Selection of Simulation Tasks in Professional Drivers‘ Training

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Lifelong Learning Programme

1 Simulation Based Training

Simulation Based Learning is learning by doing and it is learning by examples. The training consists of sessions with sequences of sample situations which correspond typical and/or critical situations professional drivers have to master while doing their work. The learning environment is very similar or almost identical to their work place in a truck or a bus. Trainers create a sequence of situations (tasks) the learners are expected to cope with by selecting a set of features (input variables). Depending on the mental, motivational, emotional, and psycho-motoric resources of the learners the tasks are more or less easy or difficult.

As the time for training by simulation is limited it is crucial to find strategies to select highly efficient task sequences. A prerequisite to do so is an analysis of the process of (professional) driving.

2 Psychological Processes of (Professional) Driving

Driving is a highly interactive process. At any time during driving a lot of different information affects all senses: Visual, auditory, haptic, olfactory stimuli are permanently received and processed and a driver has to detect and to respond by focusing attention to something and/or by acting in a specific way (steering, breaking, accelerating, switching on/off an aggregate, etc.).

From a psychological point of view the following factors are relevant to describe the process of (professional) driving:

- Personal Resources (cognitive, motivational, emotional, psycho-motoric) of the driver
- Mental processes while driving (generation of a subjective dynamic mental model of the situation, subjective belief concerning own abilities and skills, goals and intentions)
- Conditions and requirements of the current task
- Context of driving (besides the specific task requirements)
- Drivers scope of actions(e.g. opportunities to action allowed by the device)
- Drivers decision to act
- Driver's actual performance

Figure 1 shows relationships between these facets and factors influencing or triggering the actual value. The first two facets are internal conditions of the learning process the others are external conditions. Normally simulator devices allow varying the external conditions, but some offer also the possibility to simulate some internal conditions by representing the situation in a way it would be experienced by a driver who underlies these conditions (constraints due to alcohol, microsleep).

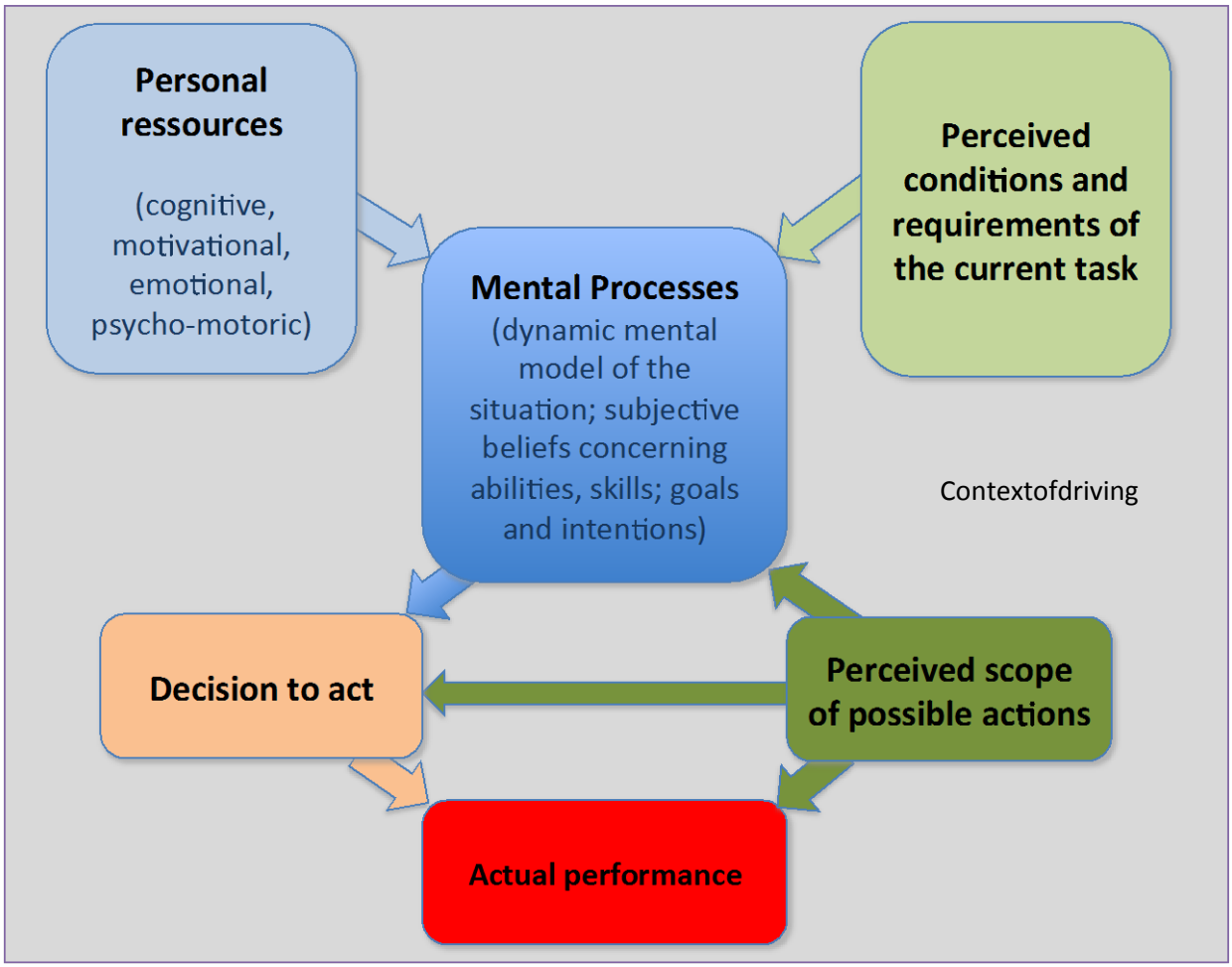

Figure 1: Factors influencing the driving process

3 Instructional Design Model

As driving is a complex cognitive and psycho-motoric process the most suitable Instructional Design (ID) model to apply is the 4-C/ID model (4D = four components) by van Merriënboer (1997) in its "10-Steps"-version (van Merriënboer&Kirschner 2007). The model requires thorough task analyses. Figure 2 provides a schematic overview over the model, which cannot be explained completely here. Regarding the concept of "learning tasks" van Merriënboer&Kirschner write:

> "Learners work on tasks that help them develop an integrated knowledge base through a process of *inductive learning*, in which they induce knowledge from concrete experiences … . Therefore each learning task should offer whole-task practice. This means that the learning task confronts the learner with all or almost all of the constituent skills important for real-life task performance, together with their associated knowledge and attitudes."
> (vanMerriënboer&Kirschner 2007, p. 14).

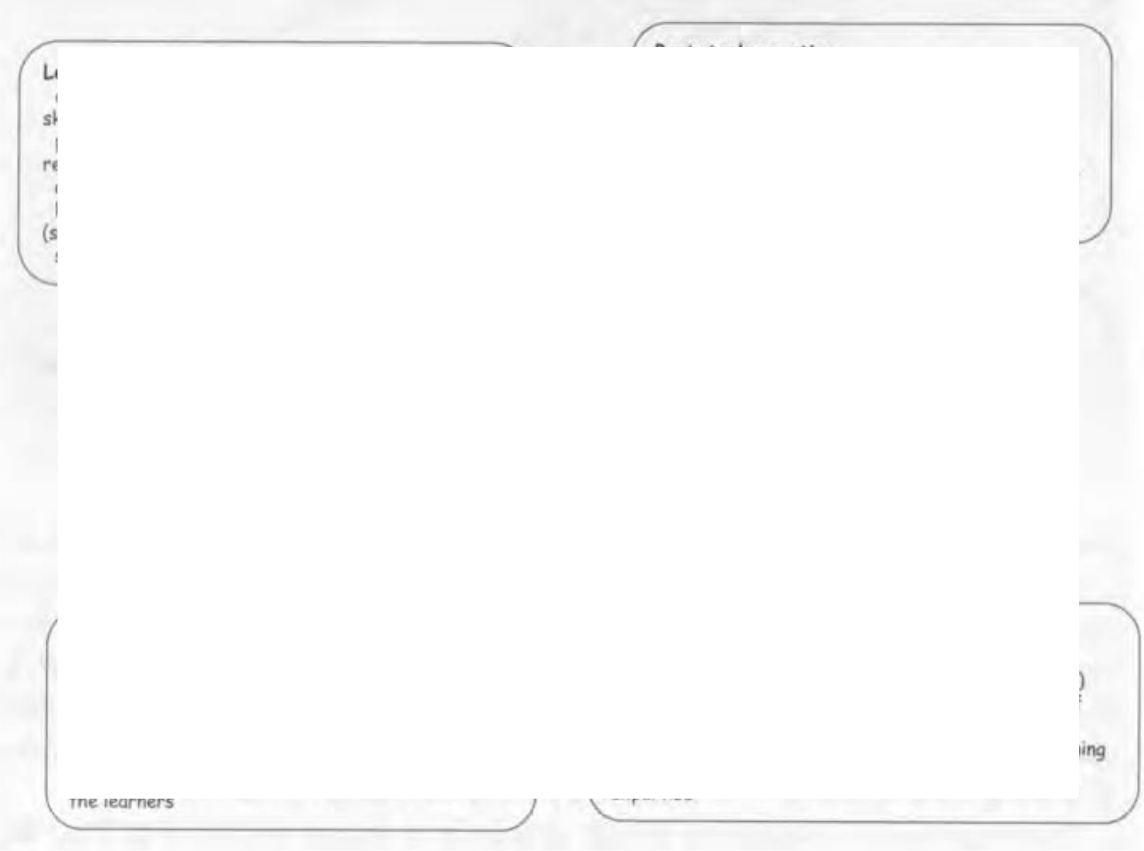

Figure 2: Schematictrainingblueprintandthemainfeaturesofthefourcomponents.
(van Merriënboer&Kirschner 2007, p. 14)

4 Conditions and requirements of tasks: variables to generate driving tasks

4.1 Conditions selected before the start of an exercise

	Facet/Dimension	Values		Systems feature
A1	Vehicle (kind of)	1 2 3 4 5 6	Truck (different products: a, b, c, d …/ up to 17 types) Truck w/ trailer Bus Semitrailer Tanker	DEKRA(KMW Progress),
A2	Activation of additional instrumen-tation/configuration of the vehicle (e.g. driver assistance systems)	0 1 2 3 4 5	All additional instrumentation deactivated ACC ABS Stability System (?) LGS Cruise control	
A3	Country w/ left side driving	1 2	Right side driving country Left side driving country (e.g. UK)	

4.2 Conditions to vary (before or)while the exercise (stable for some time)

	Facet/Dimension	Values		Systems feature
B1	Season	1 2 3 4	Spring Summer Autumn Winter	DEKRA(KMW Progress),
B2	Time (day time)	1 2 3	Day Night Dawn	
B3	Weather conditions (1)	0 1 2 3 4 5	Not too hot, not to cold, dry Thin rain Heavy rain Snow (0% to 100%) Fog (0% to 100%) Change of outside temperature	
B4	Weather conditions (2)	0 1	No or light wind (wind irrelevant) Heavy wind to storm (e.g. 1-6 bft)/side wind	
B5	Particular driving environment	0 1 2 3 4 5	No particular conditions Driving in a zone with static pedestrians Driving in a zone with moving (e.g. crossing) pedestrians Driving in a zone w/ children Driving in a zone with moving cats/dogs/(other animals ?) Driving in a zone where trees are present	
B6	Driving environment: Areas	1 2 3	City driving Industrial area driving Mountain driving	

		4		
B6	Kind of Road (1)	1 2 3	Straight road Sinuous road (e.g. winding)	
B7	Kind of road (2)	1 2 3	Ordinary width Narrow road (2 m, 2,2 m, …)	
B8	Kind of road (3)	0 1 2 3	Flat Upward slope (e.g. 3% – 20%) Downword slope (e.g. 3% – 20%) Curve progression (diff. values)	
B9	Kinds of road (4)	1 2 3 4 5	Ordinary (two lanes) Highway (four lanes) Highway (3 or more lanes)	
B10	Specific circumstances	0 1 2 3 4 5 6 7	No specific circumstances Tunnel Bridge Railway crossing Exit/Driveway to gas station Exit/Driveway to a logistics warehouse Park the vehicle (diff. environmental conditions) Driving into a truck arrester bed	
B11	Road surface	1 2 3 4 5 6 7 8 9 10 11	Dry Wet Gravel Patches of black ice Snowy Holes Aquaplaning Leaves Oil Dirt Terrain obstacles	
B12	Traffic conditions (1): Traffic density	1 2 3	Calm traffic Heavy traffic Very heavy	
B13	Traffic conditions (2): Other traffic participants	0 1 2 3 4 5 6	No other traffic participants School bus Tram Farm vehicles or similar vehicles Bicycles Motorbikes Crossing trains in industrial area	
B14	Traffic conditions (3): Navigation	0 1 2 3 4 5	No turn Right turn Left turn Traffic intersection Traffic circle (roundabout)	
B15	Traffic conditions (4): Traffic signs	1 2 3	Traffic lights (e.g. green=1, yellow=2, red=3) Yield sign Velocity regulation (10, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130)	

		4 5 6 7	No overtaking sign	
B16	Traffic conditions (5)	0 1 2 3	Straight ahead Opportunity to overtake Necessity to overtake Traffic jam ahead	

4.3 Conditions representing sudden events (relatively independent from other conditions)

	Facet/Dimension	Values		Systems feature
E1	Vehicle conditions	0 1 2 3 4 5 6	No problems Brake failure Displacement of the freight load inside the lorry (during driving) Flat tyre(s) Oil level indicator alert Battery level indicator alert Engine temperature alert	
E2	Behavior of other traffic participants	0 1 2 3 4 5 6	No other relevant participants or no problems with other participants Suddenly breaking vehicle ahead Vehicle disobey ROW (right of way) Children running on the street Ball rolls on the street Dog or cat running on the street Animal (deer, reindeer, fox, moose) crossing the road Accident/crash ahead	

4.4 Task Sequences

The systematic tries to categorize the facets in a way that facets could logically combined whenever this is an authentic possibility. Not all facets and values are logically combinable: E.g. B1.2 is not compatible with B3.3 and B5.3 not with B6.2 or B9.2.

Based on the tables 4.1 to 4.3 any task sequence will be described by the facet, the value and (if applicable) further specifying features.

A 10 second sequence (from t=0 to t=10) for a trainee with a

- truck without trailer, type a,
- without additional instrumentation and
- driving in Germany,
- using a highway (Autobahn) on a summer day
- with calm traffic

- etc.

would be symbolically represented by

t 0,10: A1.1.a A2.0 A3.1 B1.2 B2.1 B3.0 B4.0 B5.0 … B14.0 B15.0 B16 E1.0 E2.0

If in second 11 suddenly the oil level indicator shows a level too low, the task description would be

t 11,xx: A1.1.a A2.0 A3.1 B1.2 B2.1 B3.0 B4.0 B5.0 … B14.0 B15.0 B16 E1.4 E2.0

In this way the whole training sequence can be exactly described.

5 Generation of Simulation Tasks

Not all possible sequences of tasks are equally adequate for each individual learner.Based on the 4C/ID model mentioned above different sequences are needed for beginners than for experienced drivers. Ideally there should be an individual agenda or curriculum for each learner or at least several specific curricula for different categories of driver trainees.

So, for beginners a trainer perhaps would start with a bunch of rather simple task sequences, successively continued with more and more complex and difficult tasks. Observing which tasks are already mastered by the learner repeatedly and which ones seem to make problems, the latter would be built in into the sequence more often. Desirable would be a complex task sequence at the end comprising a complete complex driving mission for the driver trainee including authentic time demands (e.g. the freight has to be delivered before 6 p.m. at a logistics warehouse). Realization would include some time-lapse periods.

6 A Trainers' Automatic Advisory System

Such a systematic approach for the generation of simulation tasks is surely hard to handle by the trainers. Optimally a trainer needs to remember what situations with which features an individual trainee has mastered and in what degree he/she succeeded. Also the generation of a sequence of tasks requires a lot of time and effort.

We therefore propose the development of an automatized advisory system for trainers which administrates the learners (e.g. personal data, learning history, and learning progress) and offers the trainer individually tailored sequences for specific trainees. As an advisory system the system output is just a proposal and the trainer decides always whether he/she uses it.

7 Acquisition of Failure Knowledge

As the goal of professional drivers training is the development of the ability to avoid failures in real life the acquisition of "failure knowledge" is often not sufficient. Failure knowledge means the knowledge what one should not do to avoid a failure.

Without simulator training this knowledge can only be conveyed by narration or video presentation. Using simulator training allows the experience of feedback of the category "natural consequences" which has been shown as very effective (Schank, Bermann, &Mcpherson 1999). In practice that means that trainers in SBT should also provoke failures of the trainees so that they experience the (simulated) consequences: crashes, accidents etc. Although if learners know they are acting in a virtual world (simulation) such experiences of own failures often affect heavy emotions.

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