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**FOT-Net
Field Operational Tests Networking and Implementation**



**REPORT ON SEMINARS AND CHAT ROOMS AND
FEEDBACK TO THE FOT METHODOLOGY**

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Executive Summary

1.1 Purpose of the document

A major objective of the FOT-Net project was the transfer of knowledge on the methodology of performing field operational tests and the sharing of experiences. This deliverable provides a report on the activities performed in work package 3 “Implementation of FOT Methodology and FESTA results”.

The FOT methodology was developed in the FESTA project, and consists of a process which systematically details the steps to be taken to set up an FOT, the actual data acquisition, the analysis of the data and evaluation and interpretation of the results. To promote this methodology and to learn from the experiences in different European and national FOTs, eight seminars were organised on: starting a FOT, implementing a FOT, evaluating combinations of systems, data gathering and handling, developing a FOT, cooperative systems, data analysis and impact assessment, and best practices. These seminars consisted of a combination of presentations from speakers from different FOTs, explanation on FESTA, specially developed exercises, and small group work. The participants came from industry, public authorities, consultancy, ITS nationals and research institutes and universities. In all seminars we observed a great willingness to share information and experiences, both positive experiences and problems encountered. All seminars were highly interactive and were evaluated positively. The seminars contributed to the building of a FOT community that is able to bring forwards the methods used in conducting FOTs and that is willing to continue sharing experiences.

The feedback of the participants made it clear that the FESTA methodology proved to be of great support, it does not give all the final answers, and needs to be extended and updated on particular issues. A further objective of workpackage 3 was to provide feedback on the methodology. Next to the gathering of experiences from the seminars, a special workshop was organised to addresses these issues. Some issues are cross-cutting, concerning several phases of the methodology, such as deployment and impact analysis, evaluating cooperative systems, evaluating combinations of functions, dealing with stakeholders, and iteration between different phases. Other issues are more specific for a certain phase in the methodology. Many issues are addressed in this deliverable, some examples are: development and prioritisation of hypotheses, determining what baseline to use, incident definition, data ownership, video-analysis and impact assessment.

We distinguish three types of activities to further support people involved in FOTs. The readability and user friendliness of the FESTA handbook needs to be improved. Some topics are not (sufficiently) covered in the FESTA handbook, and in the continuation of FOT-Net working groups on issues such as data analysis, events definition, legal and ethical issues, impact assessment, and data sharing will gather more knowledge to fill the gaps. Finally we have to accept that some issues are very complex and cannot be easily described in a handbook. Sharing of experiences and knowledge is the best way to provide support in this case; that is why FOT-Net will continue to organise interactive seminars and workshops.

1.2 FOT-Net Contractual References

FOT-Net is a Support Action submitted for the call FP7-ICT-2007-1. It stands for *Field Operational Tests Networking and Implementation*.

The Grant Agreement number is 224088 and project duration is 31 months, effective from 01 June 2008 until 31 December 2010. It is a contract with the European Commission (EC), Directorate General Information Society and Media (DG INFSO).

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1.3 Project Objectives

FOT-Net's primary goal is to establish a support action for strategic networking of existing and future National, European and Global FOTs (e.g. US and Japan). The action should include all stakeholder groups that play or will play an active and needed role in existing and future National, European and Global FOTs.

The major objectives of FOT-Net are twofold. First, FOT-Net will establish a European networking body for National, European and Global FOTs where all stakeholders from public and private sectors are represented. Then FOT-Net will contribute to improve significance, visibility, comparability and transferability of available FOT results at National and European level by promoting the implementation of a common European FOT methodology (FESTA results).

2 Introduction

In the European FESTA project (Field opERational teSt support Action), a consortium of a large number of partners – both industrial and academic – has developed a methodology to conduct FOTs (Field Operational Tests). Using such a methodology guarantees a sound approach to conducting FOTs and obtaining reliable results, and allows for data and results that may be compared between tests. A handbook was written in which the methodology is described in detail (FESTA, 2008). The methodology consists of a process which systematically details the steps to be taken to set-up the FOT, the actual data acquisition, the analysis of the data and evaluation and interpretation of the results, see Figure 1.

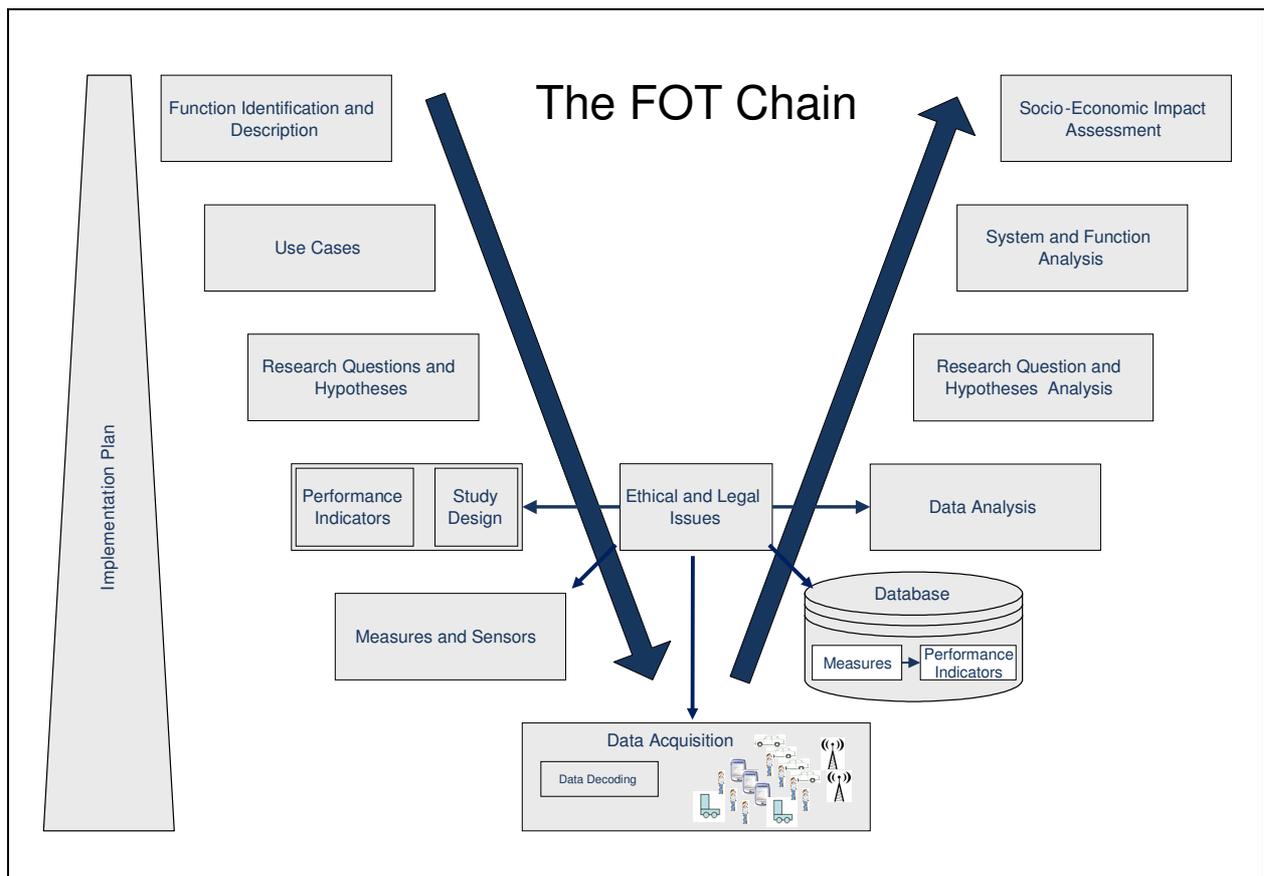


Figure 1 The FESTA-V (FESTA, 2008)

One of the goals of the FOT-Net project is to promote the adoption of the FESTA results – a common methodology for all FOTs – and to facilitate the exchange of knowledge. This is mainly done in work package 3 of FOT-Net. In order to transfer the knowledge developed in the FESTA project, seven seminars were organised in work package 3, held between June 2008 and December 2010. Additionally, one closing seminar and a seminar in Israel were organized. In addition, FESTA issues were discussed during FOT-Net stakeholder meetings and in international FOT-Net workshops at ITS World Congresses.

This deliverable contains feedback on the FESTA methodology and reports on the seminars. The feedback on the methodology is based on experiences from users. The deliverable is organised as follows. First a summary is given of the seminars organised in work package 3

(Chapter 3). After this, the feedback on the FESTA methodology and the issues raised during the seminars are summarised and discussed. First the meta and cross-cutting issues are addressed (Chapter 5). In Chapter 5, the issues raised for every box in the FESTA-V are handled. In Chapter 6 the conclusions can be found. Reports of the seminars are given in Annex A. Besides the eight seminars that are mentioned, also the report from the special seminar organised in Israel is in this appendix. Evaluations of the seminars are given in Annex B. In Annex C the results from the questionnaire on FESTA are given.

3 The FOT-Net seminars

3.1 Organisation of the seminars

The seminars were organised in order to transfer knowledge on the different phases of the FESTA methodology and to share experiences. All seminars were announced on the FOT-Net website, in the FOT-Net newsletter and by direct mail to the FOT-Net mailing list. Several announcements and updates of agendas were made for each seminar. Participants could register electronically. After the seminar they were sent a full report of the event, including the outcomes from the small group exercises. Reports were also made available on the FOT-Net website, and short reports were published in the newsletter. A discussion forum on the topic of the seminar was opened after each seminar. However, people did not make use of this forum very often. In Annex A the reports from all seminars may be found.

In the seminars there usually was a mix of presentations and interactive sessions. All seminars had activities in small groups in which participants were presented with problems they had to solve, for example defining hypotheses for evaluating systems or discussing how the impact of a system could be measured. The results were reported and discussed in plenary sessions. Also interactive discussions, question sessions and panel sessions were part of the agendas. In this way we ensured that the seminars answered the goals of both knowledge transfer and exchange of knowledge and experiences. Most speakers and facilitators came from FOT-Net, euroFOT and TeleFOT and national FOTs, with backgrounds in research, industry and public authorities. Several times we had speakers from the US. In total 22 men and 10 women contributed as speaker or facilitator.

The number of participants in these seminars was always more than 20, on average 26 participants attended. The participants were usually from different backgrounds, coming from industry, public authorities, consultancy, ITS nationals and research institutes and universities. Both experts and novices in FOTs and related areas attended. Many attendees were involved in a FOT themselves or were preparing to be involved in one in the future.

Participants were asked to complete an evaluation form after each seminar. In general they gave very positive feedback; the appreciation of sessions was mostly “good” and “very good”. Most of the participants answered the question on whether the information was useful to them with “yes”. During the seminars most participants showed a very active attitude, engaging enthusiastically in the interactive sessions. In Annex B a summary of the evaluations is given.

3.2 Summary of the seminars

The following seminars were organised:

Seminar 1: starting a Field Operational Test

October 23rd 2008 in Brussels

Topics:

- FOT-Net project
- FESTA methodology and handbook
- Practical example from euroFOT
- Creating hypotheses, use cases and research questions

- Prioritisation of hypotheses
- Ethical and legal issues in FOTs

Seminar 2: implementing a Field Operational Test

October 24th 2008 in Brussels

Topics:

- FOT Implementation Plan
- Cases from TAC SafeCar FOT and SeMiFOT
- Study design
- Selection of participants
- Study environment
- Vehicle fleet

Seminar 3: evaluating combinations of functions or systems

February 6th 2009 in Amsterdam

This seminar was organised by special request from stakeholders; the problem of evaluating combinations of functions or systems had proved to be a difficult one during the first seminar and in several FOTs.

Topics:

- Selection of functions or systems and the expected interaction between them
- Formulation of research questions and hypotheses for a combination of functions or systems
- Performance indicators
- Determining baselines
- Practical constraints and solutions in evaluating combinations of systems and functions
- Solutions for practical problems and recommendations

Seminar 4: data gathering and handling

May 13th 2009 in Munich

This seminar was organised in collaboration with Chemnitz University of Technology.

Topics:

- Practical issues in FOTs
- Data requirements and data management in German FOT's
- Data acquisition at the German1-VMC in euroFOT
- Data management: from car to database to analysis process
- Management of video data
- Data management in the 100-car study
- Reuse of data

Seminar 5: how to develop a FOT

October 16th 2009 in Paris

Topics:

- Stakeholder Analysis theory
- How do interest groups influence environment, discussion and project
- Policy maker's views
- How does a project leader deal with all stakeholders?
- Cooperation with stakeholders
- How to generate impact via the media

Seminar 6: issues in evaluation of FOTs of Cooperative Systems

March 24th 2010 in Amsterdam

This seminar was organised in parallel with the Intertraffic and the Cooperative Mobility Showcase 2010.

Topics:

- Cooperative Mobility from the infrastructure point of view: needs, potential and the North American landscape
- PRE-DRIVE C2X: preparing a European FOT on Car-2-X communication
- Evaluation issues related to interaction between drivers, in-vehicle and roadside systems
- Evaluation issues related to penetration of equipped vehicles and roadside equipment
- Scaling up the results of evaluation in order to provide recommendations for stakeholders
- Cooperative Mobility Showcase demonstration tour
- Challenges in the application of the FESTA methodology to FOTs of Cooperative Systems

Seminar 7: Data Analysis and Impact Assessment

October 5th 2010 in London

Topics:

- Data Analysis on Nomadic Systems: the TeleFOT approach to Data Analysis
- Making data meaningful: the use of time and space in FOT analysis
- Assessment of Impacts: from performance indicators to scaled up impacts
- Answering research questions
- Socio-economic aspects: how to analyse costs and benefits using FESTA
- Society level versus stakeholder level

Seminar 8: Best practices using the FESTA methodology

December 1st 2010 in Brussels

- The issues raised during the FOT-Net seminars
- Defining functions, research questions, hypotheses and performance indicators: best practices from TeleFOT, euroFOT and national FOTs
- Designing a FOT: iteration in the FESTA methodology
- Data acquisition methods and systems used in the different FOTs, advantages and disadvantages, cost-benefits, recommendations for the future
- Experiences on answering the impact question
- Best practices in organising FOTs
- The challenges for the coming years

Seminar in Israel

June 22nd and 23rd 2010 in Herzlia, Israel

This seminar was organised on invitation from ITS Israel, an associated partner in FOT-Net, and in collaboration with ILTAM.

Topics:

- The work going on in FOT-Net
- The FESTA methodology
- Research questions, hypotheses and performance indicators
- Data acquisition and data management
- Study design
- Real-life experiences from FOTs
- Stakeholder analysis
- Scaling up of the results and impact
- Simulation

3.3 Coverage of the FESTA-V phases

The seminars covered the different phases in the FESTA-V, see Figure 2. Seminar 5 and 6 covered topics that are not explicitly mentioned in the FESTA-V. Consumer relations & marketing and policy making support (seminar 5) are subjects that need attention throughout the whole FOT process and cannot be contained in one 'box'. In seminar 6 on cooperative systems also issues throughout the FESTA-V were covered, focussed on cooperative systems. Seminar 8 on best practices also covered several topics in the FESTA-V.

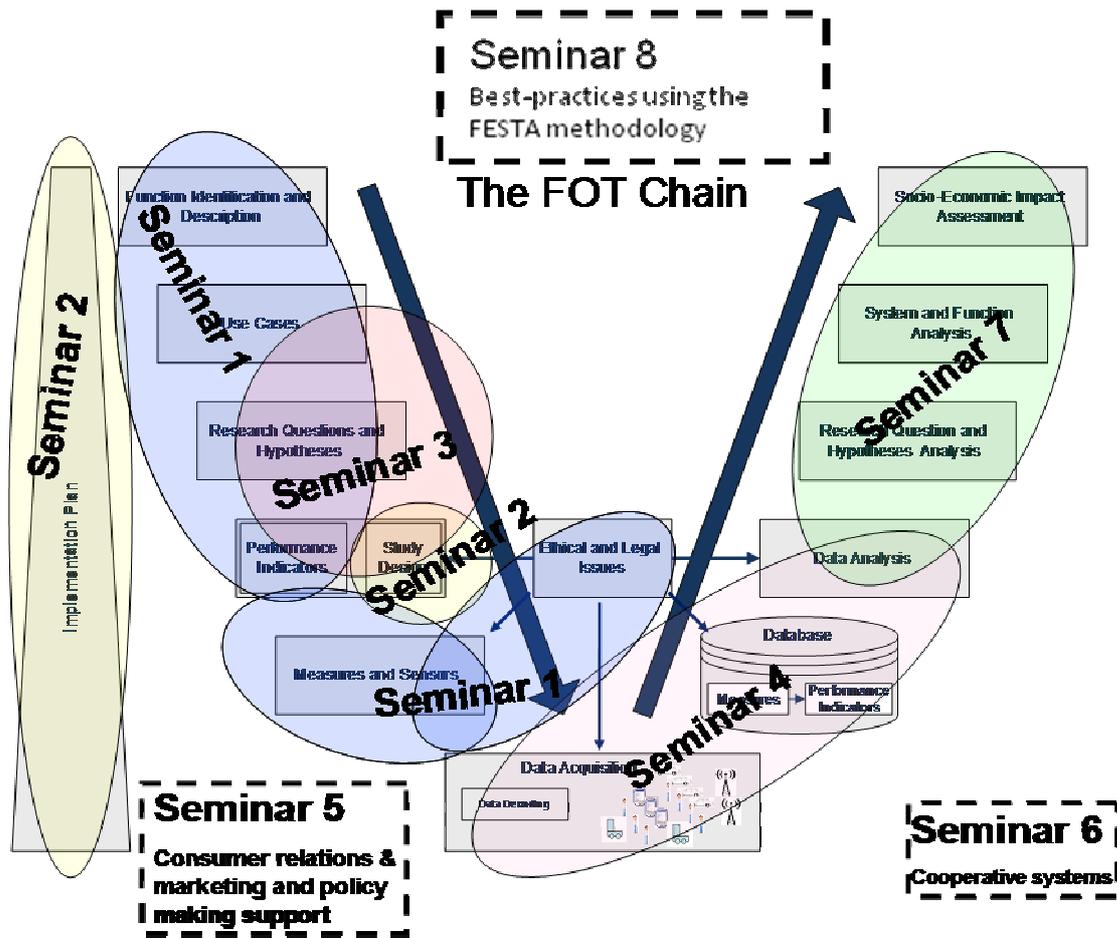


Figure 2: Coverage of FESTA-V by FOT-Net seminars

3.4 Organisation of additional sessions

In addition to the seminars, a workshop was organised to discuss the issues raised during the seminars in relation to the FESTA methodology. In a special workshop held in Leeds on June 14th 2010, the methodology was discussed by 10 representatives from different FOTs. Special attention was paid to topics coming from the FOT-Net seminars: *Baselines*, *Hypotheses prioritization*, *Incident definition* and *Scaling up of results*. Some of the cross-cutting issues are the evaluation of multiple systems and functions and the interactions between them, the analysis of stakeholders in different stages of a FOT and how to deal with them, and the way in which iteration in the design of a FOT should be handled. In preparation for this workshop a questionnaire was used to ask the opinion of people involved in FOTs. Although most of the respondents found the FESTA handbook useful and user friendly, there is also a need for further improvement and detailing on specific topics. A summary of the results of the questionnaire is given in Annex C. The specific outcomes from this workshop and the questionnaire are further discussed in Chapters 3 and 4 as part of the feedback on FESTA.

Two conference papers on the issues discussed during the seminars were presented and published:

- Annual meeting of the Human Factors and Ergonomics Society, Europe Chapter in Linköping, 2009 (Carsten and Barnard, 2010)
- European Conference on Human Centred Design for Intelligent Transport Systems in Berlin, 2010 (Barnard and Carsten, 2010).

During the FOT-Net workshop at the ITS World Congress in Busan, 2010, workshops took place on incident definition and data analysis. The outcomes from these workshops also form part of the feedback on FESTA.

The difficult topic of incident definition was further discussed during a special session during the ICTCT (International Co-operation on Theories and Concepts in Traffic Safety) Conference in Leeds, 2009. The presentations were made available on the FOT-Net website.

In collaboration with the projects PROLOGUE and DaCoTa, a special workshop was organised on November 30th 2010 in Brussels on “near crashes”.

3.5 Conclusions on the seminars

Organising interesting seminars is a challenging task, since it is determined or judged by the people attended. Targeted communication directed to the right people and the right speakers is a must. Cooperation with a national stakeholder, such as the national or regional ITS organisation is helpful to get the targeted people signing up to the seminars. Also we found that more people were attracted to a 1-day-seminar if this is organised at a well accessible location (e.g. close to an airport) or if it is scheduled the day before/after another 1-day event. These issues are regarded as preconditions for success. Nevertheless, the WP3 team found that the most important factor is to include interaction. In the organisation of the seminars a lot of time was spent finding, developing or adapting the right cases and approaches to the topics under discussion in the seminars. Working, instead of listening, gives better understanding of the challenges one will meet using the FESTA approach.

In all seminars we observed a great willingness to share information and experiences, both positive experiences and problems encountered. To conduct a FOT is challenging and by no means a routine task. There is a large need for information, ideas, lessons-learned and best-practises. Although FESTA proved to be of great support, it does not give all the final answers, and needs to be extended and updated on particular issues. In our opinion, the seminars contributed to the building of a FOT community that is able to bring forwards the methods used in conducting FOTs and that is willing to continue sharing experiences.

4 Feedback on cross cutting issues

In this chapter cross cutting issues are discussed. Cross cutting issues are issues that cannot be allocated to a specific part of the FESTA-V diagram, but play a generic role or cover different aspects throughout the FESTA-V.

4.1 *Deployment scenarios and impact analysis*

Currently, the FESTA methodology does not specifically allude to deployment scenarios. However, there is no reason why the FESTA approach cannot be extended to encompass deployment issues. This requires a FOT to be consulting early on with stakeholders to establish likely deployment scenarios.

In order to be a cost-effective and informative FOT, the results gleaned should be of the correct type and “shape” that is required for the next stage (impact assessment). This is vital as the decision makers use these results to inform policy or guide further research. Part of this process involves the development of implementation or deployment scenarios (and could be dependent on the funder of the FOT). This should be included as a further section in the FESTA handbook, to cover why, and how to do a scenario analysis. The importance of this is clear: it acts as a baseline, against which other scenarios can be tested and sensitivity testing of CBA to different scenarios can also be undertaken. An important consideration in the scenario analysis will be future vehicle fleets (including electric/hybrid vehicles).

4.2 *Cooperative systems*

Seminar 6 was devoted to the topic of cooperative systems. The FESTA methodology covers most of the issues relating to cooperative systems, however there is one that requires a little more expansion in the handbook – that of the identification of the different data sources (via infrastructure and the vehicles etc.) and the need to synchronise those data sources (using time stamps). Here, thorough piloting is an absolute necessity. Synchronising the data will be imperative for the detailed analysis of behavioural effects of cooperative systems, for example driver response to communications.

A further issue is that of the investigation of the behaviour of non-equipped vehicles, when interacting with the equipped vehicles. Do equipped vehicles, for example, alter the behaviour of those that are non-equipped and how do non-equipped drivers predict or assess the behaviours of those that are equipped? Both positive and negative effects should be considered and hypotheses and performance indicators developed accordingly.

The penetration rate of the equipped vehicles in the predefined “test” area will affect both the validity of the results obtained (i.e. is enough cooperation occurring between the vehicles in order for effects to be observed) and the behaviour of the individual drivers. One of the most important points to note is that the experimental design will very much depend on the penetration rates that can be achieved, in terms of numbers of vehicles and drivers used, and the length of time to run the FOT for.

4.3 *FESTA handbook usability*

A short questionnaire on this topic was sent around before the FESTA workshop, covering aspects of readability and usability; see Figure 3 and Figure 4. We received feedback from 13 experts involved in FOTs. In Annex C their answers may be found.

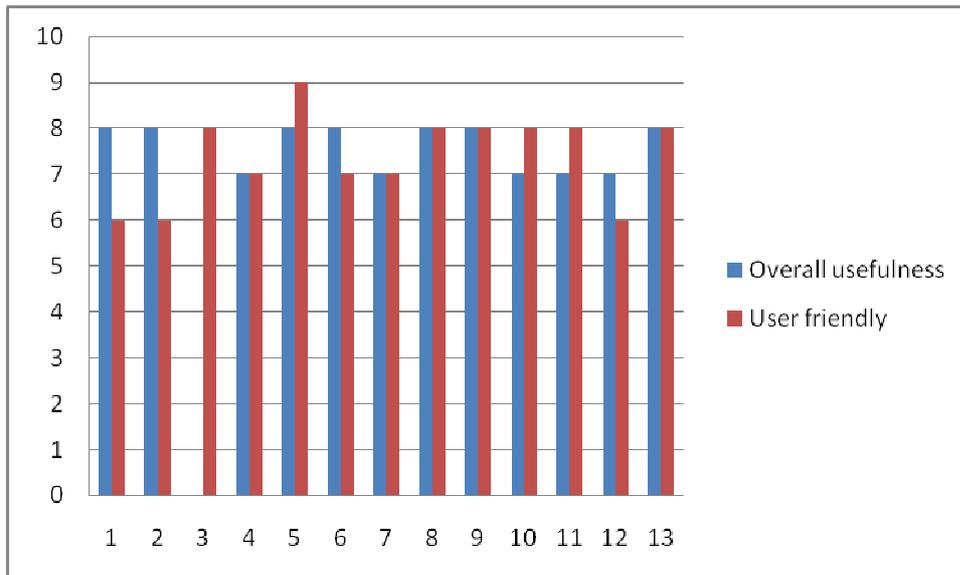


Figure 3 FESTA feedback questionnaire: Usefulness and friendliness on a scale from 1-10, 13 respondents

Overall the respondents are in agreement with each other that the FESTA handbook is useful, but that its usability required improving.

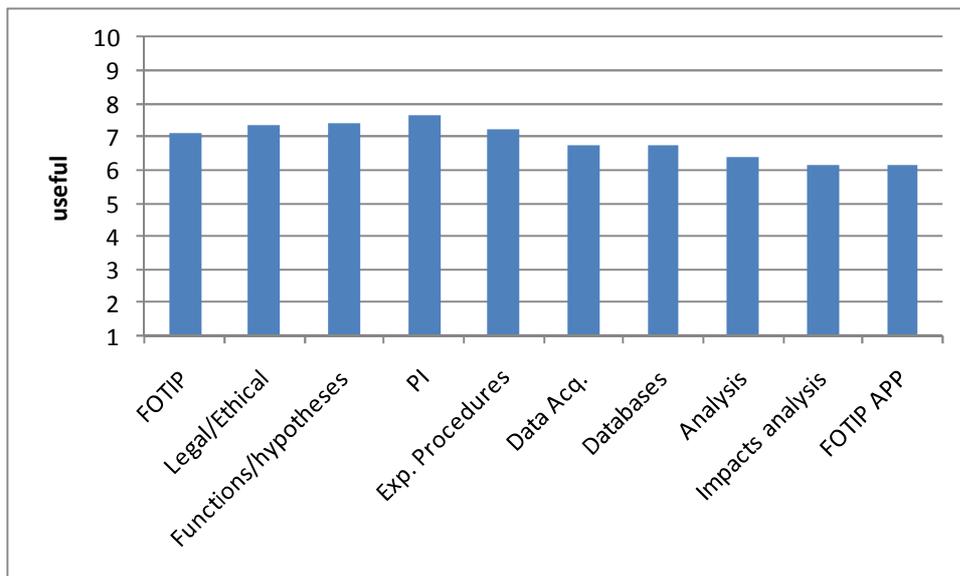


Figure 4 FESTA feedback questionnaire: Usefulness of individual components on a scale from 1-10

It is interesting to note that the handbook scores lower on usefulness as we move through the FESTA-V, reflecting the higher level issues such as impact analysis.

Participants were in favour of a hyperlinked version of the handbook, allowing easy searching and browsing between sections. In addition, the handbook does not have an index, which could be useful, and a “how to use” section.

4.4 Combinations of functions

A dedicated seminar (Seminar 3) was held on the topic of evaluating combinations of functions.

There are many cases where functions appear as a bundle or package (for example ACC and FCW), and this can have implications for the generation of the appropriate hypotheses (if we consider interactions between the functions to be important). Carrying out a FOT using real drivers and on-market systems then presents a problem of disentangling the effects of the individual functions. In summary, the FESTA methodology can be applied in exactly the same way as when there are single functions, with some extra effort required at the stage of hypothesis formulation and impact assessment. It is useful to think of the synergistic effects that one system may have on another when formulating hypotheses.

The seminar identified a useful approach to the generation of hypotheses around combinations of systems and/or functions. The recommended procedure was to:

1. Begin separately with the individual functions, generating a list of research questions and hypotheses
2. Examine commonalities and conflicts between the systems:
 - a. Can they generate simultaneous warnings?
 - b. Are the same performance indicators relevant?
 - c. Do they have a common interface and can they both be activated simultaneously?
 - d. Are there common factors influencing usage?
3. Distinguish between hypothesised additive effects when the two systems interact with each other and multiplicative effects when the presence of a second system will alter the effects of the first. Additive (or subtractive) effects mean that the size of the effects will change. Multiplicative effects mean that the relationship is different, i.e. that there is an interaction in statistical terms.

The application of this procedure should produce a comprehensive set of hypotheses on how the functions might interact and should affect the subsequent experimental design. However, it must also be realised that it is impossible to unbundle some joint functions.

4.5 Stakeholders

In the FESTA handbook (chapter 10) a financial stakeholder analysis is referred to, and the involvement of the stakeholders is also mentioned in the FOTIP. The FESTA handbook, however, does not specifically mention at what stages the stakeholders should be consulted nor how to involve them. This was discussed at Seminar 5 which concluded that it is necessary to identify and contact the stakeholders and perform a stakeholder analysis at the beginning of the FOT and keep them involved via the organisational structure of the FOT (e.g. steering group, consultation group). However, as discussed in Seminar 8, stakeholder involvement is needed to find out what they want/need, but stakeholders should not be involved in the detailed definition of hypotheses.

4.6 Iteration

Everyone agrees that the FESTA methodology is an iterative process and on a number of occasions we discussed how this iterative process should be handled. Decisions made at a certain stage of the FESTA-V influence the next steps and it is inevitable that sometimes you have to go back and redo some steps. The linear or 'waterfall' idea of the V does not always work in practice. At the right hand side of the FESTA-V you have to refer to hypotheses and research questions. This connection between the left hand side and right hand side of the V is not made explicit in FESTA. When working on the left hand V, it is necessary to consider the right hand side. But, when does one stop the iterative process? From a research perspective, this is a continuous process. However, from a project management perspective, boundaries have to be set to reflect budget constraints and timing aspects.

In Seminar 8, iteration was discussed. Iteration is especially important when defining research questions and hypotheses, because usually a selection has to be made from the large amount of possible hypotheses, both based on their relation with the main impact areas and research questions and on practical issues. Another important iteration point is the impact areas. The final question on the impact assessment may drive the design of the FOT in all its aspects. When practical issues, such as for example which data-loggers to use, make certain choices hard to realise, iteration to earlier stages is necessary. Different types of FOT, aiming to answer different questions, may have different starting points. Some FOTs may start from the impact questions; others may begin with use cases and functions, or with research questions. Cost-benefits analyses and feasibility assessment of different options for the FOT may also drive the design.

5 Feedback on the FESTA FOT chain

In the FOT-Net seminars as well as in the questionnaire and the workshop on FESTA in June 2010, a series of issues were raised. These can generally be assigned to a single box in the FESTA-V diagram (see Figure 1) that describes the sequence of the FOT chain.

5.1 *Function identification and description*

In section 4.2.1 of the FESTA handbook, it is stated that usually it is quite clear from the beginning of a FOT what functions or at least what type of functions will be the object of the evaluation. However, stakeholders have different ideas about the functions they want to test, and function descriptions are not always clear.

One issue is whether a function is generic or manufacturer-specific. In other words, how far should the particular manufacturer's specification and functionality be considered. The functionality can clearly have an impact on acceptance and behaviour. An example here might be an LDW that gives auditory and visual warnings and one that provides haptic feedback through the steering wheel. It is also possible that one design will turn out to be more effective than another. This is specifically acknowledged, for example in the EuroFOT evaluation of "Safe HMI" where different designs for navigation support are being compared.

A number of issues have been raised with regard to function identification and description. It is not necessarily the case that there is an obvious or generic solution to each issue. The first issue is how to split activities between the proposal phase and the project phase. There are clear advantages in beginning the work on the top left of the FESTA-V at the proposal stage as this will allow a more detailed planning of the data collection plans, of the experimental design and hence of the costs. But it is still necessary to further specify research questions, hypotheses and performance indicators during the project phase. On other issues there are also no firm answers. The issue of how many functions can be investigated in a FOT is a matter of the resources to be deployed and of whether the impacts of the each function is to be investigated separately or alternatively whether the functions are to be treated as a package. Multiple functions can have interaction effects with each other and combinations of functions can therefore have impacts which are not simply the sum of the individual effects. On the other hand it may not be feasible to get the functions to work separately — for example FCW is now generally provided in combination with ACC so that when using ACC it is not possible to switch off FCW.

However, if the major focus is on how drivers and other users actually use a function, then a very detailed investigation, function by function, may be required. A FOT and the funders of each FOT must make their own decisions.

5.2 *Use cases and situations*

When going from functions to hypotheses, use cases to test these functions have to be defined. This is described in section 4.2.2 of the FESTA Handbook. According to the Handbook, use cases are created in order to consider the functions in terms of specific situations. They are technology-independent and are used to group functionalities and to help in answering more generalised research questions. In practice, some issues have arisen with regard to defining use cases.

Definitions

The definitions of use cases, scenarios and situations made in the FESTA handbook are not clear. For example, the term “use case” is often used in the Intelligent Transport Systems domain to mean functions, while in the FESTA definition it is a “target condition in which a system is expected to behave according to a specified function”. Maybe because of this, the application of the use case approach is often too narrowly focused (e.g. only on expected and intended effects), while the FESTA intention is that situations which were not anticipated by the system designers and scenarios in which the behaviour of the system might be misunderstood by users should also be taken into account.

In the FESTA handbook, the paragraph on use cases could be improved by giving clearer definitions, such as those developed for the EuroFOT glossary. This newer glossary was the outcome of a discussion about the inadequacy and lack of clarity of some of the FESTA definitions. It would also help to provide more examples, and to explicitly mention the fact that unintended effects can also happen and should be considered when defining use cases.

It should also be feasible to develop a kind of check list of major considerations to cover in developing use cases and situations (the combination of a use case and a situation is defined by FESTA as a “scenario”). Examples of situations are road types, including changes of road type, weather conditions, traffic conditions, presence of vulnerable road users, familiarity with the function, etc. The examples could illustrate the application of such a checklist.

Relation with objectives and policy goals

Each stakeholder has a different view on the use cases that have to be defined. For example, a road operator is interested in different aspects and situations than a service provider. Also, the relation between use cases and the objectives of the FOT or the policy goals that are targeted with a FOT is important.

One issue here that is not made clear in the FESTA Handbook is that there should be a relationship between use cases and situations and overall objectives and policy goals. A further complication is that use cases and situations can be defined at various levels of generality or specificity — with ACC enabled on a rainy day, on a road with sharp curves on a rainy day, on a road with sharp curves while driving fatigued, etc.

5.3 Research questions and hypotheses

A suggested process for defining hypotheses can be found in the FESTA Handbook (see Chapter 4). Following this process allows one to move from general research questions to specific and statistically testable hypotheses. However, there is also the issue that the subsequent need not just to test hypotheses, but also to scale up in terms of overall system effects needs to be considered.

Development and prioritization of hypotheses

The issue of who develops the hypotheses and who is responsible for coordinating this activity will very much depend on the types of functions under consideration and the overall goals of the FOT. However, in general, hypotheses should be generated in a collaborative manner, involving all major actors, including those who will be undertaking the impact assessment and scaling-up activities.

Very large numbers of hypotheses can easily be generated when applying a structured approach, particularly from the bottom-up “use case” approach. These hypotheses may all be valid, in the sense that they can be justified. It is also possible to generate a very large number of more open-ended research questions. It should also be recognised that there can be tensions between different stakeholders in a project regarding the appropriateness of addressing certain issues.

Methods that have been proposed and/or adopted to prioritise hypotheses are:

- Concertation workshops involving multiple parties in the project
- Voting schemes, where voters have a limited number of points (e.g. 100 in total) to assign and can assign those points to particular hypotheses
- Indicate feasibility and cost of measures in order to prioritise in a practical manner

Here, it is important to ensure that there is a mechanism to ensure that the major research questions are covered. Indeed if a very large number have been generated, it is also possible to apply the same selection procedure to reduce the number of research questions to be addressed.

There are also a number of practical issues to consider. In particular there are links with performance indicators and data acquisition systems (DAS). A hypothesis may be of quite high interest, but could be extremely costly to address. Budget is not unlimited, so that, once the feasibility and costs of data collection are clearer, a review of hypothesis prioritisation is warranted. Alternative lower-cost methods of addressing hypotheses, such as via questionnaires or ad hoc studies, should be considered. Indeed comparison of the cost of data collection to the “benefits” of acquiring the data has been used for prioritisation of the research questions and hypotheses to be covered.

Once the hypotheses have been generated and prioritised, they should be documented and maintained throughout the FOT. In this way, changes in personnel will not affect the way in which the data are handled and analysed at the end of the FOT. The hypotheses should also be directly referred to when the results of the FOT are written down and presented to stakeholders.

Baseline

There is no perfect baseline. Many vehicles now come with certain ADAS as standard, and this will be even more true in the future. So just as one would not force on drivers a baseline with e.g. no automatic transmission, one should not necessarily disable all ADAS functionality for a baseline.

Further problems can arise when it is difficult to disable ADAS functionality, as for example when investigating systems already on the market and the prospective participants have purchased vehicles with ADAS functions. Disabling those functions may be (1) technically difficult and also result in sensors being disabled and (2) unpopular with users.

The alternative of trying to identify comparison epochs on the data when the systems are not activated is quite problematic, since it is inherently unlikely that such epochs will be real matches to those when a system is activated. Alternatives to consider are:

- Providing participants with loan vehicles for a baseline (without) period;

- Using a between-subjects methodology where some participants (matched as closely as possible to the “with” group) drive for the whole period without the relevant system(s).

5.4 Performance indicators / Study design

Performance indicator selection

Chapter 5 of the FESTA Handbook (especially paragraph 5.1 and 5.2) deals with performance indicators. Performance indicators are quantitative or qualitative measurements (expressed as a percentage, index, rate or other value), which are monitored at certain intervals and can be compared with one or more criteria. Performance indicators are defined for confirming or rejecting the hypotheses selected earlier. Feedback shows that the selection of PIs is not an easy task. If the wrong indicators are chosen, this may have far-reaching effects on performing the impact assessment later in the FOT. Selecting the right indicators can be difficult for three practical reasons:

1. It can be hard or even impossible to measure the chosen indicators for technical reasons. For example, the data acquisition system may already have been decided upon or bought and is not able to measure what is needed. Or the quality of the sensors is not sufficient.
2. It is too costly or complicated to measure the PI, even if it is technically feasible. For example, too many cars would need to be equipped to measure the indicator.
3. The combination of PIs would require different sets of sensors, and there is no single data acquisition system which can measure them all.

All these reasons are related to data acquisition systems, and although the decision on which equipment to use is in principle taken later on in the FESTA-V, PI selection may be driven by these practical concerns. Another reason why selecting PIs is so difficult is that for some hypotheses it may be very difficult to define indicators.

There are two practical ways of making PI selection easier. The first one is to involve technical as well as scientific personnel in the process. In that way it is not just the researchers giving their ‘wish list’ of PIs. If technical staff are involved, they can give feedback on the practical implications of the PIs that are selected and on the possibilities with regard to data acquisition.

The second action that can be taken is to make the selection of PIs, hypotheses, and maybe even use cases and research questions an iterative process. In that way they can be harmonized better, and, if it is hard to select the right set of PIs or if they cannot be measured in a reasonable way, the hypotheses, and maybe even the use cases and research questions can be reformulated.

Be aware that the function identification may not have been exhaustive, so that for some functionality there will be no PI identified. This may cause problems during the data acquisition and analysis phases. For example, if some part of the functionality may have an influence on braking behaviour and this is not measured (because not defined in terms of data markers), no conclusions can be drawn on this behaviour. Subjective data, such as questionnaires and interviews, should also be carefully selected in order not to miss out on effects of functions that are not well specified. It is also important to consider non-intended

functions and effects when defining hypotheses. In that way the PIs for these non-intended effects are included in the selection.

Definition of incidents and relevant events

In the FESTA handbook there is no information on the definition of incidents and relevant events. These special cases of performance indicators are hard to define. An example of a hypothesis from euroFOT is: “Using Forward Collision Warning, the number of forward crashes, near crashes and incidents will decrease”. Because accidents do not happen very often, FOTs are interested in studying incidents which have the potential to lead to an accident. In euroFOT an incident is defined as: “an occurrence that could have resulted in a crash or near crash, if the circumstances would have been more adverse”. It is necessary to be able to identify incidents in the continuous stream of data recorded in FOTs. It would, for example, save a lot of effort in analysing video data if the analyst could focus on only those situations that pose a threat. Examples of data from sensors such as the CAN-bus, video and radar that could be related to an incident, are hard braking, rapid evasive manoeuvres, and very close proximity to a vehicle, object or pedestrian. However, such identification requires that triggers and thresholds are well defined, and that there are not too many false positives. For example, not every hard braking action is related to some possible dangerous situation. The danger of misses also needs to be considered. False positives from triggers may lead to extra effort in e.g. manual review; misses inevitably lead to bias.

How to define and detect events of rather low severity is a question on which still more research is needed. Not all risky situations are characterised by discrete events. More work is also needed on developing continuous event severity scales and on mechanisms to detect them.

Not all events in which a FOT may be interested are safety-related. When the research focus is on, for example, eco-driving, events may be defined as situations in which sudden deceleration and acceleration occur. For these kinds of events, quantitative definitions also needed and more research is required in order to specify thresholds.

Incident definition was the focus of a special session at the ICTCT workshop in Leeds in October 2009, entitled “Incident Definition for Field Operational Tests and Naturalistic Driving Studies”. Incidents were the focus of a roundtable session at the FOT-Net international workshop in Busan in October 2010. And there was a one-day workshop on near crashes, organised by FOT-Net, PROLOGUE and DaCoTA held in Brussels in November 2010. The last started to reach a consensus on how incidents and near-crashes should be defined qualitatively, but quantitative definitions have yet to be defined.

Contextual indicators

The experimental procedures of a FOT (participants, study design, and experimental environment) are described in chapter 6 of the FESTA Handbook. The performance indicators are usually directly related to elements of the driving task. However, the context may also play a large role. The context may consist of the external environment of the car (weather, traffic, ...) but also of non-permanent characteristics of the driver, such as his/her mental and physical state. All these contextual issues may be of great influence on the use of the function to be tested.

It is not possible to be prescriptive about contextual indicators and how they relate to study design. Their definition should follow from the hypotheses.

Participant selection and recruitment

Paragraph 6.1 of the FESTA handbook is on participants (sample size and characteristics). Activities 15 and 16 of the FOTIP are on selection, recruitment and training of the participants.

Participant selection should ideally depend on the hypotheses. Here again, practical considerations may take over. For example, recruitment and management of fleet drivers may be a very practical option, but may lead to a non-representative sample.

The hypotheses provide predictions about the behaviour of drivers with the system to be tested. These behaviours may differ according to the driver population. An important distinction can be made between professional drivers and non-professional ones. Professional drivers, such as taxi drivers, truck drivers etc. may behave in completely different ways from private drivers. If the hypotheses did not state something explicitly about the driver type, and it is decided to recruit from a specific group, the hypotheses may need to be revised.

Recruitment procedures and contact with professional and non-professional drivers may also be different, as well as legal and ethical concerns. Before a decision is made on which groups to recruit, the consequences on issues further down the FESTA-V need to be clarified.

If indicators have been chosen, some reflection is needed on the expected changes in behaviour over time. Driving behaviour with a system may be different in the familiarisation phase than in the phase in which drivers have become accustomed to driving with the system, or when behavioural adaptation has taken place. This may mean that PIs that work well during a short pilot phase may be less efficient in the long term.

In order to determine how many vehicles/drivers are needed to find an effect on a PI, power analysis is a good method. EuroFOT analysis has indicated that it is more effective to increase the number of drivers than to extend the time period of data collection.

5.5 Measures and sensors

Experience in current FOTs has shown the importance of having a robust and thorough piloting phase to test sensor functionality, calibrate the sensors, identify any performance problems and ensure reasonable durability. The whole chain of transmission from device, vehicle or roadside equipment to research database needs to be checked as does the integrity of the received data and the database management process. Difficulties in the synchronisation of time stamps may be revealed in this pilot phase.

5.6 Ethical and legal issues

Introduction

In the first FOT-Net seminar ethical and legal issues were discussed. Following the finalisation of the FESTA handbook, projects such as TeleFOT, EuroFOT and SeMiFOT have accumulated further experience.

In FESTA special attention was given to ethical and legal issues, particularly as concerns participant recruitment, participant agreement, data protection, risk assessment, system safety, approval for on-road use, insurance, video data collection, and ethical approval.

Reference to FESTA handbook

Legal and Ethical issues are addressed in FOTIP activity 6 “identify and resolve legal and ethical issues” and FESTA deliverable D6.3, *FOT requirements, legal aspects, planning and development*, chapter 2 “legal and ethical issues of FOTs”.

Issues identified during the seminar and in the FESTA workshop are:

- Responsibility
- Data ownership and stakeholder interests
- Ownership of CAN-bus data
- Interests of the participants
- Data ownership
- Re-use of data
- Other road-users and passengers

Responsibility

An important set of issues that have arisen during discussions within FESTA and FOT-Net has to do with responsibility. For example, who is responsible if the participant has an accident or is fined by the police, or if the system does not function properly? Some of these questions have to do with the fact that the systems studied are quite new. For example, what if the system can override the decision of the driver (e.g. by braking), what are the responsibilities of the driver and the car manufacturer? Or how to deal with testing a system that is not (yet) entirely mature or ergonomically optimal?

Not all questions on responsibility have yet been solved, and feedback is needed from projects that have dealt with these issues.

Data ownership and stakeholder interests

Data ownership and data sharing relates to stakeholder interests. Some stakeholders will regard data as strategic or sensitive. For example data can be used to compare systems, and this is usually not in the interest of the system producers or OEMs while on the contrary for policy-makers and road operators the effectiveness of specific systems is an objective that is relevant.

To deal with these stakeholder interests, agreements on how to address these issues should be proposed as far as possible in advance. This can be done on two levels:

1. Agreements on how to deal with data ownership and re-use as such
2. Procedures on how to change or introduce new research issues based on the collected data

3. Address ownership of data in the tendering procedures or contracts with the (public) organisation providing the grant.

Ownership of CAN data

Data coming from the CAN bus is a special case. Some of the data may reveal information that is confidential to the manufacturer, who may not want to share these data with third parties.

One of the projects found a solution for dealing with these issues. They divided data into three categories:

- Open: data that are available to all partners in the consortium to perform analyses
- Closed: data that are only available to certain partners, with special agreements in place
- Proprietary: data that are only accessible to the OEM

Before data acquisition and analysis start, it is important to define to which categories the data belong. These decisions may have an influence on the selection of performance indicators.

Interests of the participants

A specific stakeholder is the driver/user. The collection of data might raise ethical issues such as whether the project should reveal information about the driver or his behaviour to third parties or if illegal activities are detected, and whether the project should use that knowledge.

Many of the issues can be solved by making clear arrangements before the FOT starts, by performing a risk assessment, and by informing the drivers about these issues and having them sign a letter of agreement.

One possible mechanism for avoiding discussions with the driver is to provide the driver with the possibility to delete the data in the transmission process from driver to project. In that case the driver is considered as the owner of the data until the moment of transfer. However, the appropriateness of this option is debatable, because it may lead to the loss of very interesting data, and also because it may not be very practical in terms of data logging and data transfer procedures.

Informing drivers is good, but has to be done with care in order not to influence their driving behaviour, so information needs to be given mostly about the context of the test.

A clear agreement with the participant should solve most of the privacy issues. However, even with anonymous data, it may be possible to detect more information about a person than he/she has agreed to give. For example by having data on route choice, it may be comparatively easy to establish where a driver lives and works.

Re-use of data

Data may be used or re-used after the end of the project, to do further analysis and to answer new research questions. In order to reuse the data, the database needs to be maintained. This incurs costs in data maintenance and the provision of access and support. The organisation that maintains the data needs to be trusted and needs to apply procedures to ensure the continuity of privacy and confidentiality. A possibility for introducing safeguards for reuse is to introduce the principle of Trusted Third Party.

Other road users and passengers

Data may be collected on other road users who are not aware of the study and did not agree to participate. For example in the case of collecting video data, passengers and other road users might be filmed. This needs to be addressed in the ethical review, but it should be remembered that the filming of a variety of road uses is a normal and accepted part of roadside traffic studies. However, the experiences from euroFOT show that this issue may be country-specific.

General directions for solutions

The FESTA handbook provides suggestions for dealing with these issues. Practical experiences from projects should be recorded and shared. Lessons learned can then be identified and best practices developed.

One of the most important recommendations is to establish clear procedures right from the start of the project on how to reach agreement between the partners on data ownership and on participant handling.

5.7 Data acquisition

The FESTA Handbook provides guidelines and recommendations for how to handle data in a FOT study in Section 7. Data acquisition, data storage, and data analysis tools are covered.

The issue of what data to collect will depend on the hypotheses and PIs that have been selected by the prioritisation method, but a minimal requirement is to ensure that time and date stamps and participant IDs are provided.

When the hypotheses have been selected and the PIs defined, there is then the matter of deciding how to collect each PI. The PI matrix, which is part of FESTA Deliverable 2.1, outlines the pros and cons of different measurement techniques and this should be used as a starting point. Where cost allows, the most reliable method should be chosen, but a compromise could be to equip only a proportion of the FOT vehicles with high cost data loggers and either rotate them around participants for a short period of the data collection, or simply assign them to a few participants over the course of the FOT. Logistical arrangements will influence which of the two methods are chosen. As already noted, the statistical power of the study will be increased by extending the number of participants, and the use of low-cost data loggers may allow an increase in participant numbers.

The choice of data acquisition systems will also be influenced by the requirements of the PIs, and again advice regarding strategies in recording data (frequency, processing) are detailed in the PI matrix. Not all data are required to be collected at the same level of granularity: for example it is useful to collect speed at a higher frequency (e.g. 10 Hz) than say indicator use.

5.8 Database

A FOT-Net seminar on data gathering and handling was held in Munich in May 2009. Many of the issues covered there have already been addressed in the preceding sections, including the maintenance of data after the end of a project, restrictions on access to OEM proprietary data and data synchronization.

One concern raised was about whether a more open-ended approach to data collection should be adopted. It was conceivable that a theory-driven approach could lead to the omission of useful and relevant data. Therefore an argument could be made to simply collect as much data as possible. A reasonable response would be that there is a large chance of such an unstructured approach leading to the omission of critical data.

It was also emphasised that data should include qualitative (subjective) data as well as quantitative data. How to derive performance indicators from collected data was also raised as was how to protect against data loss, especially of video data.

5.9 Data analysis

Introduction

Chapter 9 of the FESTA handbook deals with data analysis. Again most of the issues raised in the Munich seminar have already been covered. One additional issue raised was whether there were any new data mining techniques and whether data mining could be applied to identify types of driver in terms of, say, experience.

During the ITS world congress 2010 in Busan a workshop on data analysis discussed many issues related to data analysis.

Large data-sets

One of the discussion points was the large amount of data collected in an FOT. Often a FOT collects so many data that there are not enough resources and time to analyse them all during the project. There are different answers to the question what data to select for analysis. An option is to take the “space mission” approach in which as many data as possible are collected because the FOT provides a unique opportunity (and funding) to collect data which may be hard to collect later on. However, before starting collecting data, it is recommended to develop a plan on how to store the data and make them available for later analysis or analysis by others. This plan should include detailed data dictionaries, open software formats etc. In order to be able to search for data from other projects, there is a need for defining meta-data, and developing a meta-database to be able to search for relevant studies and data and data-bases.

Although analysis later on and by others (in other words, re-using data from other projects) seems a good idea, reducing the need for expensive and time-consuming data collection phase, it also poses problems. Data may become out of date because traffic and vehicles and driver support and information systems change, so data collected today might not be of much relevance in ten years time, because of the changed environment and driver behaviour. However, although the context may change, the fundamentals of driving behaviour do not, so whether it is possible to re-use data fruitfully depends on what you want to know about driving with a support or information system. An additional problem is that sponsors and stakeholders may want to have fresh data and that it may not be easy to get a project funded that analyses data from another project.

The opposite approach is only to collect only a minimum set of relevant data. Selection of data should be driven in the first place by the research question that needs to be answered. With limited resources it may be useful to find a compromise between an explorative study with naturalistic driving and a more strict experimental study in which the expected behaviour of drivers and systems are evoked in a more condensed manner, requiring less time and providing more focussed data.

To make analysis more efficient it is recommended to take a layered approach to data analysis, making sure that first those data-sets are selected that look the most promising and interesting, before going into a detailed analysis.

The lack of resources to analyse all data is usually the lack of human resources, and not a problem of computational resources, so methods for automation of analyses are welcome, especially for video analysis. Data mining methods are important to tackle this problem. An additional problem with resources is that data analysis comes late in a project, and if delays occurred in the data collection phase, which is often the case, the phase of data analysis may have to be shortened and resources will be diminished. It is therefore important to plan the data-analysis from the beginning of the project.

Video analysis

Collecting video data is easy, but it may be hard to synchronize them with other data and to analyse them. Video analysis is very useful, it can give a lot of information about what is going on both in the vehicle and in the environment, however, manual analysis is very time-consuming. Analysing videos requires analysts who know what to look for, who are properly trained. Efficient data analyses will depend on the objectives set (for example identifying the contexts of use of a driver support system; assessing the frequency of “critical interactions” with the support system, or with other road users). To perform video analysis, first it needs to be defined what the interesting events are, this will determine what fragments need to be looked at. It is recommended to start large, looking at the most important fragments, next to add additional data, and enrich the analysis. Often the goal of the analysis is not so much to isolate events, but to identify patterns of behaviour, this is of course more difficult. Video analysis could best be started by analysing a sample set of data, the results could then be used to guide the selection of fragments to be analysed and to determine the analysis categories. Synchronization is needed with other data, such as data collected by the vehicle sensors and drivers’ verbal report and diaries.

In order to be able to analyse large sets of video data automatic analysis is needed. This analysis may be done “quick and dirty” as a first processing step of data to identify fragments that are worthwhile to look at in a more detailed level. Automated computer vision may be a solution, but more work is needed to make this useful for FOT data. Learning mechanisms should form an important part of automated analysis. Automated analysis will not be able to identify all interesting data but the results can be compared with that of human analysts and statistical analyses may be performed to determine the error rates. Where manual analysis usually starts from identified events (for example hard braking) automated analysis could start by identifying the context from the video data (for example rural roads) and identify (automatically or manually) events that occur in that context.

Detecting driver behaviour issues such as distraction

In order to detect driver distraction more data are needed than that is recorded automatically by the vehicle sensors. Subjective data such as that coming from questionnaires, interviews

and driver diaries are needed, although these will only give general indications. Observations and video data, or reviewing video fragments with drivers, may provide more information. Combing different performance indicators and measures is necessary. In order to detect patterns of behaviour, machine learning techniques may be valuable to support automated analysis.

Methods and measurements that are needed to detect driver distraction are: algorithms to evaluate vehicle measures (e.g., steering wheel), eye glance measurements (real-time or post-processed), human review of video, data mining on vehicle network messages for interaction with in-vehicle systems and GPS and road network maps for data about the road context.

In studying driver behaviour issues, one should be aware that drivers may avoid critical situations (e.g. elderly drivers avoiding driving at night). Also anticipation behaviour by drivers may lead to a situation where it is hard to find critical events in the data (for example never receiving a warning from a driver support system). This anticipation behaviour is important in studying driver behaviour but very hard to detect in the data.

In order to study driver behaviour with new systems it would be very useful to know what “normal” behaviour is. However, there are no detailed models of driver behaviour and there is not enough knowledge available about what is normal. Finding this out is the purpose of Naturalistic Driving studies, valuable information may come from these studies.

To study driver behaviour, data from the car sensors need to be connected with attitudinal data from questionnaires, log-books and interviews. Because of time-stamps, diaries can be connected with automatic data, although only on a general level, such as the date, not on specific instances. In questionnaires the driver may be asked about events. When designing questionnaires one should think about how the questions may relate to the objective data, and questions could be asked that are specific to the functions of the systems under study.

Questionnaires can be used for selecting participants, for identification of groups of drivers and for selecting drivers for further interviews and focus groups.

New techniques and tools for data analysis

Several new techniques for data analysis are becoming available, now or in the near future, such as: data-mining, automated video-analysis, data-stream management, machine-learning techniques, and simulation for pre-analysis purposes. As new techniques become available, old data from former projects could be re-analysed. In order to be able to do that standardisation is necessary, especially standardisation of data-exchange, definitions of events, measurements of eye-movements and the meaning of data, such as semantic structures, annotations, ontologies and data dictionaries.

We have to be aware that different questions may require different data analysis techniques and sometimes more detailed studies are needed to answer specific questions.

5.10 Socio-economic impact assessment

Introduction to the problem

A socio-economic impact assessment involves a number of steps. Some steps require very specific knowledge of the systems and local situations, such as the impact analysis,

modelling of driver behaviour and scaling up of effects. These issues are very difficult problems that will not be solved easily.

Reference to FESTA handbook

The socio-economic impact assessment and related issues are mainly addressed in chapter 10 of the FESTA Handbook. This describes a number of methodologies that can be used for impact assessment, the purpose of which is to provide stakeholders with an indication of function impacts with large-scale use. The problems identified stem from what is sometimes a lack of knowledge in the field regarding future scenarios (including market penetration rates and costs), and such matters require additional investigation e.g. via stakeholder analysis and or market analysis. In addition, there is a lack of consensus on methodology and common tools.

An impact assessment can only be as good as the data on which it is based, and hence those carrying it out should also be involved at the PI stage, to ensure that the relevant indicators are being collected. These may be the more obvious indicators, such as speed, route choice etc, but there may be occasions where the FOT cannot provide the data directly and therefore another method (e.g. willingness to buy surveys) may have to be undertaken on the “general” population. After all, carrying out such a survey on a group of drivers who have already purchased/used a system is a bit nonsensical.

Future scenarios may also include changes in the vehicle fleet, such as the increasing popularity of electric vehicles, new communication technologies or the distribution of intelligence in the network and the vehicles. When vehicle platforms supporting safety functions emerge, these also enable other type of services.

It is questionable whether there can ever be a definitive guide to doing an impact analysis, for, like any other data analysis, the process will depend on the research questions and the functions. For example in terms of scaling up, the area of interest may be a particular city, country or group of countries. For a function that operates e.g. on highways it makes sense to scale up according to those networks only and there is the added problem that scaling up data from one country to another may be inappropriate for a wide variety of reasons (driver types, weather, cultural aspects etc). More empirical data and information is needed to increase certainty on effects and conclusions.

The modelling of driver behaviour, by representing it in micro-simulation which provides an input into the impact analysis, relies on not only specific indicators being collected in the FOT from the equipped vehicles but also some knowledge about the interactions of those vehicles with non-equipped vehicles and other road users. These knock-on effects are rarely addressed in the hypotheses or in measurement processes. This can only really be addressed by undertaking observational studies (or where possible analysing video data).

Current micro-simulation methods have their own limitations. Typically the most generally used software packages do not properly represent vehicle dynamics in terms of interaction with the road surface. They therefore are not properly capable of covering lateral control of the vehicle. The networks covered tend to be geographically small and have often been created for purposes other than the evaluation of new vehicle-related technologies. They may not be very representative of overall national road networks and origin-destination matrices (i.e. traffic flows) are generally lacking for night-time and weekend periods.

Business analysis in a private environment serves the same purpose as socio-economic impact assessment in the public world. It provides crucial information for use in the decision-making process on further steps towards deployment. Where socio-economic analysis tries to rule out double counts on the cost side, the business analysis focuses more on the feasibility of the concept and the roles and consequence for each of the actors required in the value web. The process of balancing the transfer of value (hardware, software, money, data, permits etc.) needs to be investigated and usually there are a number of options for the business model (private, public-private and public only), each with a specific constellation of the roles of the actors involved and each with a specific risk pattern.

As at the hypotheses formulation stage, consideration needs to be given to the potential bundles of systems to be handled in the impact assessment. Indeed, there can be a large number of permutations of market penetration of different bundle sizes and not all can be covered, and some combinations of functions may be more likely than others. Some expert judgement has to be applied here, make reference back to market surveys, etc.

5.11 FOTIP

One set of feedback about the FOTIP concerns its usability and the fact that, at the various stages in developing and carrying out a FOT, it is not always clear what the required and advised procedures and processes are. Thus a general comment is that the FOTIP is one long list of issues. The feedback has expressed a preference for checklists (“by the time you get to here, you should have done the following”), electronic templates and hyperlinks. It can also be observed that the stages in the FOTIP, e.g. those in Table 2.1 on page 8 of the FESTA Handbook, do not match the stages in the FESTA-V.

Solutions that could be applied to help users are:

- Hyperlinks from the text to relevant parts of the FOTIP;
- A more developed Gantt chart than the one provided in Table 2.1 of the Handbook;
- Distinction between “musts”, “shoulds” and “coulds”;
- Flow diagrams or columns in the FOTIP, showing e.g. when stakeholder involvement is critical; and
- Diagrams in the main text showing the FOTIP “musts” at each stage of the project.

A further comment has been made that the focus of the FOTIP is on FOTs with ADAS systems. Consideration needs to be given to whether it is applicable to FOTs on cooperative systems and Naturalistic Driving Studies. This could well require a substantial effort, since it may be the case that specific versions of the FOTIP need to be created for such studies.

6 Conclusions

In general, it is clear from the seminars that the FESTA methodology has provided support and structure in the design, implementation and execution of FOTs. Participants involved in FOTs often use recommendations from FESTA. However, it should be clear that FESTA is not a cookbook and it does not provide an answer to all problems one may encounter in designing and performing a FOT.

The concept of the “V” in the FOT chain means that the phases on the left and the right hand side are closely related. However, how this interaction should work and how to iterate between different phases is not always easy to determine. Also the starting point may be different for different projects, some starting with defining impact areas or research questions and others with the definition of functions. This depends of the aims posed in the FOT.

What also came forward in the FOT-Net seminars and workshops is that FOTs are very complex, in all aspects. Interdisciplinary teams have to learn to work together, stakeholders may have different interests, many selections and decisions have to be made, which can be quite painful if funding and time are not sufficient to do everything originally envisaged, and many unforeseen practical problems occur. As FOTs are a relatively new method of evaluating systems and functions this does not come as a surprise. Sharing experiences, the good and the bad ones, is crucial for all FOTs.

FESTA does provide support, but more support may be needed. There are three types of activities to do this:

- Improving the readability and user friendliness of the FESTA handbook. More explanation of difficult topics and examples is useful, and also an electronic document structure with hyperlinks makes the handbook more accessible.
- Some topics are not (sufficiently) covered in the FESTA handbook. In the continuation of FOT-Net working groups on several issues will gather more knowledge to fill the gaps. Evaluation of cooperative systems and naturalistic driving studies need to be addressed more explicitly and elaborated. Other topics are data analysis, events and incident definition, legal and ethical issues, impact assessment and scaling up, and data sharing. Also an inventory of tools for FOTs will be made.
- Finally we have to accept that some issues are just very complex and cannot be easily described in a handbook. Sharing of experiences and knowledge is the best way to provide support in this case; that is why FOT-Net will continue to organise seminars and workshops. An active FOT community, on a national European and international scale, will ensure that a common FOT methodology will be further developed and kept alive.

In the continuation of FOT-Net there are several activities that will take up the issues addressed in this deliverable:

- Revision of FESTA: many issues and potential solutions identified in this deliverable will be taken into account in the work package that will revise the FESTA handbook
- Working groups on several issues that require additions to the FESTA methodology

- Work package on tools for FOTs that will make an inventory of tools for different phases in FOTs
- Seminars that are planned in order to transfer knowledge on the (revised) FESTA methodology and to discuss new issues coming from the FOTs, with special attention for the European FOTs on cooperative systems that will start in 2011

In the following table these activities are linked with the different topics and sections from this deliverable.

Activity in FOT-Net 2011-2013		Topic	Section
Revision of FESTA		Cooperative systems	4.2
		Improve user friendliness and readability	4.3
		Combinations of functions	4.4
		Stakeholders	4.5
		Iteration	4.6
		Function identification and description	5.1
		Use cases and situations	5.2
		Research questions and hypotheses	5.3
		Performance indicators / Study design	5.4
		Measures and sensors	5.5
		Ethical and legal issues	5.6
		Data acquisition	5.7
		Database	5.8
		Data analysis	5.9
		Socio-economic impact assessment	5.10
	FOTIP	5.11	
FOT-Net working groups	Data analysis	Data analysis	5.9
	Events and incident definition	Performance indicators / Study design	5.4
	Ethical and legal issues	Ethical and legal issues	5.6
	Impact assessment and scaling up	Deployment scenarios and impact analysis	4.1
		Socio-economic impact assessment	5.10
	Data sharing	Ethical and legal issues	5.6
		Stakeholders	4.5
Work package Tools for FOT		Measures and sensors	5.5
		Data acquisition	5.7
		Database	5.8
		Data analysis	5.9
		Socio-economic impact assessment	5.10
Seminars	The interpretation and	Deployment scenarios and impact	4.1

Activity in FOT-Net 2011-2013		Topic	Section
	presentation of results at the end of a FOT	analysis	
		Stakeholders	4.5
	Practical issues starting up a FOT of Cooperative systems and on defining research questions, hypotheses and performance indicators	Cooperative systems	4.2
		Function identification and description	5.1
		Use cases and situations	5.2
		Research questions and hypotheses	5.3
		Performance indicators / Study design	5.4
	The FESTA methodology for newcomers		
	How to compare results from different FOTs and re-use of data	Ethical and legal issues	5.6
		Data analysis	5.9
		Socio-economic impact assessment	5.10
		Deployment scenarios and impact analysis	4.1
		Stakeholders	4.5
	Tools for gathering and analysing data, especially in FOTs of cooperative systems	Data acquisition	5.7
		Database	5.8
		Data analysis	5.9
		Cooperative systems	4.2

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9 List of abbreviations

ACC	Advanced Cruise Control
CBA	Cost Benefit Analysis
FCW	Forward Collision Warning
FESTA	Field opErational teSt support Action
FOT	Field Operational Test
FOTIP	FOT Implementation Plan
ITS	Intelligent Transportation System
ND	Nomadic Device
NDS	Naturalistic Driving Studies
OEM	Original Equipment Manufacturer
PI	Performance Indicator
RQ	Research Question

Annex A: Seminar reports

Seminar 1: starting a Field Operational Test

The first FOT-Net seminar was held on October 23rd 2008 in Brussels. The agenda was as follows:

1. Introduction on FOT-Net and the FESTA handbook, Yvonne Barnard – University of Leeds
2. Practical example of a FOT: euroFOT Rino Brouwer- TNO
3. Starting a FOT: introduction to creating hypotheses, use cases and research questions: Oliver Carsten – University of Leeds
4. Working session: small groups working on hypotheses for their own FOTs
5. Plenary presentation and discussion on the results from the small groups, discussion on prioritisation of hypotheses: Oliver Carsten – University of Leeds
6. Ethical and legal issues in FOTs (such as privacy, video recording, informed consent, and responsibility): Oliver Carsten, Maxime Flament, Rino Brouwer and Yvonne Barnard
7. Conclusions Yvonne Barnard – University of Leeds

There were around 30 participants during the day.

Introduction

FOT-Net was introduced; the project sees itself as a “one-stop shop” for all FOTs, European and national ones. FOT-Net aims to collaborate with the FOT projects in order to support them, to build up a common knowledge base on how to perform FOTs, and to share the results and experiences. The FOT-Net seminars are based on the methodology developed in the FESTA project on performing FOTs. The methodology is described in the FESTA handbook; more detailed information can be found in the FESTA deliverables. All materials can be downloaded from the FESTA site: <http://www.festaproject.eu/>

EuroFOT

See also the euroFOT website: <http://www.eurofot-ip.eu/>

Rino Brouwer introduced euroFOT, being one of the large European FOTs.

Challenges that were identified in the discussion are:

- How to evaluate combinations of functions? How do you assess the impact of combinations of different systems?
- How do you establish a baseline (driving without the system turned on)? It is not always possible to turn off a system, for both practical and ethical reasons. Therefore different baselines may be needed.
- How to deal with the penetration issue? Things may be different if the penetration of systems in the fleet is larger or smaller.
- Working with truck drivers and other professional drivers means that you have to take into account that they have other tasks than just driving.
- The organisational aspect is a real challenge, having to coordinate the work with other people and work packages. Making working parties may be a solution.

Starting a FOT

Oliver Carsten explained the FESTA methodology on formulating research questions, hypotheses and use cases. Two main methods may be used, which are complementary: the top-down approach, starting with the main impacts of system use on safety, efficiency and environmental impacts, and the bottom-up approach starting with use-case, situations, scenarios and events.

Working sessions on hypotheses

The participants worked in three small groups on formulating hypotheses for performing a FOT with three (imaginary) systems: an ADAS system, a nomadic device and a cooperative system. See appendix for the results from the three groups. The groups used both the top-down and the bottom-up approach.

Plenary discussion on hypotheses

Three general conclusions may be drawn from the group work:

- The bottom-up and the top-down approach are complementary, and both approaches lead to hypotheses that are not generated in a single approach.
- Group work is necessary for generating useful hypotheses and for prioritizing them. It is not work that can be done by a single person or by distant communication.
- Although we worked with imaginary systems, it was a very useful exercise, flashing out the possibilities and problems that would be encountered when working on real systems.

Ethical and legal issues

Four topics on ethical and legal issues taken from the FESTA handbook were discussed with a panel: briefing of participants, administrative fines, data privacy and ethical principles.

Some of the problems and solutions discussed are:

- It is easier to have participants sign a letter of agreement than using a contract.
- How do you deal with testing a system that is not conform the European Statement of Principles, and/or which is not entirely safe or ergonomically optimal?
- A FOT is not the same as an experiment on the road in which an experimenter is sitting next to the driver.
- How do sales-persons position the systems?
- Who is responsible if the system can override the decision of the driver (e.g. by braking), the car manufacturer?
- Beware that equipped cars with sensors may not be allowed to enter private sites or security sensitive sites (airports, borders, military sites etc.) for security reasons. Even when turned off this may not be allowed.
- Record data near the participants' houses may be very sensitive to privacy. However, not recording them may lead to extensive loss of potentially interesting data.
- Think about presenting pictures or videos in which participants may be recognised, either arrange it in the letter of agreement, or make them unrecognisable.
- An option for dealing with privacy and data ownership is to provide participants with the possibility to delete information that is still in the car and not yet uploaded. This may be of interest when the driver is involved in an accident or non-legal action. However, this option is disputed.

- There is some consensus that data should not be given to outside parties, other than by court-order.
- Beware not to give driver data to insurance companies, in order not to harm the driver's interests. However, they may be a problem when an insurance company is part of the consortium.
- For cross-border studies it may be possible to arrange dispensations for national regulations. This should be further studied with the European Commission and with EU-Car.

Questions formulated by participants during the day are:

1. Do you have to inform participants in advance about everything that might happen?
2. How to deal with cross border experiments (different laws on privacy, different attitude regarding accidents)?
3. If accidents occur, who is "responsible" (if the system has had an influence e.g.)?
4. Who "owns" the data gathered in a FOT, e.g. video? Will the project be forced to hand it over to the police in case the driver is suspected of a traffic offence?

Conclusions

The day was interesting and highly interactive. Participants were all willing to share their experiences. Participants especially enjoyed the group work.

It will be investigated whether we can organise a separate seminar in the near future on the problem of combined systems.

Seminar 2: implementing a Field Operational Test

The second FOT-Net seminar was held on October 24th 2008 in Brussels. The agenda was as follows:

1. Introduction: Kerry Malone – TNO
2. FESTA handbook: FOT Implementation Plan: Michael Regan – INRETS/SAFER-Chalmers
3. Case 1: TAC SafeCar FOT: Michael Regan – INRETS/SAFER-Chalmers
4. Case 2: SeMiFOT: Helena Gellerman – SAFER-Chalmers
5. Working session on FOTIP
6. Introduction study design: Rino Brouwer – TNO
7. Selection of participants: Rino Brouwer – TNO
8. Study environment: Rino Brouwer – TNO
9. Working session on study design
10. Vehicle fleet: Tom Alkim – Rijkswaterstaat
11. Conclusions: Kerry Malone – TNO

There were around 30 participants during the day.

Introduction

Most of the participants were also present on the first seminar, so FOT-Net and the FESTA project were introduced very briefly. Providing a summary of Seminar 1, Kerry Malone interviewed Yvonne Barnard on the sessions of the previous day and their results. After this the program for seminar 2 was explained as well as the “rules” of the day: interaction is the key!

FESTA handbook: FOT Implementation Plan

Mike Regan, research director at INRETS (Fr) and co-writer of the FESTA handbook, introduced the FOT Implementation Plan (FOTIP). For a FOT to run smoothly, a plan of action must be developed which documents the scientific, technical, administrative and procedural activities and tasks that are needed to progress successfully through the FOT Chain. The FOTIP serves this purpose; it is a checklist for planning and implementing a Field Operational Test. The FOTIP provides a framework; there is not one way to run a FOT. The FOTIP focuses on critical issues: dos and don'ts

Case 1: TAC SafeCar FOT

Mike Regan also held a presentation about the Australian TAC SafeCar project, the first Australian FOT of Advanced Driver Assistance Systems. Mike Regan emphasized the lessons learned from this FOT. According to him, the three most critical issues were:

- a. The sponsor wanting to read the deliverables and thus delaying deployment
→ make sure there is a clear understanding about this from the beginning
- b. Include deployment recommendations in the report, to make sure there is enough attention / time for deployment
- c. Have important stakeholders in the steering committee

Case 2: SeMiFOT

Helena Gellerman, project leader for SeMiFOT at SAFER, gave a presentation on the Sweden-Michigan FOT, a naturalistic driving FOT which focused on in-vehicle functions. In her presentation Helena presented a lot of good practice and advice on practical issues in using the FOTIP. An important one (that is not in the slides) is that the FOT project team should really make use of the steering committee.

Working session on the Implementation Plan

The participants worked in three small groups on using the FOTIP for the three imaginary systems that were introduced in seminar 1: an ADA system, a nomadic device and a cooperative system. The groups chose some topics from the FOTIP to work with for their FOT: how should they deal with it? What are the difficulties in using the FOTIP and how do they handle these difficulties for their cases?

Introduction study design

Rino Brouwer, senior project manager at TNO, gave a short presentation on the aspects of study design. The study design includes selection of the participants / test drivers, the experimental environment, and the vehicle fleet to be utilised.

Selection of participants

After his introduction, Rino Brouwer held a presentation on the selection of participants. He explained critical issues about sample size, participants' characteristics, experience, personality and attitudes. The main message he gave is that you can't take everything into account; sometimes you don't have much choice in your participants, vehicles or study environment. But, it is important that you are aware of the differences there are and the (implicit) choices you have made.

Study environment

Rino Brouwer presented the different aspects on the study environment of the FOT. His presentation included aspects as: geographical location, road type, timing and weather conditions. In his presentation is a checklist from FESTA for geographical location, just as with the selection of participants. His main message was: there are so many aspects to deal with; you can't take everything into account (for example the weather is hard to predict!), however, you have to be aware of the study environment and the impact it has on your experiment. This awareness enhances the analysis of the obtained data.

Working session on study design

The participants worked in three small groups using again the three imaginary systems that were introduced in seminar 1. They had a short discussion on the following questions:

- a. What kind of participants do you want in your FOT?
 - i. What are inclusion or exclusion criteria?
 - ii. What are your possibilities to influence this?
 - iii. If you don't have much choice what kind of influence does this have and how are you going to deal with this?
- b. Try to estimate how large the effect will be of the system
- c. What kind of study environment do you want in your FOT?
 - i. Geographical location
 - ii. Road type
 - iii. Weather conditions

- d. How are you going to exclude or include certain circumstances?

After this working session, one of the groups reported back to the whole group.

Vehicle fleet

Tom Alkim gave a presentation on how to organize a vehicle fleet. He was involved in the Dutch project 'the assisted driver', where he organized the fleet. He told the participants to aim high in the negotiations since you usually don't get all that you want. Tom gave some practical examples of the problems you can run into while setting, operating and maintaining a fleet for FOT.

Conclusions

At the end of the day Kerry Malone gave a summary of the most important aspects and issues of the day. She also drew some conclusions on the overall program and addressed issues that were interesting to take into account for future seminars. Slides are available on the website, the main conclusions were:

- a. Keep the FOT Implementation Plan updated with new experiences, exclude parts which have become standardized
- b. Use the FOTIP as a checklist for FOT set-up
- c. The FOTIP is well-suited for in-vehicle functions. What about cooperative systems and nomadic devices? This still needs to be proven in new projects.
- d. Feedback on FOTIP:
 - i. Now focused on private drivers. What about "professional drivers", e.g. fleet managers?
 - ii. Is there a need to separate project and scientific management?
- e. Concerning study design, there are a lot of things that need to be considered. Cost issues play a role in the study design and quality of the results (for example considering sample size).
- f. Have the (financial) support ready and react to your findings (report) quickly
- g. Include recommendations for deployment in report on findings
- h. Involve stakeholders with influence on supporting and deployment of technologies e.g. OEMs
- i. How to deal with combined functionality?
 - i. Possibility of a special session in FOT-NET
- j. Legal & ethical issues
 - i. Lots of questions but few answers: discussion forum at www.fot-net.eu

Confirmed by the participants, the final conclusion was drawn: the seminars fulfill a strong need for more information and practical on conducting FOTs.

Seminar 3: evaluating combinations of functions or systems

This FOT-Net seminar was held on February 6th 2009 in Amsterdam. The agenda was as follows:

1. Introduction: Oliver Carsten – FOT-Net
2. In small groups: selection of functions or systems and the expected interaction between them
3. In small groups: formulation of research questions and hypotheses for a combination of functions or systems
4. In small groups: define performance indicators
5. Brainstorm on determining base-lines
6. Conclusions and summary of morning discussions: Yvonne Barnard – FOT-Net
7. Practical constraints in evaluating combinations of systems and functions: Samantha Jamson – EuroFOT, Stig Franzen – TeleFOT
8. In small groups: brainstorm on solutions for practical problems
9. Presentations from small groups and plenary discussion
10. In small groups: formulation of recommendations
11. Plenary discussion and conclusions: Oliver Carsten – FOT-Net

Summary

Most of the 22 participants were involved in a FOT (euroFOT, SeMiFOT, TSS-FOT, Telefot, AOS, Regional FOT InCar (V21), and Naturalistic Driving Studies). Most of the participants came from research institutes, but also from car manufacturers and public authorities. Presentations of the seminar can be found on the FOT-Net website (http://www.fot-net.eu/en/library/_/).

Work in small groups

In small groups of three participants (the composition changing with each exercise) the following exercises were made:

1. Selection of functions or systems and the expected interaction between them

Select 3 functions or systems that are combined in a FOT. List 3-5 possible interactions between the functions/systems when they are installed in a car and used by the driver.

2. Formulation of research questions and hypotheses for a combination of functions or systems

Look at the list with research questions:

- Is it positive for the environment?
- Is it positive for safety?
- Is it negative for efficiency?
- Do drivers accept it?
- What is the market potential?

- What are the future costs and benefits?

Individually: select a research question for 1 system and formulate 3 hypotheses per research question

In your group: Discuss the hypotheses and the interactions between them; if possible, formulate common research questions and hypotheses

Individually: write 1-3 notes with conclusions; stick them to the large sheet

3. Define performance indicators

Take combination of systems/functions plus research questions and hypotheses from group 11 and generate as many performance indicators as possible

4. On the flip-charts write pros and cons of different baseline solutions:

- Control group with all systems off
- Several control groups with permutations of systems on and off
- No baseline

5. Formulate solutions to the problems presented

Experimental Design Questions

Baseline

What is an appropriate baseline when dealing with multiple systems and functions?

- Are we interested in comparing a package of systems to driving with no package?
 - Does that mean the baseline should be no package?
- Are we interested in the influence of one part of the package?
 - Does that mean the baseline should be the package without System X?
- What happens if different systems are targeted at different driving environments?
 - Do we then need multiple baselines?

Exposure

How do we measure and control for exposure to a system or combination of systems?

Is it in:

- Time elapsed (calendar months)
- Distance driven
- Number of alerts or warnings from a warning system

What happens if a driver never activates a system?

What happens if a driver never receives alerts from a system?

- Do we need to carry on until he/she has “experienced” the system?

Counterbalancing or not

How do we take care of:

- Learning effects
- Seasonal effects

6. Formulate recommendations

Conclusions about generating hypotheses for combined functions/systems

Defining hypotheses for combined functions/systems is difficult, complex and time-consuming.

Hypotheses formulation requires:

- A clear idea of research questions
- System functioning

Probably it should be advisable to follow a 2 step approach:

1. identify/list hypotheses per function (isolated)
2. and then move to the combination of functions

There may be unexpected interactions between systems despite entirely different functionalities and purposes. Different functions may “hide” each other’s impacts or emphasize them.

Interactions can be divided into:

- user-related interactions
- technical interactions

More hypotheses may emerge when looking at the combination

Categorizing research questions helps to indicate interactions. Research questions should be broad enough to allow the development of both positive and negative hypotheses.

Research questions depend on the viewpoint of the one who asks them.

Hypotheses about combined effects influence the experimental design. Comparison situations may increase/change when more than 1 system is available. Use of long term support may influence use expectations. Long term effects seem to be important, but difficult to specify (and to measure).

A selection of conclusions on the baseline problem

We discussed different options about the problem on how to establish a baseline in FOTs. The first option was to have a control group with all systems off. Advantages identified were

that this allows for a good and easy basis for comparison between groups and brings robust results. Some disadvantages are that it is hard to find a representative control group, which also drives in similar conditions, and that it may be hard to keep this group motivated and be sure that the systems are really off all the time. Another option is to have no baseline at all. Some advantages are that the FOT becomes easier, quicker and cheaper to perform, but some disadvantages are that It is impossible to assess the impacts of the systems/functions.

The option of having several control groups with permutations of systems on and off are was the third option discussed. Advantages are that this option brings more information, the different interactions may be measured, and the effects of different systems can be separated and (in)compatibilities identified. However, disadvantages are that the FOT will need more resources and becomes more complex.

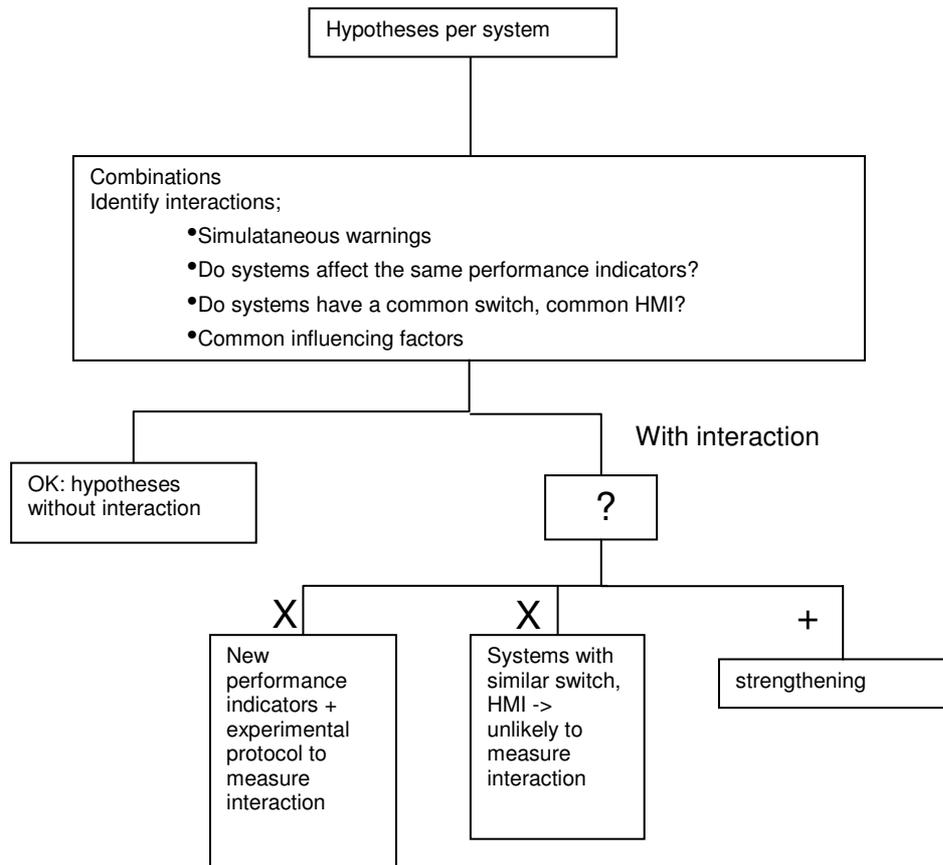
Some alternatives for these options are: comparing experimental groups of drivers with the different combinations with one group that has the possibility to put systems on and off.

Having a group with the permutations of systems off and on over time, using data from other studies to get information about some of the effects, and using data from naturalistic driving studies as a baseline.

Recommendations

When deciding what tests to do in a FOT, what experimental set-up to follow and what hypotheses to test, it is necessary to find the right balance between:

- Costs and price
- Science and practicality
- Research questions and hypotheses and combinations
- Prioritizing of research questions and hypotheses
- Detailed analysis of hypotheses, events and performance indicators
- Combine the hypotheses of the single systems to generate those for the bundle of applications
- Test development of a first “rough” experimental design; iterative process in order to improve the rough design during the next steps (loops) -> FOT-loop



Conclusions

The day was interesting and highly interactive. Work in the small groups of three participants, in changing combinations, was intensive. Participants rated the sessions as good and useful. Many of them want to apply the results in their own FOT.

Although the topic of evaluating combined systems/functions is a complex one, we succeeded in coming up with ideas for approaches and recommendations to address the challenges. Although, as one participant noted on his or her evaluation form: "One always wants more answers". The outcomes of this day will be reflected later on in the FOT-Net project in the form of an addition to the FESTA methodology.

Seminar 4: data gathering and handling

The fourth FOT-Net seminar was held on May 13th 2009 in Munich, Germany.

The agenda was as follows:

1. Introduction, Yvonne Barnard, FOT-Net
2. Practical issues in FOTs, Mariana Rakic, BMW
3. Data requirements and data management in German FOT's, Josef Krems, Technical University Chemnitz
4. Question session
5. Data acquisition at the German1-VMC in euroFOT Mohamed Benmimoun, Institut für Kraftfahrzeuge (IKA)
6. Data management: from car to database to analysis process Frank Lai, University of Leeds, Lancashire ISA FOT
7. Management of video data Dave LeBlanc, University of Michigan Transportation Research Institute, USA
8. Question session
9. Data management in the 100-car study Michael Mollenhauer, VTTI & Transecurity, LCC, USA
10. Reuse of data Oliver Carsten, FOT-Net
11. Panel and conclusions

There were 20 participants during the day.

Summary

All slides of the presentations are available on the FOT-Net website (http://www.fot-net.eu/en/news__events/events/past_fot_events/fot-net_seminar_on_data_management.htm).

Participants

Most of the 20 participants are involved in a FOT. Most of the participants come from research institutes, but also from the automotive industry and public authorities. 60% of the participants are involved in a FOT that is still in the preparation/planning phase, and 40% in a FOT that is in progress. Participants indicated that they attended the seminar to share experiences, and to learn from others.

Presentations

During the seminar, presentations were given by people involved in FOTs in Germany, Europe, the USA and the UK. Presenters explained the work that is being done in the FOT in which they are involved and focussed on problems and solutions with regard to data management. The emphasis of the presentations was on sharing the practical experiences on data gathering and handling, gained in the FOTs. Different sensors used in gathering data were discussed as well as methods to gather and store data, and how to prepare data for analysis. There was room for questions and discussions between the presentations.

Ownership of data was discussed and the possibility to re-use data, for other studies and for simulation models.

Questions

During the day, question sessions were organised. The following questions were written down by the participants:

- Will OEMs share all data in European FOTs? If not, then ...? (e.g. detailed radar, decisions of ADAS?)
- What are typical measures for driving behaviour? Speed, acceleration, headway...?
- Has anyone yet used captured data to answer hypotheses and research questions? If so, how successful was it and what problems were encountered? Was the data sufficient?
- Issue: data sharing between 'owner' of data (car company) and research institutes/universities (maybe car companies do not want to give all their FOT data to researchers)
- What sampling rate is sufficient? How much data can we afford to throw away?
- Is there a kind of typical approach to find out which kinds of data are needed? In a sense of questions and hypotheses that come up in all conducted FOTs.
- Much is made about logging of data through the CAN-bus. However, in practise, how easy/practical is this for institutions that do not have cooperation with the industry, or is it simply a non-starter?
- Drivers behaviour upon expertise/cognition level. Data mining techniques, anything new to suggest? Improvements. Data handling/synchronisation of bytes? What to expect?
- Is data synchronization a major issue, or is it solved by current systems?
- Can we give a list of the definitions of FOT in different parts of the world? Each FOT-Net seminar presentation should start with a definition of FOT.
- FESTA describes mostly FOT as a collection of data (objective). It should however put more emphasis on other kind of data to make sure that we use the different tools effectively. Is there a list of tools with pros and cons of the different methods?
- Could the presenters define in more detail some of the performance, or behavioural metrics they seek from their collected data? I'm more interested in FOT metrics as opposed to safety metrics.
- If a "theory-only" approach leads to throwing away/leaving out important/relevant data, what is the best strategy to select a system for the "collect" as much as possible" approach?
- Are we observing the real behaviour? How to make sure we are?
- How can we best protect against data loss, especially with video data?

The questions have been put on the FOT-Net forum, together with (some) answers, so that discussion may continue.

Conclusions

Most of the participants rated the sessions as good or very good. All participants contributed actively and discussions and interactions were lively and useful. The feedback from participants stressed the following points:

- Interesting and informative seminar
- Very good to share experiences and to learn from others
- FOT data will start to improve our fundamental understanding of driving
- Realised that there are no simple answers to safety issues in FOTs, a holistic approach is needed
- Information will be useful for our own work
- Input from the USA was very much appreciated
- Discussions during breaks/lunch were also very useful

Topics to be addressed in the future are:

- Definition of incidents (a discussion forum on this topic has been started on the FOT-Net website)
- Data analysis and data mining techniques
- The future after FOTs: modelling driver behaviour

Seminar 5: how to develop a FOT

This FOT-Net seminar was held on October 16th 2009 in Paris, France.

The agenda was as follows:

1. Welcome and Introduction, Kerry Malone, FOT-Net
2. Stakeholder Analysis theory, Kerry Malone, TNO
3. How do interest groups influence environment, discussion and project (stakeholder analysis case and working session), Wil Botman, FIA
4. Policy maker's view, Jean François Janin, Ministry of Ecology, Energy, Sustainable Development and Sea
5. How does a project leader deal with all stakeholders? Isabelle Dussutour, ITS Brittany
6. Cooperation: role playing game, Han Zwijnenberg, TNO
7. How to generate impact via the media, Maarten Lörtzer, TNO
8. Conclusions, Kerry Malone, FOT-Net

There were 22 participants during the day.

Summary

On October 16th 2009 a FOT-Net seminar was organized in Paris by TNO in cooperation with ITS Brittany. The subject of this seminar was 'How to develop a FOT'. Central issues were how to identify and organize the stakeholders around your FOT and how to involve them. Twenty-two persons –from different countries and stakeholder groups – attended the seminar.

After a welcome by chairperson Kerry Malone (TNO), the day started with a session on stakeholder analysis. After theory and practical tips on stakeholder analysis (also by Kerry Malone), the participants applied their knowledge in exercises. These exercises were coupled to a case on a helicopter emergency medical service, presented by Wil Botman from the FIA. With the theory in mind, the participants tackled difficulties they encountered while performing a stakeholder analysis, including the categorization of stakeholders and identification of their interests and level of influence. After the exercises, Wil Botman revealed how he dealt with the stakeholders before the start of the project and in the project itself.

Before and after lunch, two speakers from France gave their view on how a FOT is organized and how to deal with all stakeholders based on their experiences with FOTs; first Jean-François Janin (Ministry of Ecology, Energy, Sustainable Development and Sea) from a policy point of view, followed by Isabelle Dussutour (director of ITS Brittany) from a project leader's point of view.

In the afternoon the most interactive part of the seminar took place: a role playing game. Five stakeholders around the table (government, road operator, car manufacturer, service provider and user organization) tried to make a joint proposal for a FOT in a fictional country. After a lot of discussions, negotiations and laughter, they succeeded in the end. They learned that the focus on a common goal is not an easy task and that stakeholder analysis helps to steer negotiations.

The last presentation of the day was by Maarten Lörtzer, press officer of TNO. He addressed the use of communication in a project – internal as well as external – and how to generate impact via the media: what factors make news NEWS? And how do you reach the right audience?

The sessions at the seminar were rated as (very) good by the participants. All participants contributed actively and discussions and interactions were lively and useful. We look back at a very enjoyable day.

All slides of the presentations are available on the FOT-Net website (<http://www.fot-net.eu>).

Conclusions

From the seminar, the following conclusions were drawn:

- The ‘stakes’ or level of a stakeholder depend on the context or phase of implementation
- The context in which a FOT takes place is important to define in order to understand a stakeholder’s interest or role
 - FOTs are a means, not an end
 - Strategic objectives need to be made explicit
- FOTs can give an impulse to policy
 - Remember that policy makers / government are not a homogeneous group
 - A FOT can change the way in which the goal is viewed
- Post-FOT implementation issues
 - Foresee consequences for stakeholders
 - Address exploitation of FOT results in the FOT
- News does not come out unexpectedly; it is planned for
- Use the media to reach stakeholders
 - Tailor the message, content and format to the intended audience

These conclusions are posted on the FOT-Net forum (<http://www.fot-net.eu/en/forum/>), so that discussion may continue.

Seminar 6: issues in evaluation of FOTs of Cooperative Systems

The sixth FOT-Net seminar was held on March 24th 2010 in Amsterdam, the Netherlands, in parallel with the Intertraffic and the Cooperative Mobility Showcase 2010.

The agenda was as follows:

1. Welcome and Introduction, Yvonne Barnard, University of Leeds
2. Cooperative Mobility from the Infrastructure Point of View: Needs, Potential and the North American Landscape, Jim Misener, PATH, Institute of Transportation Studies, University of California, Berkeley
3. PRE-DRIVE C2X: Preparing a European FOT on Car-2-X Communication, Ilja Radosch, Fraunhofer Institute FOKUS, Berlin
4. Evaluation issues related to interaction between drivers, in-vehicle and roadside systems, Oliver Carsten, University of Leeds
5. Evaluation issues related to penetration of equipped vehicles and roadside equipment, Marco Dozza, Chalmers
6. Showcase demonstration tour & discussion
7. Scaling up the results of evaluation in order to provide recommendations for stakeholders, Martijn van Noort, TNO
8. Discussion: challenges in the application of the FESTA methodology to FOTs of Cooperative Systems, Yvonne Barnard and Oliver Carsten, University of Leeds

There were 22 participants during the day.

Summary

On 24 March 2010 a FOT-Net seminar was organized in Amsterdam, in parallel with the Cooperative Mobility Showcase 2010 and the Cooperative Mobility Conference 2010. The subject of this seminar was 'Evaluation of FOTs of Cooperative Systems'. The central issues were:

- the Challenges in the application of the FESTA methodology to FOTs of Cooperative Systems,
- evaluation issues related to the interaction between drivers, in-vehicle and road-side systems,
- evaluation issues related to the penetration of equipped vehicles and road-side equipment
- and scaling up the FOT results in order to provide recommendations for stakeholders.

Twenty-two participants from different countries and stakeholder groups attended the seminar.

The day started with a welcome and introduction to the FOT-Net project by chairperson Yvonne Barnard (University of Leeds). The first presentation was given by Jim Misener, (PATH, Institute of Transportation Studies, University of California, Berkeley). He shared his

experiences with us from the work that is going on in the United States. He discussed Cooperative Mobility from the Infrastructure Point of View: Needs, Potential and the North American Landscape. Next Ilja Radusch (Fraunhofer Institute FOKUS, Berlin) gave a European perspective from PRE-DRIVE C2X: Preparing a European FOT on Car-2-X Communication. Their presentations are available on the FOT-Net website.

Next, participants undertook small group discussions on evaluation issues related to the interaction between drivers, in-vehicle and roadside systems. Oliver Carsten (University of Leeds) presented the participants with examples of three (imaginary) cooperative systems and asked them to come up with research questions (e.g. “What will be the effect on elderly drivers?”), hypotheses (e.g. “Elderly drivers will miss in-vehicle messages because of overload”) and data to be collected (e.g. “I need data on messages transmitted”).

After lunch, Marco Dozza (Chalmers) facilitated discussion groups on evaluation issues related to the penetration of equipped vehicles and roadside equipment. Participants discussed the effect of penetration of (examples of) cooperative systems on measurability and operation on scenarios, communication and acceptance.

To get more hands-on experience with cooperative systems we went on the Showcase demonstration tour, in which live demonstrations developed by the COOPERS (www.coopersip.eu), SAFESPOT (www.safespot-eu.org) and CVIS (www.cvisproject.org) projects could be experienced. Demonstrations included: Dynamic speed limit, Enhanced situation awareness (incidents, congestion, bad weather), Travel information, Parking guidance, Cooperative intersection, Intelligent routing, In car traffic management, Safety at intersections, Safety margin for assistance & emergency vehicle, Lane change assistance, Head-on collision warning, Frontal collision prevention, and Hazard & incident warning.

After our return we discussed our experiences. The tour was well appreciated and stimulated the discussion on how FOTs could be set-up to evaluate cooperative systems. Although participants were aware that the demonstrations shown were not mature systems and were set-up as a proof of concept, concerns were raised about the Human-Machine Interface aspects. The question was raised how to avoid driver distraction, or, more fundamentally, what do we want drivers to do in addition to the primary driving task? The systems shown have the potential to give a lot of information to drivers. Selection and prioritization become issues that can only be solved by looking at the combination of available systems, not at systems in isolation. Some information is discrete (e.g. a safety warning) but other information is continuous (e.g. on the position of the car). Especially this last kind of information may lead to visual distraction. Maybe using different modalities in interfaces could provide a solution. FOTs on cooperative systems are not meant to solve HMI problems, these can be solved in a more laboratory environment, but the HMI should be acceptable before a FOT starts. Also deployment issues were discussed; many systems would only be effective when many cars were equipped with them. Also the reliability of such systems is an issue, as well as delays in providing urgent information. Before FOTs can be realized in which drivers could rely on the systems, much work is needed.

In the last session we discussed, in small groups, issues on scaling up the results of evaluations in order to provide recommendations for stakeholders, facilitated by Martijn van Noort (TNO).

The sessions at the seminar were positively rated by the participants. Discussions and interactions were lively and useful. We look back at a very interesting and informative day.

All slides of the presentations are available on the FOT-Net website (<http://www.fot-net.eu>).

Evaluation issues related to penetration of equipped vehicles and roadside equipment

Main conclusions from the workshop:

- Penetration influences the evaluation of cooperative systems, however the extent to which penetration hinders (or limits) evaluation depends on the specific function and the specific aspects under test. For instance, for some functions (such as forward collision warning; see appendix) a low penetration rate may hinder operation of the function, thus totally defeating any possible evaluation. For other functions (such as emission manager; see appendix) operation of the function would be possible to evaluate with low penetration; effects on emissions with medium penetration; and acceptance with high penetration.
- Different penetration rates of the same function may result in different function operation. As analysis of green light speed advisor (see appendix) shows, possible scenario would change depending on penetration and enable different operation of the function. Further, acceptance at different penetration rates could be very different. It is worth noticing that it was expected for acceptance to be higher at low penetration rate and then getting lower with higher penetration rate.
- Evaluation of cooperative systems may be influenced by penetration of other in-vehicle systems. As analysis of shockwave manager shockwave manager showed, different penetration rate for ACC (adaptive cruise control) in combination with different penetration rates for shockwave manager may enable different scenarios which significantly influence evaluation.
- Evaluation of cooperative systems may require extra data from surrounding vehicles. As analysis of platooning function shown, different scenario may be enabled by different configuration of vehicles (e.g. equipped and non-equipped). For this reason, information about surrounding vehicles, such as local penetration or the cooperative function under test may also be needed for data analysis.

Scaling up FOT results

The session started with a presentation by the moderator explaining what scaling up is, and discussing the reasons for scaling up as well as the problems that need to be tackled when scaling up. This presentation can be found in the appendix.

After the presentation, the audience discussed several problem cases in three groups, each group handling one case. A case consists of a system description and a problem description that focuses on one specific aspect of scaling up.

This was followed by a short presentation by each group of their findings and finally a plenary discussion. The sections below describe the three cases and the conclusions from the plenary discussion.

Group 1 - Shockwave Management by Cooperative Braking

System description

A V2V system detects a rapid deceleration (jerk) by a driver and transmits information on that rapid deceleration to subsequent vehicles. Those vehicles have their deceleration limited to that of preceding vehicle. The aim is to maintain between-vehicle spacing at the initial value. Vehicle following can be manual or by ACC. The system operates on both light and heavy vehicles.

Problem description – modeling behavior

You wish to do traffic simulation to study the effect of this system in different scenarios. The traffic simulation is used to assess the system's effect on network flow efficiency. To this end, a driver model needs to be created for use in the traffic simulation tool. The driver model should include at least longitudinal and lateral (i.e., lane change) behaviour, and should accurately represent the findings from the FOT. You have the following problems to solve:

- Which aspects of driver behaviour do you need to model?
- Which FOT data (i.e., which parameters) do you need to develop a driver behaviour model?
- How do you create a driver behaviour model that corresponds to the FOT data?

Findings

Aspects that need to be modelled are the driver reaction (feedback) to a given stimulus in terms of (reaction) time, pulling out of a queue, and acceptance of the warning, both for manual control and for ACC control.

The FOT data that is needed includes the reaction time, the proportion of people leaving a queue (lateral behaviour), and the proportion of drivers that accept the warning, the speeding and deceleration behaviour.

In order to model this, a mathematical model needs to be created and its parameters should be estimated using the above data.

Group 2 - Emissions manager

System description

Traffic emissions are modelled in real time based on current network conditions. When emissions are calculated to be at a certain threshold value, equipped vehicles in the network are set to "clean driving mode" by wireless signals from the traffic management centre. The wireless signals also provide a table for in-vehicle digital maps with the "clean" values for every link in the local network. Drivers are informed of the mode change by means of in-vehicle HMI. The system can be operated on any road in the network, i.e. motorways, rural roads or urban streets. Clean Mode limits maximum speed and maximum acceleration, as well as providing advice on gear selection related to speed. For automatic transmission vehicles, shift points are set automatically in Clean Mode.

Problem description – scaling up in time and geography

A FOT with the system is held in a small region that includes a medium sized city and some surrounding countryside. The road network includes motorways, rural roads and urban roads. A small portion of the vehicles on this network belong to the FOT.

You are able to determine the effect of the system on emissions in the FOT by measuring the exhaust. You have also developed a method to estimate the effect at different penetration rates, on the same network. Now you wish to estimate this effect if the system is used in the whole country, in the year 2020. You have two problems to solve:

- How to scale up geographically? What characteristics of the road network and the traffic flow are important? Can you simply “multiply” the effect or is a more complicated method needed?
- How to translate to a future time when e.g. engines are different, emission norms are different?

Findings

All cities are different. In this respect, an FOT for a single city actually has a sample size of one, because the relevant object is the city and not the vehicles. Some illustrative examples of differences are: Alps versus Netherlands, and traffic with many scooters versus 4x4's versus hybrids. The following parameters are identified that need to be taken into account for scaling up geographically:

- traffic flows (rush hour, holidays)
- street layout, where situated
- climate
- temperature
- altitude
- engine efficiency
- vehicle type
- people (population characteristics), acceptance

The conclusion is that this is a multi-layered problem, which is impossible to dissect or extrapolate. An important question is “who wants to prove what”, since the difficulty of scaling up means that the answer can lie in a large range, which opens up the possibility of misuse.

Group 3 – Forward collision warning

System description

By using V2V communication, a vehicle equipped with radar and commercial frontal collision warning is able to communicate the hazard – in case of frontal collision warning – to the following vehicles. More specifically, the vehicle initiating the application must be in a car following scenario when harsh braking or a fast manoeuvre is probably necessary to avoid a collision. By sharing frontal collision warning information, the probability of chain rear-end

collisions is decreased. The frontal collision warning is presented to the driver using in-vehicle HMI similar to the forward collision warning on the market (visual and audio alert).

Problem description – estimating fatalities

You need to estimate the safety benefit of the system in terms of fatalities saved. However, the FOT will not show a significant number of fatalities, so the safety benefit of the system has to be determined indirectly. You will have data available like speeds, headways, etc. You may also make use of accident databases and other external data sources. You have the following problems to solve:

- Which FOT data (i.e., which parameters) do you need to estimate the safety benefit?
- Which other data sources do you need?
- How to estimate the safety benefit from this data?

In order to simplify matters, limit the problem as follows:

1. Safety benefit “=” probability * severity * exposure. Consider probability (of fatalities) only.
2. Focus on rear-end collisions only.
3. Focus on users of the system only.

If you want a bigger challenge, also consider lateral accidents and assume that there is no data on vehicles to the side, only on lane and road markings.

Findings

The safety benefit is estimated by looking at risky situations (i.e., incidents). They can be identified by looking at:

- crashes (but there will not be enough)
- brake events
- deceleration
- distance between cars
- driver reaction to warning (perception-reaction time; use video imaging)
- number of warnings (analyze if real or false)
- road condition and weather

This data is collected with system on and off to compare.

An accident database will be needed.

It can be expected that the system will also have an effect for the vehicles following an equipped car, because of the cooperative function. How to collect data for them in an FOT? Possible solutions are to equip many cars on a small island, or to use simulation.

Conclusions

Several conclusions and discussion points resulted from the seminar:

- FOTs of cooperative systems need to demonstrate the impact on the general traffic system and environment.
- In FOTs of cooperative systems information about individuals is needed as well as about the general network, making these FOTs more complex than FOTs of individual systems.
- In principle, the FESTA methodology is applicable for evaluating cooperative systems in FOTs, but tools and procedures may be different, for example for scaling up the results.
- Penetration influences the evaluation of cooperative systems. Some use cases in cooperative system FOTs require a very high degree of penetration in order to find effects. It is very hard to estimate how many cars and road-side points need to be equipped in order to have a successful FOT.
- Different penetration rates of the same function may result in different function operation.
- Evaluation of cooperative systems may be influenced by penetration of other in-vehicle systems.
- Evaluation of cooperative systems may require extra data from surrounding vehicles and from the infrastructure.
- User acceptance of systems is also related to the degree of penetration.
- In addition to FOTs, simulation models and tools are needed to interpret the findings of FOTs, to scale-up the results and to predict the impact.
- Not only the reaction of equipped drivers needs to be investigated, also the behaviour of non-equipped users is important: how are they influenced, how to measure their behaviour, acceptance etc.?
- In FOTs of cooperative systems it is necessary to log all communications (sent and received), which may lead to huge amounts of data.
- Pre-testing of systems is of the utmost importance to ensure they are functioning as planned.

Seminar in Israel

On June 22nd and 23rd 2010 a FOT-Net seminar was organized in Herzlia, Israel, on invitation from ITS Israel, an associated partner in FOT-Net, and in collaboration with ILTAM. The objective of this seminar was to make Israeli traffic and transport experts acquainted with the FESTA methodology and the European work on Field Operational Tests, and to strengthen the relations between FOT-Net and Israel.

The central issues in this seminar were:

- The work going on in FOT-Net
- The FESTA methodology
- Research questions, hypotheses and performance indicators
- Data acquisition and data management
- Study design
- Real-life experiences from FOTs
- Stakeholder analysis
- Scaling up of the results and impact
- Simulation

Around 25 participants from Israel from different stakeholder groups attended the seminar.

The first day started with a welcome from Moshe Salem from ILTAM and Eran Reuveni from ITS Israel. An introduction to the FOT-Net project, the FOT-Net website and the FOT wiki, and the FESTA methodology was given by Yvonne Barnard (University of Leeds). The first topic, research questions and hypotheses, was introduced by Oliver Carsten (University of Leeds), followed by an exercise in small groups, where participants formulated research questions and hypotheses for three (imaginary) systems. Yvonne Barnard introduced the topic of Performance Indicators. The working groups next defined indicators for the hypotheses generated earlier. The exercises showed that it is possible to generate a wide range of different hypotheses. In a FOT it is necessary to make a selection, depending on the importance of the effects to be studied. Choosing the appropriate performance indicators depends not only on the question what data are needed to test the chosen hypotheses but also on available budget and sensors. The outcomes of the discussion groups can be found in the appendix. The last topic of the morning was Data acquisition and data management, presented by Oliver Carsten, in which he showed several options for data acquisition tools, with different price ranges and capabilities. Data storage and data protection were other topics addressed.

After lunch, Eline Jonkers (TNO) gave a presentation on how to develop a study design, followed by an exercise in small groups where participants discussed the study design for the systems from the exercises done in the morning. The day was concluded by a presentation from Oliver Carsten in which he illustrated the “stony road to successful FOTs” with real-life examples from a Speed Adaptation FOT in the UK.

On the second day Eline Jonkers gave a short introduction to the FOT-Net project and the FESTA methodology. After this, she moved on to the Stakeholder analysis, where a practical methodology was introduced for performing a stakeholder analysis. A stakeholder analysis gives more insight: who are the stakeholders in and around a FOT, what are their interests and influences, and how to deal with the stakeholders. The session on stakeholder analysis

was concluded by an exercise in small groups, where the participants worked on a stakeholder analysis for the systems introduced the day before.

After the coffee break, Martijn van Noort (TNO) gave a presentation on scaling up of FOT results. A FOT has outcomes on the vehicle level, like speeds and headways. From these data, society level effects (fatalities, time savings) need to be obtained. The step between the vehicle level and the society level is scaling up. Difficulties about scaling up are for example a different geography and time period, interaction between users and non-users, missing FOT data, nonlinearity in penetration rates, etc. In an exercise, the participants tried to find solutions to specific scaling up problems for different cases/systems.

After the exercise, the scaling up problem was illustrated by two examples: Oliver Carsten presented the ISA (Intelligent Speed Adaptation) example, and Martijn van Noort the EuroFOT example. Based on the discussions a clear need for “proof and quantification of effects” was expressed by the participants.

The seminar ended by some concluding words from Han Zwijnenberg (TNO) and Eran Reuveni (ITS Israel), who were both very positive about the 1,5-day. Organizers, presenters, and participants were all thanked.

The sessions at the seminar were rated positively by the participants. The participants contributed very actively, and discussions in the small groups were animated. During the day many questions were asked and issues discussed. Participants were especially interested in the experiences from FOTs, which could help them in developing their own FOTs. We concluded that with this seminar, the Israeli participants felt that they now belong to the wider FOT(-Net) community. For the FOT-Net partners it was a very interesting meeting and we learned a lot about the needs and ideas on FOTs in Israel.

Seminar 7: Data Analysis and Impact Assessment

October 5th 2010 a FOT-Net seminar on 'Data Analysis and Impact Assessment' was held in London. The seminar was organized by TNO in cooperation with ITS Leeds and ITS UK. The highly interactive seminar dealt with the last parts in an FOT: data analysis, impact assessment and cost-benefit analysis. Twenty-four persons –from different countries and stakeholder groups – attended the seminar.

After a welcome by chairman *Han Zwijnenberg (TNO)*, the day started with a presentation on data analysis in the TeleFOT project by the leader of WP evaluation and assessment in TeleFOT *Andrew Morris (Loughborough University)*. Another presentation on data analysis, with an emphasis on the use of time and space, was given by *Frank Lai (ITS Leeds)*. Both speakers gave a lot of examples from their own experience and provided the group with some challenges and exercises.

After lunch, *Kerry Malone* and *Eline Jonkers (both TNO)* have a presentation on impact assessment: how to go from individual vehicle data to conclusions on the effect of a system on safety, traffic efficiency, environment, etc. In an exercise on the Assisted Driver FOT, participants tackled difficulties in answering research questions and making a plan for scaling up the results.

The last presentation of the day was by *Torsten Geissler (University of Cologne)* on socio-economic aspects: how to analyse costs and benefits in a FOT using FESTA. This session included cases (eIMPACT, Safespot BLADE) and discussed the selection of the reference year and the differences between impacts on a society level versus impacts on a stakeholder level.

The sessions at the seminar were rated as good by the participants. All participants contributed actively and discussions and interactions were lively and useful for further considerations. We look back at a very enjoyable day.

Conclusions

From the seminar on 'Data Analysis and Impact Assessment', the following conclusions were drawn:

- Data Analysis
 - Harmonisation is a key issue that consumes time. Managing different test sites, data loggers and functions is challenging; not only scientifically but also organisationally.
 - Testing feasibility of research questions (cost, effort, value) helps to prioritise and to reduce.
 - Different perspectives on analysis are possible (time/distance based); application of the perspective is depending on the research questions.
- Impact assessment
 - Real knowledge of the local situation and expertise are required for scaling-up (region, national or EU-level).
 - FESTA is not a cookbook; there is not one method to carry out impact assessment.
 - Although impact analysis is at the end, the quality of the result is largely determined at the beginning of the project.
- CBA

- Cost benefit analysis is often squeezed in the process. You have to make sure that the expected situation still exists once you start carrying out your CBA.
- Be economic in the assessment.
- Business planning is not the end of the loop; it is also a design parameter.
- FESTA also works for Nomadic Devices, improvements are needed on the deeper levels (in FESTA there are now country specific issues mentioned).

Seminar 8: Best practices using the FESTA methodology

This FOT-Net seminar was held on December 1st in Brussels. The subject of this seminar was 'Best practices using the FESTA methodology'. The central issues were:

- The issues on the FESTA methodology raised during the FOT-Net seminars
- Defining functions, research questions, hypotheses and performance indicators: best practices from TeleFOT, euroFOT and national FOTs
- Iteration in the FESTA methodology
- Data acquisition methods and systems used in the different FOTs, advantages and disadvantages, cost-benefits, recommendations for the future
- Experiences on answering the impact question
- Best practices in organising FOTs
- The EU challenges for the coming years

Thirty-one participants from different countries and stakeholder groups attended the seminar.

The day aimed at discussing the best practices and lessons learned in using the FESTA FOT methodology, and sharing experiences from different projects. The FESTA-V is given in Figure 1.

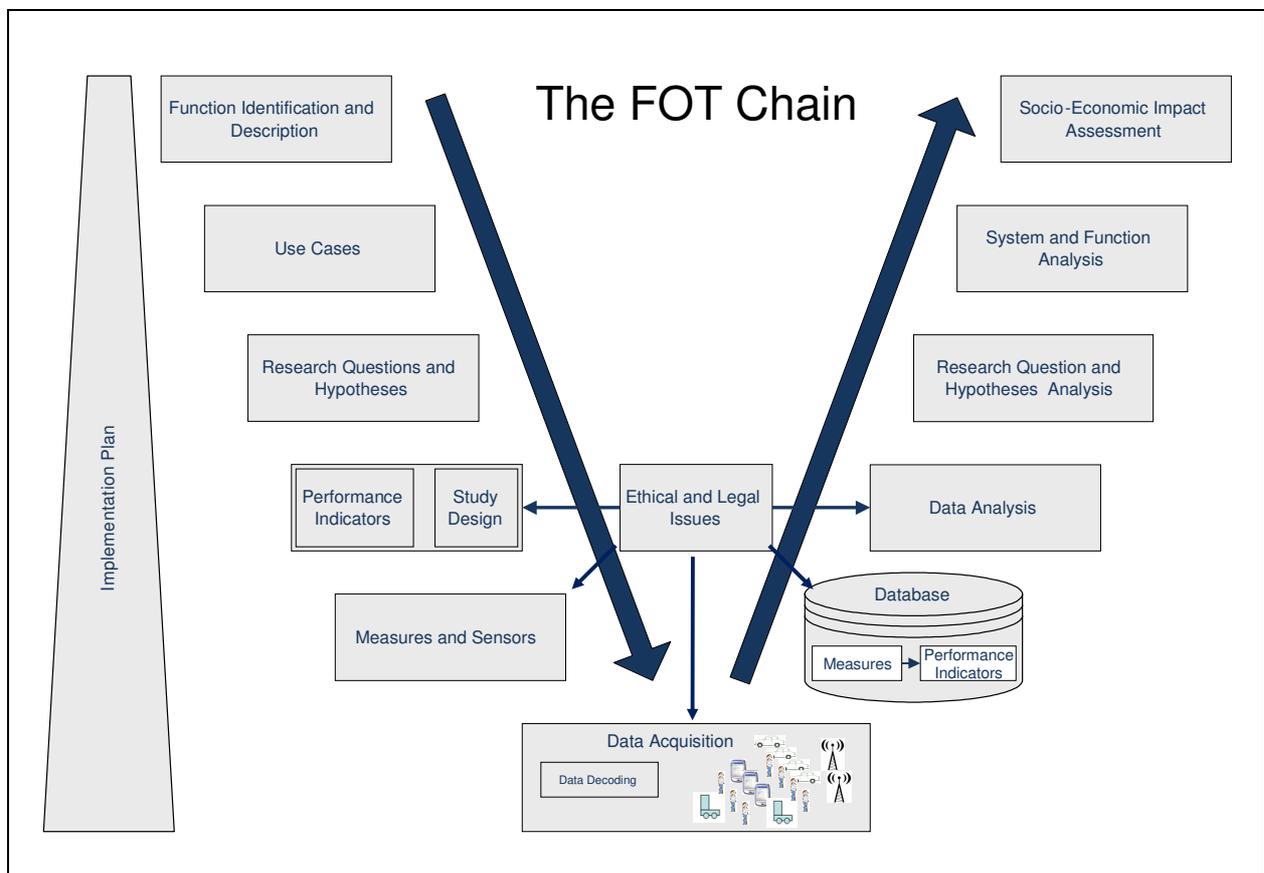


Figure 1, FESTA FOT methodology

Going down the FESTA-V

The day started with a welcome and introduction to the FOT-Net project by chairperson Yvonne Barnard (FOT-Net, University of Leeds), and an overview of the issues raised during the seminars related to the left part of the FESTA-V.

Three speakers gave presentations on their experiences in large FOTs on defining research questions, hypotheses and performance indicators: Andrew Morris (Loughborough University) from TeleFOT, Marco Dozza (Chalmers University of Technology) from euroFOT and Trent Victor (SAFER) from SeMiFOT.

Some best practices from TeleFOT:

- Have a clear definition of the different impact areas
- Don't be over prescriptive
- Specify the data to be collected before the data-logging
- Ensure continuity between those developing the research questions and the data analysts
- Centralise the research questions process – avoid 'committee decisions'

The presentation on euroFOT stressed the importance of having “horizontal lines” in the FESTA-V, meaning that the questions to be answered on the right hand side should influence the design phases on the left-hand side, and iteration should take place between them. Another point of attention was the definition of use cases and functions. Functions may be more complex than they look at first sight, systems may have different states and users may have their own ideas of the functions (correct or incorrect). Defining use cases may clarify how functions are used. The step from research questions to hypotheses is a large one; many small intermediate steps are needed.

The presentation on SeMiFOT addressed the factors that influence the choice and the prioritisation of research questions: partner interests, opportunities (to study uniquely new issues or to develop innovative methods), resources (time and expertise), and data reduction and analysis limitations.

Oliver Carsten (University of Leeds, FOT-Net) facilitated the exercise on designing a FOT: small group work addressing iteration in the FESTA methodology. The exercise was as follows: “Vehicles are equipped with a combination of an impairment/ drowsiness monitor and speed alert function. The two functions come together via an options package. How would you apply the FESTA-V to design a more iterative as opposed to sequential approach? Identify some stages when it would be useful to iterate back to the research questions, hypotheses and performance indicators. Is it useful to start at the top right-hand side of the V?”

In three groups participants discussed where iteration between the different stages of the FESTA chain is necessary and useful. Iteration is especially important when defining research questions and hypotheses, because usually a selection has to be made from the

large amount of possible hypotheses, both based on their relation with the main impact areas and research questions and on practical issues. Another important iteration point is the impact areas. The final question on the impact assessment may drive the design of the FOT in all its aspects. When practical issues, such as for example which data-loggers to use, make certain choices hard to realise, iteration to earlier stages is necessary. Different types of FOT, aiming to answer different questions, may have different starting points. Some FOTs may start from the impact questions; others may begin with uses cases and functions, or with research questions. Cost-benefits analysis and feasibility assessment of different options for the FOT will also drive the design.

After lunch a session was held on data acquisition methods and systems used in the different FOTs, advantages and disadvantages, cost-benefits, and recommendations for the future, moderated by Yvonne Barnard.

Tibor Petzoldt (Chemnitz University of Technology) shared his experiences from the German NDS/FOT and the “Mini E Berlin powered by Vattenfall” project. He stressed the importance of having video data and GPS, although sponsors may not always think they are useful. Subjective data, coming from questionnaires, interviews, travel diaries and focus groups, may provide additional valuable data. It is also advisable to think about other data such as data coming from infrastructure and databases (on e.g. weather, traffic, and accidents). As participants do not always follow procedures, it is necessary to avoid complex ones and to always explain the reasons for a procedure. He stressed the importance of communication with partners, stakeholders and participants.

David Sánchez (CTAG) talked about the Spanish SISCOGA project, explaining how data are selected and collected, and the requirements for data logging systems. Some of the lessons-learned are:

- Drivers should not take care of the logging device.
- Synchronization between vehicle data and infrastructure data is essential.
- Pilot testing time is usually longer than expected.

Jeroen Hogema (TNO) explained how power analysis can be used to determine how many participants are needed and how long they should drive in order to get valid and useful results. Three interrelated questions arise regarding the experimental design:

- 1) How large is the effect of the system?
- 2) How many cars have to be equipped to find this effect of the system?
- 3) How long do they have to be driven to obtain a sufficient amount of data?

Power analysis can help to reduce the risk of conducting a study that does not produce useful results, and to establish an experimental design with good power given the resources available. Power depends on the sample size, significance level and effect size. His conclusions were:

- For modest effect sizes, the number of required vehicles increases substantially.
- Reduce the variance measured between participants.

- The proportion of time spent with and without the system should be roughly equal. But consider training/carry-over effects.

Climbing up the FESTA-V

The second part of the seminar was devoted to the right-hand side of the FESTA-V. Eline Jonkers (FOT-Net, TNO) provided an overview of the issues raised during the seminars. The session on experiences on answering the impact question was moderated by Samantha Jamson (FOT-Net, University of Leeds). Two speakers, Isabel Wilmink (TNO) and Pirkko Rämä (VTT) talked about their experiences.

The conclusions from Isabel Wilmink, based on several projects, were as follows:

- Impact assessment is difficult, but (with Cost Benefits Analysis) needed to convince decision makers of usefulness in-car / cooperative systems.
- The more (combinations of) systems and “test sites” in a FOT, the more complex the impact assessment.
- Structured approach and lots of communication are needed.
- Impact assessment will continue to be at the end of the project, but there are probably always time and budget constraints.
- Cost Benefits Analysis is only possible and/or sensible when previous steps can provide the data needed.
- Useful tools are becoming available.

Pirkko Rämä stressed the need to cover all impacts (mobility, traffic flow and efficiency, safety, and environment) mediated by driver behaviour. The research questions and hypotheses should address the identification of change and the direction of change. Changes in behaviour may be intended and not intended, and expected and unexpected.

In three small groups it was discussed how we can involve people who are responsible for the impact assessment from the beginning of the project:

- Stakeholder involvement is needed to find out what they want/need, but they should not be involved in the detailed definition of hypotheses; they can stay informed by meetings and proper reporting.
- Start thinking about the impact question already in the proposal phase.
- Avoid having a project structure that is too compartmentalised.
- Use funding mechanisms: Keep some resources/money back for competitive tendering.
- Have enough travel budget for intensive, interdisciplinary workshops.
- Make sure (in the proposal) that the right people are in the different work packages.

- It is important to realise the importance for the whole project of impact assessment.
- Organisational challenge: you cannot have everyone in every phase of the project, but have a procedure to inform people.
- A clear link is needed between hypotheses and cost benefits analysis.
- Document the steps of the process.
- Communicate!
- There are different models for impact assessment.
- Involve the relevant people at the decision stage, e.g. on what model to use.

At the end of the afternoon Yvonne Barnard asked all speakers, and some participants, about a positive experience from their project and recommendations for new FOTs. Experiences came from the following projects: SISCOGA, TeleFOT, EuroFOT, German FOTs, Dutch FOTs, and FOT-Net.

Positive experiences:

- Involvement of the administration: very active in the project and providing the right data (important, because cooperative systems FOT)
- Working out of the research questions (filtering process) went very well. They are confident they have the right research questions now.
- Successful piloting in the Swedish FOT, now up to analysis.
- Development analysis tools.
- Analysis plan. Some are based on hypotheses; others are not (such as cost benefits analysis).
- The subjective data: a good supplement to the dataset.
- Good cooperation: there are many partners with each their specific expertise. Surprised at how fast we go.
- Cooperation.
- Learned well from previous FOTs (by checking other reports, filling in template). It was possible to work more efficient. The experience was used and a next step taken.
- Politicians want to have 'evidence' before they move. FOTs can be really useful for this.
- The goal of FOT-Net is to support FOTs. We have a good group now.

Recommendations:

- Do not overlook the piloting phase

- Perform a decent pilot study. Loose ends become apparent and you can still deal with them.
- Plan an extensive pilot phase, also apart from technical things (more on the analysis).
- Develop performance indicators and research questions before thinking about how to log the data.
- In data analysis and data reduction: check everything. There is no such thing as an evident check.
- Learn from previous projects. Use this experience to take a next step
- When doing multiple FOTs: take care that there is as much similarity as possible, especially in the data.
- Communication: between different teams (technical, administrative, etc.), between partners, within partners when people are working on different parts of the project.
- Communication is hard, but we learn.
- You need a strong coordinator.

Conclusions on FESTA:

- We need to reach out to new groups (cooperative systems FOTs). Lots of people still do not know FESTA.
- FESTA is used in different projects, also in more experimental work. Going through the process is already useful, even if FESTA is sometimes an oversimplification of how it really works. A structured approach is always better than a non-structured approach. We have to convince other people of this.
- In The Netherlands, FESTA is 'translated' to a general method for the Dutch situation in evaluating traffic management measures. In doing this, the part of FESTA on use cases, scenarios and situations was the hardest one. This part needs updating.

The day was concluded by a presentation from Francisco Ferreira on what the European Commission sees as challenges for the coming years, particularly environmental issues and deployment of research results.

Sharing of experiences and the active participation of all participants made this day a success. The results will provide a valuable input for the revision of the FESTA methodology in the continuation of FOT-Net.

All presentations can be found on the FOT-Net website.

Annex B: Seminar evaluations

After every seminar a questionnaire was distributed among the participants. These questionnaires contained questions about

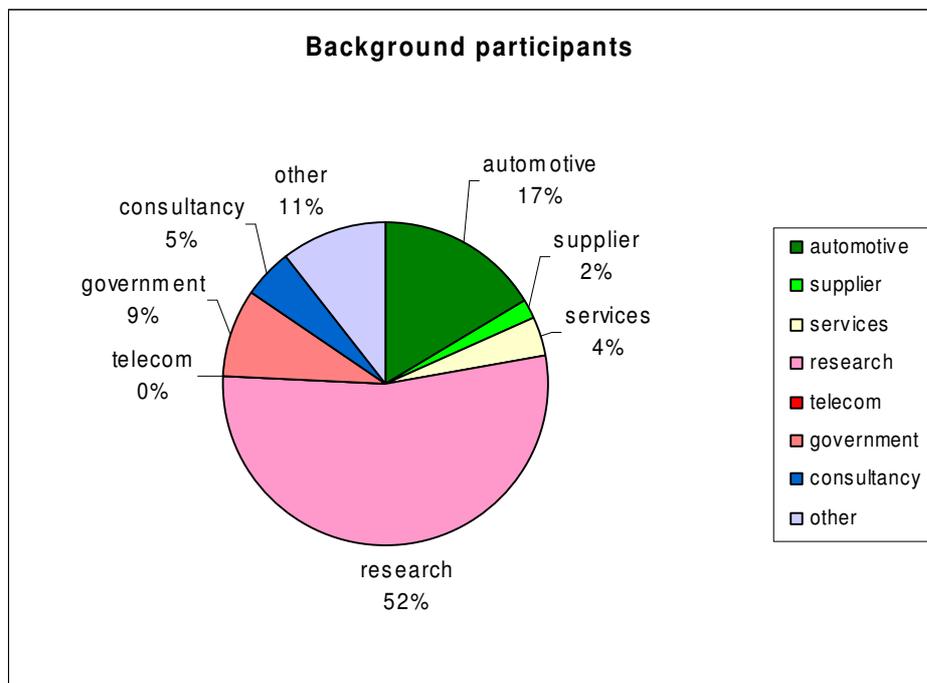
- content of the day, presentations and working sessions
- organization of the seminar
- background of the participants
- familiarity with the FESTA methodology
- motivation for participation
- plans what to do with acquired knowledge
- expectations met
- missing something in the seminar
- usefulness of the information provided

The questionnaires were filled out by a large part of the participants. Their feedback was used to improve later seminars and gear them better to their needs and wishes.

In this chapter the main results of the questionnaires are given, bundled for all seminars.

Background participants

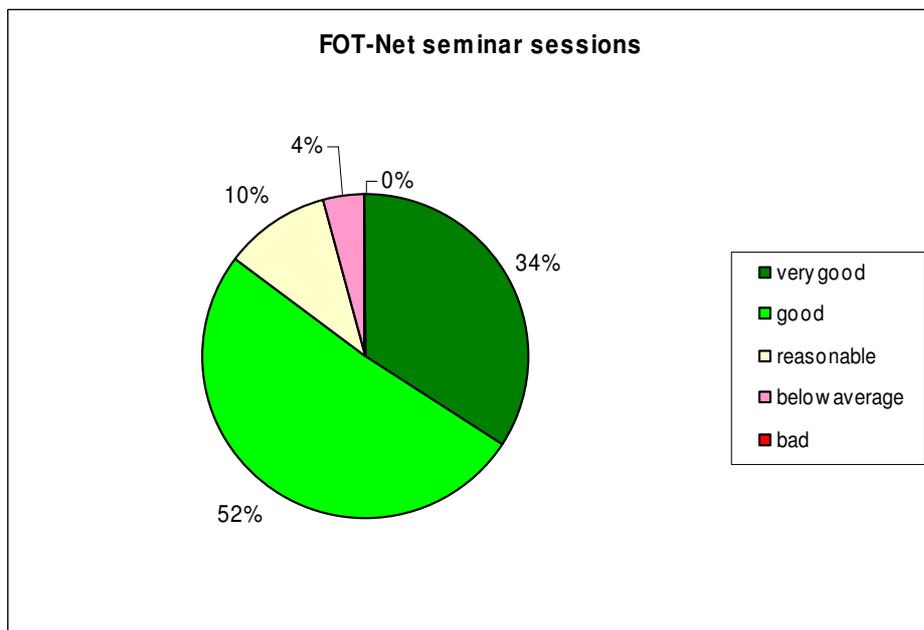
The background of the participants is as follows:



Around half of the participants have a research background (university or research institute). Category 'other' mainly contains people from ITS nationals.

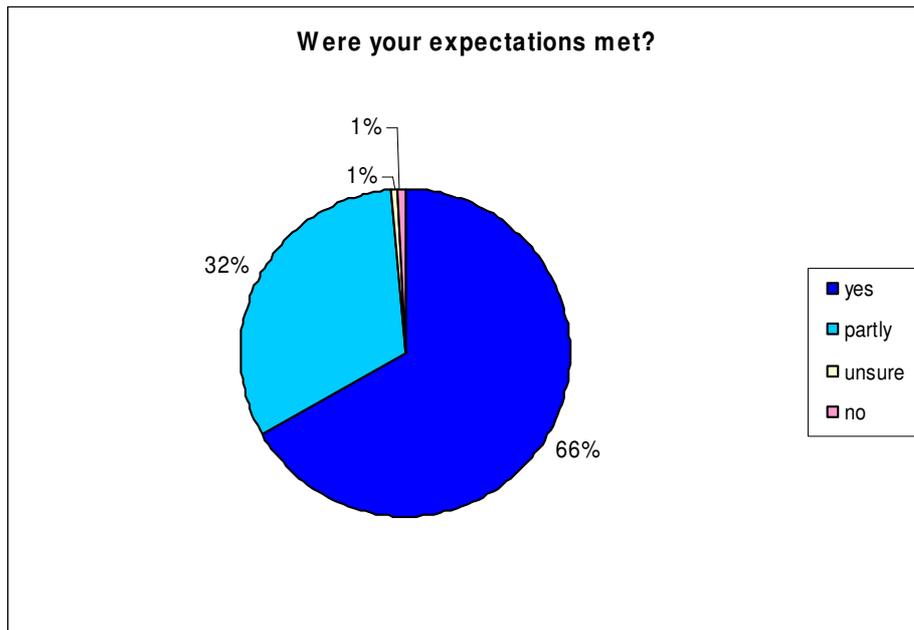
Appreciation of the sessions (presentations and working sessions)

Participants were asked how they appreciated the sessions (presentations and working sessions) on a scale from 1 to 5. The results show that the sessions were appreciated very well; around 85% were rated as good to very good. 10% was rated reasonable and 4% below average.



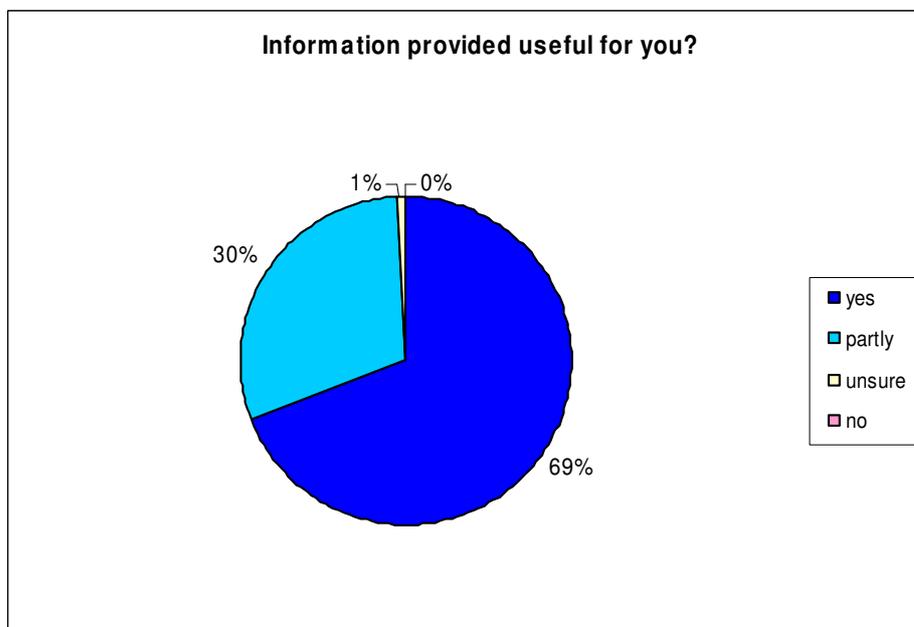
Expectations met

The participants were asked if the seminar met their expectations (possible answers: yes, no, partly, unsure). Two third of the respondents answered 'yes', one third answered 'partly'.



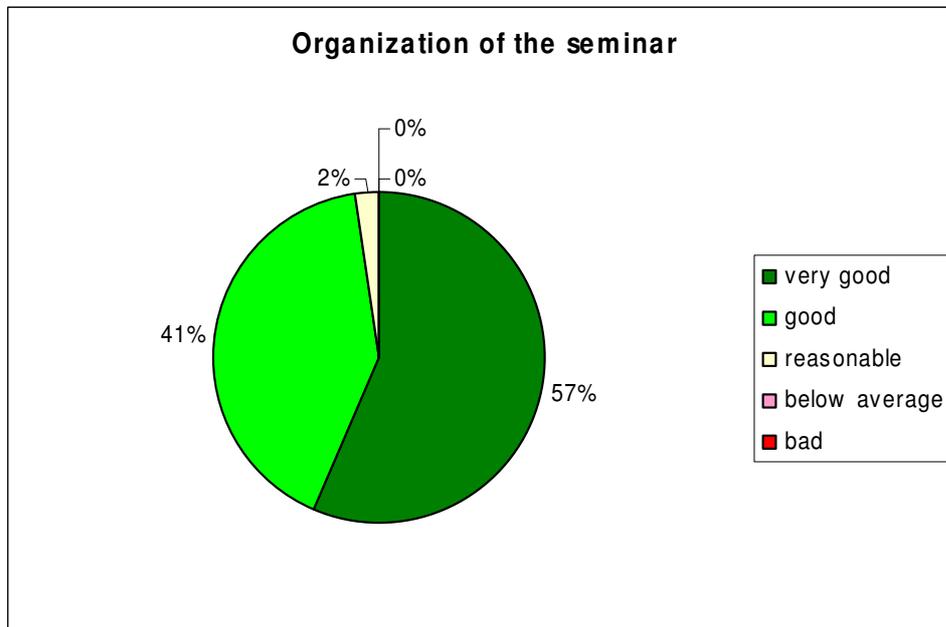
Usefulness of information provided

The participants were asked if the information provided at the seminar was useful for them (possible answers: yes, no, partly, unsure). Almost 70% of the respondents answered 'yes', 30% answered 'partly'.



Organization of the seminar

The organization of the seminar (asked on a scale from 1 to 5) was rated as very good by more than half of the participants, and as good by 40% of the participants.



Effectiveness seminars

During the FOT-Net project, a total of nine seminars were organized in 2,5 years. During this time the organizing team of the seminars gained a lot of knowledge about how to organize these seminars as effective as possible. This starts with having a well defined goal you want to reach with the seminar. Usually this goal was split in some bullets with things we wanted the participants to learn during the day (for example: how to do a cost benefit analysis, how to define research questions).

After this the different parts of the program need to be defined with a balance between presentations, discussion, and working sessions. It is difficult to have the speakers be aware of the total program and their place in it, and make them give a presentation that fits well into the total program and teach the participants what we envisaged. This needs to be guided by the organizing team. Sometimes also speakers need to tune their presentations to each other, the organization needs to take care of this or bring the speakers in contact with each other. Also making the exercise costs a lot of time and is not easy; there are no existing materials that are ready to use.

Summarizing, organizing the content of the seminar and have presentations and working sessions that connect well together with room for interaction cost a lot of time, but the seminar benefits from this a lot!

Annex C: Results from FESTA questionnaire

13 questionnaires were returned.

How familiar are you with the FESTA handbook?

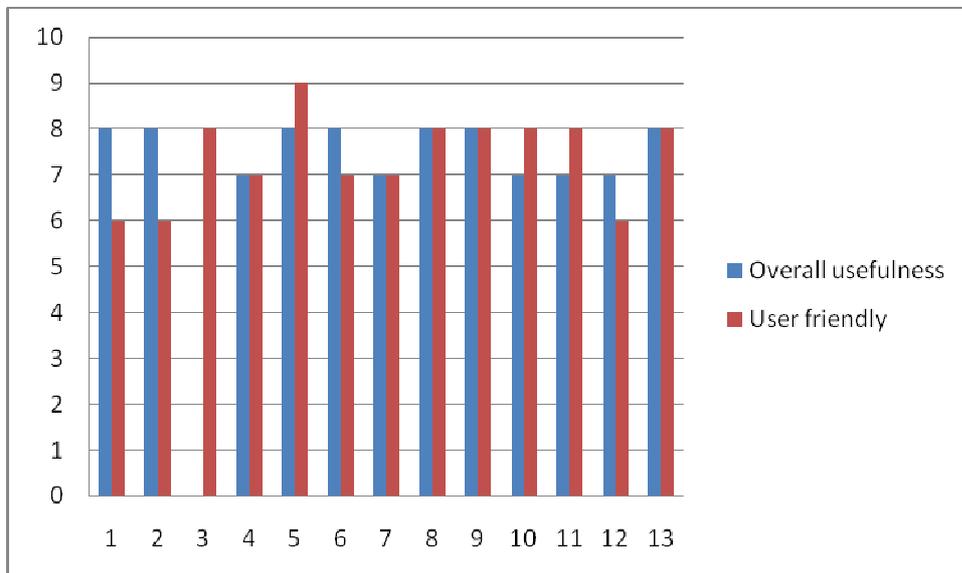
Never heard of it 0

Heard of it, not read it 2

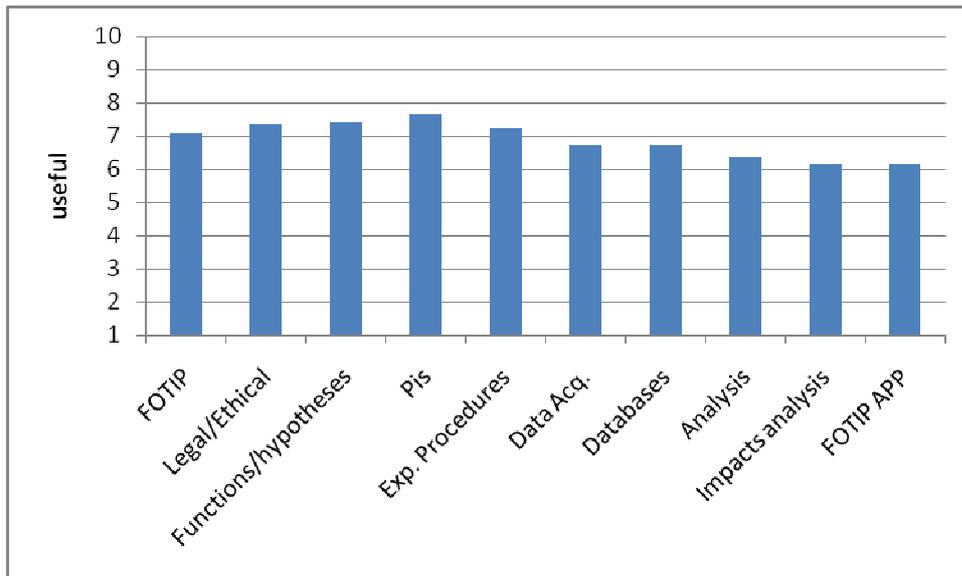
Read in parts, as needed 9

Read it all 4

Usefulness and friendliness



Usefulness of individual components



Suggestions for improvement

Function identification and description

- i. It is often difficult to get a good description of the function and what is expected to have as effects on a higher level of aggregation. I guess the technical level is usually covered, but if you ask what effect it is expected to have on traffic flows, this is often not available.
- ii. Identifying functions is sometimes not so easy since users' understanding over the system should be also considered (a function for experts may be different for users)
- iii. We experienced the variety in stakeholders. Each stakeholder has a different view on the functional requirement for a FOT.
- iv. The issue of what "the system" really is needs to be discussed. Although customers will have access to singular functions such as FCW, they most often will be bundled with other functions such as ACC, Emergency Brake, etc. We should perhaps consider function cluster testing procedures.
- v. This section is quite clear. As far as I can remember terminology was not always clear: what is difference between a function, application and service?
- vi. Analysis of potential C2X communication based functions for suitability for Europe-wide implementation. Standardised functional description. No particular problems encountered

Use cases

- i. It is difficult to explain to people what use cases are (and situations, and scenarios). If people have defined use cases, they're often too narrowly focused (only focusing on expected and

intended effects, not looking at unintended effects, which is especially relevant when the assessment looks at several aspects (traffic efficiency, safety and environment).

- ii. Same as functions. For different stakeholder you need different Use Cases. A road operators wants to see other things than a service provider, or the man-in-the-street.
- iii. Difficult what exactly are use cases, situations and scenarios, what is the difference? It seems that this division makes things more difficult than they are.
- iv. Identification of use cases based on function analysis. No particular problems encountered

Research Questions & Hypotheses

- i. There are always too many hypotheses and how do you prioritise them? Who gets to decide which ones have priority? This can have far reaching effects on the system and function analysis and the socio-economic impact assessment. Also, hypotheses are often vague and do not meet the requirements mentioned in FESTA (having a measurable indicator).
- ii. Specifying research questions applying to combination of functions is more complicated (and thus, also extracting conclusions from these combinations is difficult, especially if the influence of separate functions is to be analysed)
- iii. Need to make this process more iterative! A reality-grounded approach is needed whereby it is recognized that both research questions and hypotheses are developed together with an interaction with the data. The researcher gets to know what is possible in the dataset, what is not possible, and (importantly) what is most interesting from a research perspective. Having now had experience with the way hypotheses become very specific and, most importantly, very adapted to data limitations and opportunities, it is clear that working strictly "front-end" is not most calibrated with reality.

Performance Indicators and study design

- i. Again: too many possible indicators, who gets to choose? This can have far reaching effects on the system and function analysis and the socio-economic impact assessment.
- ii. Selecting relevant and available indicators has been a hard task but it is a very relevant step in the chain, that needs to be carried out jointly with the definition of research questions so that double checks can be made (to see which correspondences there are)
- iii. PIs were also specifically adapted to constraints in the study. It is difficult to, perhaps prematurely, standardize the calculation of measures and PIs. This is because there are a lot of quality issues that are specific to the sensors available.

Measures and sensors

- i. The people doing the analyses and impact assessment are usually not the ones working with data loggers, so you need a lot of time to figure out what can be measured and what should be measured and how to find the balance between what's desired and what's feasible.
- ii. Integration of data considering different types of data loggers

- iii. Not all data can be measured easily. For instance CAN bus data.

Legal and ethical issues

- i. I guess the legal and ethical issues can often, all of a sudden, cause major problems, in that they can limit the data collection.
- ii. Many issues are identified, but not really been properly tested.

Databases

- i. Probably, the data that are left after all the previous steps is not exactly what you want for the analysis. So, the problem is that you have to provide a comprehensive analysis with less data than you'd want (and then could be collected if data loggers and databases had "higher capacity").
- ii. getting all data fused and related is quite a job. in particular if you are working with legacy systems.
- iii. Performance and network capabilities.

Data acquisition

- i. I suppose this is research question and hypothesis analysis as well as system and function analysis? Many problems here stem from decisions made earlier in the process (which research questions and hypothesis were given priority, which data were collected, is the function description adequate so that effects found can be explained (situational variables also play a role there, so were they collected?).
- ii. Attention needs to be paid on the frequency these data is logged, on how data acquisition works in practical environments and on ensuring that data being gathered satisfies the specified requirements
- iii. Extremely difficult to do DAS "generically". It will continue to be specifically adapted to each study because of the quick development of technology.
- iv. Data acquisition through friendly user tests, analysis of data accident bases and simulations; no particular problems encountered, with exception of the fact that accident data bases are not very consistent across Europe

Impact analysis

- i. The input for a socioeconomic impact analysis should come from the function analysis but the translation of effects found into input that a CBA needs is tricky, especially for traffic safety (step from changes in e.g. surrogate safety measures to changes in the number of accidents/victims). Also, effects found locally need to be scaled up, often the data needed for that is lacking.
- ii. I thought this was better developed than it actually is. There is clearly more work left in this area before it is a sound method.

Additional issues to be addresses by FESTA chain

- i. It could be useful to include a step in which it is elaborated what the goal of the impact assessment is - how are the results going to be used? This could help the prioritisation of hypotheses. The available time and budget for the FOT also play a role (what can be done with the resources available? --> expectation management!).
- ii. Start working from the location where the FOT will be organised. Look at the possibilities, but also take the specifics on the locations in the FOT. For instance if you execute a FOT in a harbour environment , you expect the FOT to show the interaction with the harbour systems and stakeholders. Working from these systems make it easier to have a successful FOT than starting with a generic functional analysis
- iii. The Naturalistic Driving Study MUST be addressed and related to the FOT methodology. For example, SHRP2 is investigating the impact of ADAS.
- iv. General remark: it is not very practical that the blocks in the FESTA-V do not exactly match with the chapters/paragraphs in the handbook. Also, a list with definitions would maybe be useful.