Applying the TRIZ Principles of Technological Evolution to Customer Requirement Based Vehicle Concepts
- Experience Report –

Dr. Eckhard Schueler-Hainsch and Dr. Christine Ahrend
DaimlerChrysler Society and Technology Research Group
Berlin, Germany

Introduction

One of the major tasks of the DaimlerChrysler „Society and Technology Research Group – STRG" is observing the development of the company's environment, looking for future trends in society and their implications on technology and products. And the most important products of DaimlerChrysler are passenger cars (Mercedes-Benz, Maybach, smart, Chrysler, Dodge and Jeep).

Another important task is looking for better and more effective methodologies, which enable us to be more successful in future. As a connection of these two tasks we carried out a vehicle concept development project powered by two methodologies we combined the first time, GTM and TRIZ.

Future vehicle concept development means linking future customer requirements with future technology evolution options. The analysis of future customer requirements we carried out with the Grounded Theory Methodology (GTM) *[Ahrend 2002]*, for the technology evolution options we used TRIZ. Using TRIZ for a entire vehicle concept is obviously a quite big task. We aimed at and ended with three vehicle concepts. That means also focussing on the most important issues.

The pre-TRIZ phase: Customer Requirements

But how to find these most important issues? By detailed analyses of customer requirements.

To get customers requirements, STRG uses various methodologies depending on the special task; intensive personal interviews, focus group discussions, expert interviews, customer surveys via paper and pencil or via Internet, trend analyses and scenario approaches.

The Grounded Theory Methodology, we applied here, uses the transcriptions of intensive interviews with customers (up to two hours) and leads to a methodological approach of extracting the important customer requirements out of these interview texts. That means that people tell themselves and with their own words what they really expect and require from cars as a basis to elaborate typological connections between requirements.

We concentrated on a special target group:

- age of 30 – 45 years
- family households
- middle class car (e.g. Mercedes-Benz C -Class, BMW series 3, VW Passat)
- medium to upper segment of income

The Grounded Theory Methodology also allows to describe the interdependencies between the different requirements, so we can describe not only what people want, but also why they want it. The result of these intensive research have been three typological requirement profiles, describing three main customer subgroups. That means although the target group seems to be quite homogenous, we elaborated three very different requirement profiles.

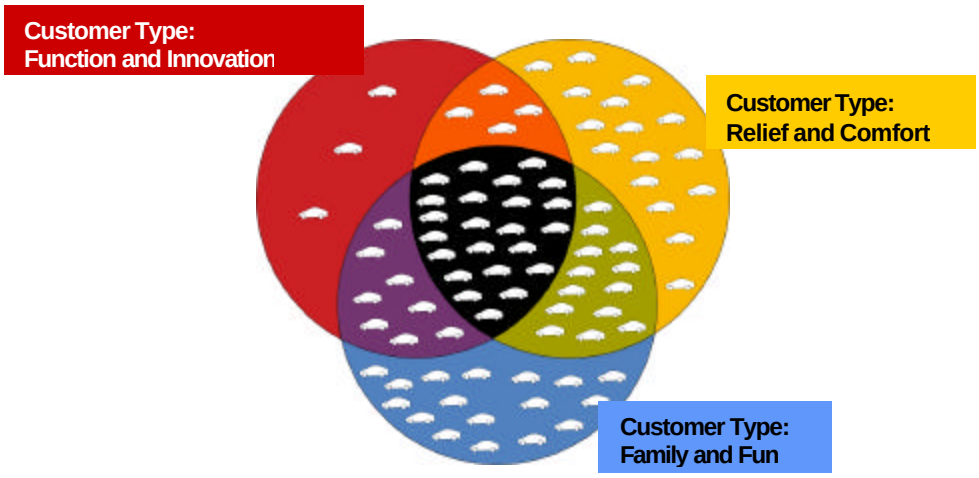

Figure 1: Requirement typology with three main customer subgroups

Every small car in the picture represents one specific requirement. In the centre are the (black) basic requirements every group has (e.g. air conditioning). The outer segments show the unique requirements of every target group segment (red, blue, yellow).

In a next step we combined the requirement profiles of today with future trends in society to assess requirement profiles related to their future perspectives.

The TRIZ phase

These requirement profiles as statements of customer's voice we translated in required vehicle functions (or in TRIZ terminology: useful functions) to start the TRIZ process.

For every important vehicle function (quite different for the three segments) we described the today's technology, assessed the today's evolutionary status and used the lines of technological evolution to generate ideas for future technology options. These ideas have been evaluated and integrated to three vehicle concepts.

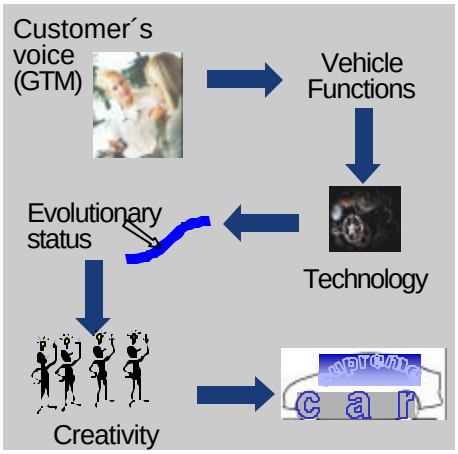

Figure 2: From customers voice to vehicle concepts

Finding the Workshop team

As a result of the customer requirement profiles and the appropriate vehicle functions we defined a list of those technologies, which seem to be of special importance for the vehicle concepts:

- conventional and alternative drives
- materials and surfaces
- active and passive vehicle safety
- human machine interaction
- vehicle dynamics
- automation
- driver assistance systems
- vehicle concept development
- information systems

For all these technologies we invited experts from DaimlerChrysler Research and Technology Group to participate in a workshop process. That means that not a team was looking for a problem solution but a problem was searching a team.

For internal reasons of using bigger technological experience we elected managers and senior managers to work with us. But working with senior managers means normally that they can't spend a lot of time to work between the workshops. Therefore we organised a project office, that supported the process by investigations, preparations and restructuring of results between the workshops.

As a good basic condition we had a lot of interested and open minded people in that process.

The workshop process

We carried out the first and the last workshop together with the entire team (about 12 to 14 researchers), for the second and the third workshop we splitted the team in two groups (A and B), to get a more efficient team size and to speed up in a parallel approach.

We went out of the normal business environment to hotels or conference centres. We recognised that as very important and with a rather big influence on workshop atmosphere.

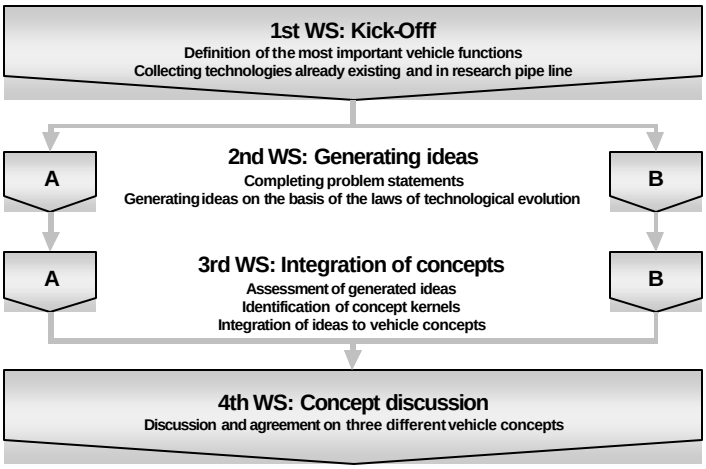

Figure 3: Sequence of workshops

1st workshop: problem analysis

At the beginning of the workshop we presented the customers' typologies to the workshop team. To intensify the understanding of the different customer types we divided the group into three subgroups, one for each requirement profile, and asked them the following questions:

- Which vehicle functions are necessary to fulfil the customers requirements for each group?
- How are the functions realised today?
- Is that realisation satisfying?
- What technologies do we have in our research pipeline?

The results of these workshop have been

- a clearer understanding of the three typologies,
- the recognition, that we have a lot of existing technologies, that we have many in our research pipeline, but that there are various existing gaps to fulfil the customer requirements.

Project office between 1st and 2nd workshop

The project office prepared the results of the first workshops and made analyses about existing solutions for the most important technological subsystems.

2nd workshop: Applying the laws of technological evolution.

Analysing one after the other vehicle function in detail related to the following issues

- technologies, which are used today,
- completing the list of technologies in the research pipeline to the function,
- working with the lines of technological evolution (here we found a valuable support in [Herb, Herb and Konhauser, 2000])

We asked questions like:

> *Seats are currently consisting of seat and backrest, connected by a joint and together movable forward, backward and partly upward. Customers want to have a more flexible interior. How can a higher degree of segmentation (related to seats) fulfil this requirement?*

We collected all these ideas without any assessment at this stage.

Project office between 2nd and 3rd workshop

As a homework for the participants they had to evaluate the ideas concerning

- estimated increase of ideality (low – medium – high)
- estimated time horizon of series application (2003, 2006, 2010, 2010+).

The feed-back of these evaluations has been used to arrange all ideas concerning their function and their time horizon on three pin boards, one for each requirement profile (blue, yellow, red).

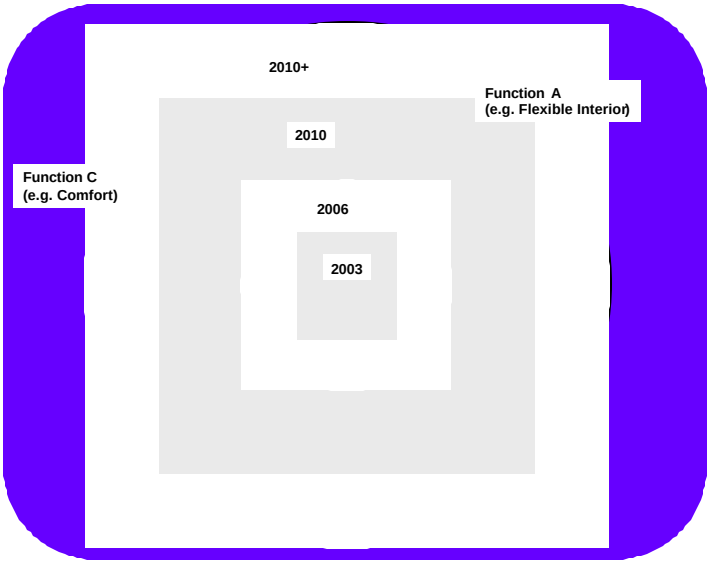

Figure 4: Structuring scheme of ideas (Profile blue, 7 functions, 4 time horizons)

3rd workshop: Concept integration

Main issues of the third workshops have been

- the discussion of the personal evaluation to find a common group evaluation,
- the integration of the high rated ideas to future vehicle concepts and
- picturing first design studies.

Project office between 3rd and 4th workshop

The different concepts have been described more in detail and for every vehicle concepts additional design studies have been prepared.

4th workshop: Concept determination

After working during the 2 nd and 3 rd workshop in parallel the whole group discussed together the results. This achieved

- a final discussion on the fit of the technological solutions to the requirement profiles and
- a common sense of the results for all participants.

Major experiences - or - our lessons learned

The task itself

Developing vehicle concept is a very sophisticated task for a TRIZ process. The intensive analyses of customer requirements have been extremely helpful during the whole process because it provided us with a very sophisticated basis of customer requirements. Thinking in TRIZ terminology in this case (vehicle concepts) it is not enough to define only the „major useful function“. Because we are dealing with a very complex system with a lot of technical subsystems there are a lot of functions to consider. Although we had a quite intensive workshop process, we remained mostly on a conceptual level of solutions.

Of course, technology road maps are existing in every research area, but not all of the customer requirements are covered by these roadmaps. Therefore additional generating of ideas was necessary.

The locations

Going out of the normal business to hotels or conference centres was one of the success factors. If you want to think out of the box it is important that you really are out of your daily box (office).

By chance we made a very interesting experience related to the workshop ambience. One of our ideas generating workshops took place in a hotel of a small town in the south of Germany in a conference room with a mid-age knight ambience. It was very nice to be there but very difficult to think there about future technologies. Although we had a reservation there for one of the next workshops, too, we did not come back to this lovely place.

Dealing with TRIZ Methodology

During the first workshop some of the participants expressed their interest in getting taught TRIZ during that process, too.

The 2nd workshop we carried out in splitted teams, focussed on TRIZ application. But trying to explain TRIZ during that workshop proved to be very difficult, because the team members were intensively occupied with putting themselves in the complex requirement profiles. In that situation explanation of TRIZ was hindering the process. Under the basic condition of the sophisticated approach to generate vehicle concepts and of the available time frame there was too less time for teaching TRIZ. That was a experience of the 2nd workshop we carried out with group B.

As a reaction of that, we used TRIZ for the other team, giving continuously impulses during the idea generating phases. But we did not teach it there. That worked very well and the satisfaction rate of the team was quite higher.

The result

When I am talking about TRIZ methodology and possible applications to managers in my company, they every times want to have exiting and topical success stories. But these stories are that kind of stories which are normally secret. So they mostly remain a little bit frustrated.

That is exactly the point where I am now. We got very interesting results which got a very positive resonance in the DaimlerChrysler research group, the vehicleengineering group and the sales division.

But ... these results are (still) secret. That is why I am referring here about experiences, not about results.

Conclusion – Part I

The TRIZ laws of technological evolution are well appropriate to apply them to the development of future vehicle concepts. The very detailed analyses of customers requirements (GTM) have been very helpful in understanding the „useful functions“ for the different customer types and have been a big support for focussing the TRIZ process.

Because of the big number of relevant functions and the complexity of the technical subsystems the level on detail remained on the conceptual stage (this experience we already made during a pilot TRIZ application to develop a environmentally friendly vehicle concept [SCHUELER-HAINSCH, 2003]).

The next step has to be going more in technical details for interesting technical subsystems. After having made that we can prove how good our concepts really are.

Conclusion – Part II

Finishing my contribution to this congress I would like to express my major demand to the TRIZ community. To market TRIZ in big organisations like my company DaimlerChrysler, it would be extremely valuable to have some real success stories of high level inventions by applying TRIZ. T hat does not mean only to demonstrate that TRIZ principles are applicable to inventions (re -inventing), but that means showing real high level TRIZ success stories of the last five to ten years.

I myself mentioned some reasons why that is so difficult. But on the other hand my personal forecast is that a collection of that kind of success stories and a good marketing concept to managers are a precondition for a breakthrough in industrial TRIZ application.

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ETRIA World Conference - TRIZ Future 2003, Aachen, Germany

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A view into the future, part I

Car Manufacturer will launch first TRIZ- car

First complete application of the invention method developed in Russia

Europe, 20xy: Coming soon one of the big European car manufacturers will launch a new car based on the „Theory of Inventive Problem Solving - TRIZ“, developed by russian scientists during the 20th century.

This invention me
been applyed in

branches but until now never to the development of all components of an entire passenger car.

Until now TRIZ experts as well as automotive experts are puzzling abou the question which manufacturer v come out with this new concept. „W ever this will be is achiev historical breakthrough“ is opinion of the predomi experts.

What a vision !

DAIMLERCHRYSLER

Society and Technology Research Group

Our Strategy

How will we live in the future?

How will we produce in the future?

„Our customer´s questions serve as the foundation for our look at the future. An iterative feedback loop with our customers enables us to identify key questions regarding the future."

How will the future unfold?

How will we sell in the future ?

DAIMLERCHRYSLER

Society and Technology Research Group

Selected Tasks

- Observing the changes of the company´s environment
- Looking for future trends and scenarios and their implications on our products
- Looking for more effective methodologies

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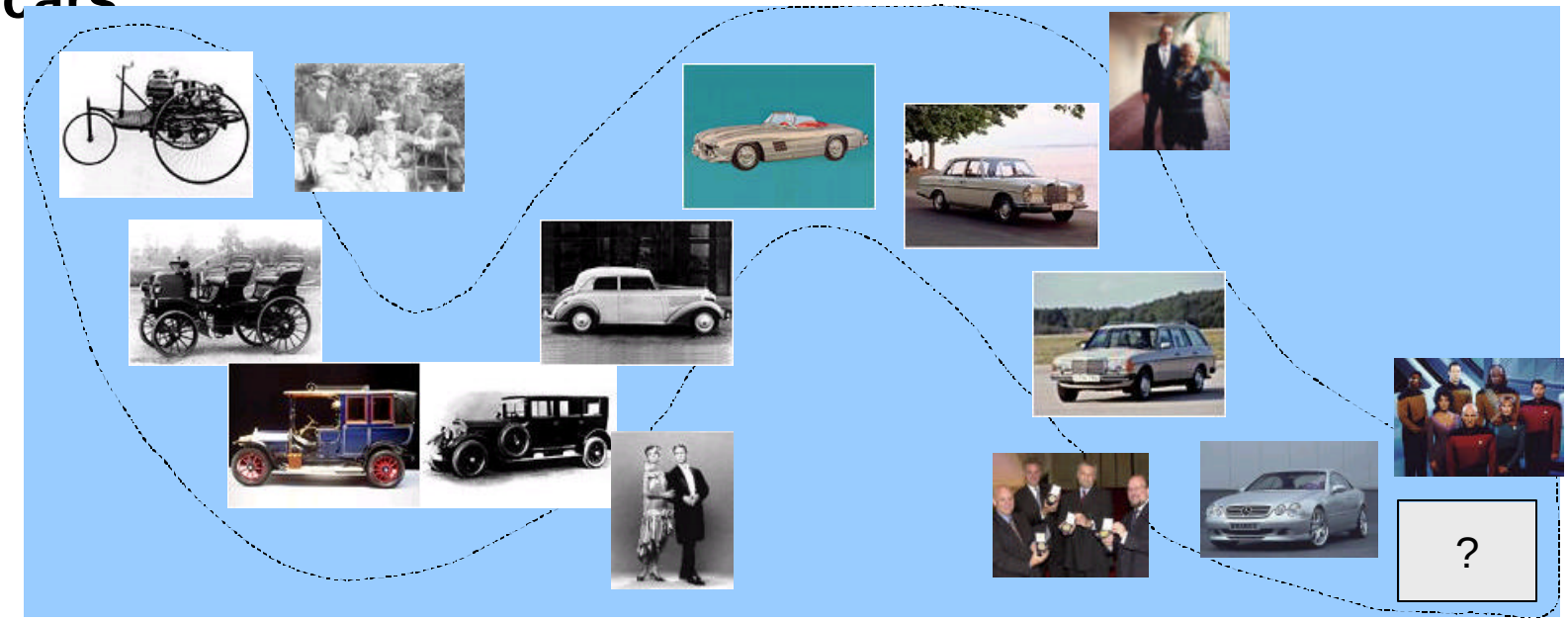
Research field: Future Customers and their future requirements on cars



Pilot Research Project:

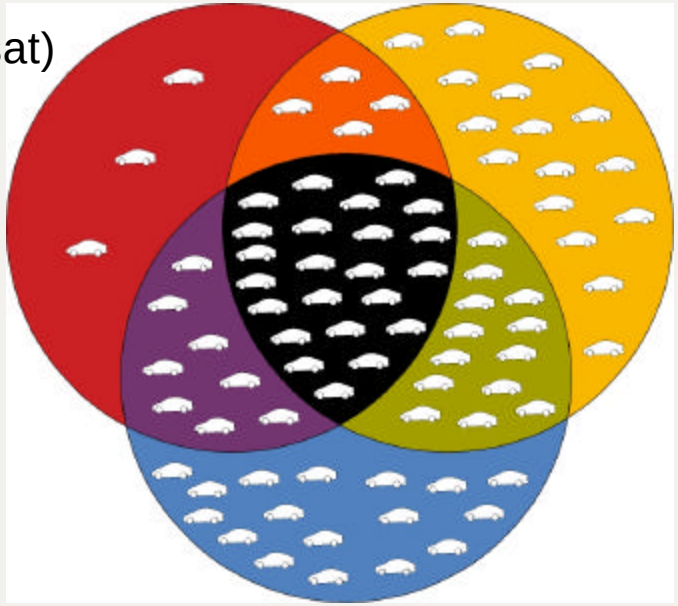
Developing customer requirement driven vehicle concepts powered by Grounded Theory Methodology (GTM) and TRIZ

The customer target group

- **Country: Germany**
- **30 - 45 years old with family**
- **> 2,600 € household net income**
- **mid-range car**
  (e.g. Mercedes-Benz C-Class, BMW series 3, VW Passat)

- **ca. 155 hours of interviews**
- **ca. 1850 pages of interview text**
- **62 categories/requirements**

Three typological requirement profiles



Typological requirement profiles: Selected results

Type:
Function and innovation

- **Driving pleasure** means to experience technology
- **Comfort** features shall support primary or secondary functions
- **Environmental protection** is desirable
- **...**

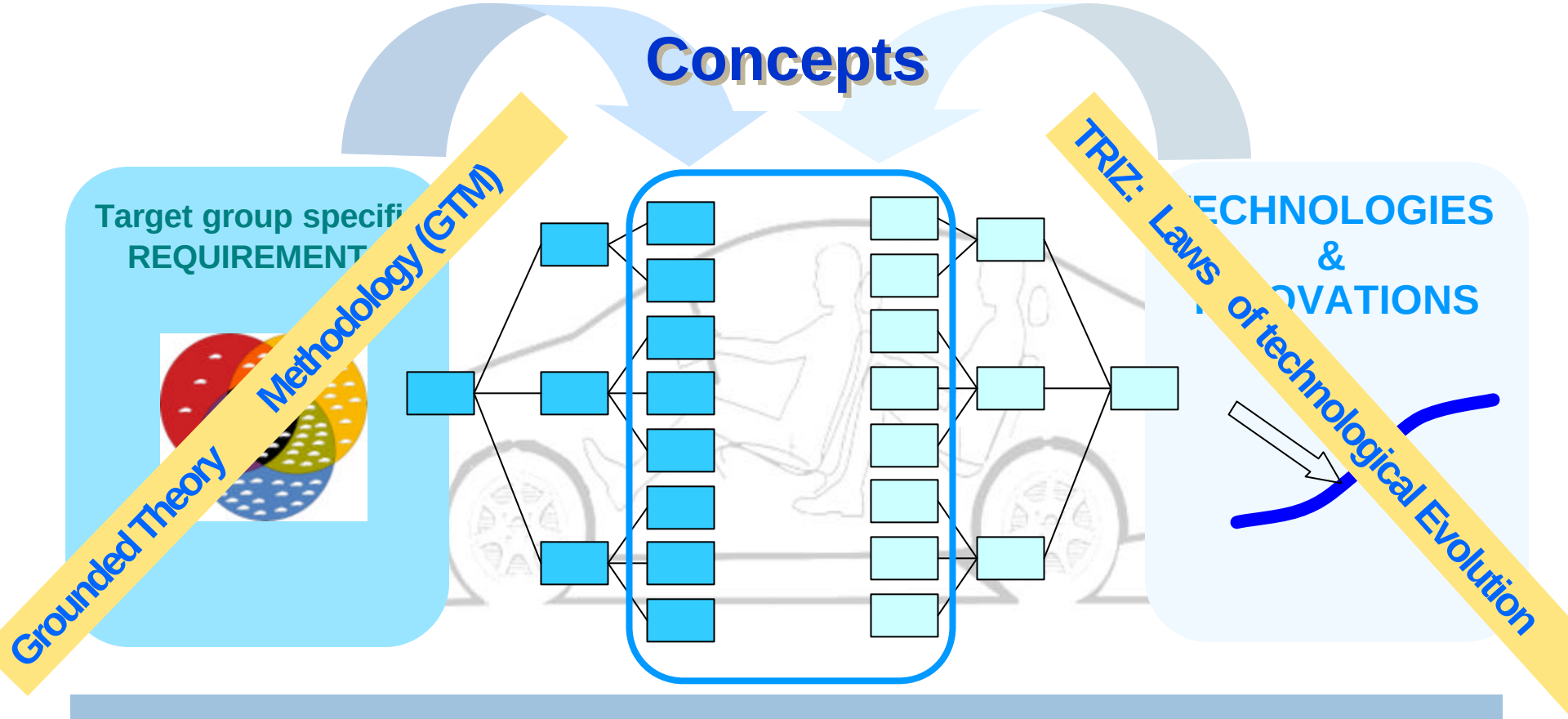
Type:
Relief and comfort

- **Driving pleasure** means cruising and special equipments to relief
- **Comfort**: means room for retreat
- **Alternative drives** only through financial incentives
- **...**

Type:
Family and fun

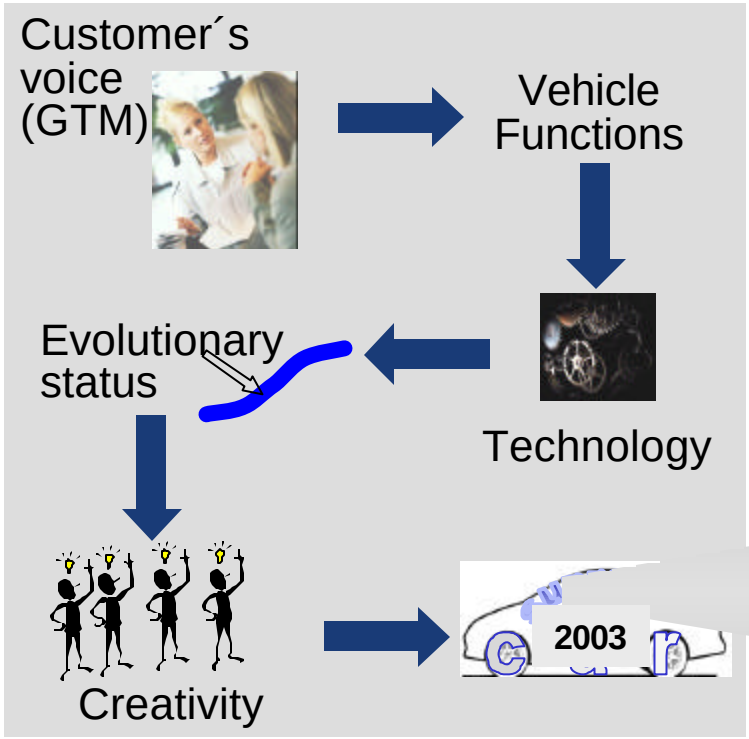
- **Driving pleasure** is obtained by optimal road performance
- **Comfort** means space and felxibility functionalities
- **Environmental protection** only without any loss of accelaration power
- **...**

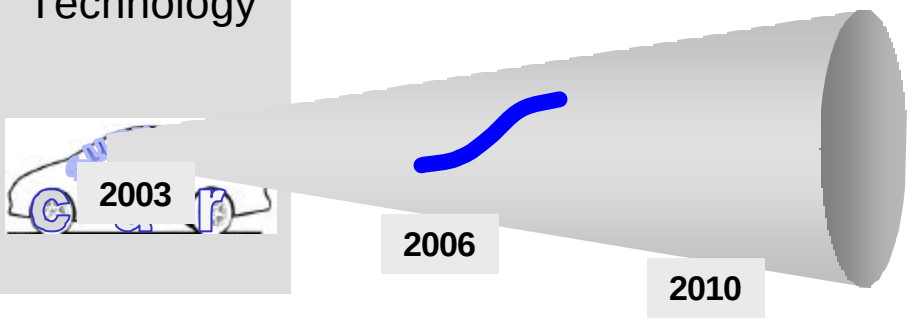
The approach



Linking tomorrow´s customer requirements with tomorrow´s technology

The general process





Different Time Frame

The workshop team

Members of DC-Research group

- customer research
- vehicle concept development
- conventional and alternative drives
- vehicle dynamics
- active and passive vehicle safety
- human machine interaction
- information systems
- driver assistance systems
- automation
- materials and surfaces

Applying Laws of Evolution

1) **Technical systems develop conforming to the laws of technical evolution.**

Example:

Increase of dynamics and control

Technical systems pass through an evolution towards higher dynamics and controllability.

2) **Within this evolution they pass through concretely namable phases.**

Example:

Segmentation

rigide - 1 joint- many joints- elastic - liquid-based - field based

3) **By analyzing the past evolution phases of a technology and by applying the laws of evolution and the evolutionary steps we are able to determine the technological potentials of the future .**

Example:

Segmentation

Seats consist currently of the actual seat and the backrest which are jointed and conjointly lengthwise relocatable. How could ***the request of more flexibility in the interior*** *be fulfilled by increasing the degree of segmentation?*

Workshop process

1st WS: Problem analysis
Definition of the most important vehicle functions
Collecting technologies already existing and in research pipe line

2nd WS: Applying laws of evolution
Generating ideas on the basis of the laws of technological evolution

A

A

B

B

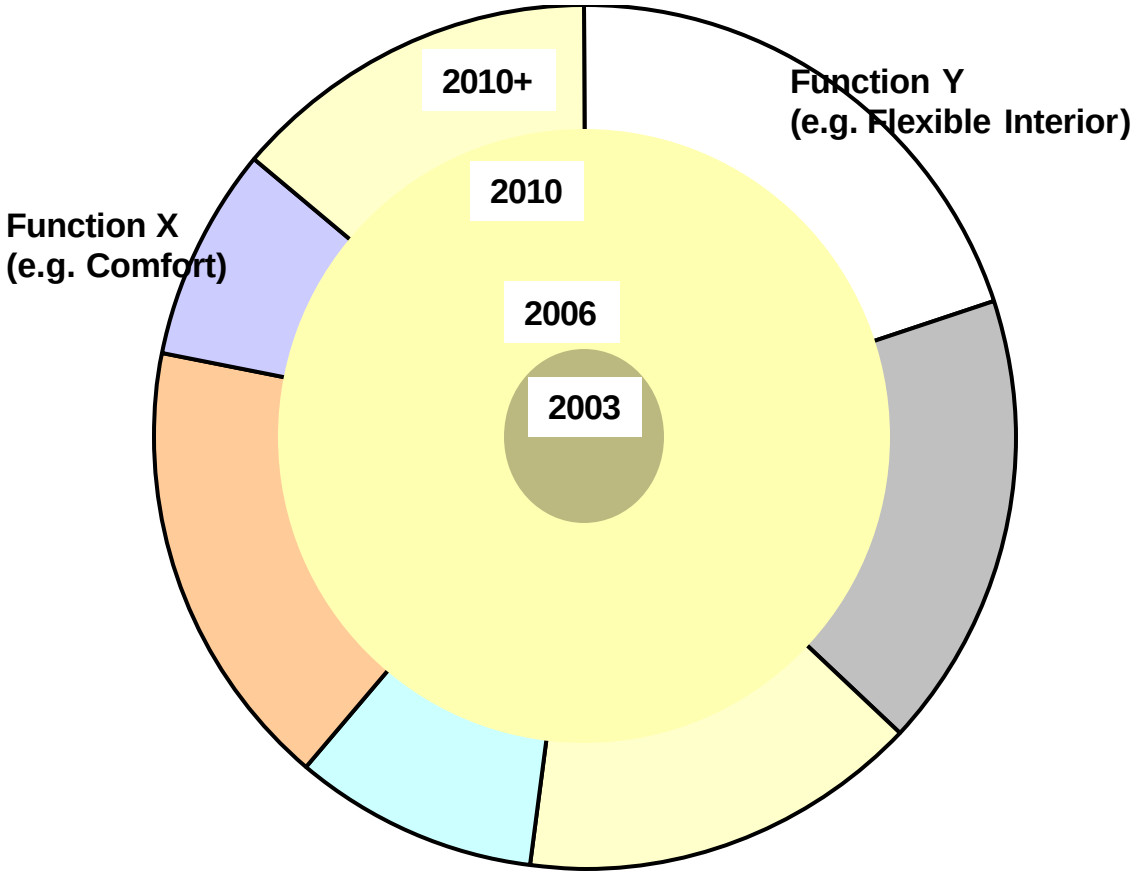
3rd WS: Integration of concepts
Assessment of generated ideas
Identification of concept kernels
Integration of ideas to vehicle concepts

4th WS: Concept discussion
Discussion and agreement on three different vehicle concepts

Structuring of ideas: principle

Structuring criteria

- Functions
- Time horizon
- Evaluation



Process lessons learned

- **Vehicle Concepts as a very sophisticated task:**
  - **Remaining on a conceptual stage**
- **Location: Out of the box (office) with appropriate ambiance**
  - **The knight story**
- **Methodology worked better from the background**
  - **Caution: Excessive demands**

Conclusions I (out of the process)

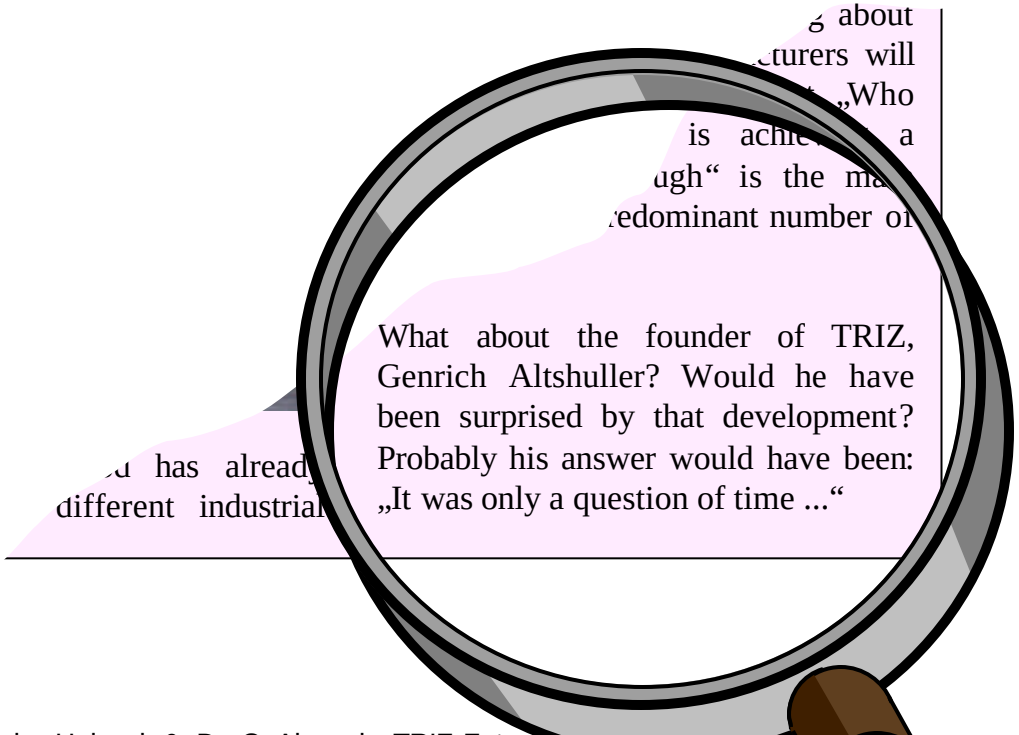
- TRIZ laws of technological evolution are well appropriate to apply them to the development of future vehicle concepts
- Detailed knowledge of customer´s requirements (provided by GTM) was a very important support for focussing the TRIZ process.
- In the next step we have to go more in technical details for interesting technical subsystems. After having made that we can prove how good our concepts really are.

Conclusions II (out of the company experience)

The precondition for a breakthrough in industrial TRIZ application:

- **TRIZ success stories and**
- **TRIZ marketing concepts for manager**
  (who will never really understand TRIZ)

A view into the future, part II



... but it will not happen automatically!