



DEPARTMENT  
OF PSYCHOLOGY

PHILOSOPHICAL FACULTY  
PALACKY UNIVERSITY IN OLOMOUC  
CZECH REPUBLIC

# Road design

## Human factors perspective

Traffic psychology 1  
PCH/DP1

Matus Sucha

Presentation 7





## Agenda

1. The Sustainable safety vision of road safety
2. Functionality of roads
3. Predictability by recognizable road design
4. Homogeneity of mass, speed and direction
5. Physical forgivingness



# 1. The Sustainable safety vision of road safety

The Sustainable Safety vision of road safety is based on **five principles**:

1. The functionality of roads,
2. The homogeneity of mass and/or speed and direction,
3. Physical and social forgivingness,
4. Recognition and predictability of roads and behaviour,
5. State awareness.



# 1. The Sustainable safety vision of road safety

These five principles should lead to a **sustainably safe traffic** system in which:

- **(serious) crashes are prevented**, and, where this is not possible, **severe injury is almost totally prevented**;
- the premise is that **man is the measure of all things**: his physical vulnerability and cognitive capabilities and **limitations** (such as fallibility and the desire to explore boundaries);
- the elements man, vehicle, and road are not only tuned to the human measure but are approached and **dealt with in an integrated manner**;
- safety gaps in the traffic system are bridged through a **proactive approach**.



## 2. Functionality of roads

The **functionality principle** aims at a clear **division** of roads into categories on the basis of **their traffic function**.

Traffic has **two functions**: (1) to flow (traffic function, A → B) and (2) residential function (access).

These are very different functions, and they each require a *specific infrastructure*.

The flow function requires traffic space, a public area with traffic as a priority. The residential function includes a living space (e.g. premises, pavements) where the priority is residing (e.g. inhabitants, personnel).



## 2. Functionality of roads

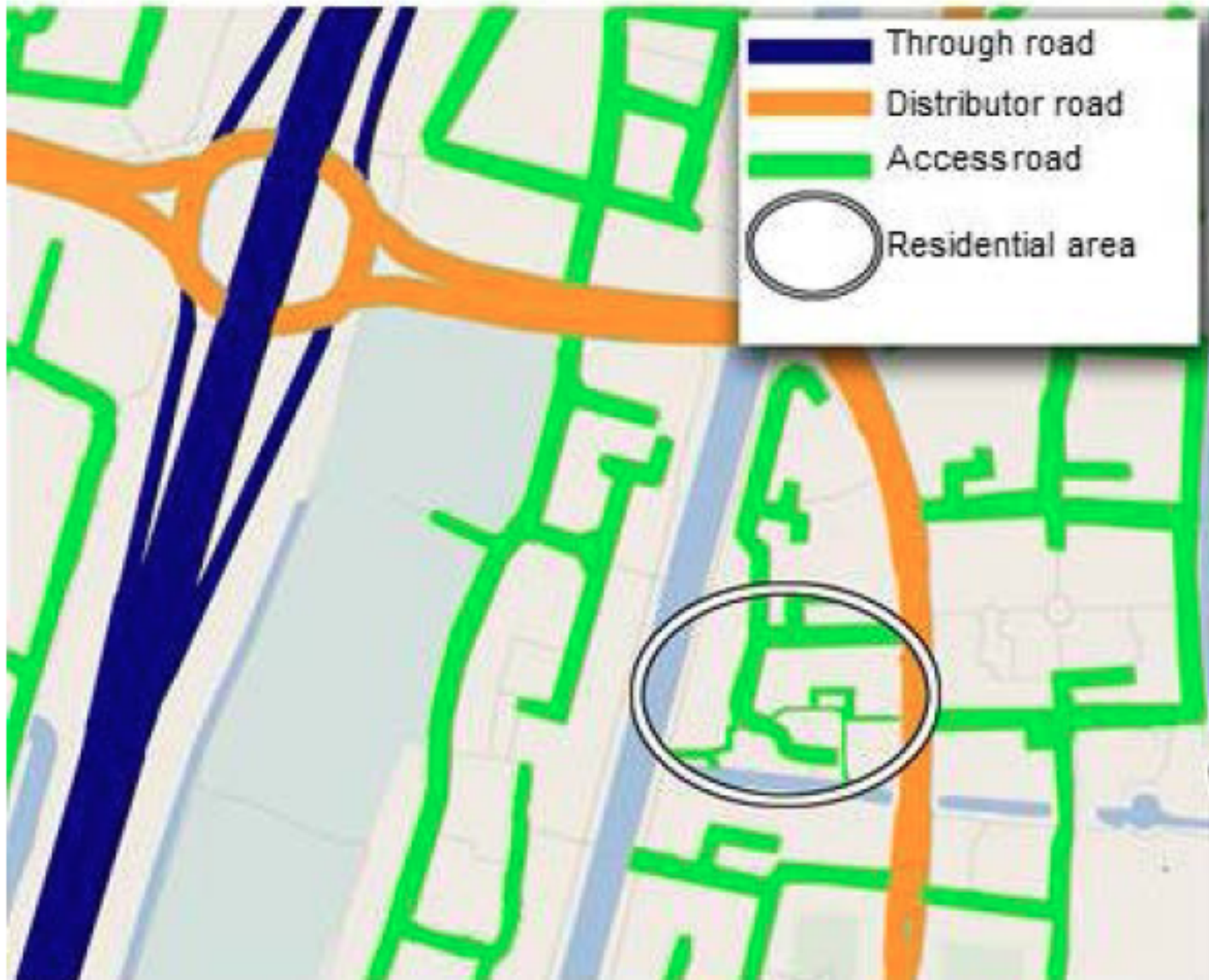
*Sustainable Safety distinguishes three road categories:*

1. ***Through roads** are meant to enable traffic to **flow** as much as possible and are designed in such a way that traffic can move safely from A to B at high speed. This road type is specifically suited for through traffic. Preferably, traffic would drive the largest part of a journey along through roads.*



## 2. Functionality of roads

2. **Connecting roads** have been defined and are called **distributor roads**. *This road type has a **flow function** on road segments and an **exchange function at intersections**, and connects through roads with access roads, as well as through roads and access roads among each other.*
3. Finally, **Access roads** are meant to provide access to destinations. *On these roads, fast traffic mixes with vulnerable road users such as pedestrians and cyclists. **Residence is the main function** here and motorized vehicles are **guests**. This traffic function also requires its own infrastructure.*







## *Example: Through road*





## *Example: Connecting/ distributor road*



Phil Logsdon, Kentucky Transportation Cabinet





## *Example: Access road*





### 3. Predictability by recognizable road design

A **predictable layout** of a road prevents unsafe actions in traffic as much as possible because **it allows road users to better know what to expect** (types of road users, manoeuvres, road course) and **what will be expected of them** (speed, manoeuvres).

Studies have shown that people make fewer mistakes when they have to react to (traffic) situations they expect than when they react to unexpected situations (for example, see Theeuwes & Hagenzieker, 1993). Their actions are then routine, which results in fewer (dangerous) errors (Rasmussen, 1983; Reason, 1991).

A predictable layout of roads helps to predict the traffic situation; this is of vital importance, especially when **high speeds are involved**.



### 3. Predictability by recognizable road design

A **predictable road layout** can be achieved by:

1. consistency in road design,
2. continuity in road course.

Ideally, the road layout supports the road user **expectations** along the entire road and the road design elements correspond to these expectations.

For roads to be **recognizable**, it is not only important to distinguish *between road categories (Functionality of roads)*, but also to have *uniformity within categories*.



### 3. Predictability by recognizable road design

In a Sustainably Safe road system, each **road category** has its **own characteristics** for road design and **speed limit**, according to the homogeneity principle.

Furthermore, the characteristics of each type of road category relate to **types of road users** (motorized vehicles only or a mixture of motorized traffic, cyclists, and pedestrians), and **permitted manoeuvres** (such as overtaking, joining, or crossing).

In an ideal situation, the **appropriate behaviour** for each road category should be supported or **evoked by the road image**. That is how different road types are made recognizable.



### 3. Predictability by recognizable road design

The principle of **predictability** is based on the idea that **human errors**, and the resulting crashes can be **prevented** by providing a road environment that is **predictable by means of a recognizable road design and predictable alignment**.

The road features should **tell** the road user immediately what road type he is driving on, **which driving behaviour is expected** of him and other road users, and which other types of road user he can meet.

In the ideal case, the road should be **self-explaining** as much as possible. This makes the traffic system more predictable and indecisive behaviour and crashes as a result of that may be prevented.



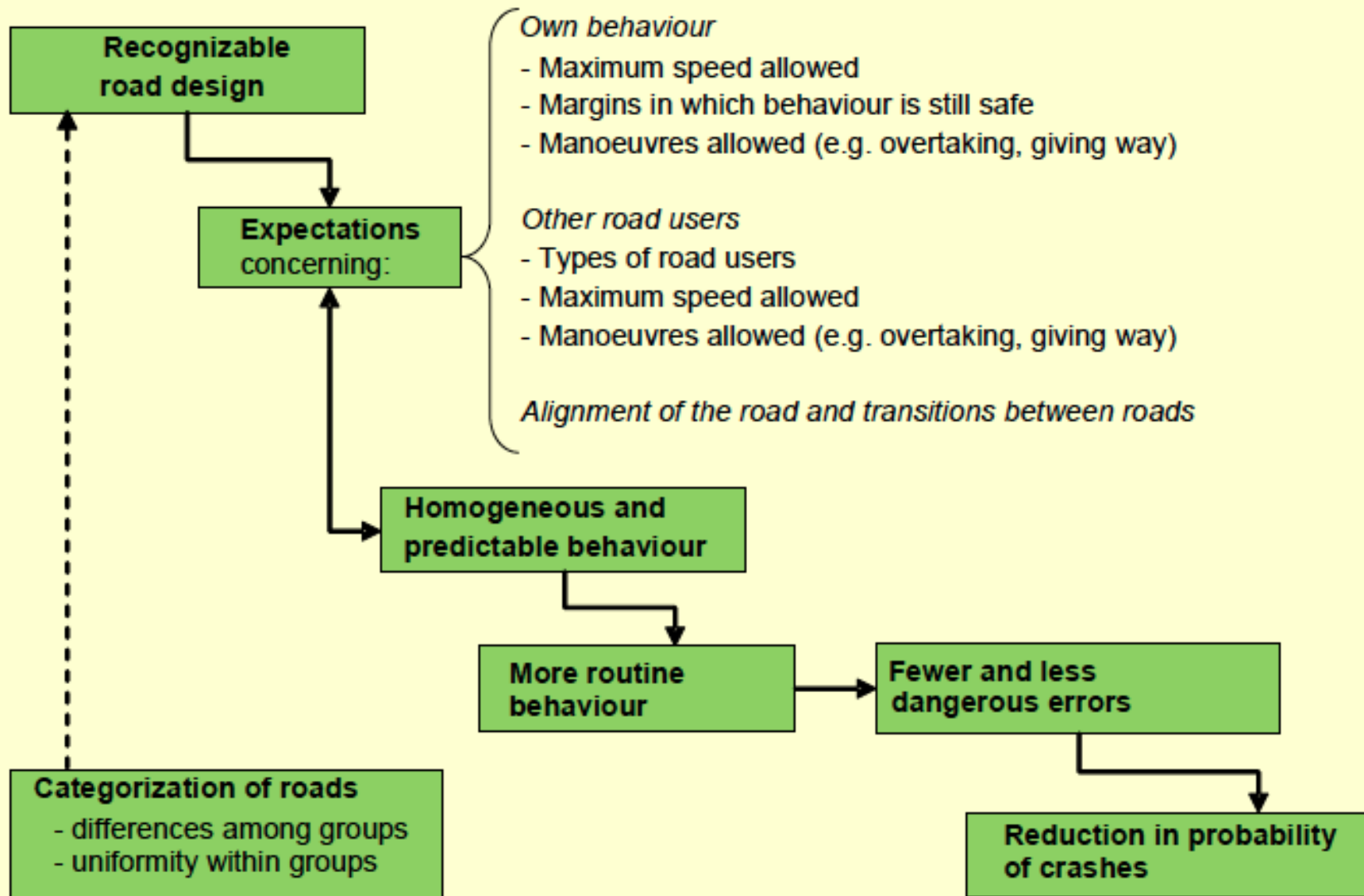
### 3. Predictability by recognizable road design

Recognition is preceded by a process of **mental categorization**.

This means that people recognize an image if it resembles an image that they **have perceived earlier** and which may, as such, belong to the same group or category.

Categorization, and consequently recognition, is easier the more the **roads in the same category resemble each other**. The **differences between the categories should be as large as possible** (Aarts et al., 2006; Theeuwes & Diks, 1995). This







## 3. Predictability by recognizable road design






### What can roads make recognizable?

These characteristics must be: 1) *continuously perceivable*, 2) *be practical*, and 3) *not be disadvantageous for road safety*.

Research (Aarts et al., 2006) has shown that the following characteristics can contribute to **recognizability**:

1. type of road surface;
2. design of the driving direction separation (axis markings or physical separation);
3. edge marking;
4. (anti) flow marking;
5. salient colour and shape of kerb marker posts;
6. urban road characteristics such as buildings, parking spaces, and exit roads;
7. (red) recommended cycle lanes on the carriageway.



Essential recognizability characteristics	Through road		Distributor road			Access road	
	SW120	SW100	GOW80	GOW70	GOW50	ETW60	ETW30
Zone sign	Motorway sign 	Trunk road sign 	Sign n.a. (general speed limit))	Speed limit sign 	Sign n.a. (general speed limit)	Zone sign 	Regulation or zone sign 
Edge marking	Continuous marking	Continuous marking	Broken marking	Broken marking or kerb	Broken marking or kerb	None or broken marking	None or broken line, or kerb
Driving direction separation	Vehicle barrier or wide median	Double axis line with green 'filling', barrier, or median	Double axis line or median	Double axis line or median	Double axis line or median	None	None



## 3. Predictability by recognizable road design

Road markings





### 3. Predictability by recognizable road design

Dutch way





## 3. Predictability by recognizable road design

Predictability of other road users





## 3. Predictability by recognizable road design



Not a safe  
design.



### 3. Predictability by recognizable road design



Safe design.





## 4. Homogeneity of mass, speed and direction

In a crash, **human's physical vulnerability** comes into play. Injury is the result of a combination of:

- **released kinetic energy (mass x speed)**
- **biomechanical properties of the human body**
- **physical protection that the vehicle offers its occupants.**

➔ **The more homogeneous the traffic, the lower the risk of (severe) injury.**

There where road users/vehicles with **large mass differences** use *the same traffic space, the speeds should be so low that the most vulnerable road users and transport modes come out of a crash **without any severe injuries.***



## 4. Homogeneity of mass, speed and direction

At locations where traffic uses **high speeds**, different types of road user and road users driving in different directions should be **physically separated from each other as much as possible** and road users should be protected by their vehicle.

Road types in combination with permitted road users	Safe speed (km/h)
Roads with possible conflicts between cars and unprotected road users	30
Intersections with possible transverse conflicts between cars	50
Roads with possible frontal conflicts between cars	70
Roads with no possible frontal or transverse conflicts between road users	≥100



## 4. Homogeneity of mass, speed and direction

**The twelve requirements for a sustainably safe categorization and layout of the road network are:**

1. residential areas must be adjoining and as large as possible;
2. a minimal part of the journey is travelled on relatively unsafe roads;
3. journeys must be as short as possible;
4. shortest and safest route must be the same;
5. searching behaviour must be avoided;
6. road categories must be recognizable;
7. the number of traffic solutions must be limited and uniform;
8. conflicts with oncoming traffic must be prevented;
9. conflicts with intersecting and crossing traffic must be prevented;
10. different road user types must be separated;
11. speed must be reduced at potential conflict locations; and
12. obstacles alongside the carriageway must be avoided.



## 5. Physical forgivingness

In addition to functionality and homogeneity, physical forgivingness is also an important factor in preventing injury, even if the infrastructure did not give rise to the crash.

***Forgiving surroundings ensure that the physical consequences of errors remain limited. This is particularly important in traffic situations where people drive fast.***

*In the elaboration of this principle, one could, for example, think of safe (i.e. matted) shoulders, obstacle-free zones, or collision-friendly obstacle protection.*



## 5. Physical forgivingness

Forgiving roads  
(Claes Tingvall in Vision Zero).





## 5. Physical forgivingness



Not a safe  
design.



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## 5. Physical forgivingness



Safe design.



# Thank you for listening!

## **Based on:**

SWOV Fact sheets:

Background of the five Sustainable Safety principles (2012),

Functionality and homogeneity (2010),

Predictability by recognizable road design (2012).

Theeuwes J., vd Horst R. & Kuiken M. (2013). Designing Safe Road Systems.

Ashgate Publishers.