milestone in 2020

An important goal set out by CMC was therefore to define a first Basic Specification for motorcycles to connect and 'talk the same language' to other vehicles or infrastructure by means of wireless communication.

This is being achieved with the official publication in 2020 of a set of documents to address important topics related to the introduction of C-ITS for motorcycles, such as:

- Accidentology
- Application and Use case definition
- System specification
- Testing and evaluation
- Requests to other industry standardization bodies
- Application strategy
- Human Machine Interface

These CMC 'Basic Specification' documents are available for download on the CMC website: https://www.cmc-info.net/basic-specification.html

CMC 2.0: A wider scope

The scope of CMC 2.0 is wider, and the motorcycle experts are looking at further improvements of the specification while at the same time taking account new functions supported by on-board sensors both in cars and in motorcycles.

The work included investigating the level of conspicuity of motorcycles by ADAS systems. This system approach looks at the potential of on-board sensor systems and connectivity.
Modern cars are increasingly equipped with on-board sensor systems (radar, camera, etc.) and driver assistance systems. These vehicle systems need to include motorcycle specifics to enhance their safety effects in case of mixed traffic with motorcycles.

CMC believes that tailored motorcycle/car scenarios and tests need to be developed and standardized.

Advanced Driver Assistance Systems

Autonomous Emergency Braking (AEB) features as part of Advanced Driver Assistance Systems (ADAS) have been in series production for about 10 years. These systems are based on state-of-the-art sensors and additional information like map data. AEB functions are capable to avoid or mitigate collisions through warnings and automatic brake interventions.

Due to current legal regulations, every series-produced car is equipped with ADAS and AEB systems and Euro NCAP has included PTW specific AEB test cases in their rating system by 2023.

For use cases like Crossing Traffic, Left Turn and Longitudinal Collision autonomous emergency braking can make a difference. The CMC feature team testing demonstrated and validated the efficiency of state-of-the-art AEB systems in cars reacting on motorcycles. Therefore, this technology has a major impact on improving motorcycle safety.

Accident scenario in-depth analysis (IMA, LTA, DNPW)

For the creation of accident scenarios, GIDAS data was used, representing the German accident situations involving PTWs.

In the process, 10 scenario groups were formed (Crossing Traffic, Left Turn, Longitudinal Traffic, Lane Change, Left/Right Curve, Straight, U-Turn, Animal, Technical Defect and Others).

In addition to grouping the individual accidents, the main cause of each accident could be identified. With these distinctions and categorizations, the potential of the C-ITS application was estimated.

To gain a better understanding of PTW accident scenarios, each scenario group was analysed in detail. The scenarios were evaluated to show the respective proportions of the use cases (accident types). This evaluation made it possible to identify specific and distinct accident types, which were subsequently investigated further and in detail.

Finally, it was examined whether the GIDAS data also met global expectations. For this purpose, the IGLAD database for European accidents and the CRSS database for American accidents were evaluated. An evaluation of Japanese ITARDA data is planned as well.

Application and Simulation (IMA, LTA)

CMC has developed specifications of several C-ITS applications such as Intersection Movement Assist (IMA) and Left Turn Assist (LTA), which corresponds, to crossing and left turn scenarios respectively.
These applications take PTW specific characteristics into consideration (e.g., vehicle size, speed at accident) which were studied in the PTW accident analysis. In a second step, CMC has created prototype systems including application software. The software was verified in CARLA (state of the art simulation software) to check if the applications work correctly in expected scenarios, and to check if the applications could avoid false positives in unexpected scenarios. The simulation results were used to further enhance the performance of each application.

Portfolio with hazard warnings (SVW, EEBL)

Next to the above-mentioned scenarios, which are the most frequent cause of collisions between cars and motorcycles, other scenarios create dangerous situations for motorcycle riders as well.
The Stationary Vehicle Warning (SVW) and the Electronic Emergency Brake Light (EEBL) can alert road users to events faster than they are visible to the drivers themselves. This is especially the case when the vehicle is obscured and not detectable by 'line of sight' sensors. The warnings emitted allow the following road users to prepare for an obstacle on the road up ahead. This obstacle may be a stationary or broken-down vehicle on the side of the road, or a vehicle ahead that spontaneously brakes hard. These two warnings draw attention to potentially dangerous situations and give the driver the opportunity to react appropriately.

Rider Reaction Time

With ARAS and C-ITS applications, the motorcycle receives a lot of information about the environment and potential threats. A very important topic to solve is how it can be ensured that the rider gets that important information from the motorcycle. Therefore, CMC investigated riders' reactions towards different types of warnings to identify the most appropriate directions for a PTW-specific warning design.
For that purpose, two user studies were conducted on the WIVW dynamic motorcycle-riding simulator. A visual warning in the dashboard was compared with mirror-mounted LEDs, a Tilsberk Head-up Display, an auditory warning and a motobit vibrating bracelet.
While all warning concepts helped to decrease the perceived criticality in the test situations, the mirror-mounted LEDs received the highest ratings regarding perceived level of safety and acceptance, while triggering fast responses at the same time.

CMC 3.0: Further research and towards deployment

The Connected Motorcycle Consortium is now heading for its 3rd phase in 2024. This includes further research on key factors to reduce motorcycle accidents. A revision of the CMC 'Basic Specification' will be the result of the various activities planned in this 3rd phase. Cooperation with infrastructure stakeholders is envisaged as well as extended cooperation with other vehicle makers towards deployment.

Useful links to CMC documents

CMC continuously contributes to the C-ITS and safety communities by freely available White Papers, Technical Reports and Use Case descriptions in general in particular focused on Powered Two-Wheelers.

Area	Document	Published
Fundamental Research	CMC_WP_0006_PathPrediction	07/04/2023
	CMC_WP_0009_PoweredTwoWheeler_Conspicuity	04/08/2022
	CMC_TR_0005_RiderReactionTime_Study	31/10/2022
Accident Analysis	CMC_TR_0002_AccidentAnalysis_LeftTurn	24/12/2021
	CMC_TR_0003_AccidentAnalysis_AdditionalCrossing	23/09/2022
	CMC_TR_0004_AccidentAnalysis_SingleAccident	23/09/2022
	CMC_TR_0011_AccidentAnalysis_LongitudinalTraffic	01/12/2022
	CMC_TR_0012_AccidentAnalysis_U-turn	01/12/2022
	CMC_TR_0013_AccidentAnalysis_LaneChange	17/01/2023
	CMC_TR_0014_AccidentAnalysis_European	12/09/2023
Use Cases	CMC_UC_0007_Crossing	14/10/2022
	CMC_UC_0010_LeftTurn	14/10/2022