TRIZ based Technology Forecasting for Automotive industry: Dichotomy of Voice of the customer and Voice of the Product

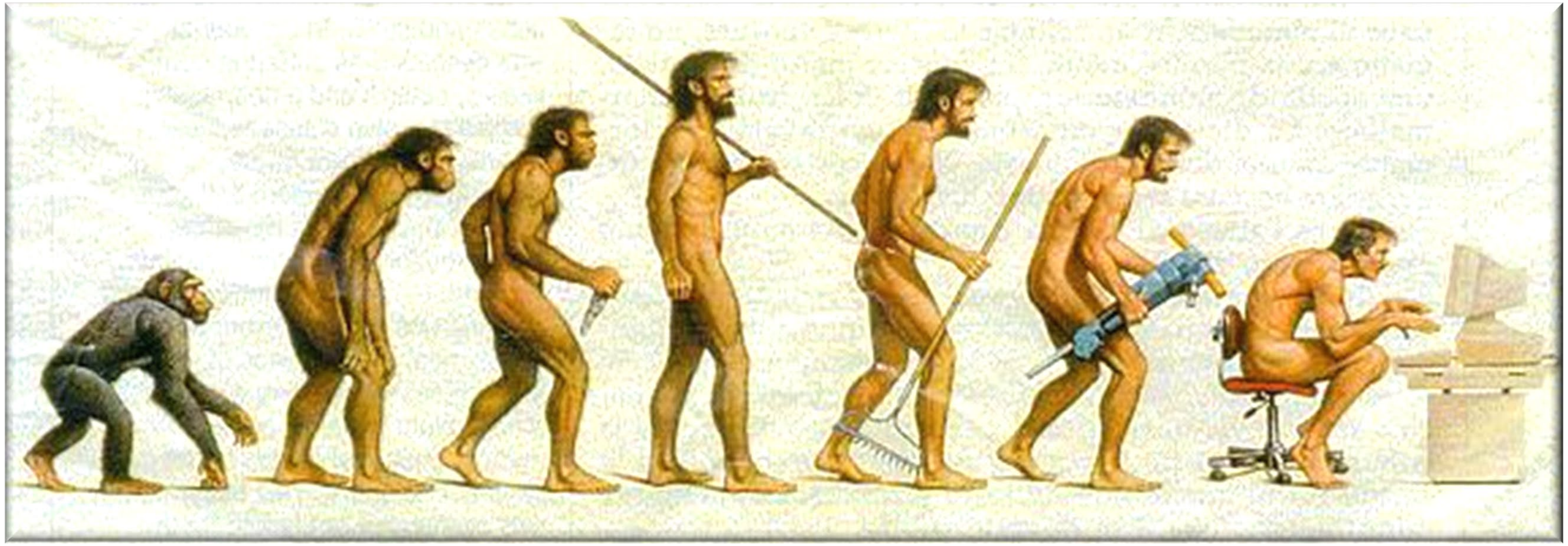
Nikhil Phadnis, Junior researcher LUT University, Consultant

Date:24.11.2022

Technology Forecasting- The buzz word

LUT University

- Technology forecasting is a process that is applied against an open-ended goal to determine the longer-term directions in which technology will develop
- Ideally: Forecasting should predict the directions in which technology will evolve, and also deliver specific design solutions



MPV Definitions

LUT University

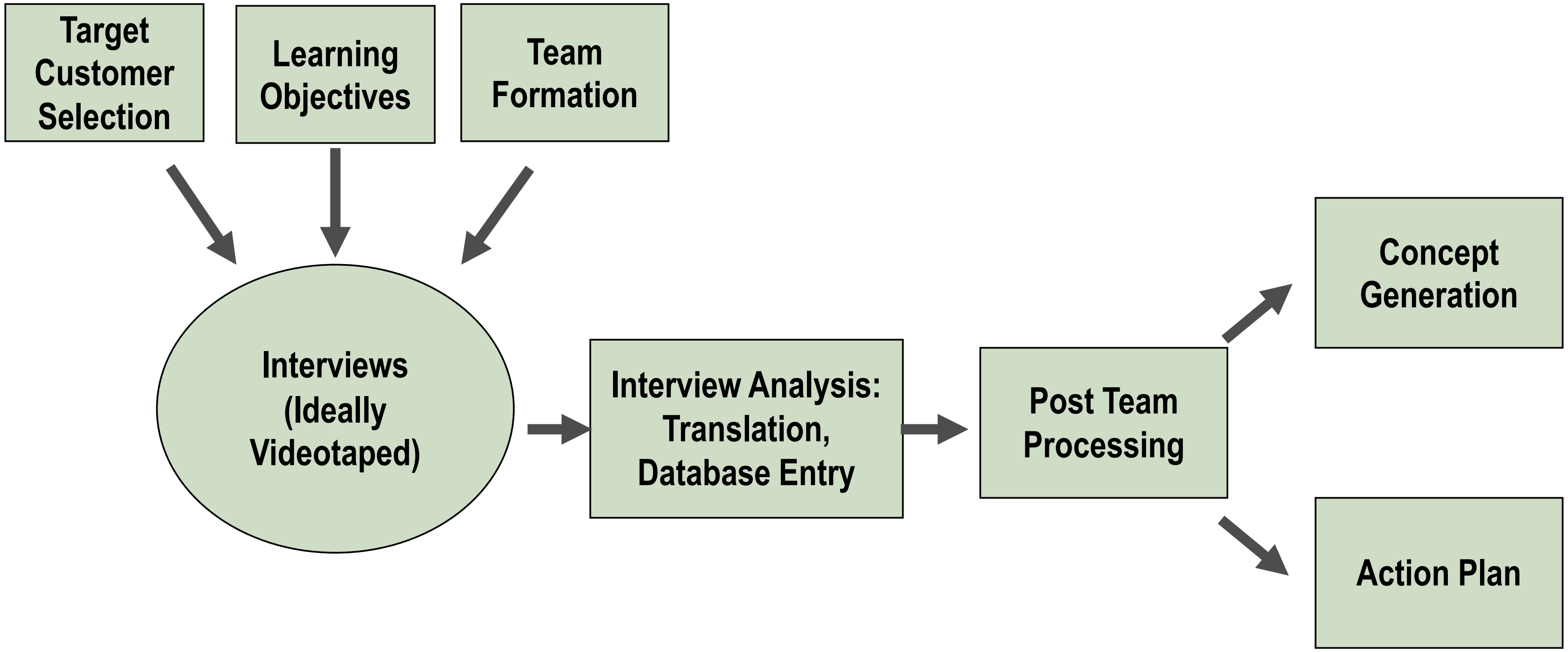
Main Parameter of Value (MPV):
Key attribute of a product/service that is hereto unsatisfied and important to the purchase decision process

Innovation:
Market available significant improvement along at least one Main Parameter of Value

"A good hockey player plays where the puck is. A great hockey player plays where the puck is going to be."
Wayne Gretzky

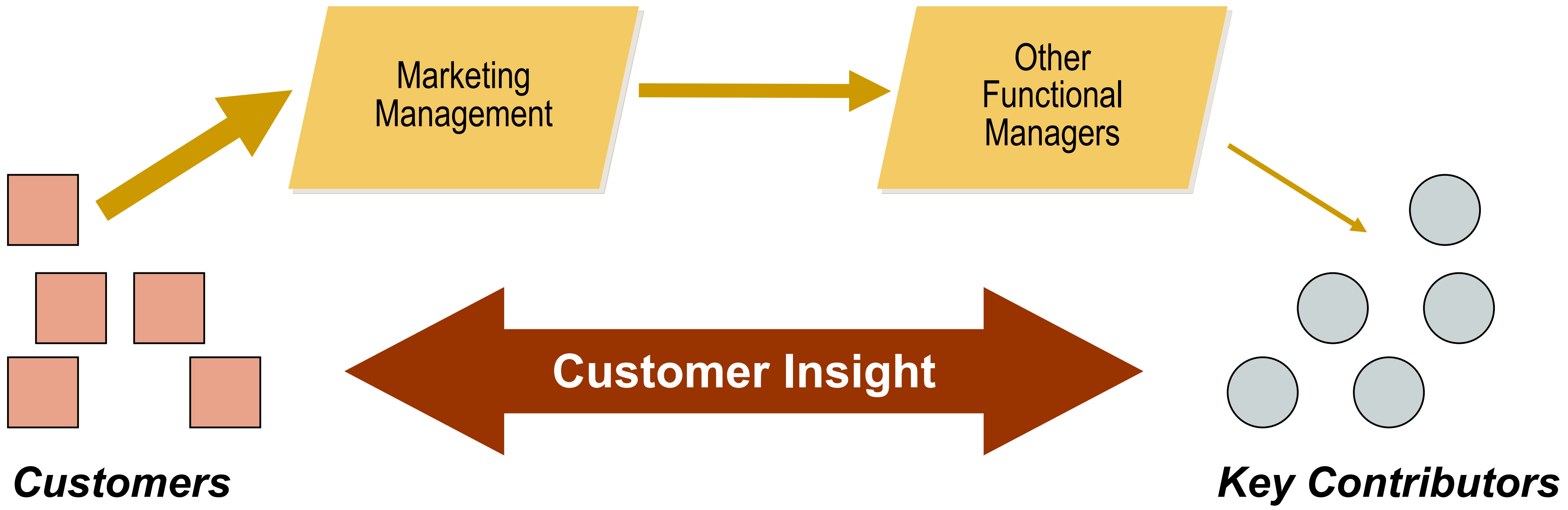
MPV Example: What do Consumers Want from Domestic Airlines?

Voice of the Customer: Process



- VOC translates team-based customer interviews into a prioritized list of customer needs (MPVs), which map to ultimate product requirements

Voice of the Customer: Principles



- Create a high-bandwidth communication channel between target customers and key contributors, providers of solutions = less filtering
- Foster coordinated team action through group data sharing, analysis and decision making
- Establish direct customer relationships for follow-up questions, concept testing, etc.

MPV Sources

- How to identify MPV?

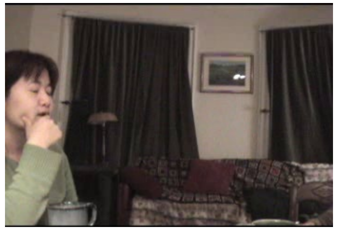
Voice of the Customer
(Market Parameters of Value)

Market Research

Field Interviews

Conjoint Analysis

Focus Groups



You can't just ask customers what they want and then try to give that to them. By the time you get it built, they'll want something new.
Steve Jobs

Voice of the Customer Limitations

We are not very good at identifying needs

- Limitations of market surveys – people don’t know what they don’t know
- Limitations of needs assessment - people can’t believe they may ask for some advanced product’s features

Review of Traditional Forecasting Methods

- Normative methods (e.g. the Pattern Method)
  - For planning, not forecasting – not predictive
  - Subjective
- Research methods
  - Analogy methods
    - The analogy is often superficial and, in the end, incorrect (for example, prediction that computer will evolve as a “calculator” machine)
  - Extrapolation methods
    - Forecast is good only as long as the function being extrapolated is valid (for example, prediction that London would be buried in horse manure by mid-20th century)
  - Expert evaluations
    - Hindered by psychological inertia
    - Only as good as the intuition of the expert (for example, prediction of K. Roentgen that X-Rays would have no practical applications)

Disadvantages of Traditional Forecasting Methods

LUT University

- Strong element of chance
- Abstract predictions, not product concepts/designs
- Quantitative, not qualitative
- Limited long-range accuracy
- Do not effectively predict jumps in technology development
- Do not effectively identify new "functional opportunities"
- Do not effectively take inflections in S-Curves into account

MPV Sources

- How to identify MPV?

Voice of the Customer
(Market Parameters of Value)

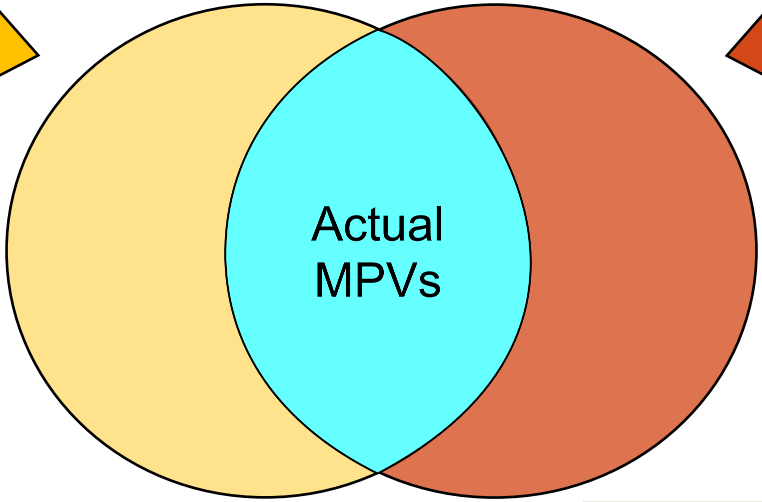
Voice of the Product
(Functional Parameters of Value)

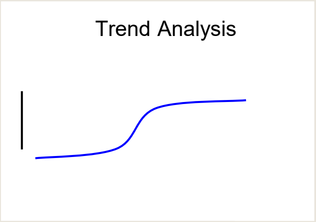
Market Research

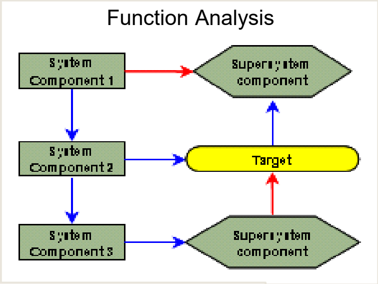
Field Interviews

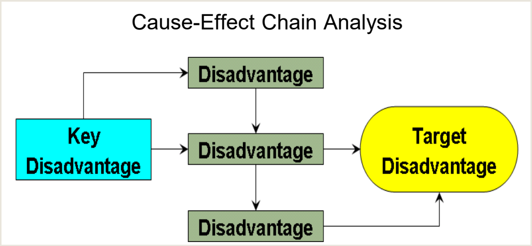
Conjoint Analysis

Focus Groups









Latent MPV Identification: VOP tools

Initial MPVs

- MPV 1
- MPV 2
- MPV 3
- MPV 4
- MPV 5
- MPV 6

Functional Analysis

What are the non-existing, but potentially attractive properties that address poorly performing functions?

Industry Trends (Patents)

What do other industry experts think about improvement of selected product and similar products?

General Trends (TESE)

What would Leonardo da Vinci and Thomas Edison do if they had the same challenge – to improve selected product?

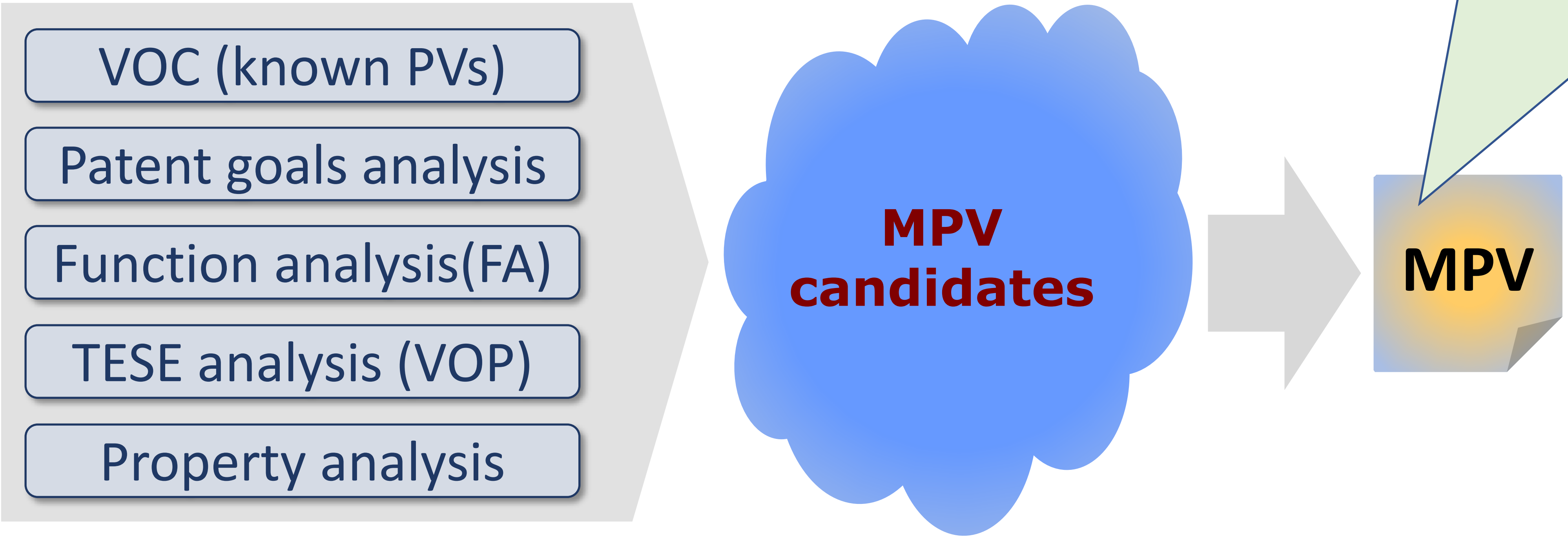
- We can build the patent wall not where the Client's current IP positioning is but where it should be
- We are not going to play defense against Competitors but rather offence by predicting their next steps

Where MPVs Come From

Screening process:

- Does the MPV candidate meets both VOC and VOP?
- Can the MPV candidate be monetized by the client?
- Does the client approve the MPV candidate?

The sources of MPVs in TRIZ:

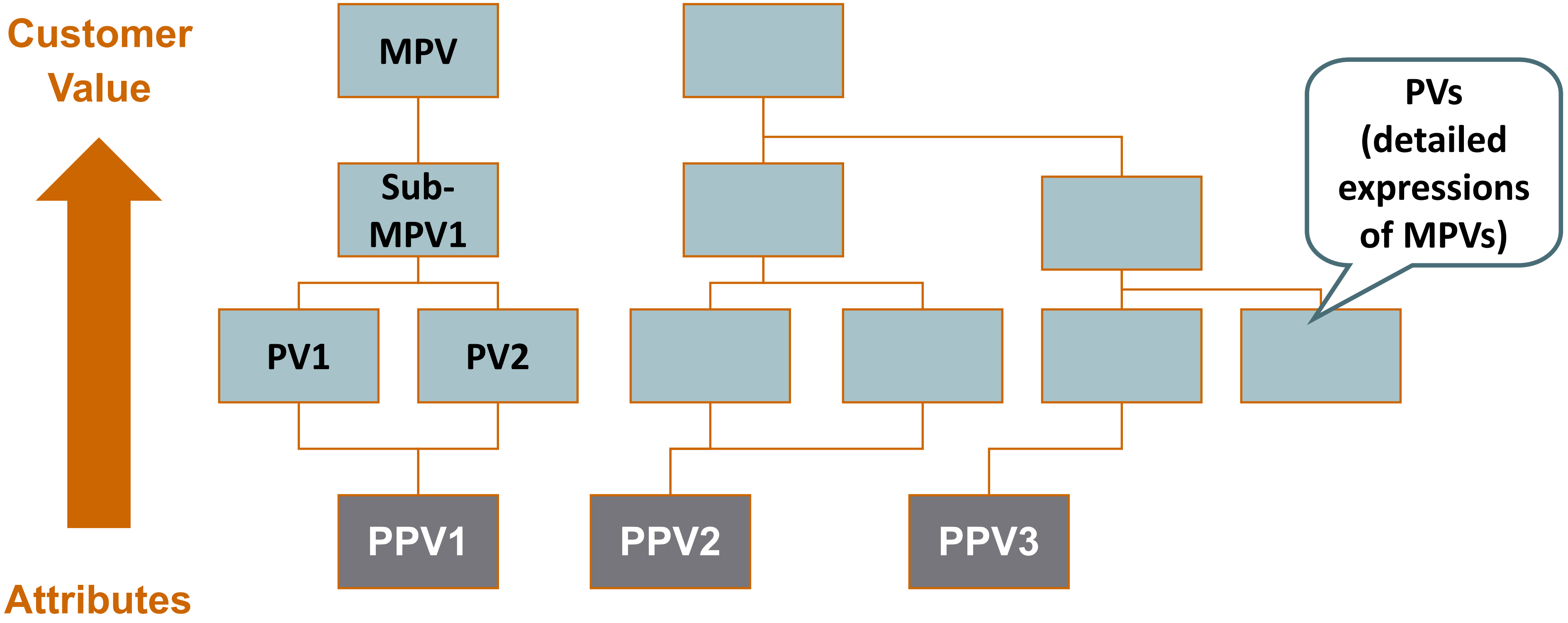


Power and Uniqueness of TRIZ Forecasting

- **MPV- driven:** Delivers market-based innovation concepts
- **Predicts not only "what", but also "how"** (i.e., delivers specific product/technology solutions, not just directions)
- Encompasses cross-disciplinary global knowledge
- Built on the **Trends of Engineering System Evolution**
  - Forecasts feasible **new product concepts for multiple product iterations**
  - Predicts new-generation products by *identifying new action principles*
  - Includes Supersystem considerations, resulting in higher reliability
  - Identifies latent functionality, potential new MPVs and potential new markets
  - Accuracy of the forecast increases over time

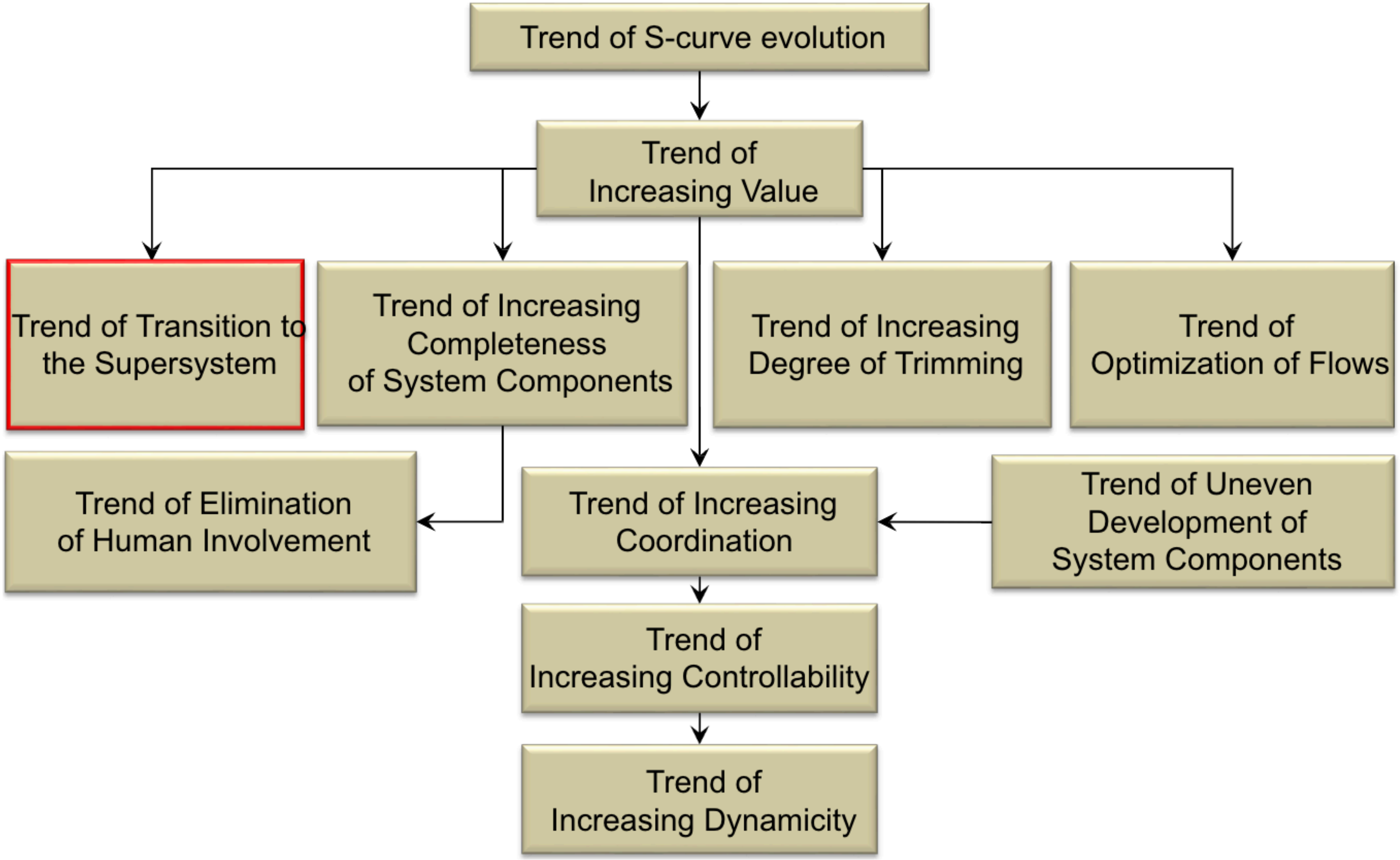
MPV Hierarchy: Mapping back from High level Motivators to Physical Parameters

High level strategic, market recognizable MPVs are linked to more detailed Parameters of Value (PVs) which are matched to Physical Parameters (PPVs)



We can predict the Technological evolution of Physical parameters easier , because they are more predictable!

Trends of Engineering Systems Evolution



Trends of Engineering System Evolution

- Definition: Trend of Transition to the Supersystem
  - As an Engineering System evolves, it is integrated with Supersystem components

  Example: *Student chair = seat + desk*

Trends of Engineering System Evolution

- The Trend of Transition to the Supersystem has 4 subtrends:

1. **Parameters of the integrating systems become increasingly different from those of the Engineering System**
2. **The main functions of integrating systems become increasingly different from those of the Engineering System**
3. **The level of integration between the Engineering System and integrating systems becomes deeper**
4. **The number of systems that integrate with the Engineering System increases**

Trends of Engineering System Evolution

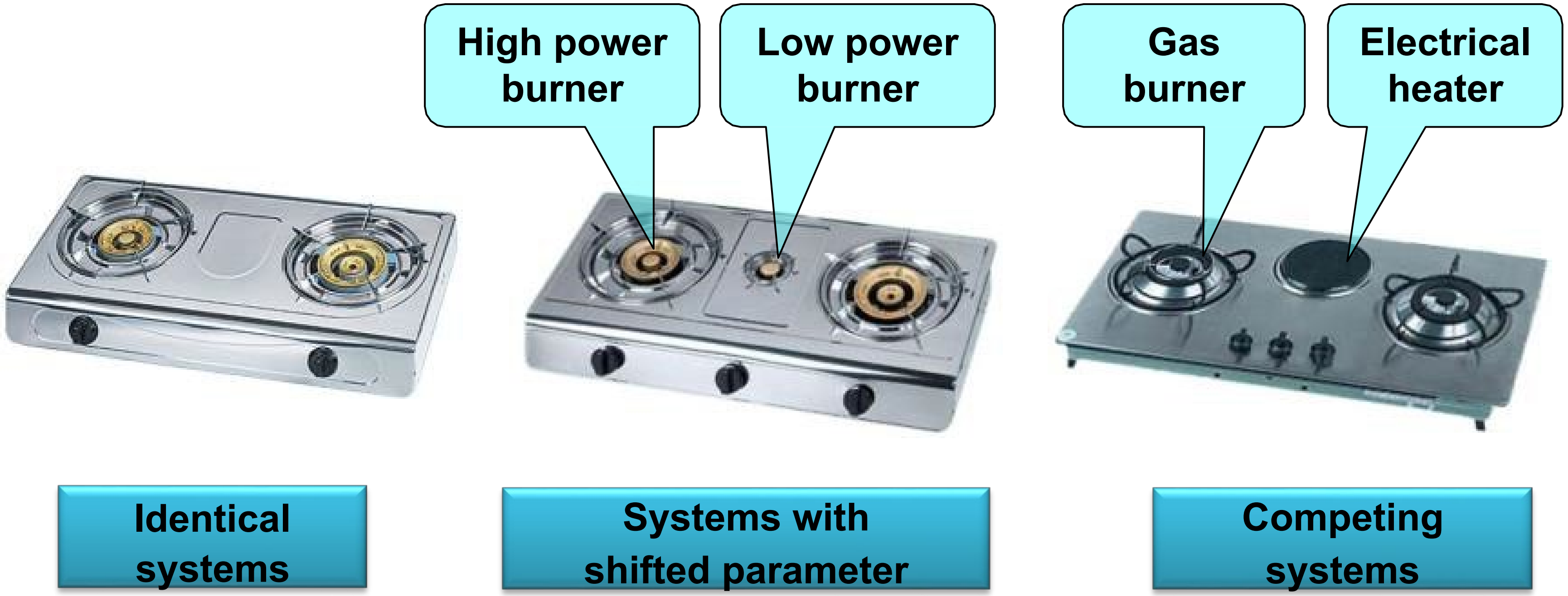
- Trend of Transition to the Supersystem:
  Subtrend 1 – Increasing Differentiation of Parameters

  – Types of integrating Engineering Systems
    - Identical (same parameters as the Engineering System)
    - Differing by at least one parameter from the Engineering System
    - Competing Engineering System's (different systems, but similar main function)

Trends of Engineering System Evolution

- Trend of Transition to Supersystem: Subtrend 1 - Increasing Differentiation of Parameters

Example: ***Improving universality for a gas stove***



Case studies

MPV Case Study 1: MPV Translation into PPV – Heavy Truck

Heavy Truck

- **Scenario:**

  A company that produces heavy trucks is looking to dramatically improve its position on the market

- **Challenge:**

  One of the highest ranking MPVs for the company's customers (Fleet owners and Owner-Operators) is Fuel Efficiency. The company wants to identify the best ways to improve Fuel Efficiency.

MPV Case Study 1: MPV Translation into PPV – Heavy Truck

Heavy Truck

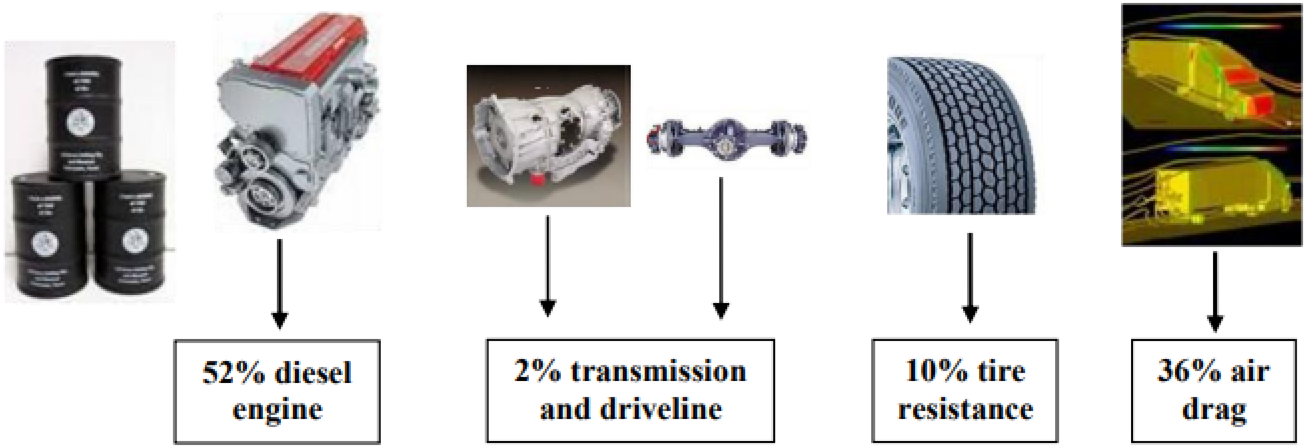


Figure 1.1-1: Average fuel energy expenditures in a typical class 8 tractor / trailer combination at highway speed. The picture is reproduced from Ogburn et al (2008) where some of the expenditure magnitudes are modified in accordance with results of other studies.

MPV Case Study 2: MPV Translation into PPV for Heavy Truck

MPV	Sub 1 MPV	Sub 2 MPV	Physical Parameter
Fuel Economy	▪ **Aerodynamic drag**	▪ Form drag ▪ Resistance from friction against external surfaces ▪ Resistance generated by protruding parts of the car ▪ Turbulence resistance	▪ Air density ▪ Air viscosity ▪ Air temperature ▪ Area of the largest cross-section of the car ▪ Car speed ▪ Shape (size) of cabin, fairings, trailer ▪ Material surface energy ▪ Van-der-Waals forces (forces of mutual attraction of molecules)
	▪ **Cost effectiveness of engine**	▪ Engine efficiency	▪ Combusting temperature of combustible mixture ▪ Combustible mixture density ▪ Size (arrangement) of piston-rod group ▪ Size of particles of atomized fuel ▪ Air temperature ▪ Uniformity of fuel mixture spray ▪ Excessive air coefficient
	▪ **Rolling resistance**	▪ Structure (composition) of road surface ▪ Truck weight ▪ Weight of cargo carried ▪ Quality and number of rolling contact bearings	▪ Unevenness of road surface ▪ Unevenness of tire surface ▪ Shape (relief) of tire protector ▪ Mechanical parameters (rigidity, elasticity) of ti ▪ Metal density ▪ Size of point of contact between wheel and road pave ▪ Load on one axis of truck ▪ Optimality of load-bearing structure

Cost effectiveness of engine and Rolling resistance heavily worked on!

MPV Case Study 1 – Heavy Truck: Key Problem

- **MPV: Fuel Economy**

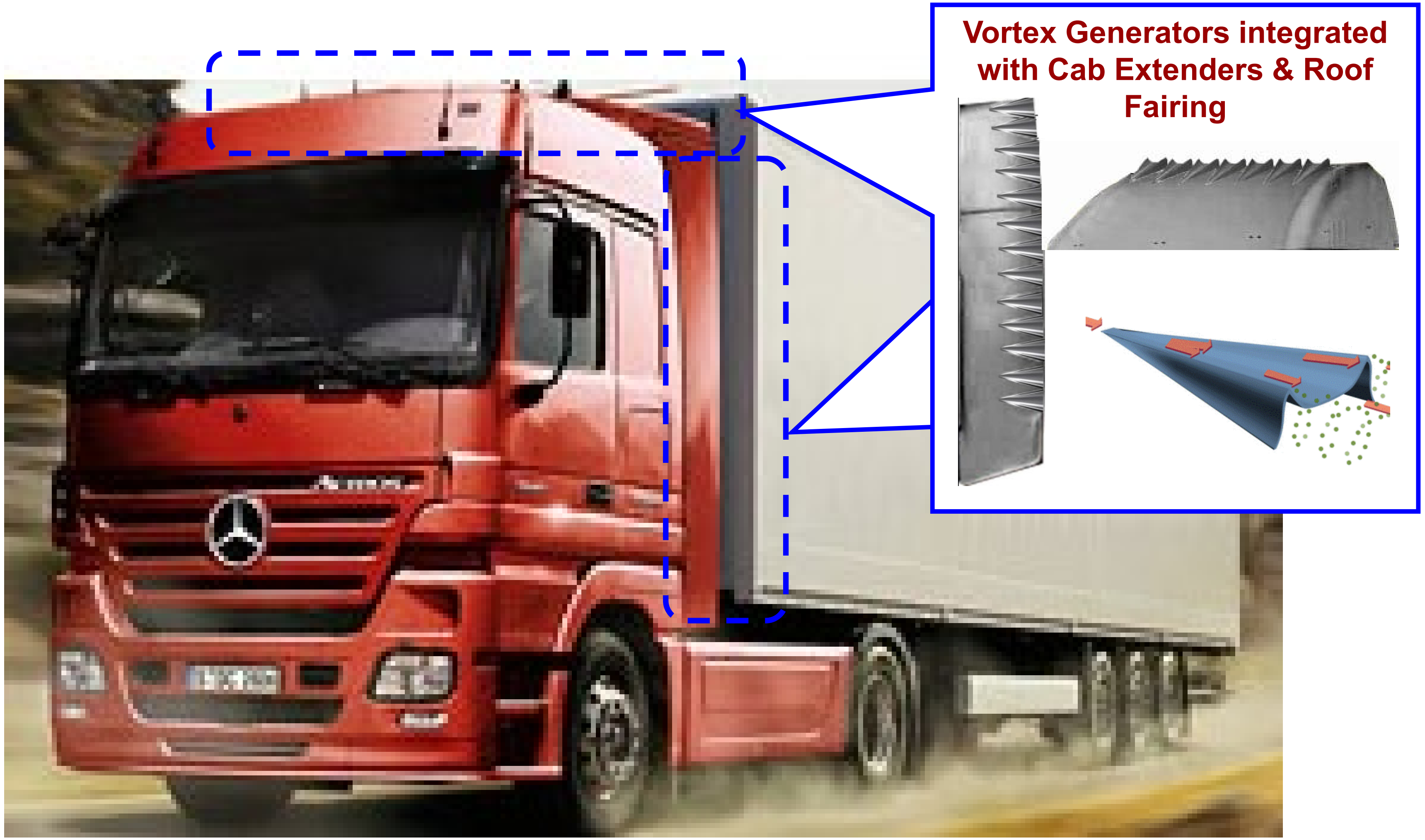
- **MPV translation into PPV:** Fuel Economy -> Aerodynamic drag (resistance) -> Form Drag -> Shape of cabin and trailer
- **Contradiction:** The space between the cab and the trailer should be large to ensure maneuverability and it should be small to reduce aerodynamic drag

Small gap: low aerodynamic drag (+), poor maneuverability (-)

Large gap: good maneuverability (+), high aerodynamic drag (-)

MPV Case Study 1 – Heavy Truck: Solution

Solution was found using Principles of Resolving Contradictions: Principle of substitution mechanical action principle with pneumatic one



Improving Range of Vision for A-pillar – Current Solution

LUT University

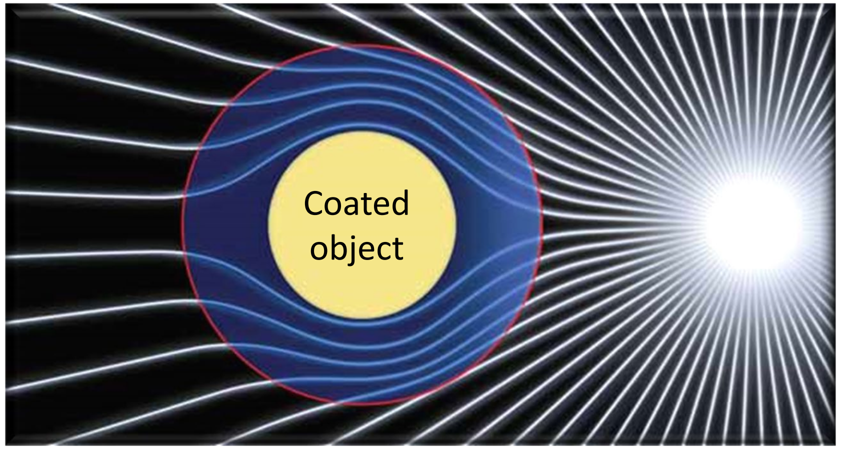
- Problem:
  - The pillar obstructs driver's vision and thus reduces driving safety
  - How to eliminate this negative effect?

- Existing Solution:
  - Image from external camera is projected onto the pillar making it virtually transparent
  - Drawback – it is too expensive

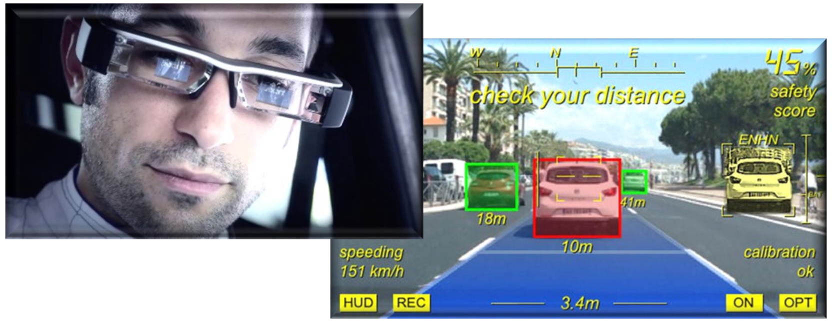
Improving Range of Vision for A-pillar –TRIZ Approach

LUT University

- Solution on the System Level:
  - The pillar is covered with an optical metamaterial that has negative refraction coefficient at least for one visible wave length
  - Light just bypass the pillar making it virtually invisible



- Solution on the Super-System Level:
  - Augmented reality glasses can make entire car body virtually invisible



- Long Term Forecast:
  - Worldwide application of car autopilots will eliminate this problem at all

Thank you

Contact: Nikhil.phadnis@lut.fi

Acknowledgements: Dr Simon Litvin, Dr Oleg Abramov and GENTRIZ team for some research material provided