04 DEC.2019
ASPARI SYMPOSIUM

Program

08:30-09:00 Inloop met koffie en thee, *Seirgei Miller,* Opening en Welkom (UT)
09:00-09:15 *Niels Hop*, WITOS Paving - ervaringen met implimentatie (UT/TWW)
09:15-09:30 *Sam Rutten*, Aziëhavenweg - PQi in 2008 uitgevoerd en nu? (UT/BAM)
09:30-09:45 *Chris vd Pol*, Asfalt recyclen in één werkgang (UT/Dura Vermeer)
09:45-10:00 *Wido de Witte*, Evalueren van temperatuur drempels voor verdichting (UT/Boskalis)
10:00-10:15 *Peter Baars*, Valideren van asfalt afkoelingsvoorspelling (UT/Roelofs)

10:15-10:45 Koffie en Thee

10:45-11:00 *Farid Vahdatikhaki & Sajad Mowlaei*, Developing an asphalt construction simulator (UT)
11:00-11:15 *Denis Makarov*, Automation of Asphalt Construction Process (UT)
11:15-11:30 *Michael Primavera*, A comparative Life Cycle Assessment of Traditional & Cement Treated Recycled Base Layers (UT)
11:30-11:45 *Monik Pena Acosta*, Reflectivity, roads and urban climates (UT)

11:45-12:45 Lunch

12:45-13:10 *Babs Ernst*, Asfalt onderwijsmaterialen voor de HBO sector - stand van zaken (UT)
13:10-13:35 *Denis Makarov & Afshin Jamshidi*, Modernizing the PQi method (UT)
13:35-14:00 *Janine Profijt*, Het promoten van MBO onderwijs civiele techniek (UT)
14:00-14:30 *Seirgei Miller*, Overzicht ASPARi in Nederland en het buitenland (UT)

14:30-15:00 Koffie en Thee met hapjes

in Program

ASPARi BSc projects

VR & simulators in asphalt construction

Automation!?

New educational methods

ASPARI
Ceintuurbaan 2
3847 LG Harderwijk,
Netherlands

www.aspari.nl

04 dec. 09:00 – 15:00

WITOS Paving
Ervaringen met implementatie

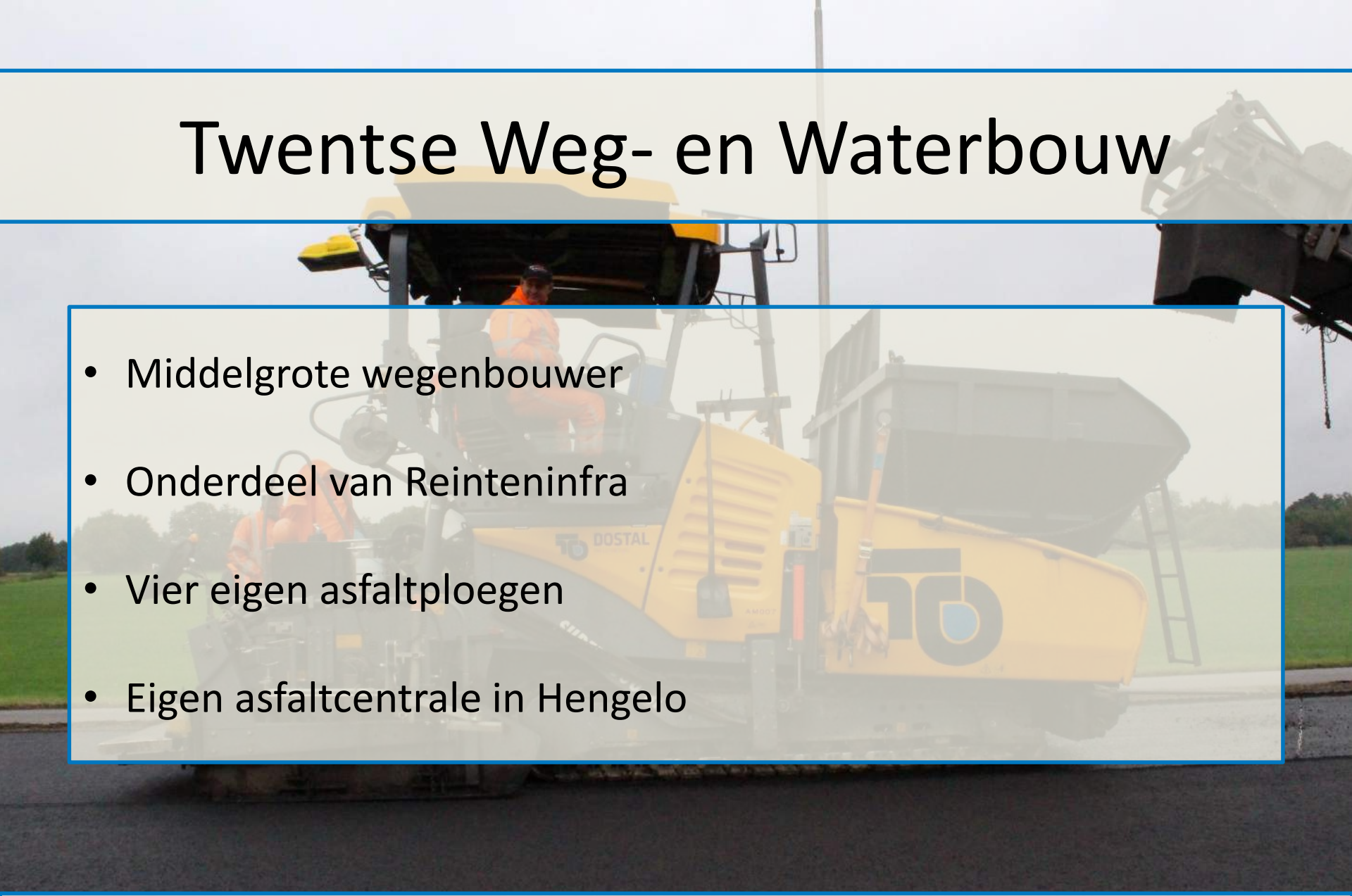
Niels Hop – Twentse Weg en Waterbouw

Inhoud

- Inleiding bedrijf & Witos
- Hoe is het onderzoek opgezet
- Ervaringen met Witos
- Hoe gaan we verder?

TWW
TWENTSE WEG- EN WATERBOUW BV

Twentse Weg- en Waterbouw



- Middelgrote wegenbouwer
- Onderdeel van Reinteninfra
- Vier eigen asfaltploegen
- Eigen asfaltcentrale in Hengelo

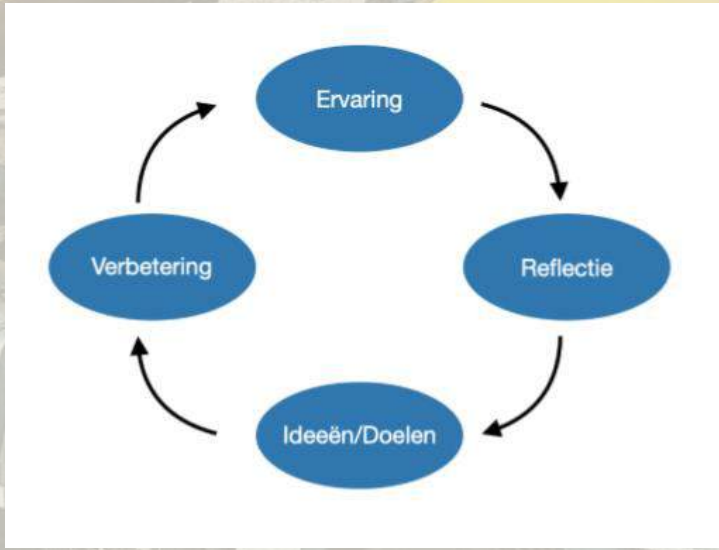
TWW
TWENTSE WEG- EN WATERBOUW BV

Wat is Witos Paving?

TWW
TWENTSE WEG- EN WATERBOUW BV

Hoe krijg je nieuwe technologie binnen een asfaltploeg geaccepteerd?

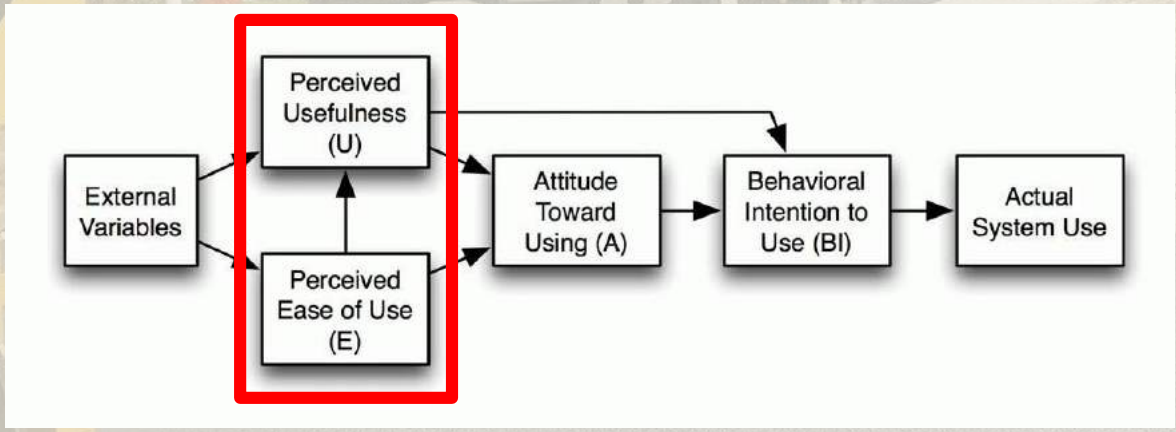
- Reflectieve leermethode
- Gedragsverandering van de gebruiker staat centraal



TWW
TWENTSE WEG- EN WATERBOUW BV

Hoe krijg je nieuwe technologie binnen een asfaltploeg geaccepteerd?

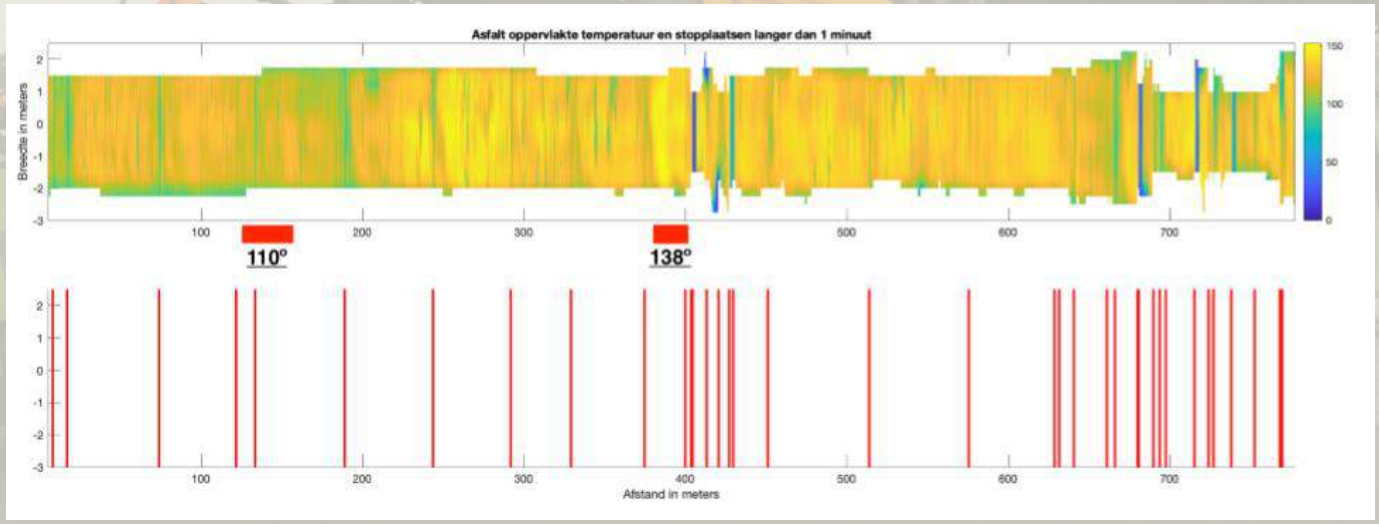
- Wat beïnvloed de acceptatie?



TWW
TWENTSE WEG- EN WATERBOUW BV

Het nut van Witos

- Het nut van de data wordt gezien door de asfaltploeg
- Door sensoren wordt het proces expliciet gemaakt



TWW
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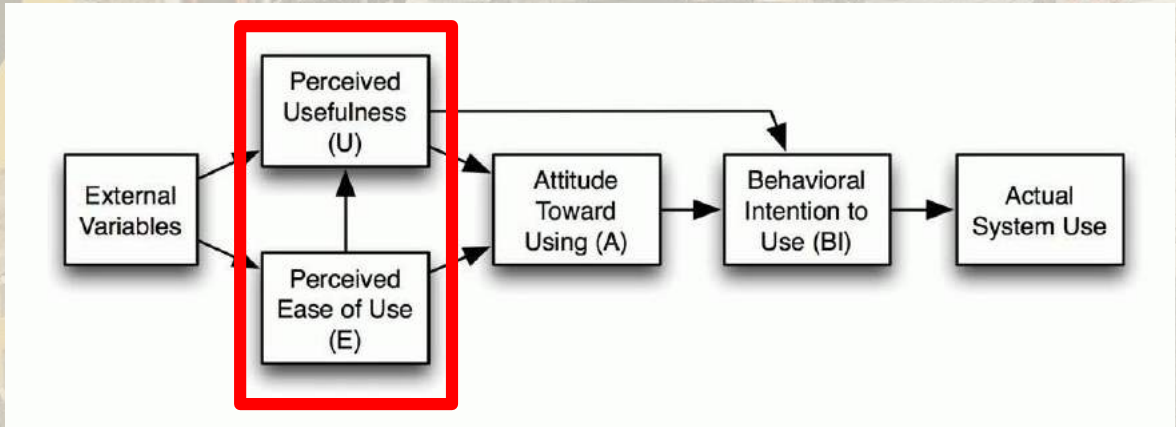
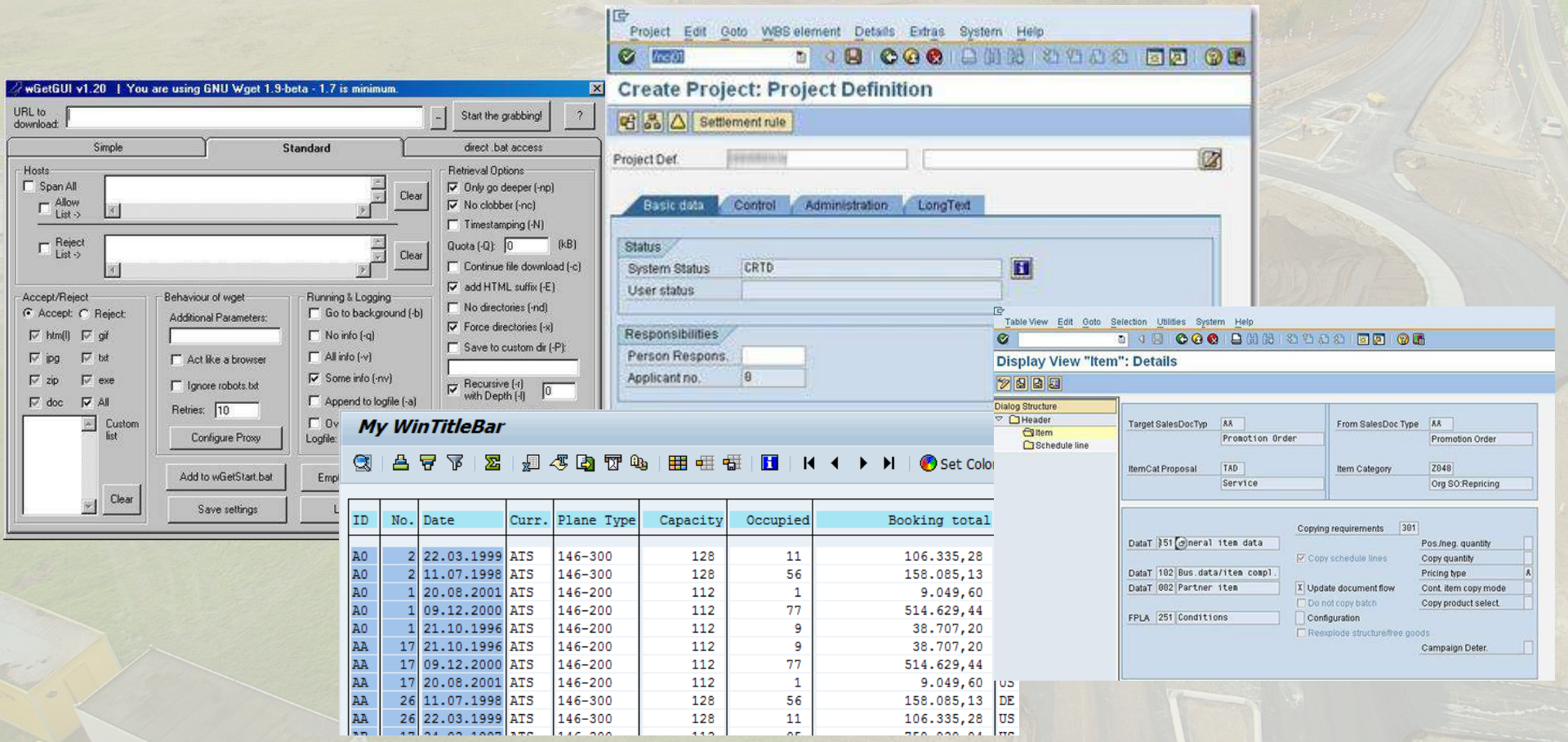
Invloed van gebruiksgemak

- Gebruiksgemak heeft grote invloed op het waargenomen nut

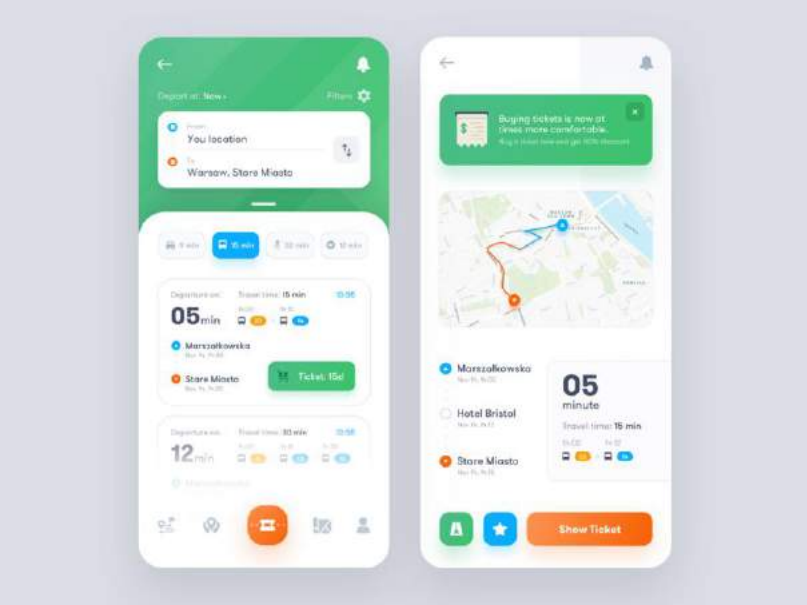


Gebruiksgemak van Witos



TWW
TWENTSE WEG- EN WATERBOUW BV

Gebruiksgemak van software in de huidige maatschappij



TWW
TWENTSE WEG- EN WATERBOUW BV

Stelling

De focus van asfaltonderzoek moet verschuiven.
De focus ligt nu vooral op de technologie die gebruikt kan worden, maar de focus moet veel meer liggen op de menselijke interactie met de technologie.

Source: BAM Infra, 2014

Effect of Asphalt Compaction and Temperature During Paving on Asphalt Lifespan

By Sam Rutten

Research Question:

What relationship is there between asphalt processing, particularly compaction and temperature homogeneity during paving, and the asphalts ultimate lifespan?

Methods

Literature study

Expert Interviews

Empirical study

- 2 roads: A35 and Aziëhavenweg

Literature Study Findings

- Temperature differentials of 20 °C within the asphalt mat have a high likelihood of causing segregation
- 1% more voids could result in up to 10% decreased pavement life
- Raveling is largely influenced by compaction
- Load associated cracking is highly influenced by compaction
- Non-load associated cracking is influenced by temperature (cooling of asphalt)

Historical data

Distress data

Overlay

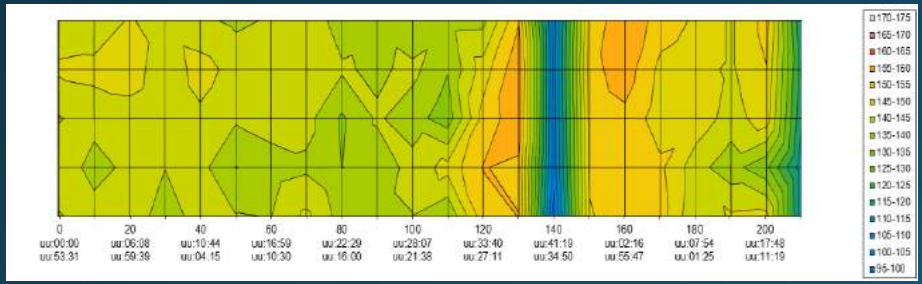
Conclusions

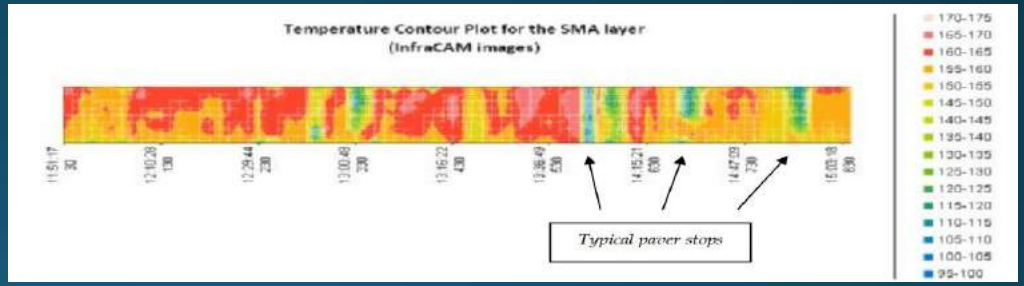
Epirical Study

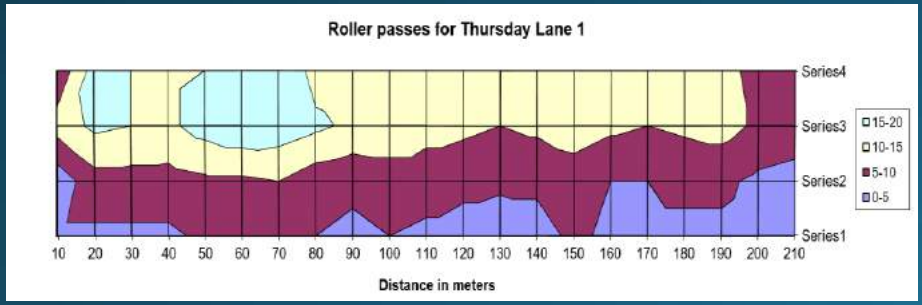
A35 Test Section 3 and Aziëhavenweg

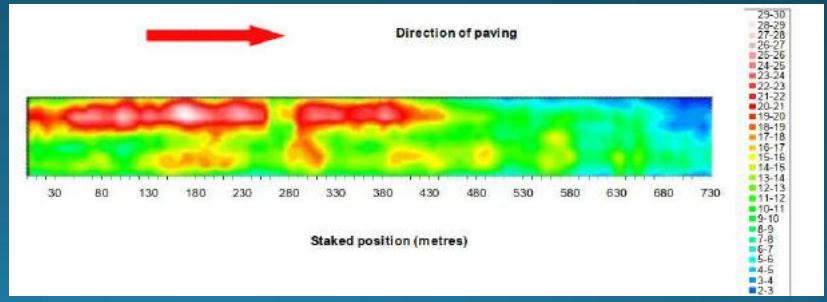
Source: Rijkswaterstaat, 2019

Source: Google Maps, 2019

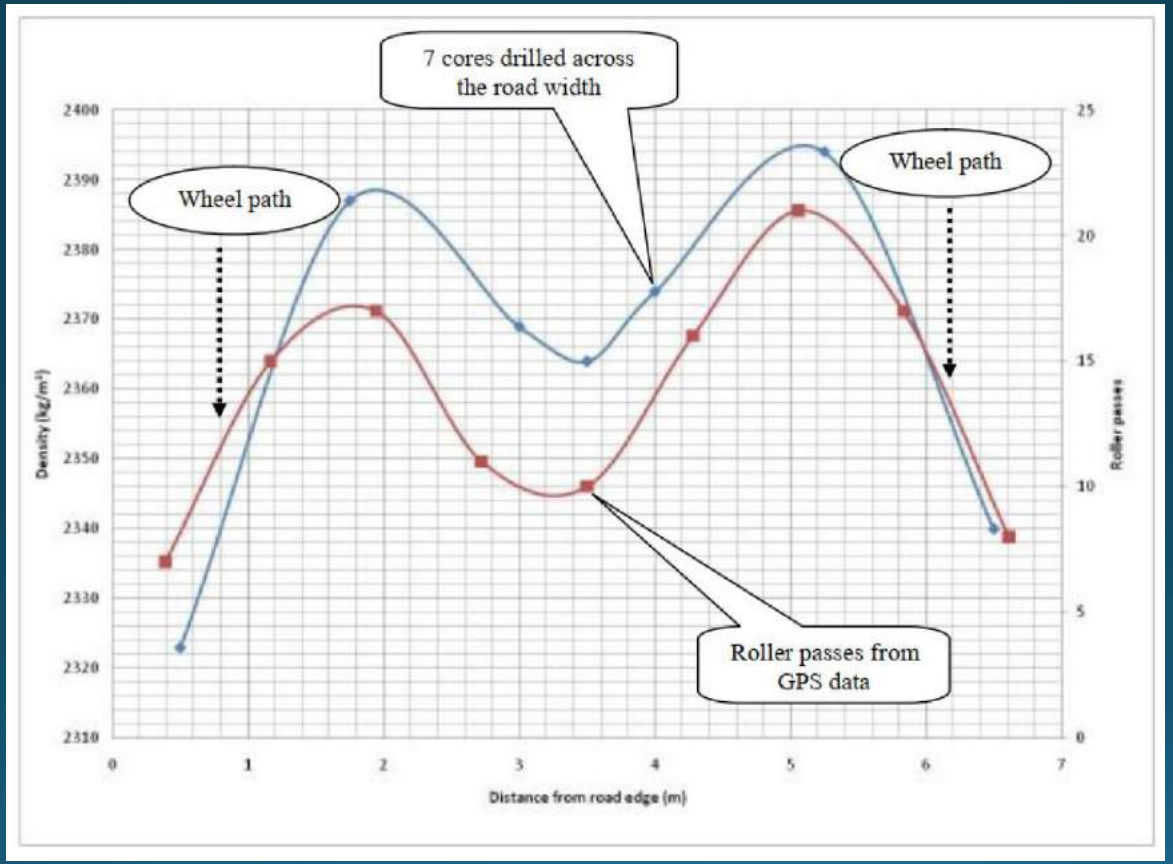






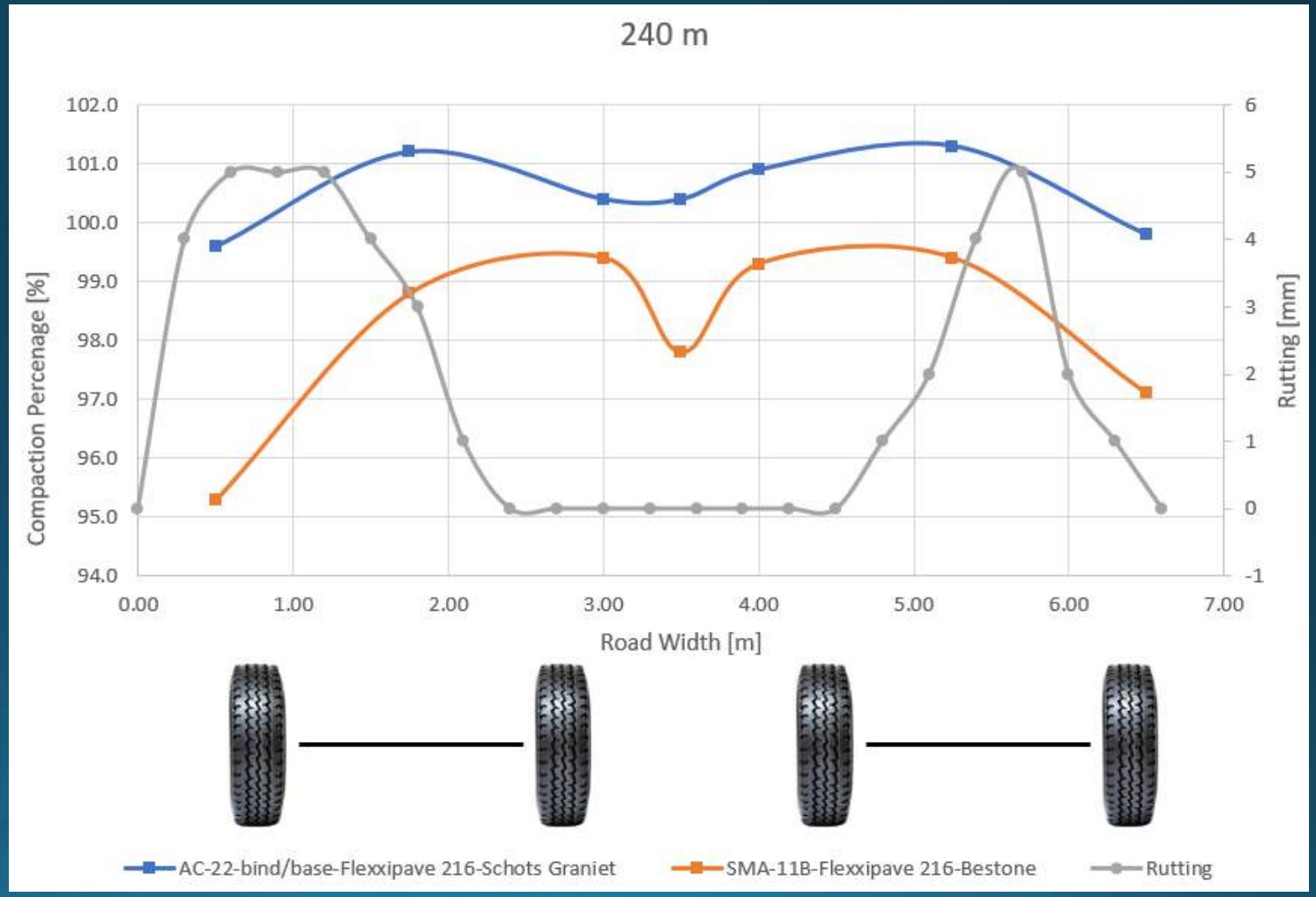


Aziehavenweg 2008



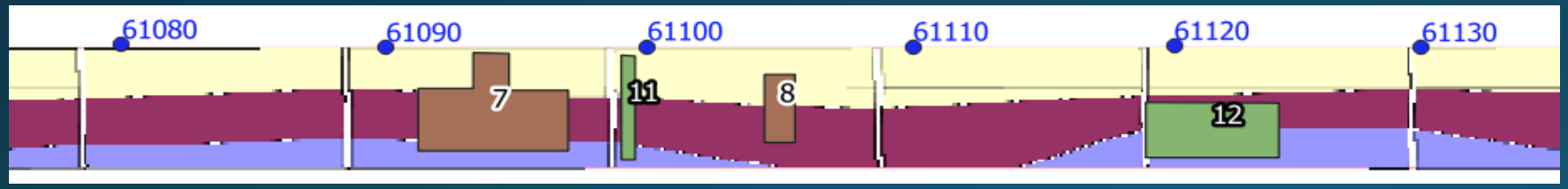
Aziëhavenweg 2019: Rutting

- Significantly more rutting on the outside of the road
- Difference in rutting between central 3 meters and outside 2 meters



Final Conclusions

- Literature study and expert interviews suggests clear connection between temperature homogeneity and compaction and distress
- Empirical study suggest little to no connection between temperature homogeneity and compaction and distress such as cracking and raveling
  - Does suggest a connection between compaction percentage and rutting



Compaction map A35 overlaid with distress areas

Temperature Homogeneity map Aziehavenweg overlaid with distress areas

ASFALT RECYCLEN IN ÉÉN WERKGANG

EEN BIJDRAGE AAN DE ONTWIKKELING VAN EEN ASFALT RECYCLING TREIN IN NEDERLAND

Chris van de Pol

Bsc Civiele Techniek

Bachelor thesis

ASPARi Paving the way forward

UNIVERSITY OF TWENTE.

DURA VERMEER

IN SITU RECYCLEN

FULL DEPTH RECYCLING

COLD IN PLACE RECYCLING

IN SITU RECYCLEN
HOT IN PLACE RECYCLING

DOELSTELLING ONDERZOEK

ZOAB 100% IN SITU RECYCLEN

Heating of porous asphalt for in-situ recycling

A contribution to the development of an Asphalt Recycling Train in the Netherlands

Chris van de Pol
Civil Engineering
University of Twente

Bachelor thesis report
11-11-2019

ASPARi
Paving the way forward

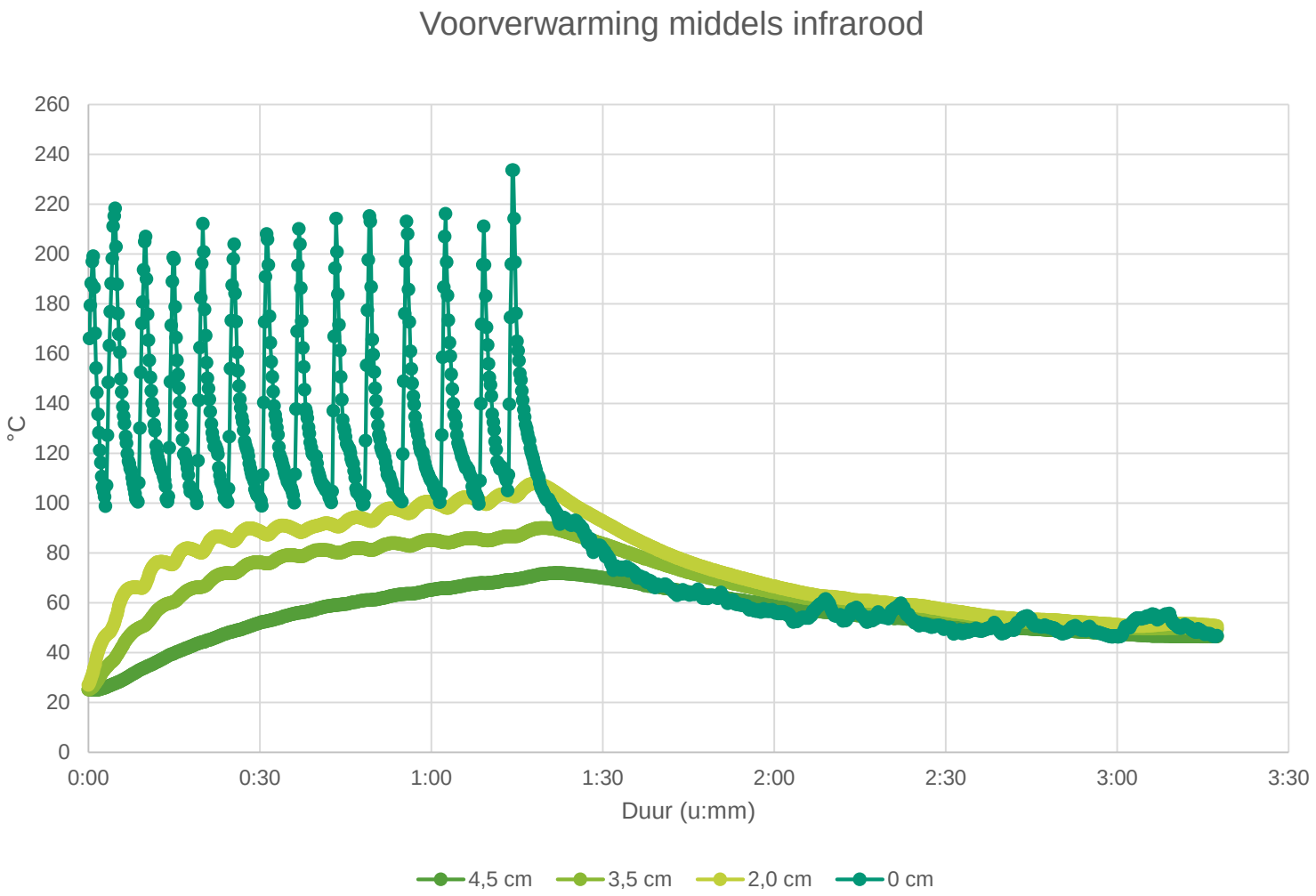
UNIVERSITY OF TWENTE.

DURA VERMEER

PROCES STAPPEN

1. **Voorverwarmen**
2. Loswoelen
3. Herstellen
4. Naverwarmen
5. Homogeniseren
6. Verwerken
7. Verdichten

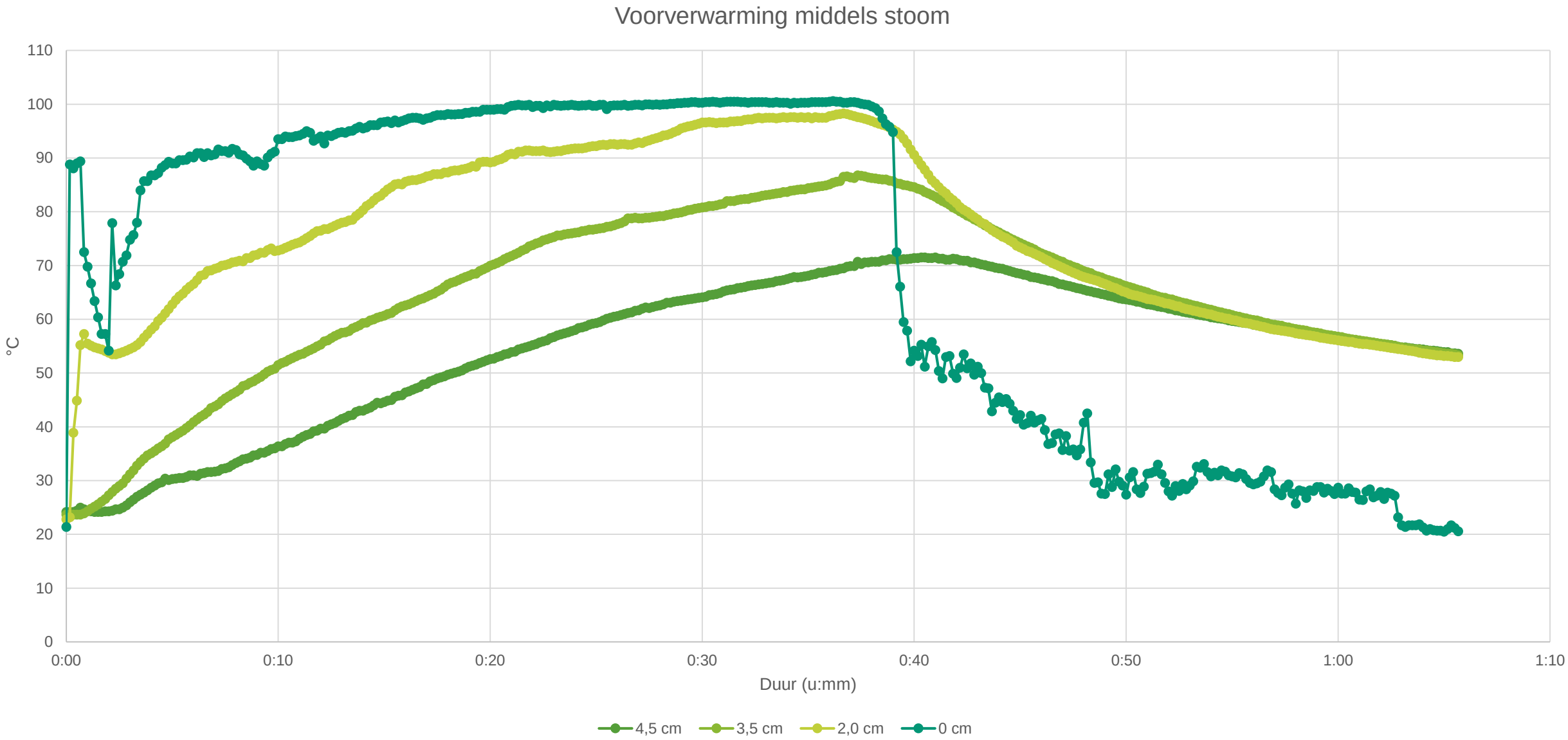
VOORVERWARMEN VAN ZOAB
INFRAROOD STRALING



VOORVERWARMEN VAN ZOAB
STOOM

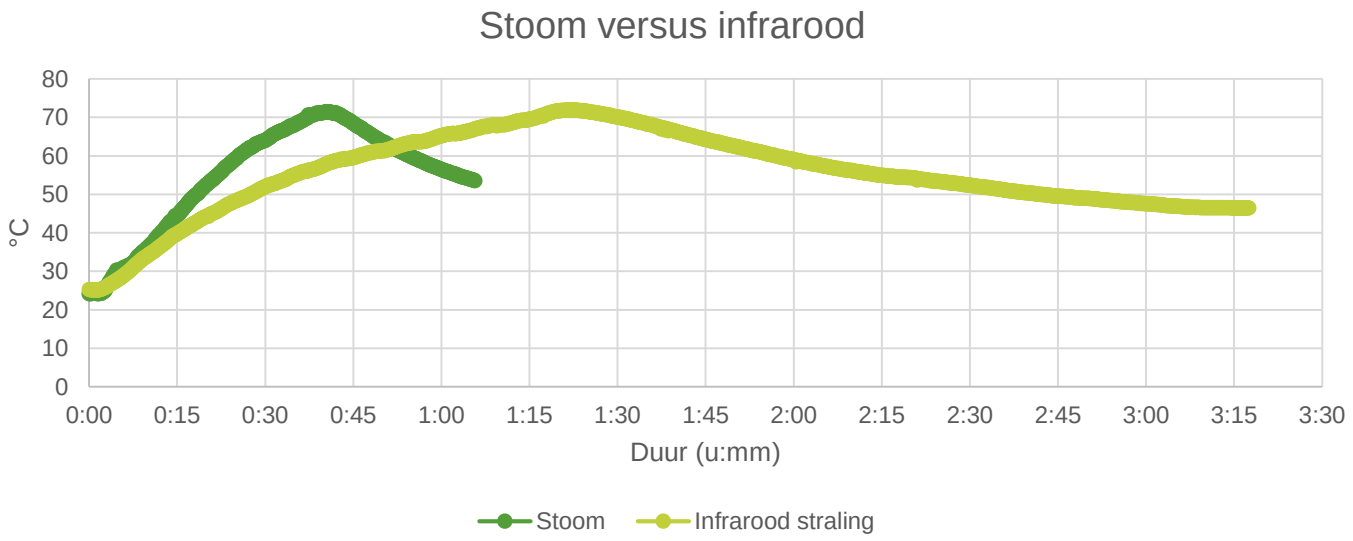
VOORVERWARMEN VAN ZOAB

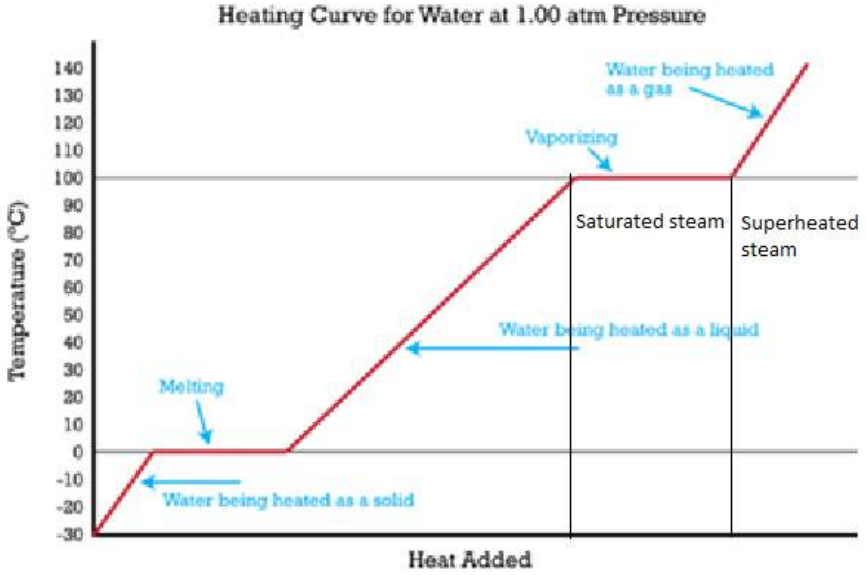
STOOM



VOORVERWARMEN VAN ZOAB

STOOM – INFRAROOD – HETE LUCHT





NAVOLGING

A27 EEMNES

A67 HAPERT

ASFALT RECYCLING TREIN IN NEDERLAND?

DISCUSSIE & VRAGEN

100% RECYCLEN == 100% AFHANKELIJK VAN……

100% in-plant recycling
100% in-situ recycling

Vooronderzoek?

Dataopslag door: Rijk, Provincies, Gemeenten, Aannemer?

- Type asfalt (mengselrecept, bitumen)
- Datum van aanleg
- Reparatievakken, vorstschade
- ASPARi data?
- CAD, GIS, BIM?
- Onderlagen?

Temperatuurdrempels voor verdichtingsproces

Aspari Mini-symposium

4 december 2019 te Harderwijk

Universiteit Twente/Boskalis

Wido de Witte

Probleem en onderzoeksrichting

- Temperatuurgrens voor verdichtingsproces
- Geen model voor grensbepaling
- Nieuwe asfaltmengsels
- Impliciete kennis

- Verwerkbaarheid
- Dichtheidsprogressie
- Analyse en evaluatie

Verwerkbaarheidsproef

- Verwerkbaarheid
  - Koppel
  - Temperatuur
- Drempelwaarden
  - Minimum
  - Optimum
  - Softening point
- Protocol
  - 20 kg
  - 15 rpm

Verwerkbaarheidsproef

- Verwerkbaarheid
  - Koppel
  - Temperatuur
- Drempelwaarden
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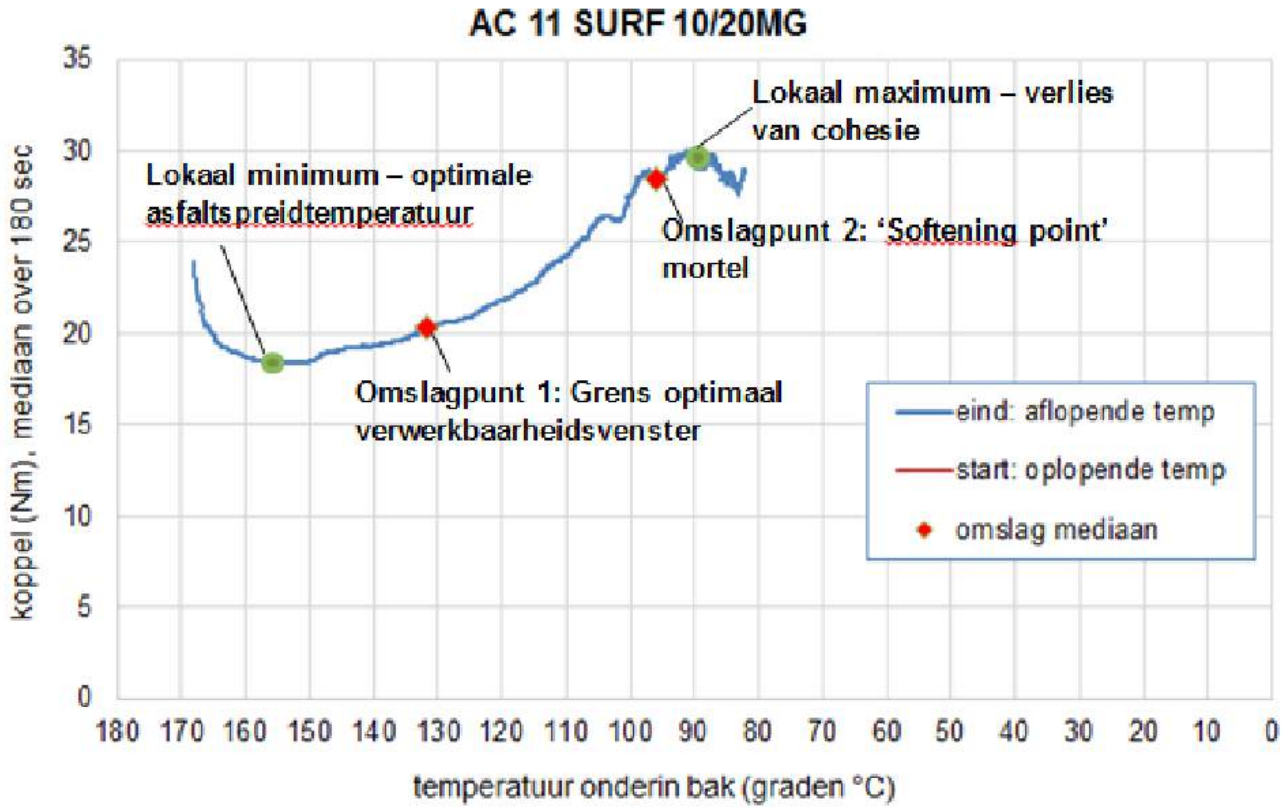


Doel en scope

- Validatie en evaluatie
- Verwerkbaarheidsproef
  - Temperatuurvenster
- Verdichtingsproces veldproject
  - Dichtheid progressie
  - Temperatuur
- Data vergelijken
- Evaluatie van de verwerkbaarheidsproef

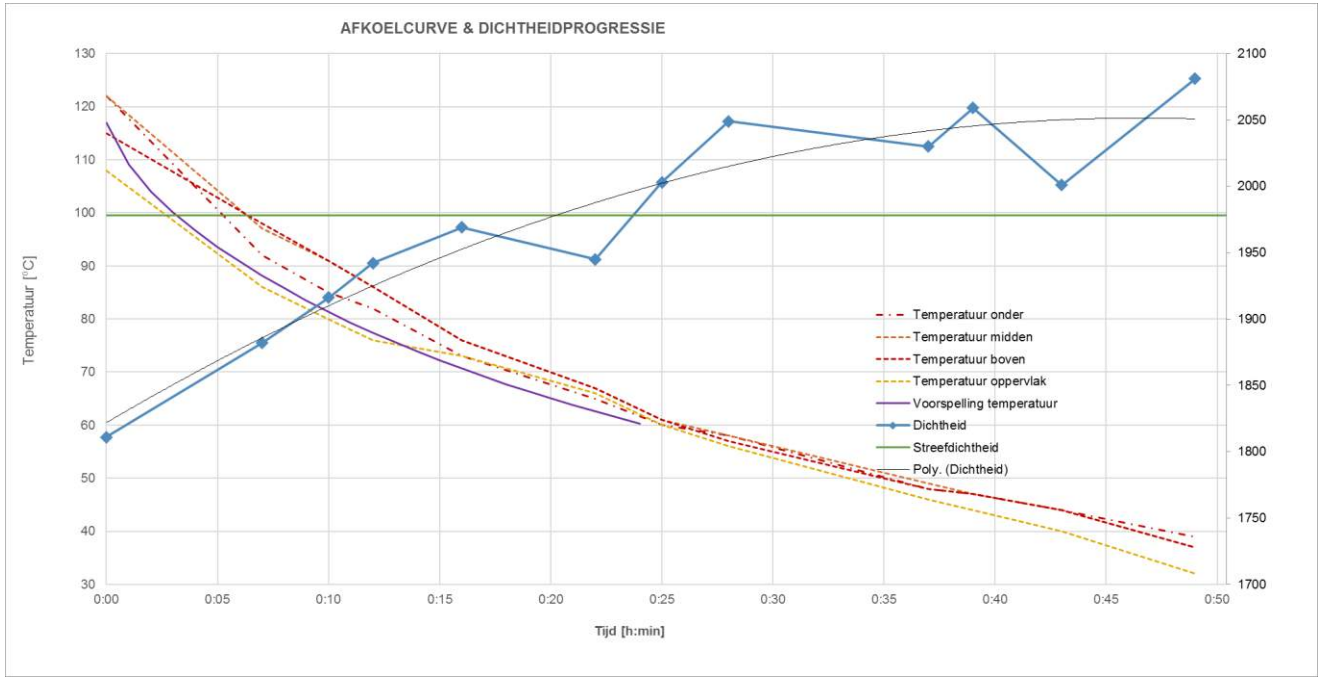
- ZOAB-mengsel
- Asfaltbeton mengsel
- Metingen wintermaanden
- Wel en geen gemodificeerde bitumen

Veldmeting

- Verloop dichtheid
  - Nucleaire dichtheidsmeter
- Temperatuurverloop
  - In en op asfalt
- Observatie walsen
  - Type wals
  - Interval

Veldmeting

- Verloop dichtheid
  - Nucleaire dichtheidsmeter
- Temperatuurverloop
  - In en op asfalt
- Observatie walsen
  - Type wals
  - Interval



Analyse

- Verwerkbaarheidsproef
- Veldmeting
- Verhouding koppel
- Streefdichtheid
- Dichtheidprogressie

- Voorspelde afkoeling
- Weer

Uitdagingen

- Verwerkbaarheidsproef
  - Definiëren verwerkbaarheid
  - Snelheid mengarm
  - Temperatuurverdeling
- Veldmeting
  - Nauwkeurigheid meetapparatuur
  - Geen invloed omstandigheden

- Vergelijking
  - Verandering dichtheid t.o.v. temperatuur
  - Streefdichtheid behaald
  - Walspassage
  - Variabiliteit temperatuur hoogte

Einde presentatie

Wido de Witte

Universiteit Twente/Boskalis

VALIDEREN VAN VOORSPELLINGSMODELLEN VAN ASFALTKOELING

BACHELOR THESIS

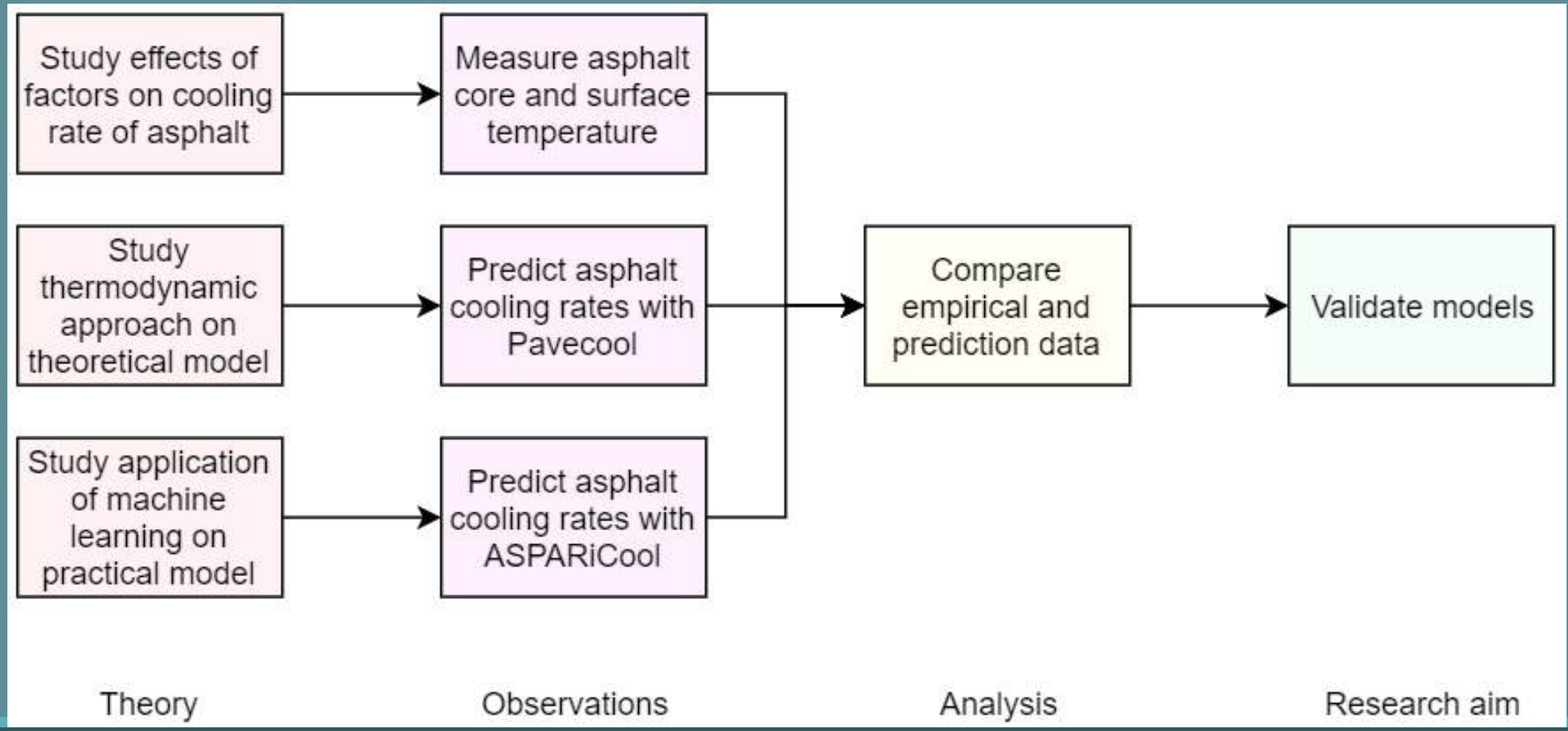
PETER BAARS

ASPARI & ROELOFS – UNIVERSITY OF TWENTE

Beschrijving project

- Koeling asfalt belangrijk voor verdichting
- Kwaliteit asfalt
- Afkoelingscurve
- Voorspellingsmodellen (o.a. Pavecool, ASPARiCool)
- Gebrek aan empirische data
- (Nederlandse) variërende weersomstandigheden

Onderzoeksmodel



Meetverslag 3

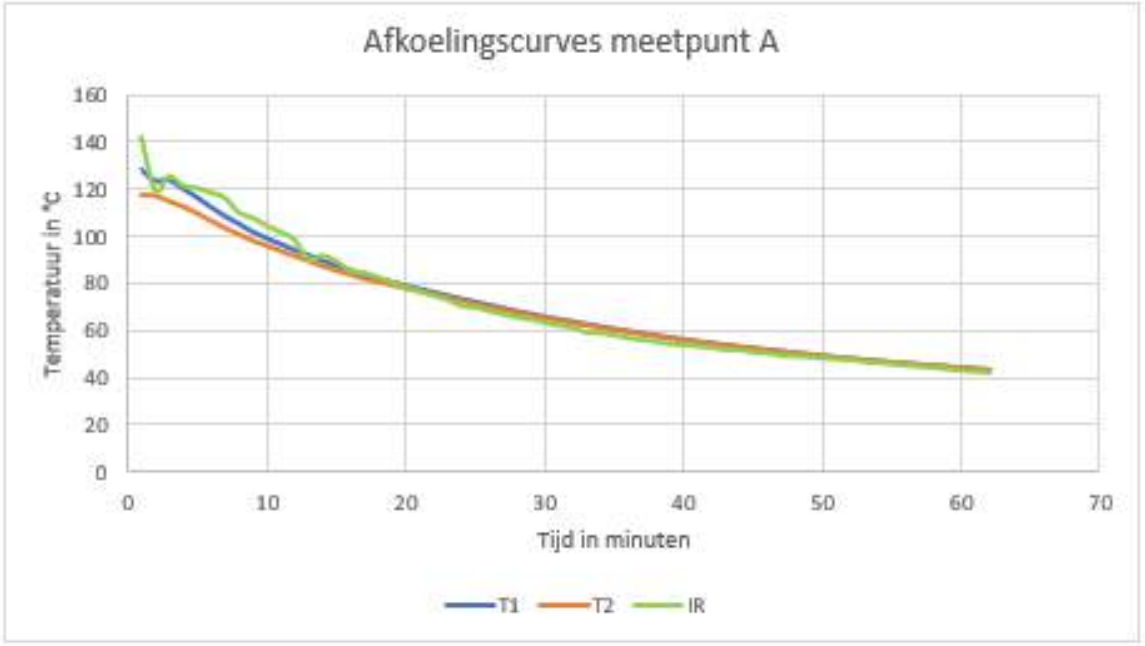
Datum: 15 november 2019
Locatie: Runderweg 6, Lelystad

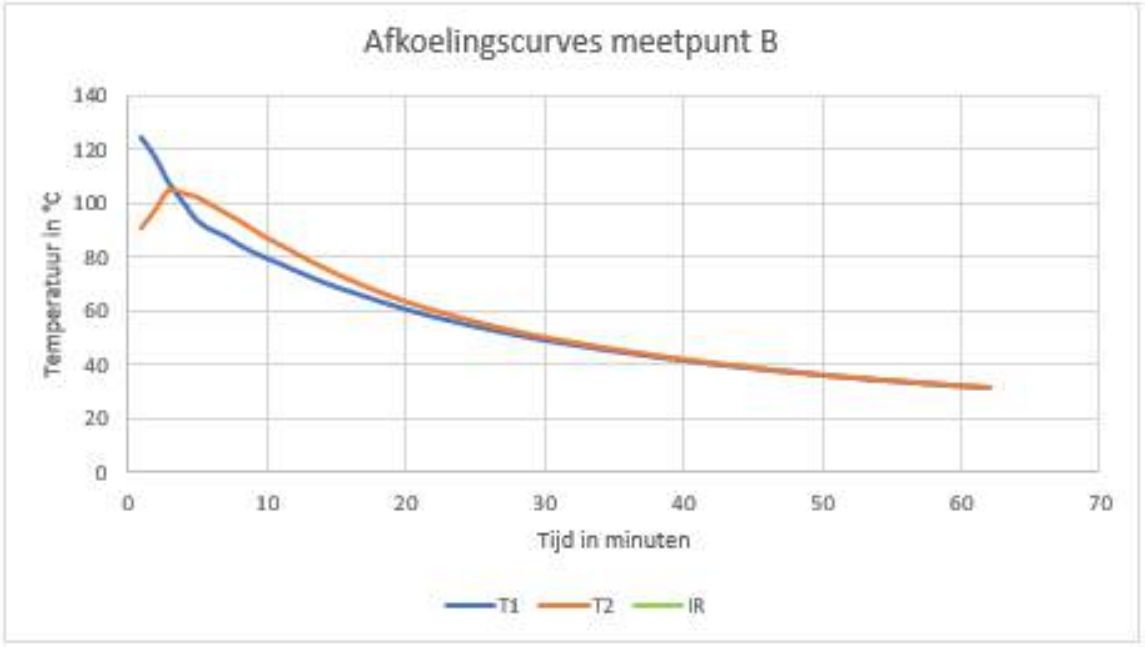
Situatieschets:

Situatiebeschrijving:

Type weg:	Privé asfaltweg
Geschatte lengte traject:	400 m
Geschatte breedte traject:	6 m
Mengsel:	AC 16 Surf DL-C
Laag:	Deklaag
Laagdikte:	4 cm
Oppervlakte asfalt:	2750 m²
Hoeveelheid asfalt:	275 ton
Bijzonderheden:	Weerstation is verplaatst van B naar C vlak na begin meting punt C

Afkoelingscurves per meetpunt





Meetverslag 5

Datum: 26 november 2019
Locatie: Kroezenhoek-West, Den Ham
(Nieuw industrieterrein aan de Vriezendijk)

Situatieschets:

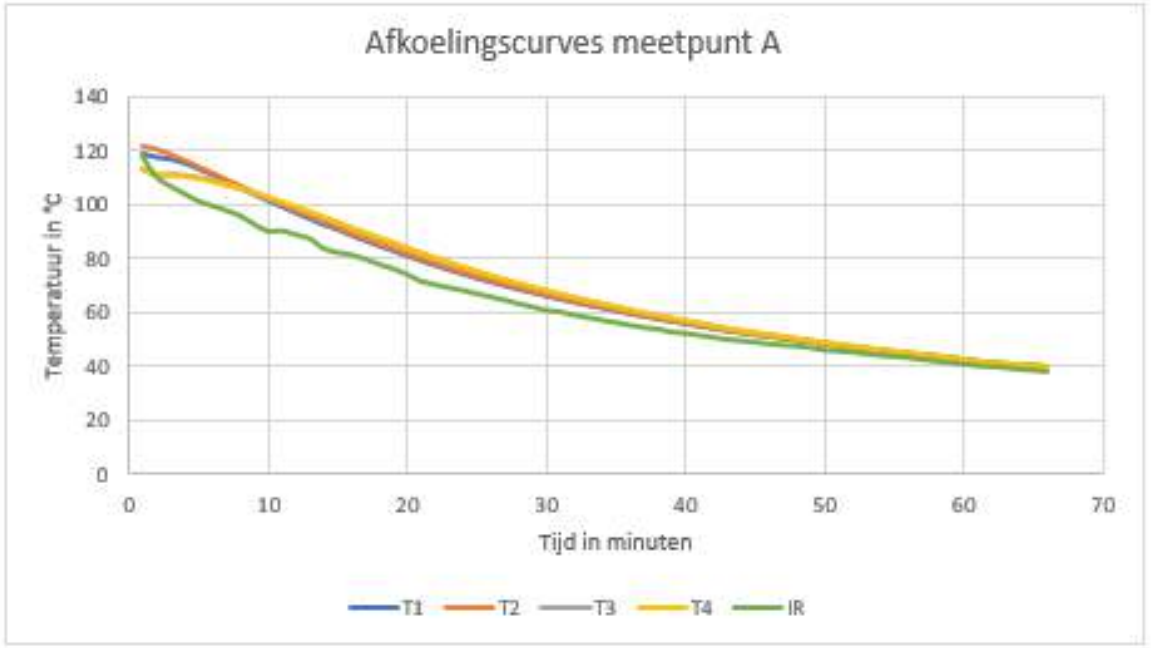
Situatiebeschrijving:

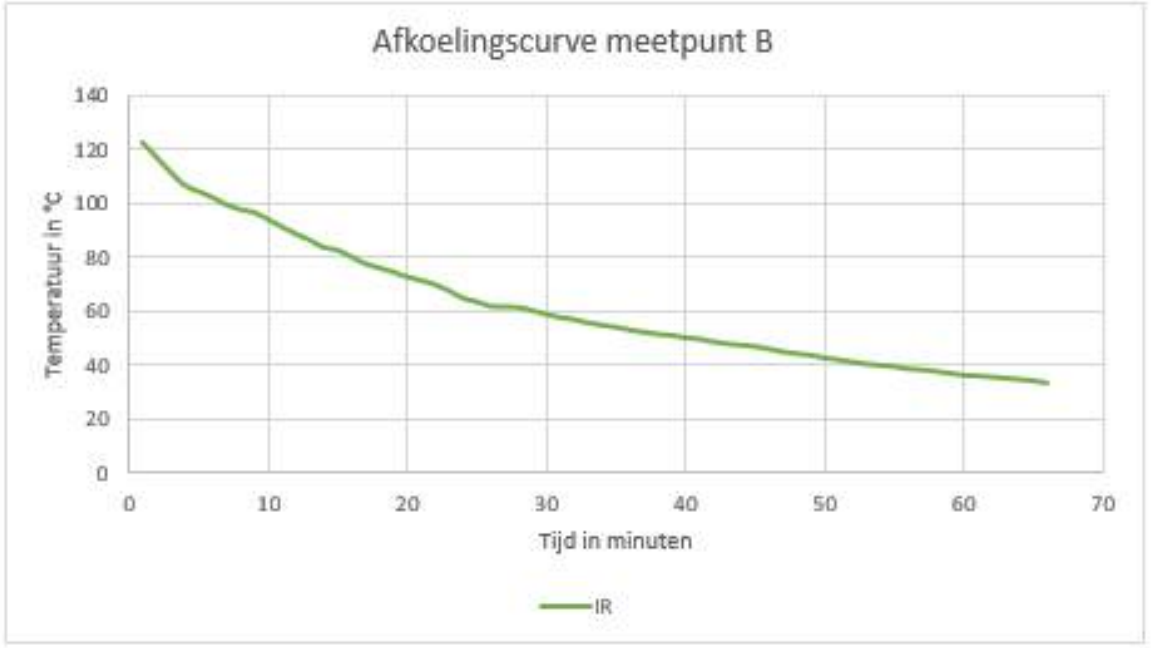
Type weg:	Erftoegangsweg industrieterrein
Geschatte lengte traject:	
Geschatte breedte traject:	
Mengsel:	AC 22 Base OL-B
Laag:	Onderlaag
Laagdikte:	6 cm
Oppervlakte asfalt:	3175 m²
Hoeveelheid asfalt:	477 ton
Bijzonderheden:	

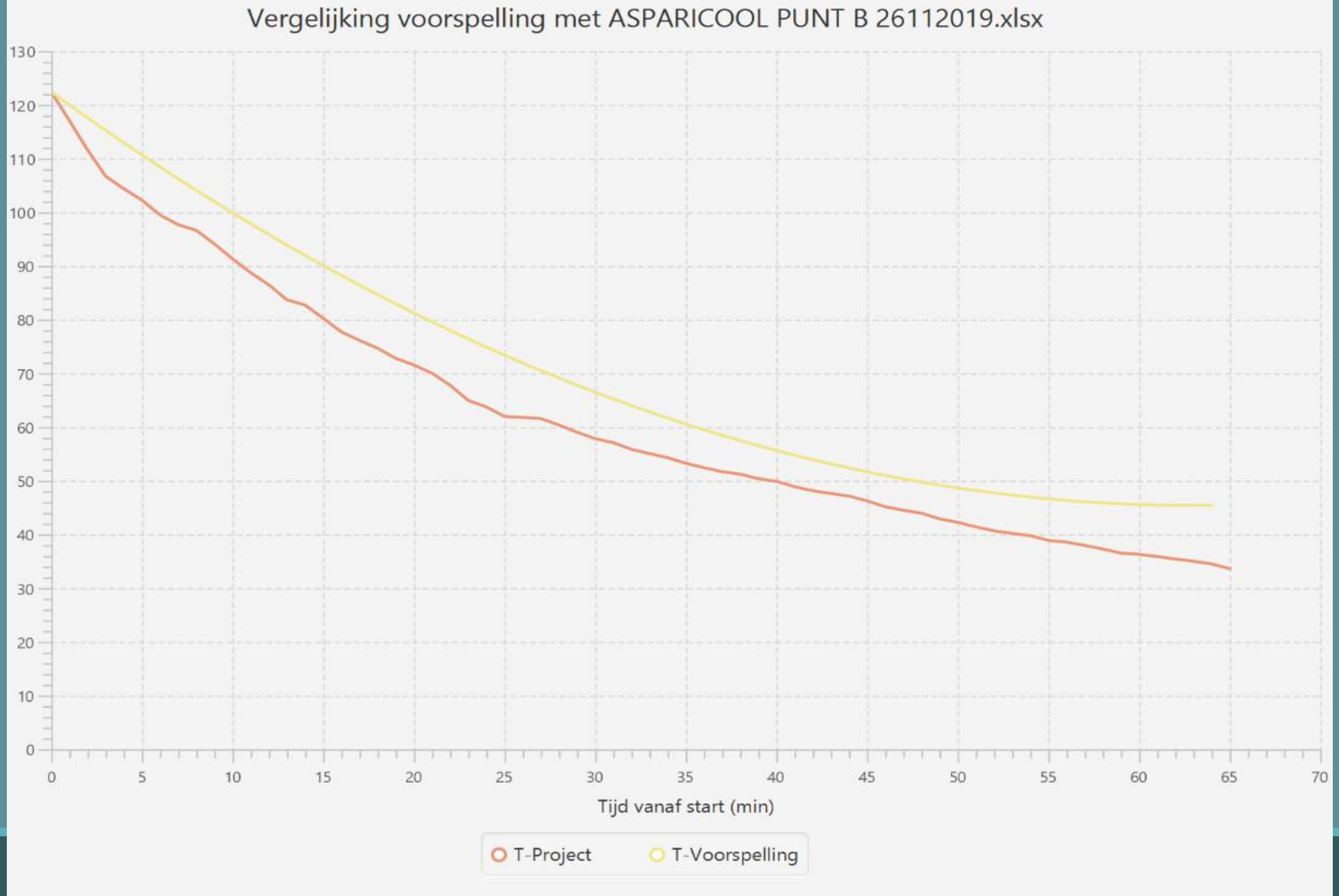
Materialen:

- 1 infraroodcamera (op meetpunten A, B en C)
- 1 infraroodscanner (handmatig data loggen, meetpunt D)
- 3 thermokoppelhouders (met ieder 4 thermokoppels)*
    - *Niet alle thermokoppels konden worden gebruikt, doordat niet alle stekkertjes in de datalogger pasten

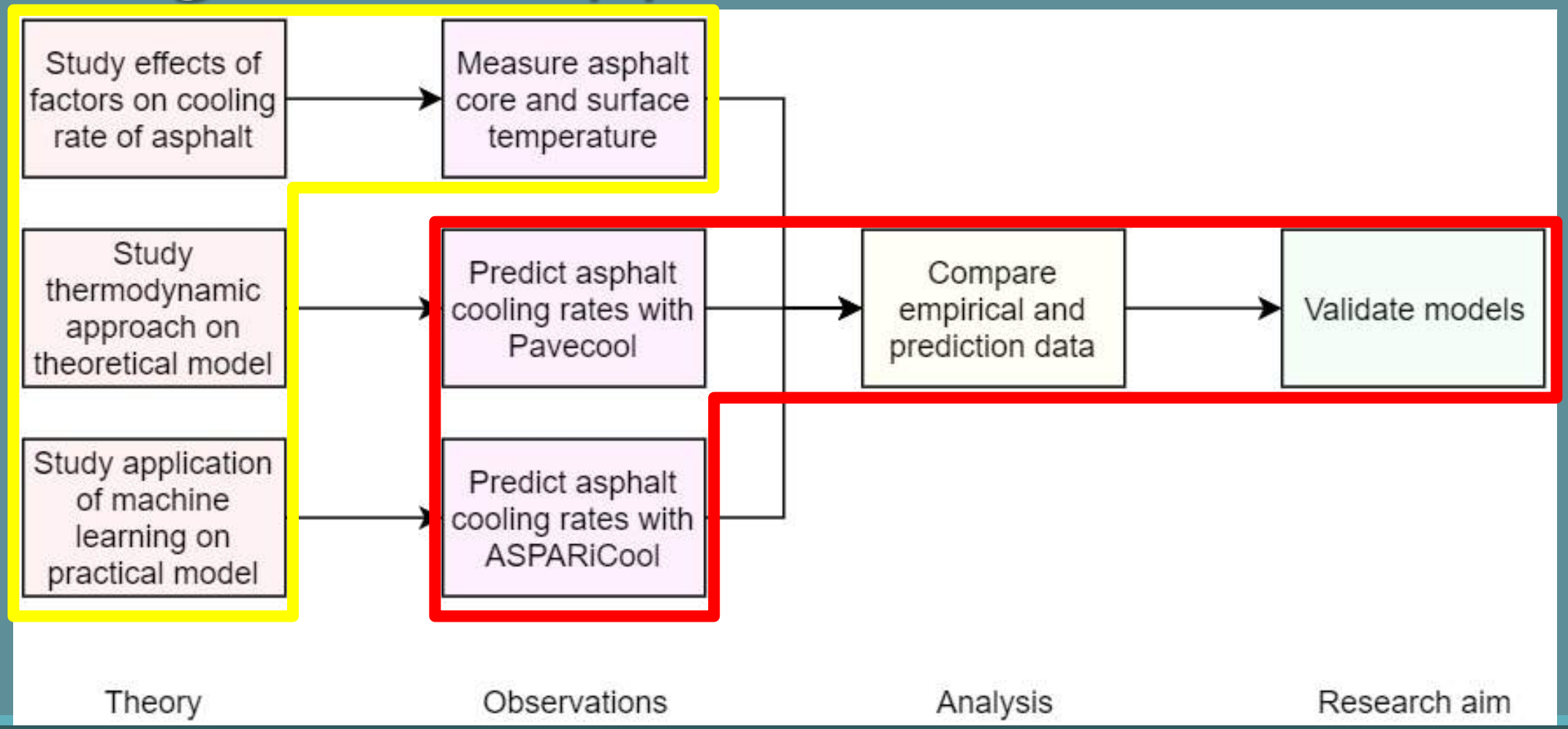
Afkoelingscurves per meetpunt






Vergelijking voorspelling met ASPARICOOL PUNT B 26112019.xlsx
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Tijd vanaf start (min)
T-Project
T-Voorspelling

Volgende stappen



Activity	Week:	1	2	3	4	5	6	7	8	9	10	11	12
Finishing proposal													
Literature research			*				*						
Field measurements													
Processing and structuring data			*	*			*						
Predictions								*					
Analyse and compare data													
Compare output with literature													
Conclusions/recommendations													
Write report													
Examination													
Eventual delay project													

**Optional*

BEDANKT VOOR UW AANDACHT

ZIJN ER NOG VRAGEN?

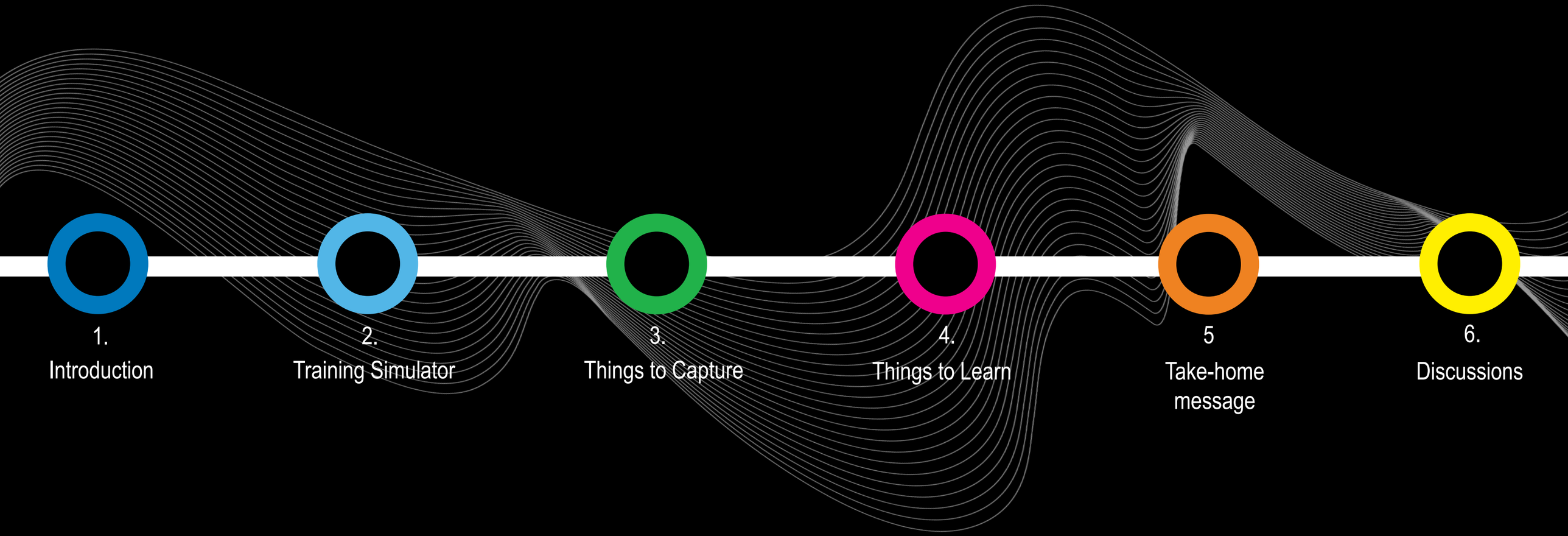
VIRTUAL REALITY-BASED TRAINING SIMULATOR FOR PAVING OPERATION

FARID VAHDATI & SAJJAD MOWLA

DEC. 2019

UNIVERSITY OF TWENTE.

IN THIS PRESENTATION:



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ASPARi showed that there is more to paving operation than we thought before!

Together, we generated new insights!

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We need to transfer these insights to the next generation!

UNIVERSITY OF TWENTE.

It is also important to support operators to better carry these insights into their work.

But, what, when, and how?

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Development of support systems and training with actual equipment is time-consuming, costly, and unrealistic (i.e., controlled environment)

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Virtual Reality (VR) provides an easy, cheap, and safe platform for training and testing

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There are many VR simulators for different types of construction equipment. But, there are virtually no simulators for paving equipment

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ASPARi intends to build on its rich data- and experience-base to take the initiative for building a VR-based training simulator for paving operations

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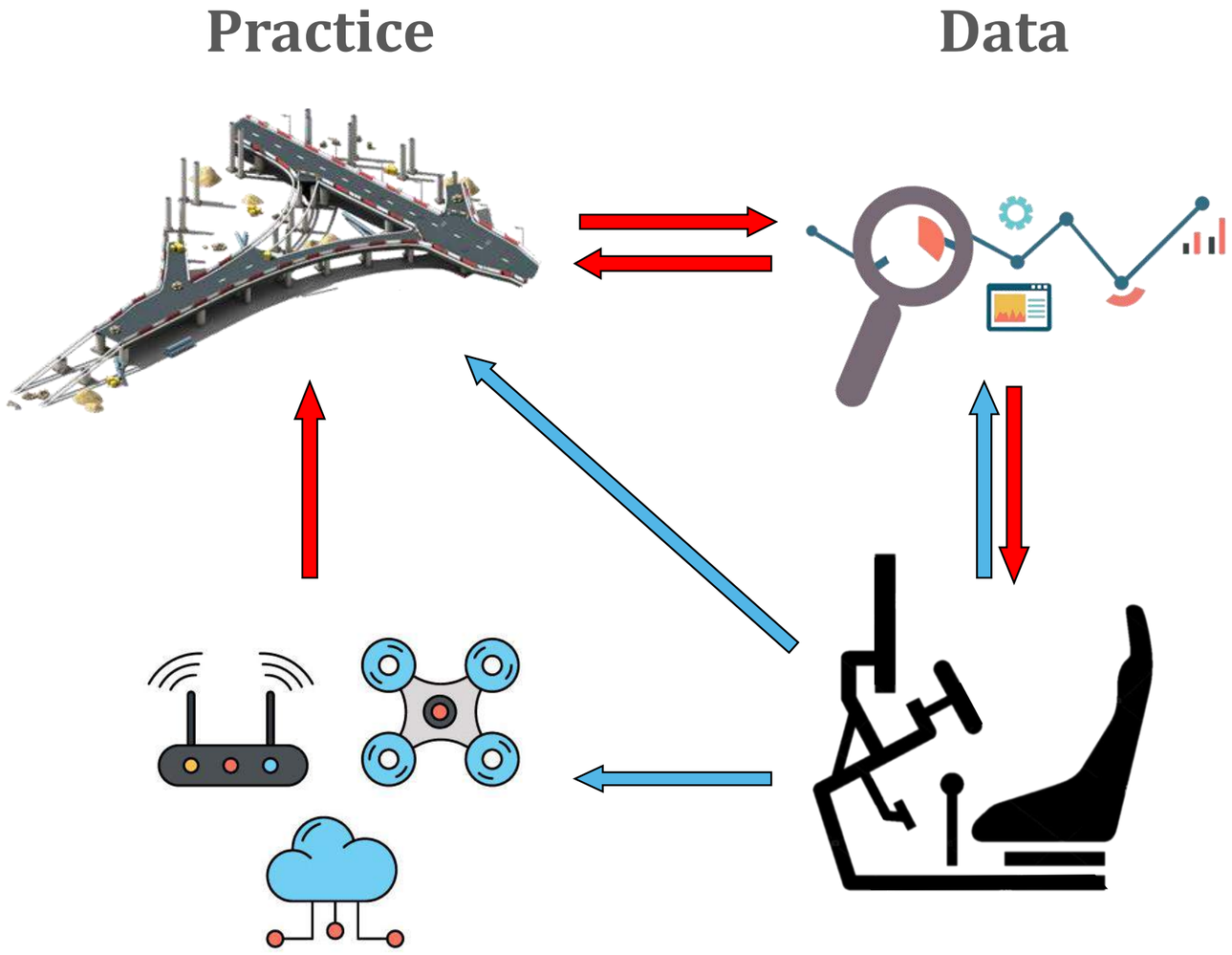

Our approach is to use simulators as a mediator to close the loop between practice, technology, and data.

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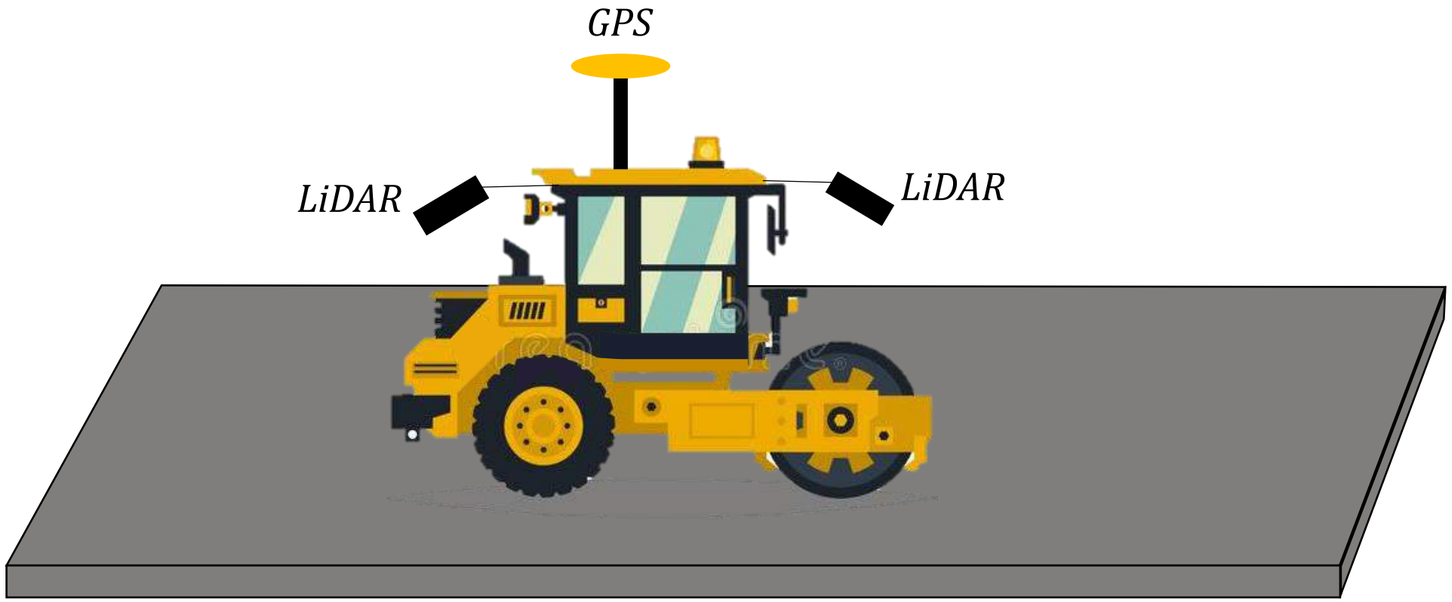

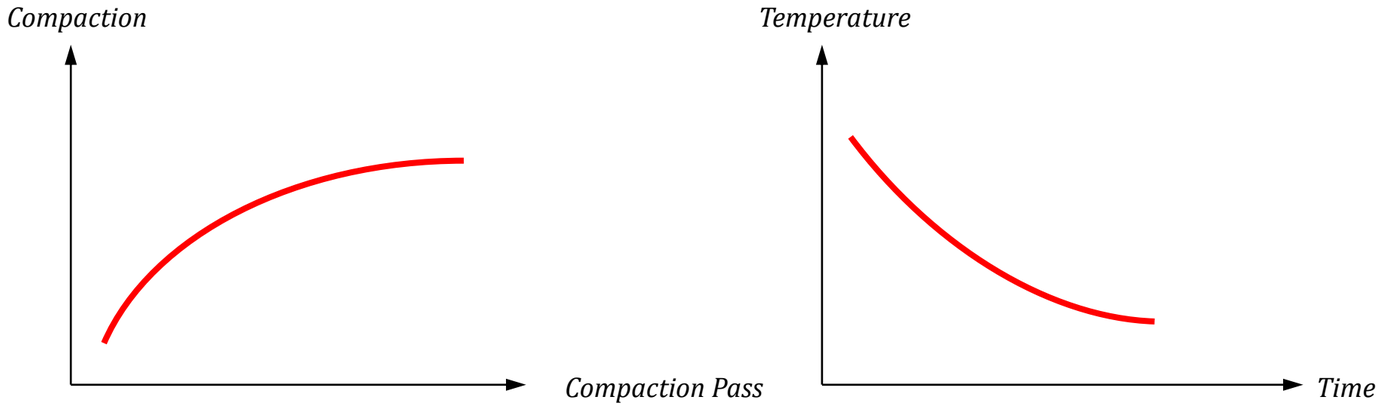

ASPARi data can be leading in developing a physics- and context-realistic simulator

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Feedback from operators, teachers, and students is essential.

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VR simulator is not only a way to train new operators, but also, but also to learn more from data and to assess technological solutions before implementation.

HOW CAN WE IMPROVE TRAINING EVEN FURTHER?

Is automation all about technology?

..or do we need just a little bit of that human touch

ASPARi symposium 2019
Denis Makarov

ASPARi
Paving the way forward

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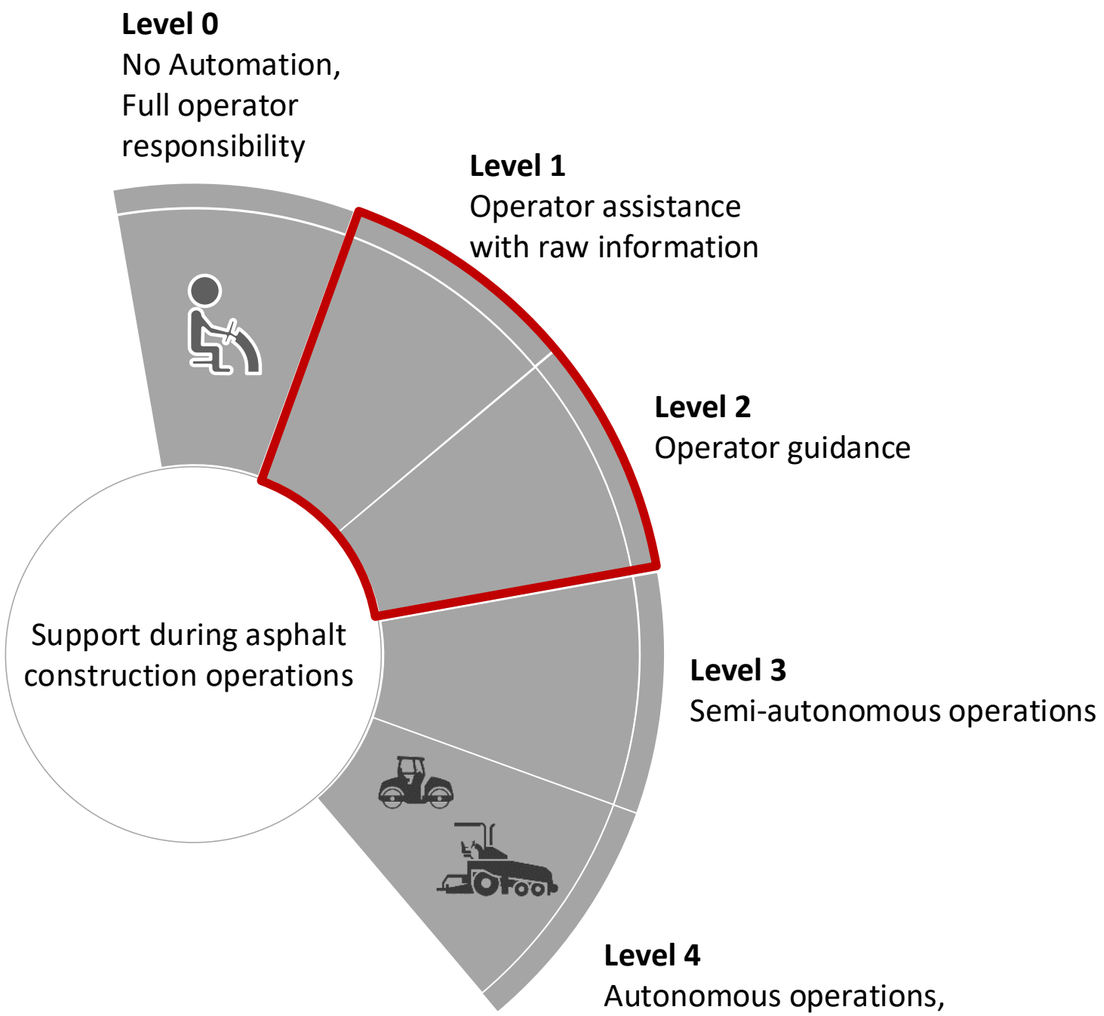
Agenda

- ..2018 symposium
- Current state of autonomy in asphalt construction
- ASPARi approach

ASPARi symposium 2018..



- Provide operators with actionable guidance over their operations instead of 'raw' process related data

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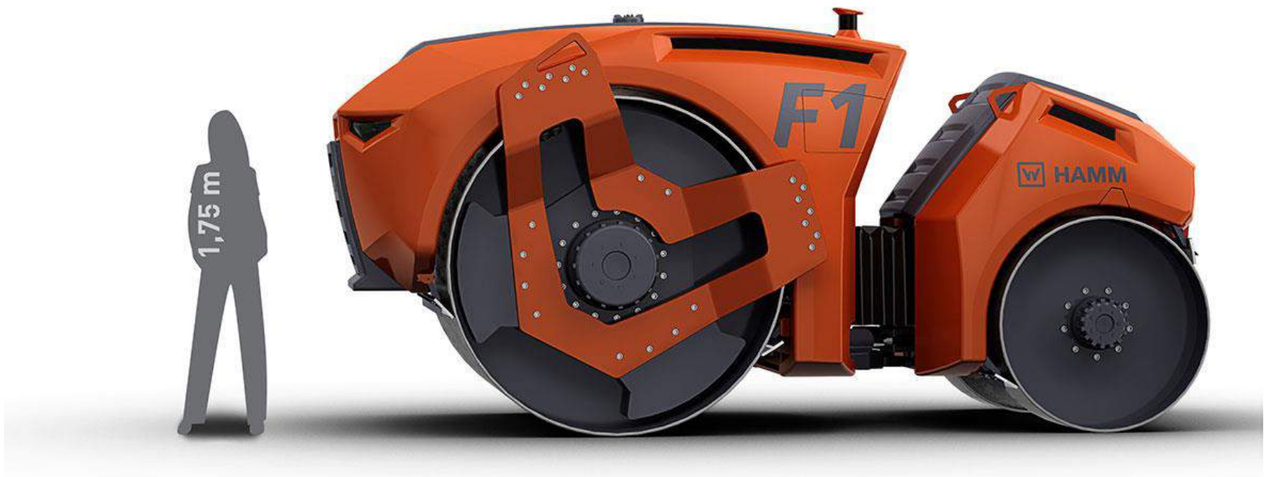
Industry initiatives

..

Dr. Axel Römer, Head of R&D at HAMM, has already examined with his team what a self-driving roller might look like: “We have considered technical, constructive and economic aspects and evaluated them in various studies. The result: A driverless roller will not have an operator’s platform anymore but will need significantly more sensors to monitor not only the compaction parameters but also the area surrounding the roller. We have connected these requirements and see many new and constructive possibilities. For example, we could construct autonomous rollers with significantly larger drum diameters, bigger water tanks and more space for the batteries of electrically powered rollers. This offers advantages in terms of quality, environmental friendliness and efficiency.” In collaboration with industrial designers, HAMM has elaborated and drawn up a corresponding concept plus design study. The result is impressive – in particular the drum of the 9-tone machine with its diameter of just under two meters. At the same time, the overall height of the machine is significantly lower than that of current machines with cab or roof.



https://www.hamm.eu/en/news-media/news-jobreports/2019/01-construction40.php

https://www.bomag.com/ww-en/press/news-videos/future-study-fully-autonomous-tandem-roller/

..

The fully autonomous tandem roller ROBOMAG can be used completely independently in a defined work area. For loading or manual operation, the ROBOMAG tandem roller can be operated simply by remote control. The system obtains information on position, situation and movement using a combination of different technologies for spatial orientation, environmental perception and environmental safety. A comprehensive safety concept with sensory environment recognition is used to prevent collisions. In addition to the fully automatic mode, the ROBOMAG also has the option to follow manually entered movement patterns so the roller can perform its task autonomously even with special compaction jobs. It goes without saying that the roller has a mechanical emergency stop mechanism in every mode.

Industry initiatives

..

Dr. Axel Römer, Head of R&D at HAMM, has already examined with his team what a self-driving roller might look like: “We have considered technical, constructive and economic aspects and evaluated them in various studies. The result: A driverless roller will not have an operator’s platform anymore but will need significantly more sensors to monitor not only the compaction parameters but also the area surrounding the roller. We have connected these requirements and see many new and constructive possibilities. Fo
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https://www.hamm.eu/en/news-media/news-jobreports/2019/01-construction40.php

Are we really ready for fully autonomous machines?

- Accuracy of sensory data
- Process quality
- Asphalt quality
- Safety of the process

/news-videos/future-study-fully-autonomous-tandem-roller/

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Classification matters

- Provides a common terminology, which eases the sharing of knowledge;
- Provides a better understanding of the interrelationships between the levels;
- Helps to identify gaps in a knowledge;
- Supports decision making processes.

Examples of existing metrics

Aviation

HIGH

10. The computer decides everything, act autonomously, ignoring the human.
9. informs the human only if it, the computer decides, to
8. informs the human only if asked, or
7. executes automatically, then necessarily informs the human, and
6. allows the human a restricted time to veto before automatic execution, or
5. executed the suggestion if the human approves, or
4. suggests one alternative
3. narrows the selection down to a few, or
2. the computer offers a complete set of decision/action alternatives, or
1. the computer offers no assistance: human must take all decisions and actions.

LOW

Levels of automation of decision and action selection, adapted from: National Research Council. The future of air traffic control: Human operators and automation. National Academies Press; 1998 Feb 9

Autonomous cars

Level 0	Level 1	Level 2	Level 3	Level 4	Level 5
No automation	Driver Assistance	Partial Automation	Conditional Automation	High Automation	Full Automation
Zero autonomy, the driver performs all driving tasks.	Vehicle is controlled by the driver, but some driving assist features may be included in a vehicle design.	Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.	Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all time with notice.	The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.	The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.

Society of Automotive Engineers levels of autonomy, adapted from: Automation Levels for cars, SAE, https://automotivelectronics.com/sae-levels-cars/

Agriculture

Guidance	Coordination & Optimization	Operator Assisted Autonomy	Supervised Autonomy	Full Autonomy
All manned vehicles	All manned vehicles	Manned back-up	In-field supervision of unmanned vehicles	No local supervision (Remote supervision or artificial intelligence)

CASE IH automation, adapted from:
Categories of Autonomy and Announces Pilot Program,vCase IH, https://www.caseih.com/emea/en-za/News/Pages/2018-02-14-Case-IH-Defines-Categories-of-Autonomy-and-Announces-Pilot-Program.aspx

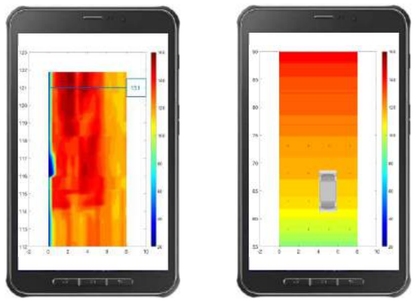
ASPARi approach

Level 0

No automation

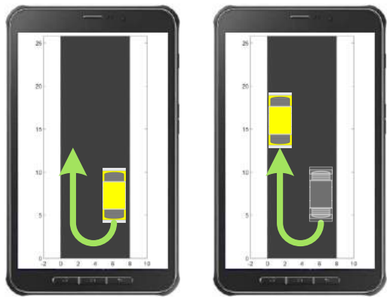
Level 1

Operator assistance with raw process related information (no guidance, engaged control)



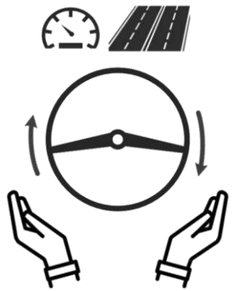
Level 2

Operator guidance during paving and compaction operations



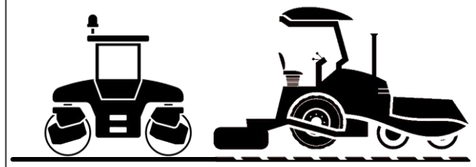
Level 3

Semi-autonomous construction operations, disengaged control of machine operators



Level 4

Autonomous construction operations, disengaged monitoring of machine operators



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ASPARi approach

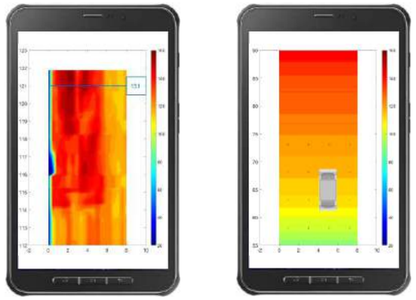
Level 0

No automation

Transition

Level 1

Operator assistance with raw process related information (no guidance, engaged control)



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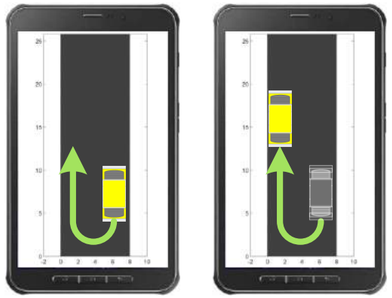

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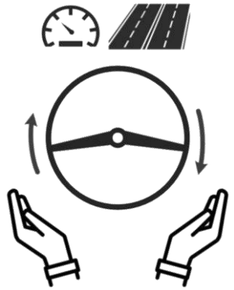
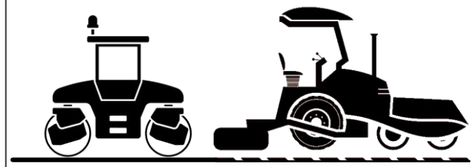


Level 4

Autonomous construction operations, disengaged monitoring of machine operators



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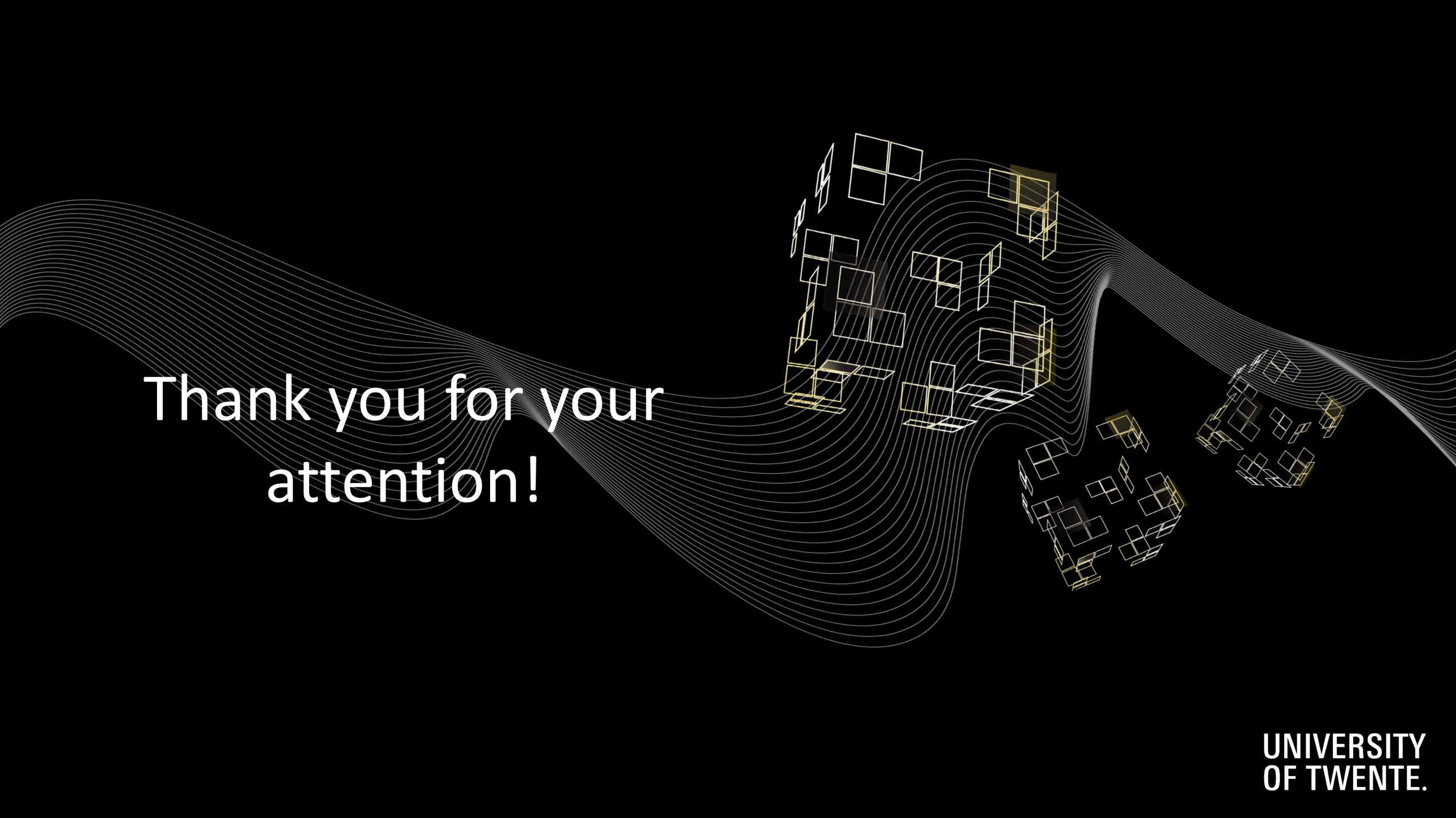
Human role

- User experience
- User interface
- Information overload
- Reliability
- Building trust
- Functionality
- ..and changing role of operators



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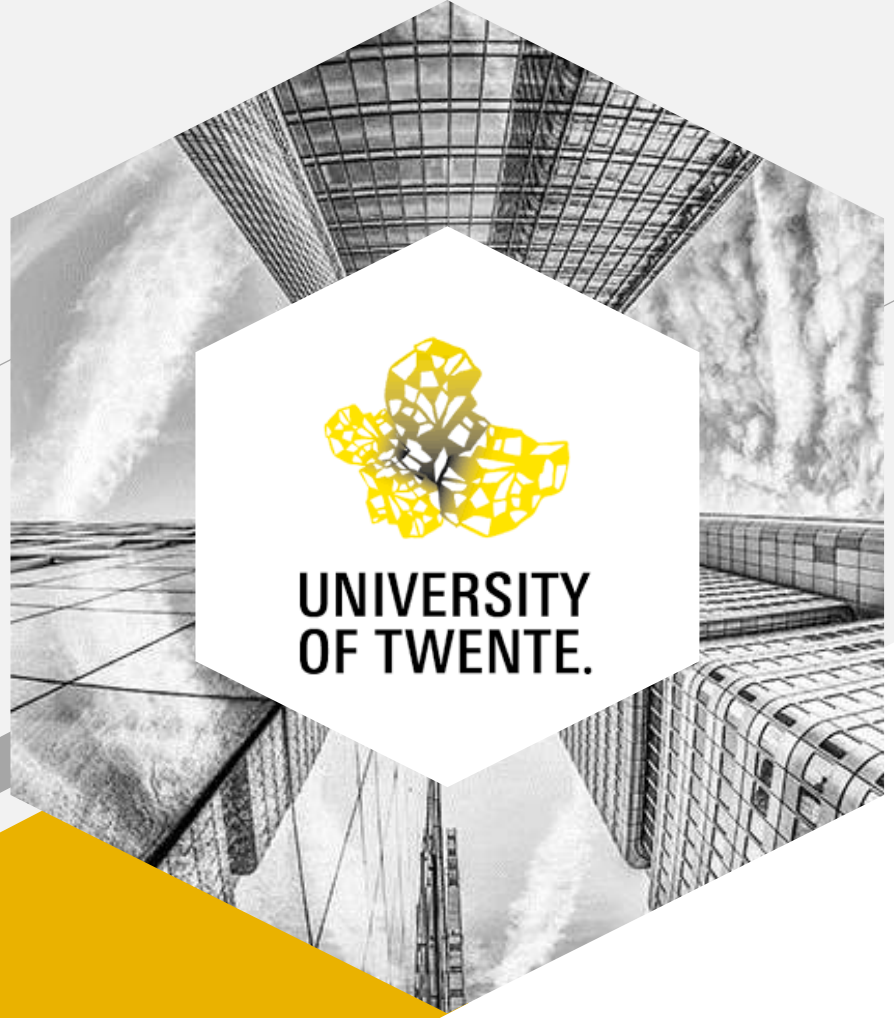

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A comparative Life Cycle Assessment of Traditional and Cement Treated Recycled Road Pavement Base

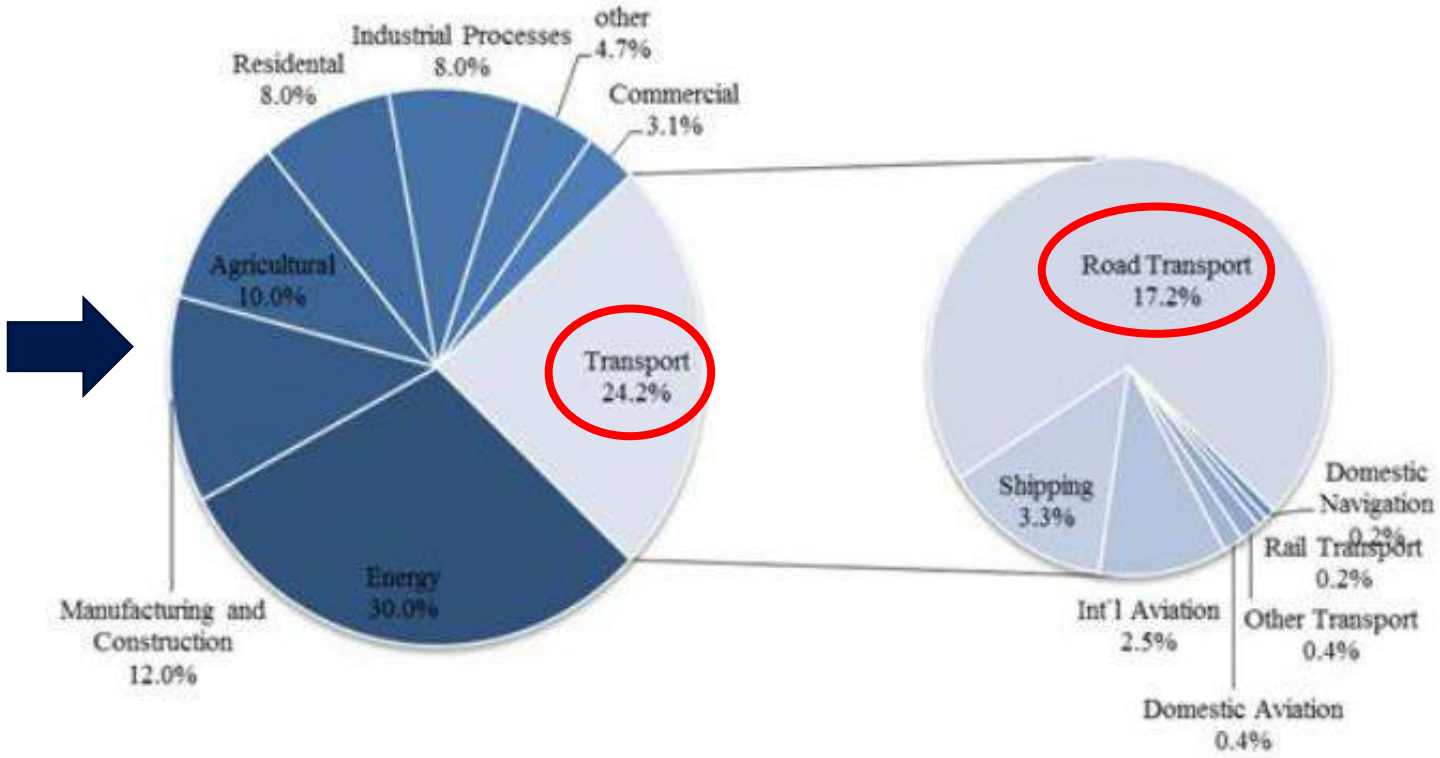
Student *Michele Primavera*

Supervisors *Dr. Joao Santos - Dr. Sara Bressi*

CONTENT

ENVIRONMENTAL IMPACT

The transportation sector generates enormous amount of airborne emission



EU27 greenhouse gas emissions by sector and mode of transport, 2007 (EU, 2014)

The future scope is to be more sustainable

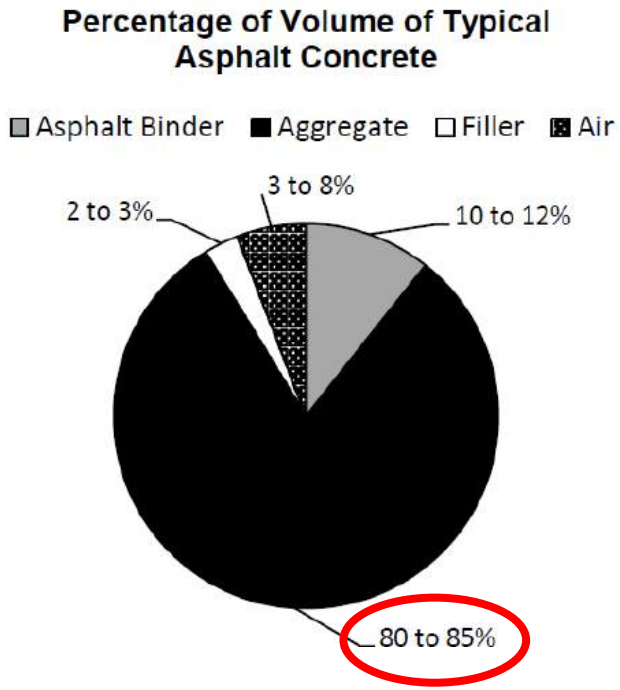
Benefits of Being More Sustainable

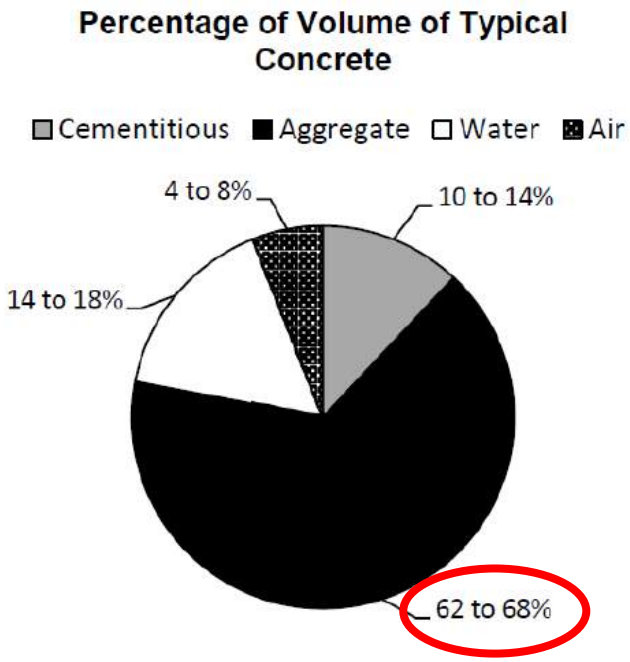
- Reduced pavement life-cycle costs

- Reduced energy
- Reduced noise
- Improved air quality

- Improved safety
- Improved ride
- Conservation of resources

Aggregate Volumes in Asphalt and Concrete





Source: Tayabji, Smith, and Van Dam 2010

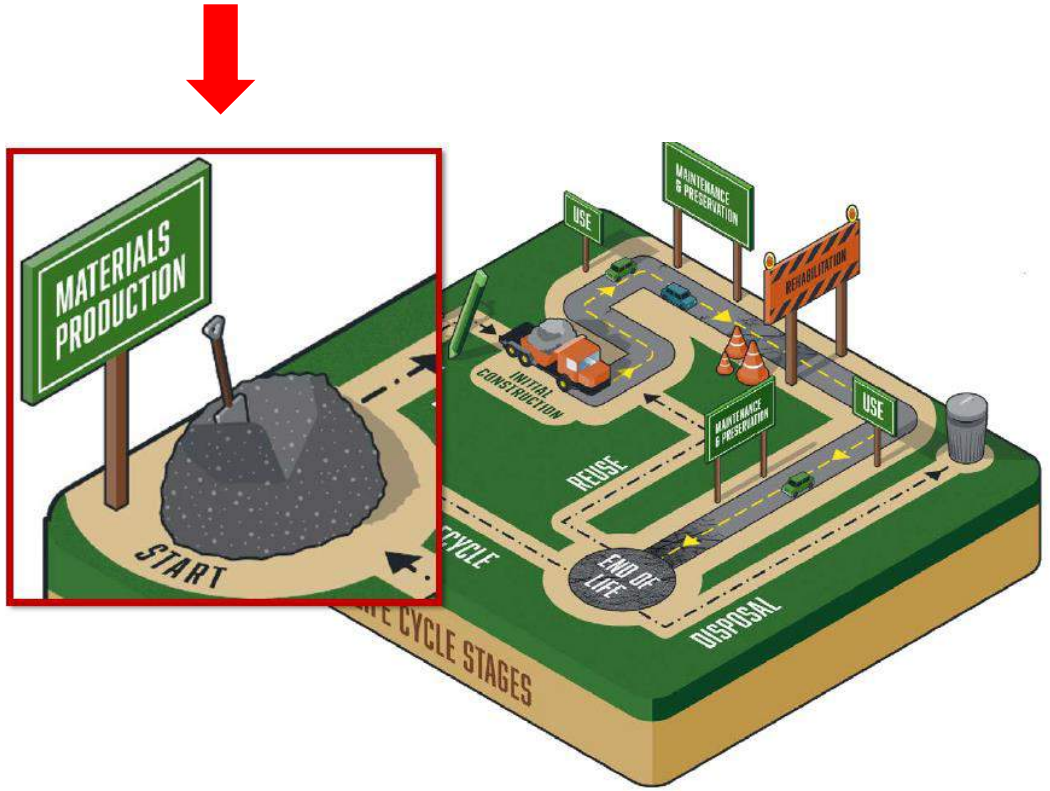


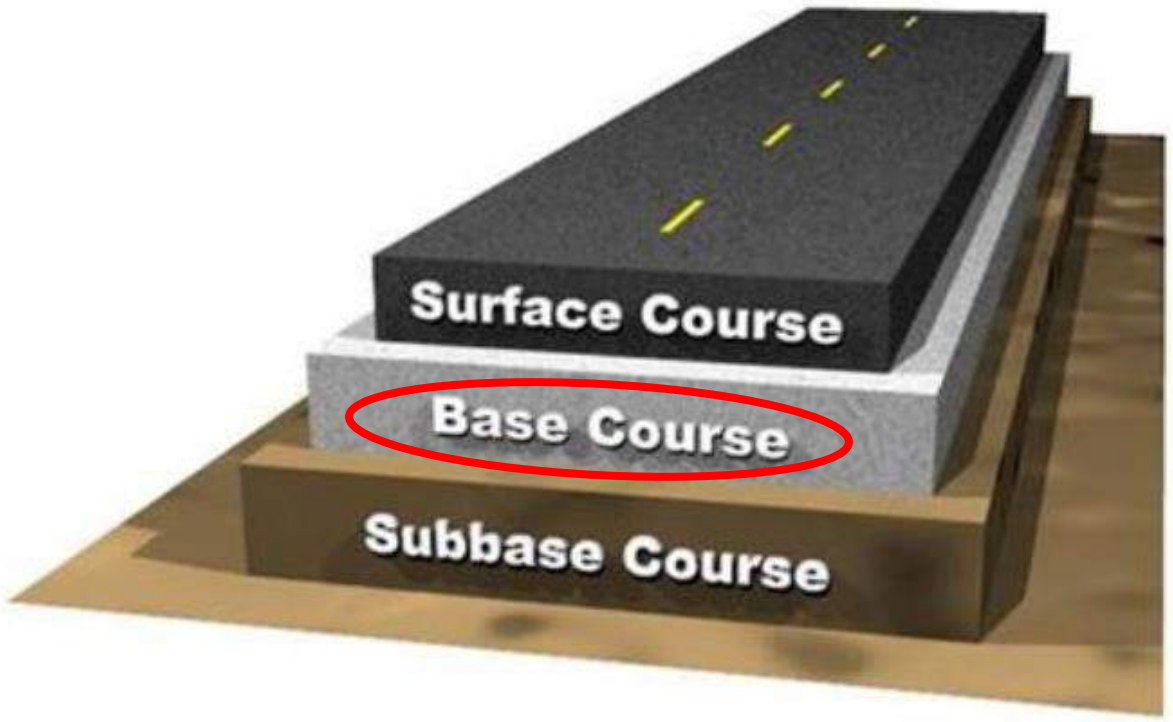
Image Source: FHWA/APTech

QUESTION

Is it always environmentally beneficial to use recycled materials to replace the virgin aggregates?

In this study the layer in pavement road structure that we'll consider is:

CEMENT TREATED BASE COURSE



Cement Treated Base course consists of a uniform mixture of :

Cement Treated Base

VIRGIN AGGREGATE

Or

RAP
(Reclaimed Asphalt Pavement)

CEMENT

WATER

IN PLANT PRODUCTION

Mixing in central plant

Transport

Placing

Slope finishing

Compaction

Bitumen emulsion spreading

IN PLACE PRODUCTION

Transport

Placing

Cement spreading

Water spreading

Mixing

Slope finishing

Compaction

Bitumen emulsion spreading

SCOPE

The objective of the work is the comparison, in terms of environmental impact, between:

- ***In Plant and In Place Production***

- ***CTB (with 100% of Virgin Aggregate) and CTRB (with 100% of RAP)***

The methodology used to assess the environmental impacts is:

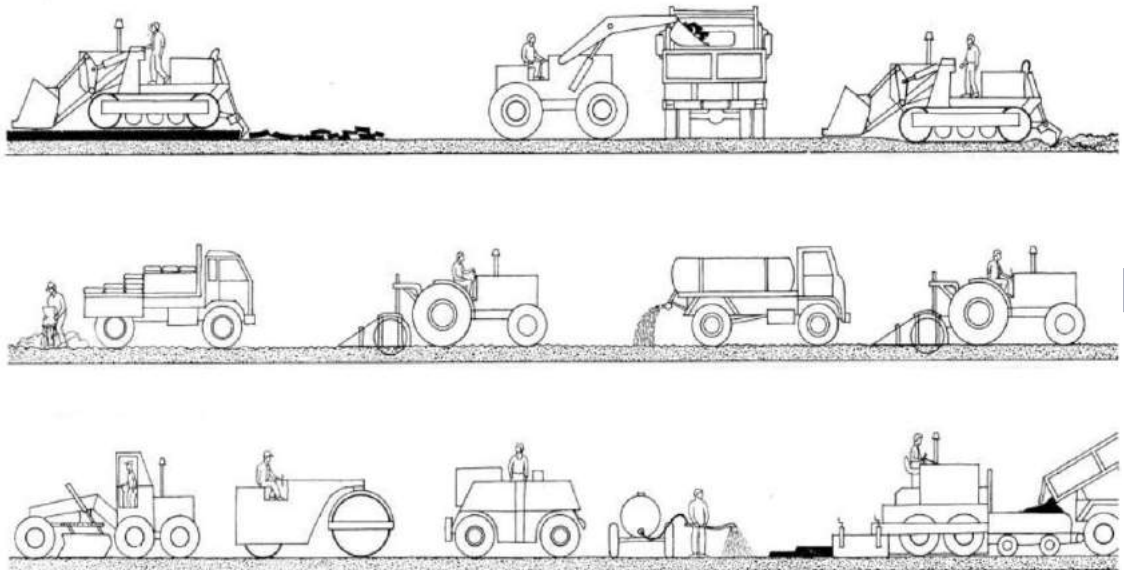
Life Cycle Assessment

Software program

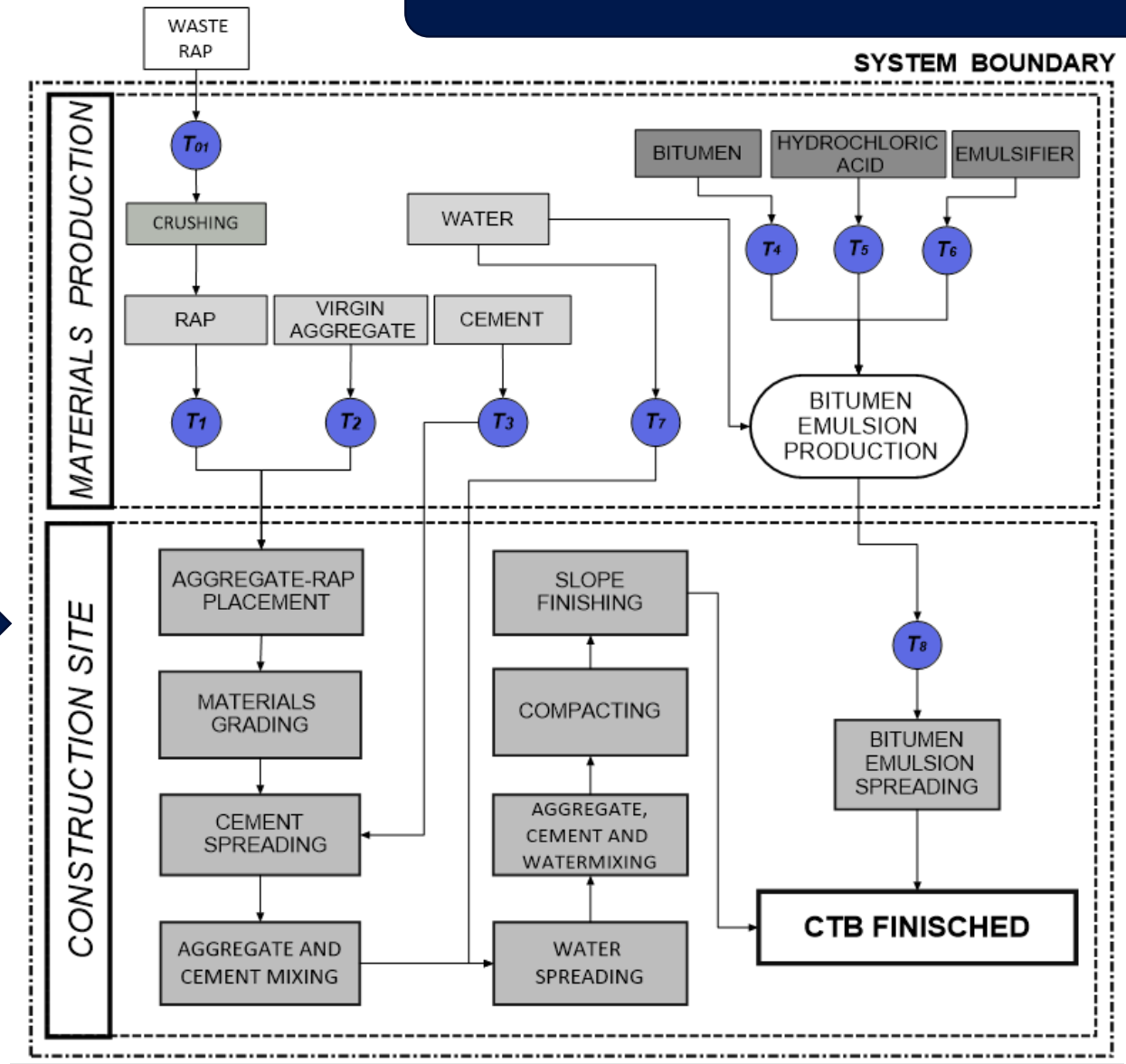
openLca

https://edificacionsostenible.saint-gobain.es/certification/breeames-2015/aislamiento-para-suelos/mat-1-impactos-de-ciclo-de-vida?language_content_entity=es#

IN PLACE PRODUCTION

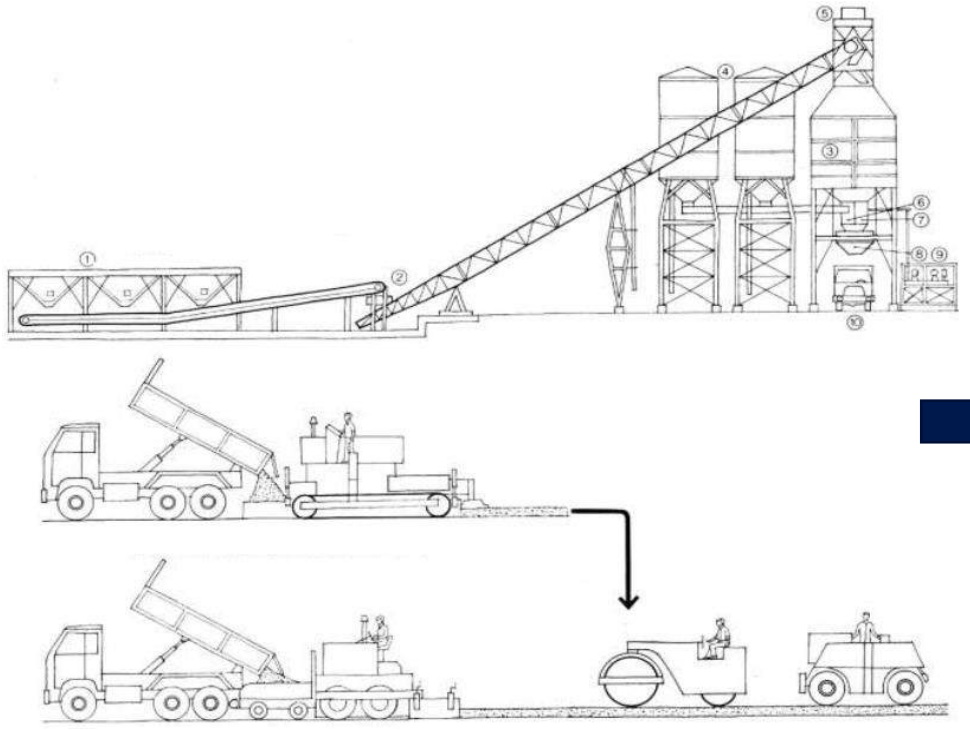


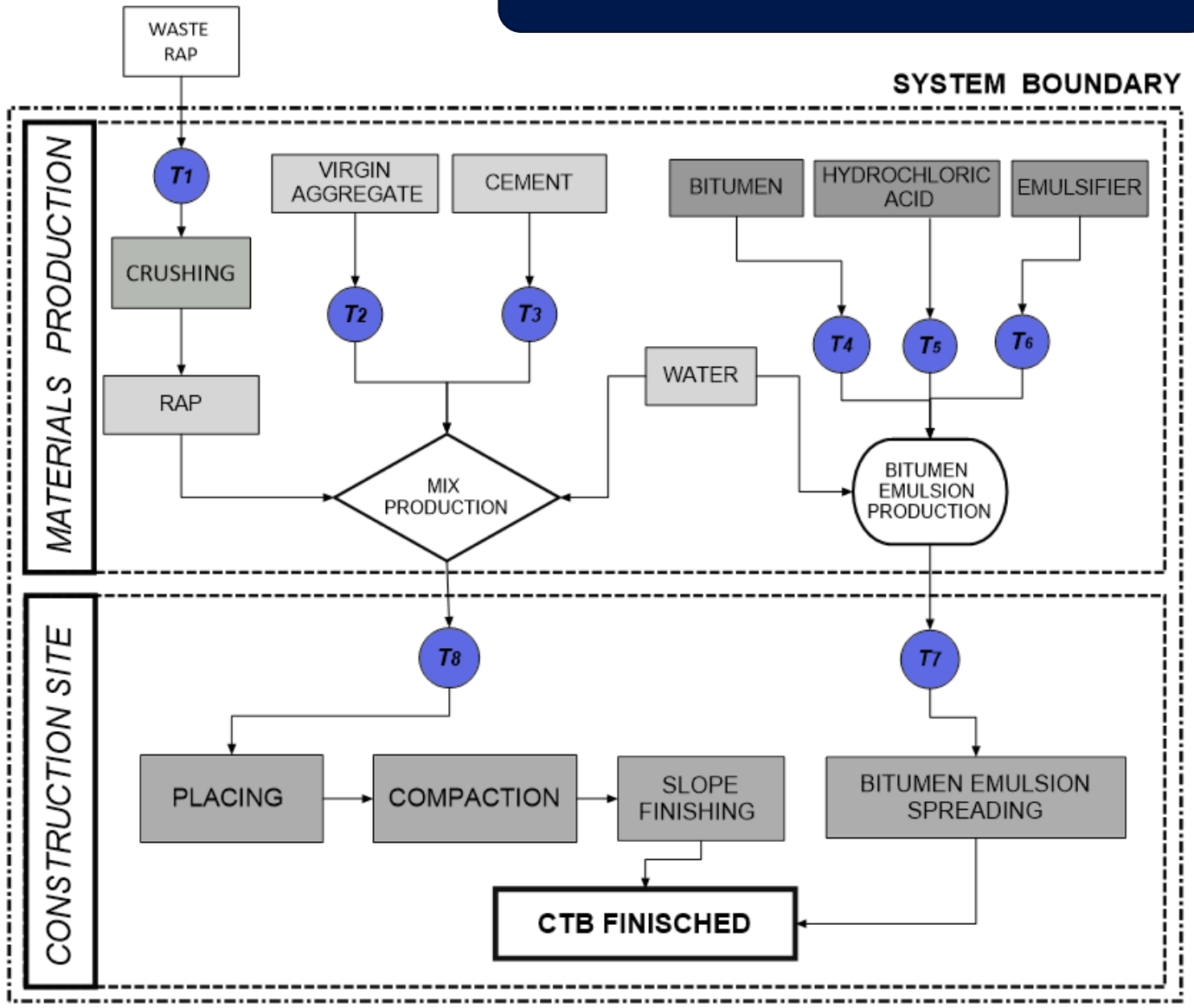
SYSTEM BOUNDARIES



SYSTEM BOUNDARIES

IN PLANT PRODUCTION





Based on a laboratory test, a pavement design was conducted to determinate the thickness of the layer for each mixture.

INPUT DATA

Table 3. Flexible Pavement Design Conditions

Category	Condition
Pavement type	Major city streets and thoroughfares and country highways
Total equivalent 18-kip single axle loads ($ESAL_{18\text{-kip}}$)	2,028,404
Analysis period	30 years
Design period	20 years
Initial pavement serviceability index (P_0)	4.2
Terminal pavement serviceability index (P_t)	2.5
Reliability (R)	90%
Overall standard deviation (S_0)	0.35

PAVEMENT DESIGN ANALYSIS

Table 6. Results of Pavement Design Analysis

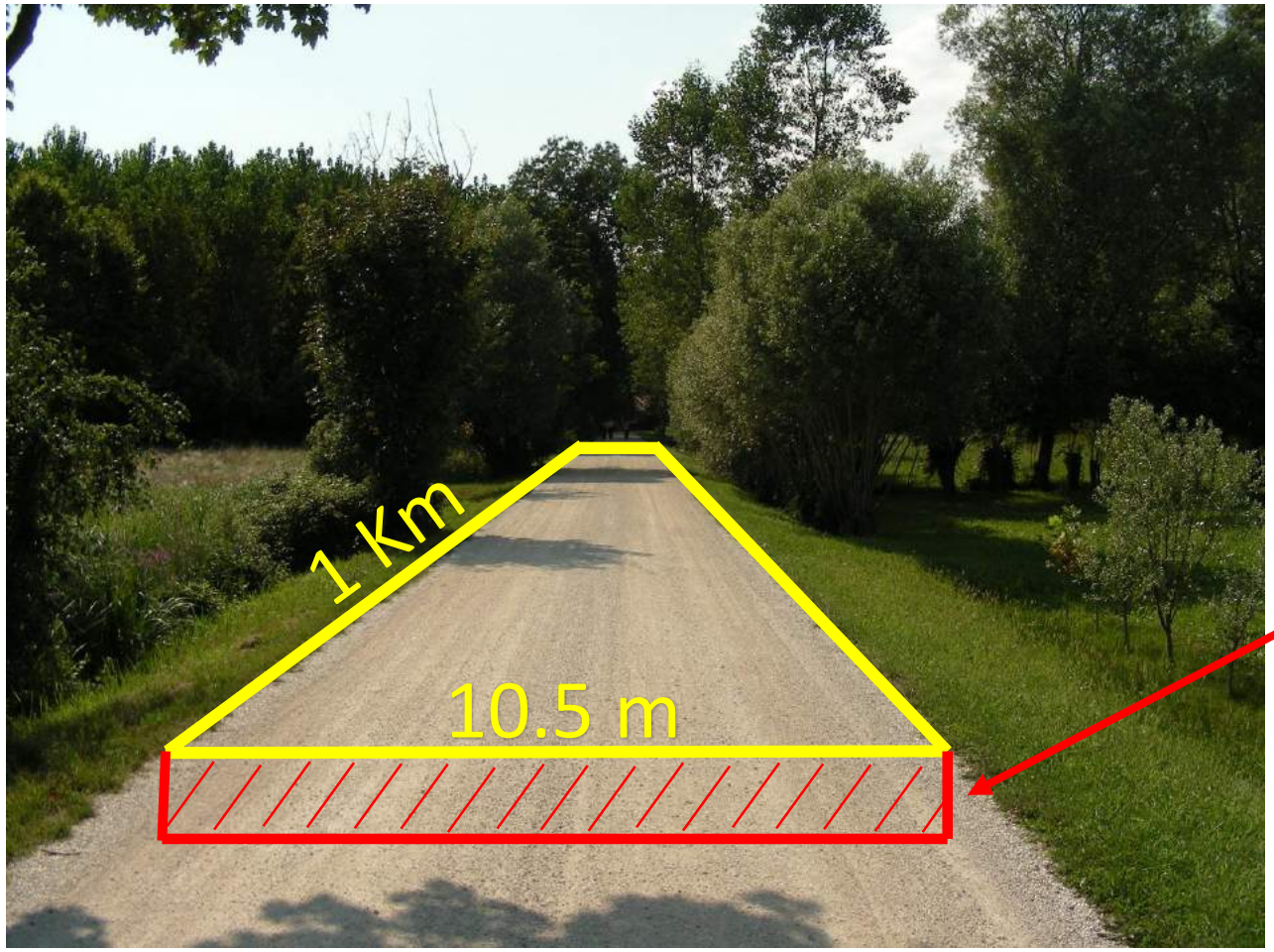
Base material		Thickness (mm) Surface	Base	Subbase
100% virgin aggregate	+0% cement	127	127	114
	+3% cement	76	241	114
	+5% cement	76	191	114
	+7% cement	76	165	114
100% RAP[a]	+0% cement	178	0	89
	+3% cement	76	343	114
	+5% cement	76	318	114
	+7% cement	76	292	114
90% RAP[a]	+0% cement	165	13	114
	+3% cement	76	318	114
	+5% cement	76	292	114
	+7% cement	76	292	114
80% RAP[a]	+0% cement	165	51	114
	+3% cement	76	292	114
	+5% cement	76	292	114
	+7% cement	76	280	114
70% RAP[a]	+0% cement	152	76	114
	+3% cement	76	292	114
	+5% cement	76	280	114

[a]Reclaimed asphalt pavement.

+ 102 mm

Ramzi Taha, A.M.ASCE, Ali Al-Harthy, Khalid Al-Shamsi and Muamer Al-Zubeidi (2002).

FUNCTIONAL UNIT



LENGTH = 1KM

WIDTH =10.5m

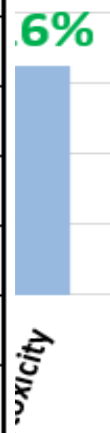
THICKNESS= variable

IN PLANT - IN PLACE PRODUCTION

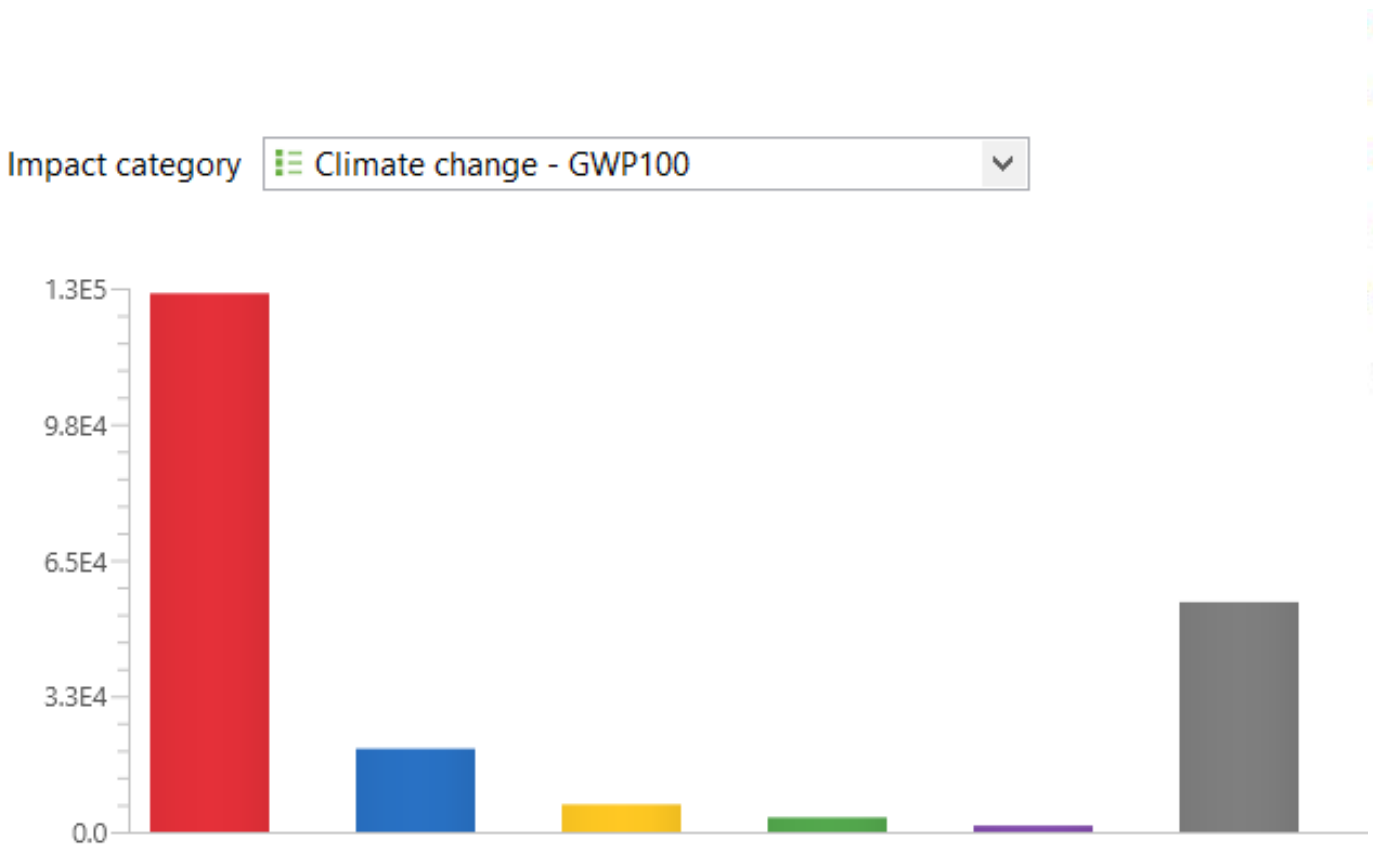
100% VIRGIN AGGREGATE - 5%CEMENT			
IMPACT	IN PLACE	IN PLANT	Unit
Ac	392.39523	575.6014	kg SO2 eq.
PO	16.48638	24.91602	kg ethylene eq.
CC	1.79E+05	2.23E+05	kg CO2 eq.
OLD	0.01385	0.01879	kg CFC-11 eq.
DAR-FF	1.26E+06	1.80E+06	MJ
Eu	96.19581	146.01721	kg PO4--- eq.
MAE	3.67E+07	7.78E+07	kg 1,4-dichlorobenzene eq.
TE	846.9613	952.38532	kg 1,4-dichlorobenzene eq.
FAE	1.27E+04	2.28E+04	kg 1,4-dichlorobenzene eq.
DAR-E	0.054	0.12069	kg antimony eq.
HT	2.29E+04	3.98E+04	kg 1,4-dichlorobenzene eq.

CTRB (100% RAP) - **CTB** (100% VIRGIN AGGREGATE)

Central Plant Production			
IMPACT	100% VIRG AGGR	100% RAP	Unit
Ac	575.6014	738.94112	kg SO2 eq.
PO	24.91602	31.4999	kg ethylene eq.
CC	2.23E+05	3.05E+05	kg CO2 eq.
OLD	0.01879	0.01956	kg CFC-11 eq.
DAR-FF	1.80E+06	2.08E+06	MJ
Eu	146.01721	194.01068	kg PO4--- eq.
MAE	7.78E+07	1.07E+08	kg 1,4-dichlorobenzene eq.
TE	952.38532	1041.78616	kg 1,4-dichlorobenzene eq.
FAE	2.28E+04	3.06E+04	kg 1,4-dichlorobenzene eq.
DAR-E	0.12069	0.14253	kg antimony eq.
HT	3.98E+04	4.63E+04	kg 1,4-dichlorobenzene eq.



CTRB (100% RAP) - **CTB** (100% VIRGIN AGGREGATE)



1.288E5 kg CO2 eq. → CLINKER PRODUCTION

1.988E4 kg CO2 eq.

6.559E3 kg CO2 eq.

3.444E3 kg CO2 eq.

1.487E3 kg CO2 eq.

5.494E4 kg CO2 eq

TOTAL AMOUNT OF CEMENT	
TRADITIONAL BASE	**RECYCLED BASE**
214 ton	306 ton

QUESTION

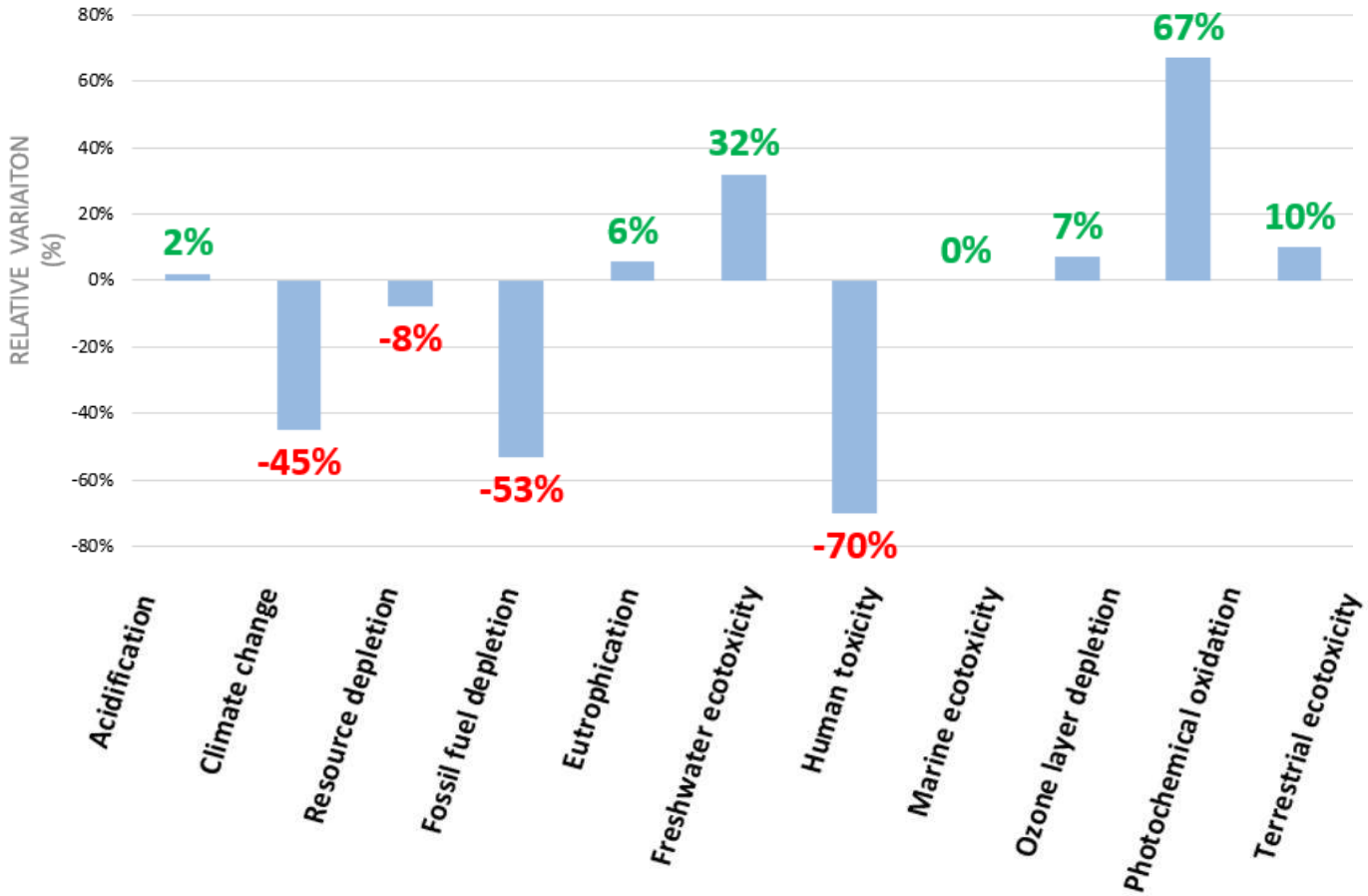
Is it always environmentally beneficial to use recycled materials to replace the virgin aggregates?

ANSWER

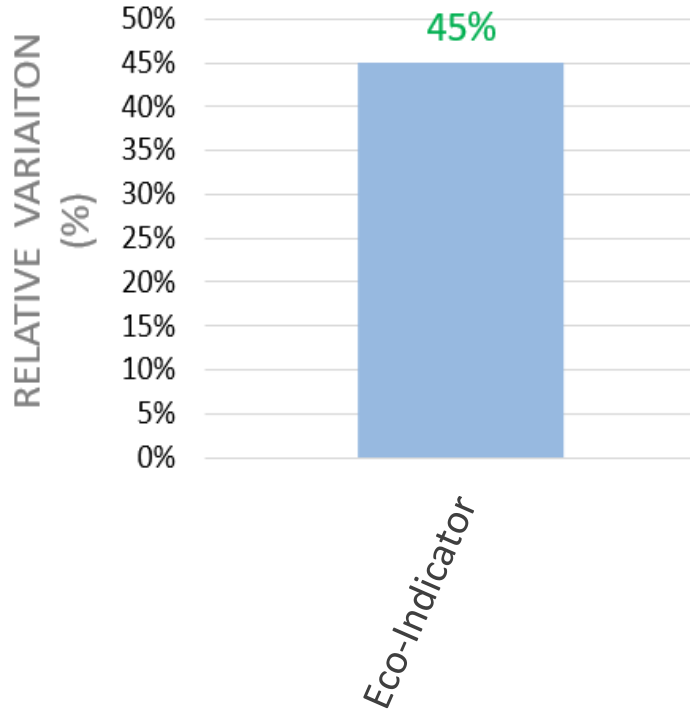
NO!!!

Which alternative to choose?

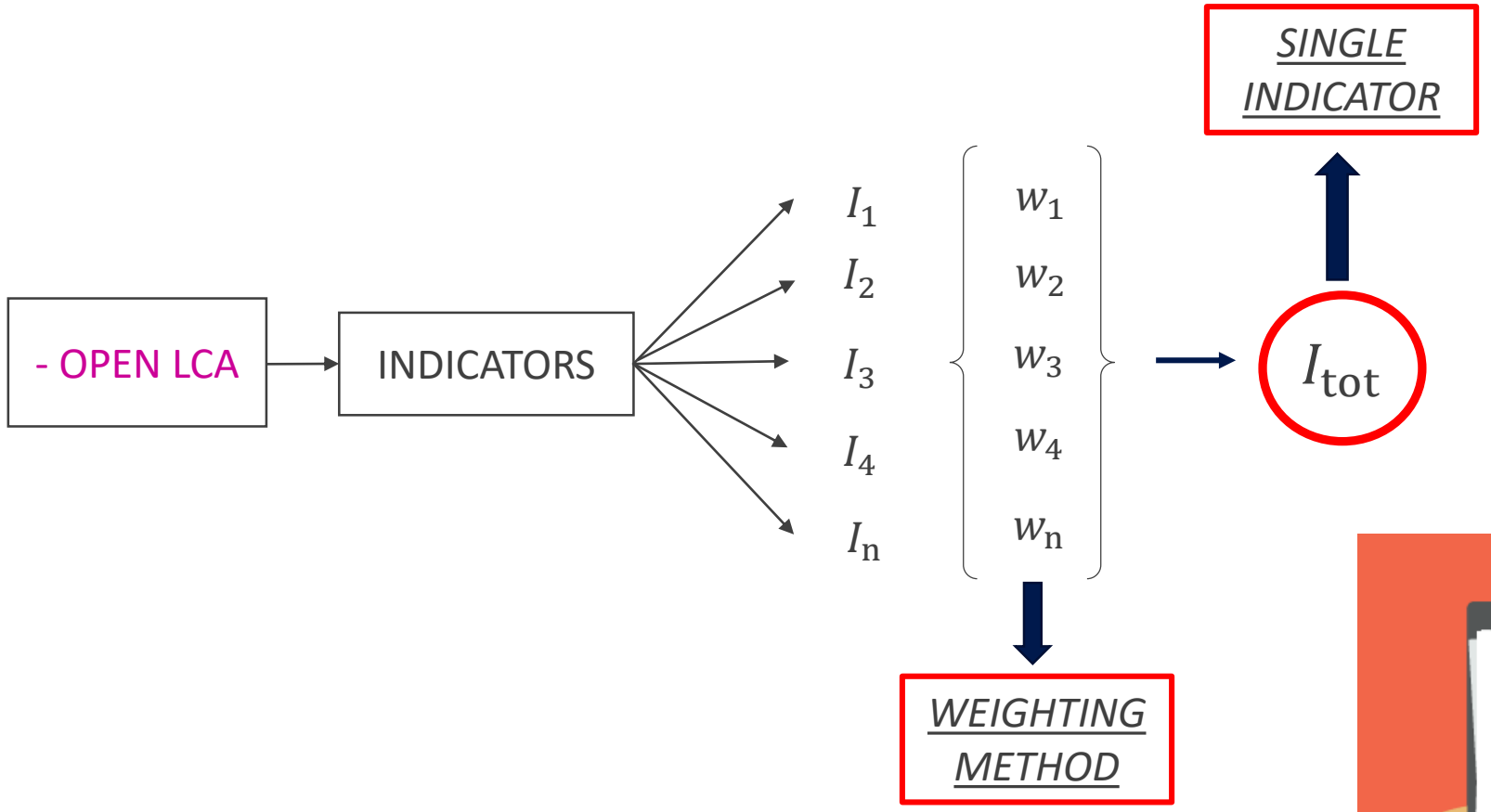
WEIGHTING METHOD

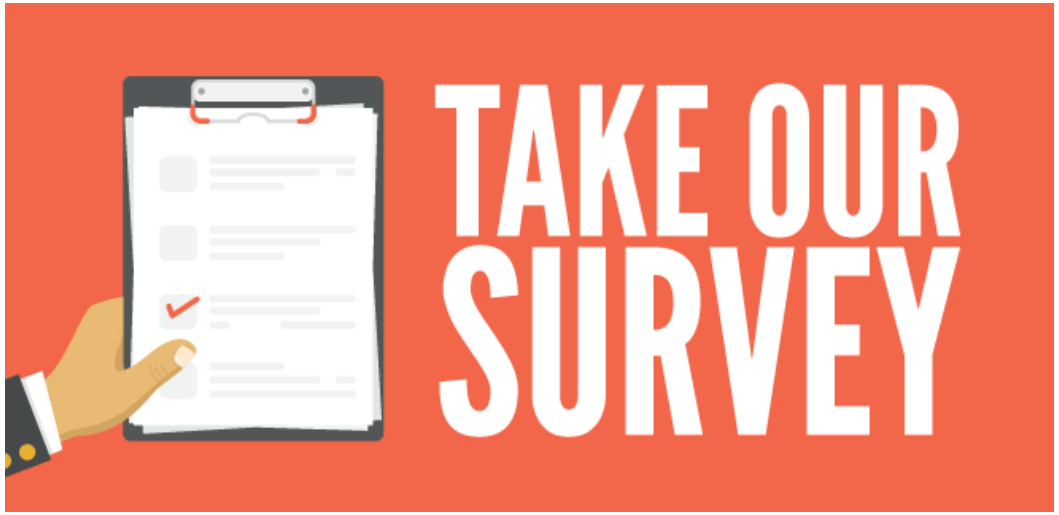


SINGLE INDICATOR



Procedure


- OPEN LCA
INDICATORS
I_1
I_2
I_3
I_4
I_n
w_1
w_2
w_3
w_4
w_n
I_{tot}
SINGLE INDICATOR
WEIGHTING METHOD


TAKE OUR SURVEY


THE END !!!

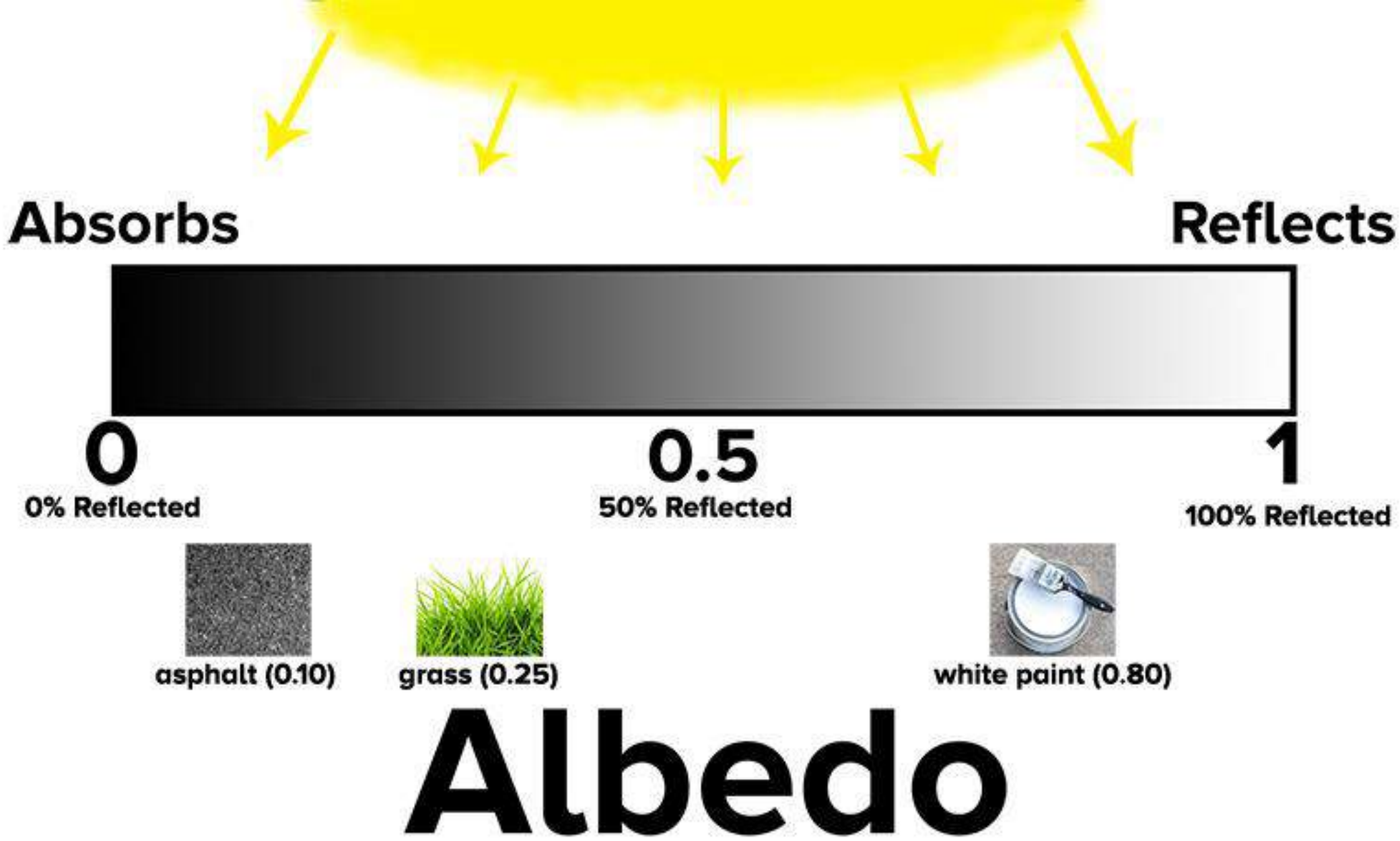
UNIVERSITY OF TWENTE.

Reflectivity, roads, and urban climates.

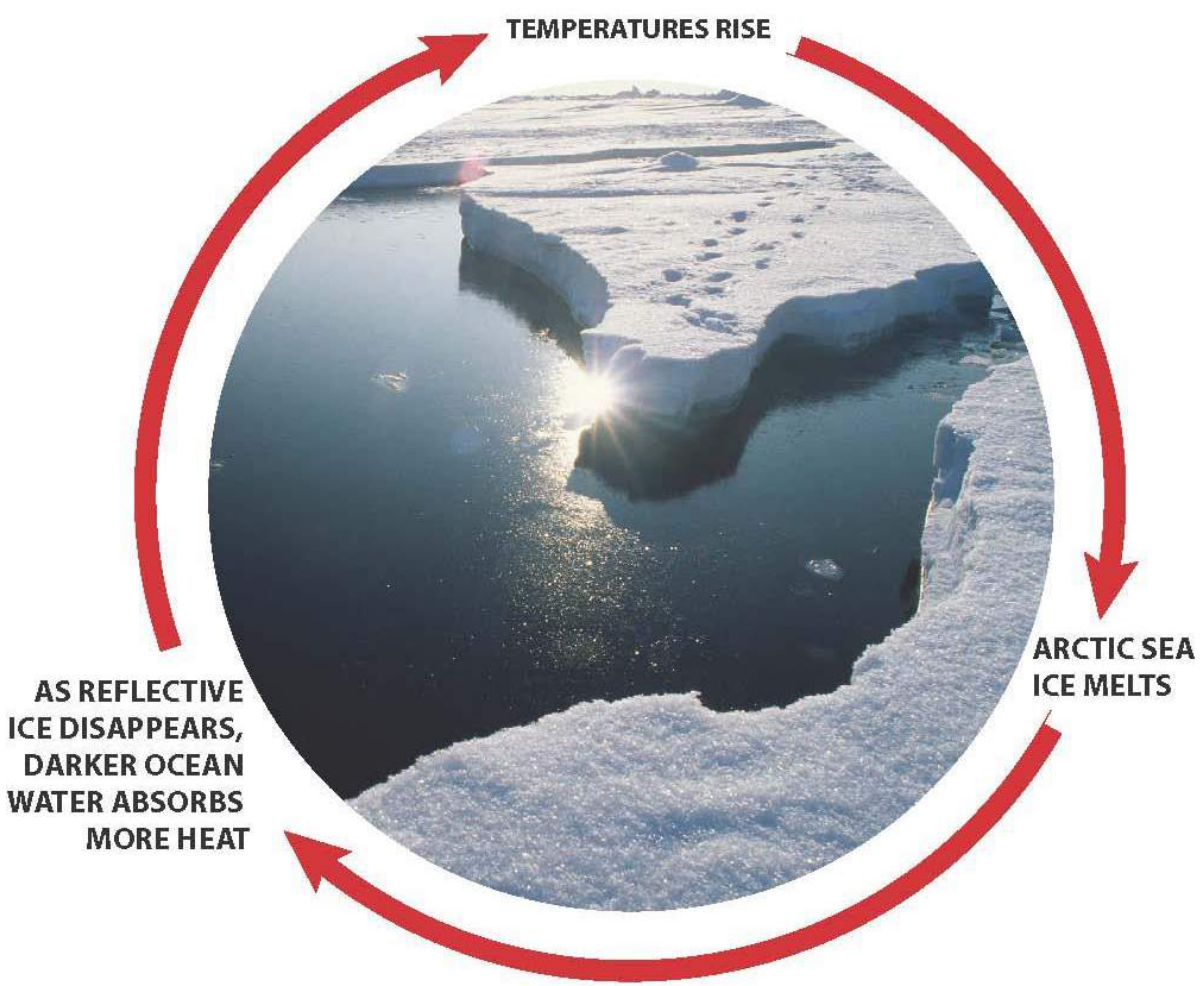
M. Pena Acosta (Monik)

PhD Researcher

4th of December 2019



http://www.nc-climate.ncsu.edu/edu/Albedo



Surface albedo feedbacks

Ice is very reflective, some of the solar energy is reflected back to space

Urban climates

Would it be nice if we could design, maintain and operate our roads considering heat potential?


Reflects 10%
Reflects 40%
Reflected Sunlight
Dark Pavement
Cool Pavement


www.ave.cz
AVE

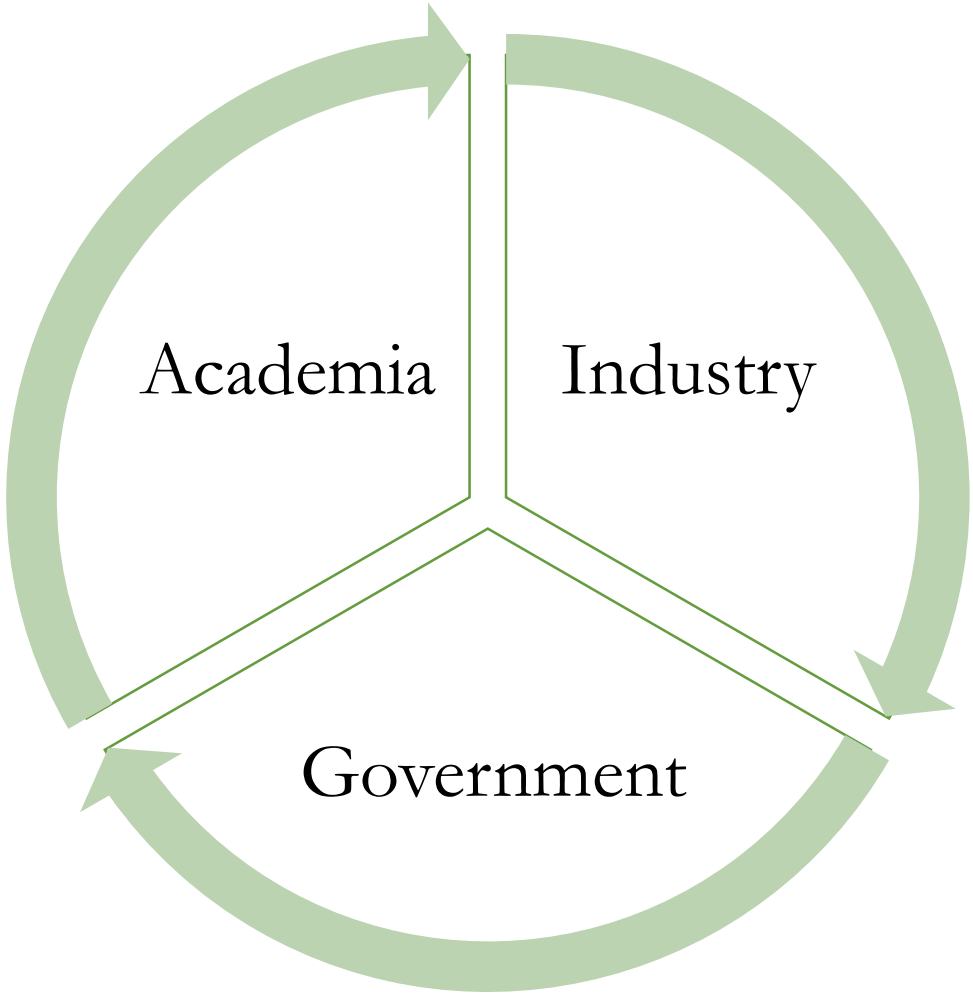

Urban temperature
1.
2.
3.
Urban geometries

Challenges

- Local climate
- Climate change
- Urban geometry
- Materials
- Policies

Evaluating the impacts of pavement albedo is complicated.

Data-driven techniques are a potential solution


Academia
Industry
Government

Experimental set-up

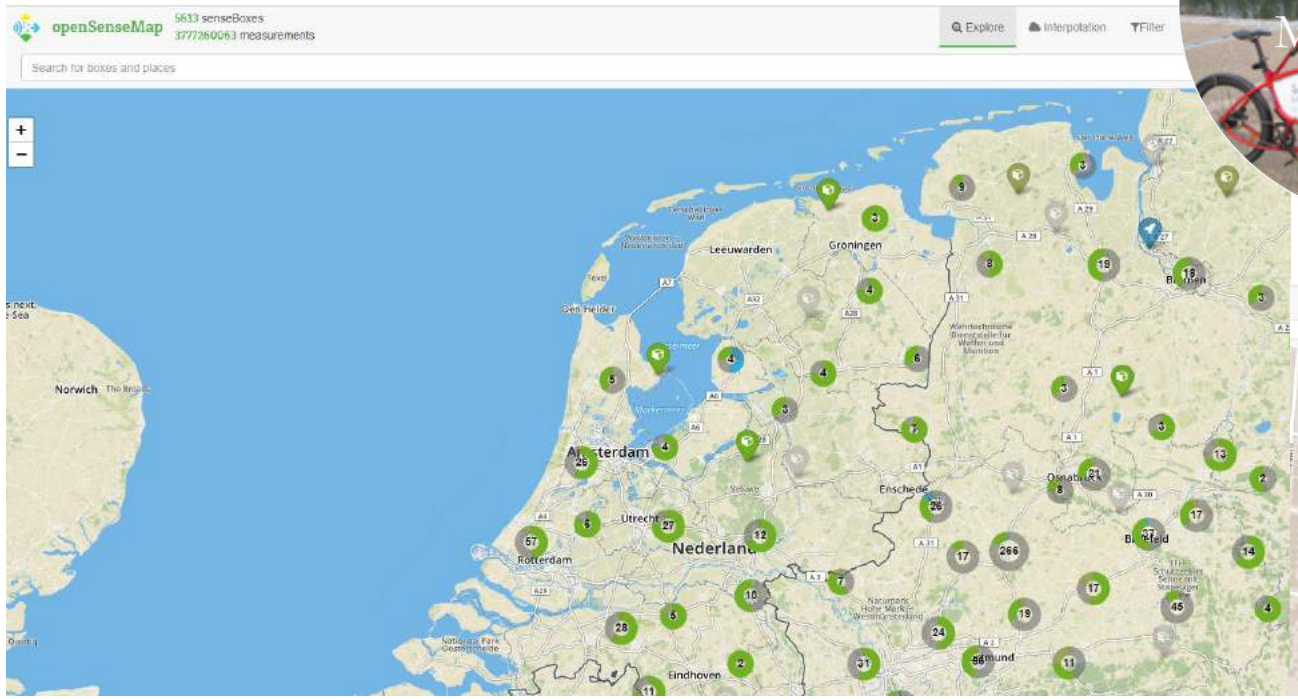
Air temperature

A10

	A	B	C
1	**Create a street profile**		
2	Location	Latitude	Altitde
3	Width of street	cm	
4	Sky view factor	0-1	
5	Average height of building	cm	
6	Vegetation	0-1	
7	Materials of façade		
8	Others		
9			

Road surface temp

Experimental set-up



Air temperature

	A	B	C
1	**Create a street profile**		
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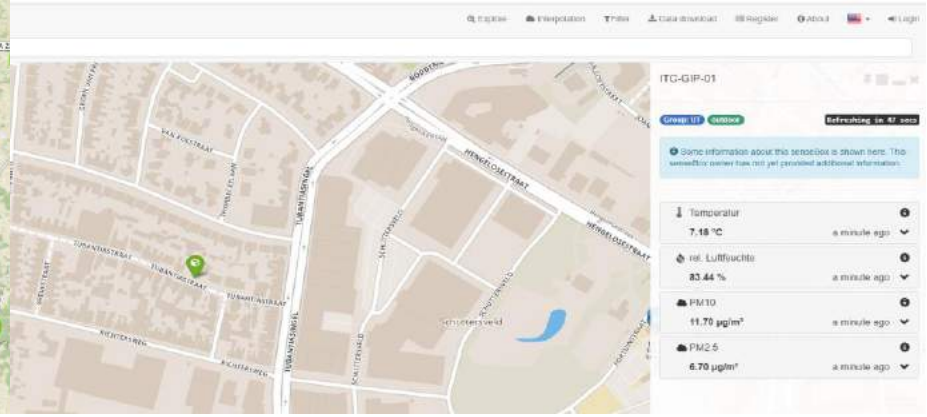
7	Materials of façade		
8	Others		
9			

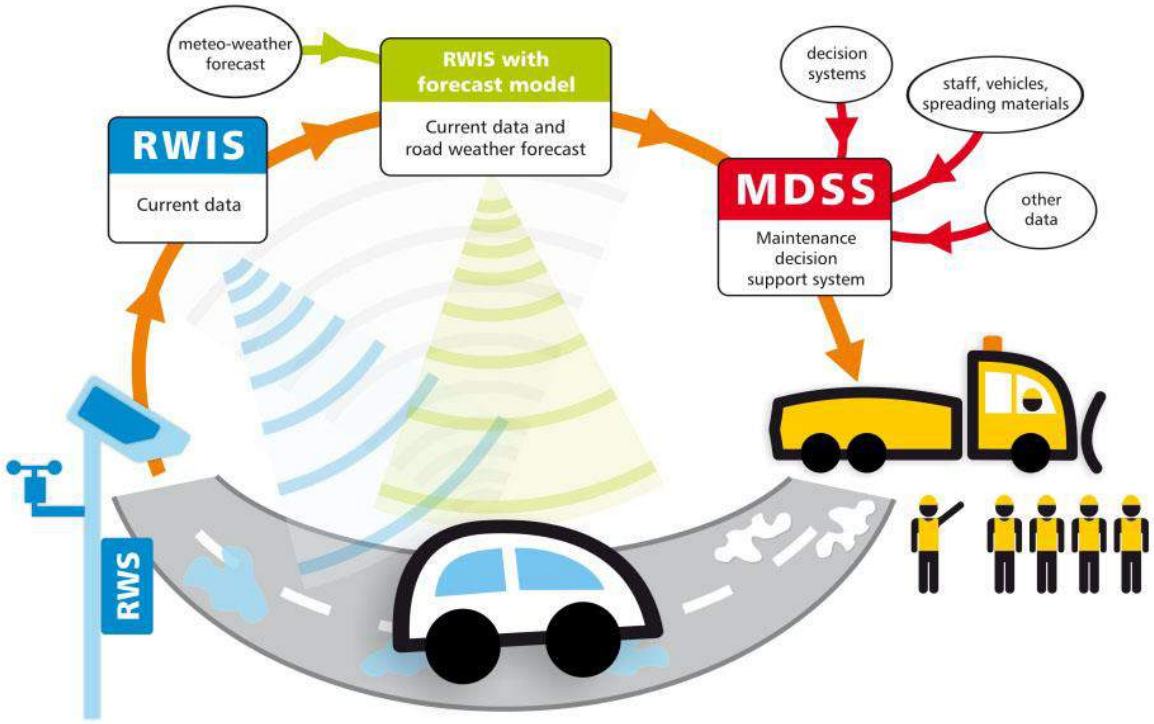
Road surface temp



Not enough

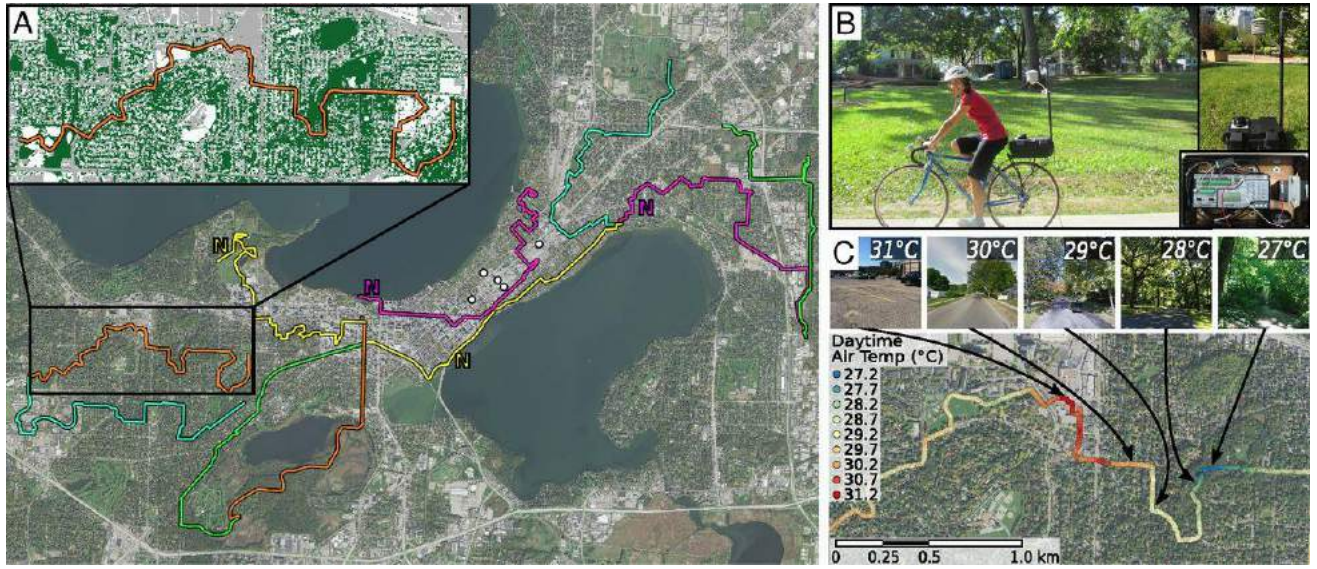
Road safety and weather information system

From the SWOV Institute for Road Safety Research



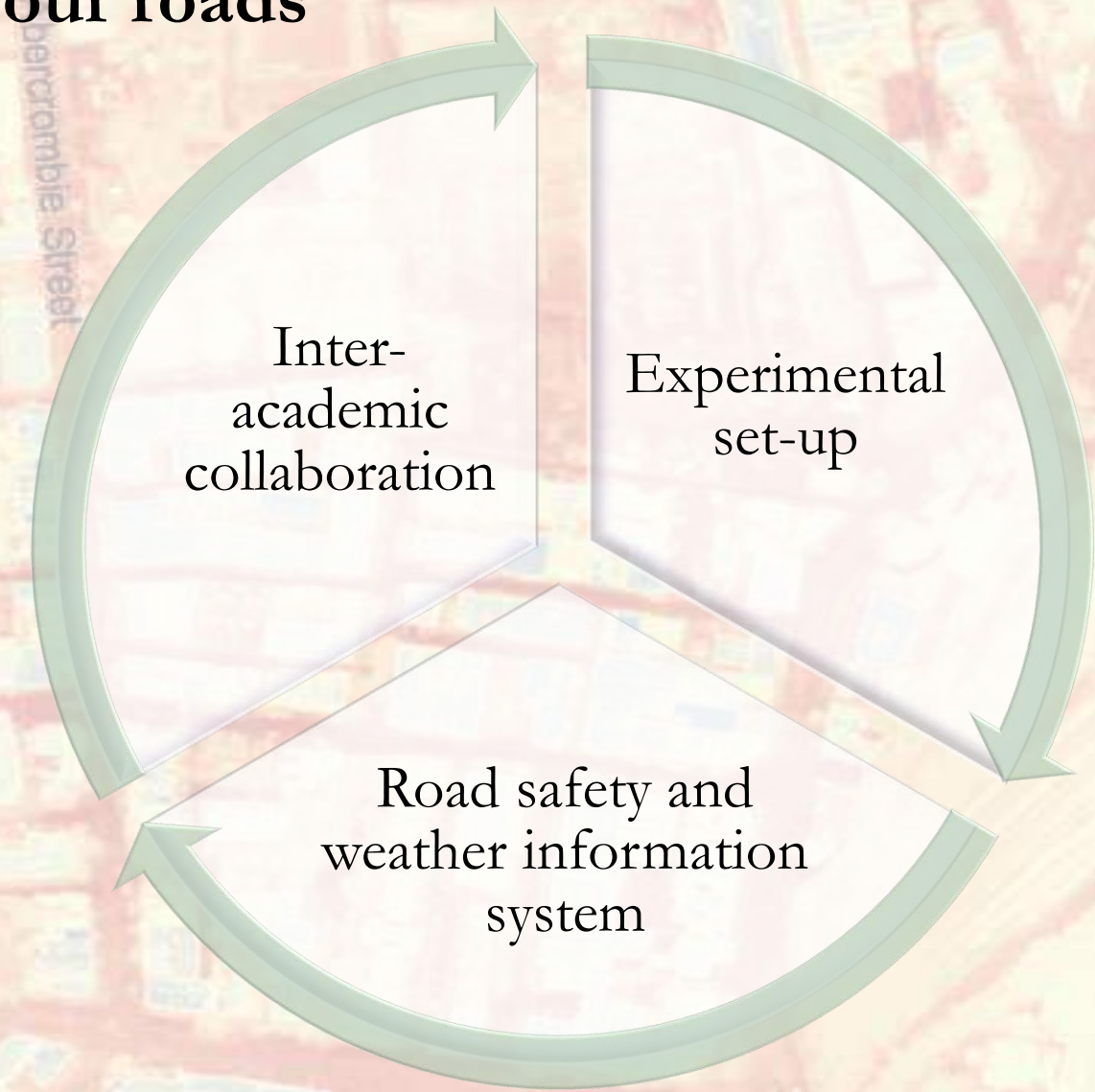
Road weather stations (RWSs) collect current weather data

Inter-academic collaboration



Share knowledge and expertise with researchers from Canada
Could we lower the solar panels?

We can design, maintain and operate our roads in terms of heat potential



Take-home message

From your expertise, what do we have already that we can implement to cool our roads?

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THANK YOU!

m.penaacosta@utwente.nl

4th of December 2019

DE ONTWIKKELING VAN INNOVATIEVE LESMATERIALEN VOOR HBO-WEGENBOUW

ASPARi
Paving the way forward

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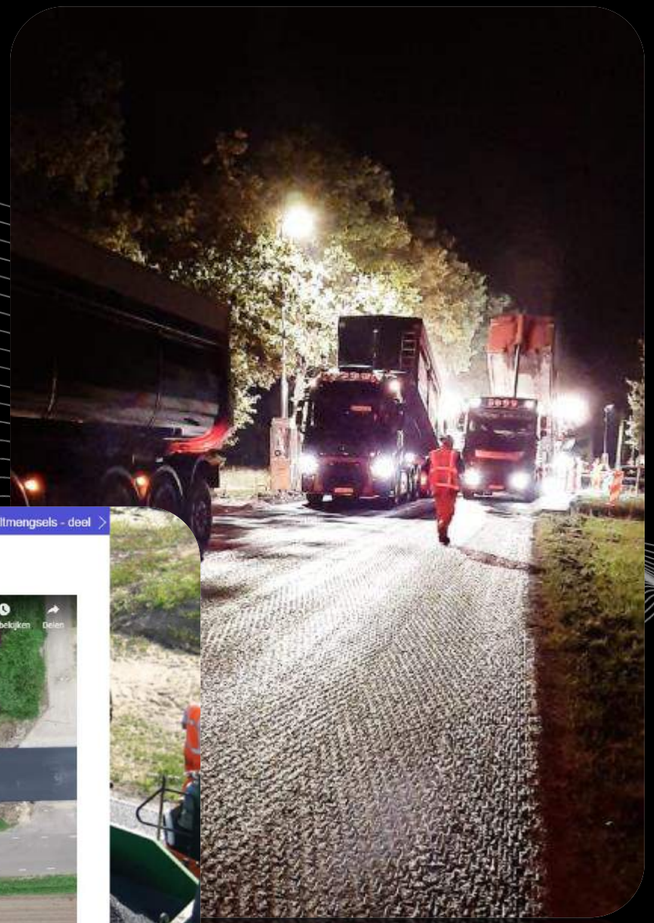
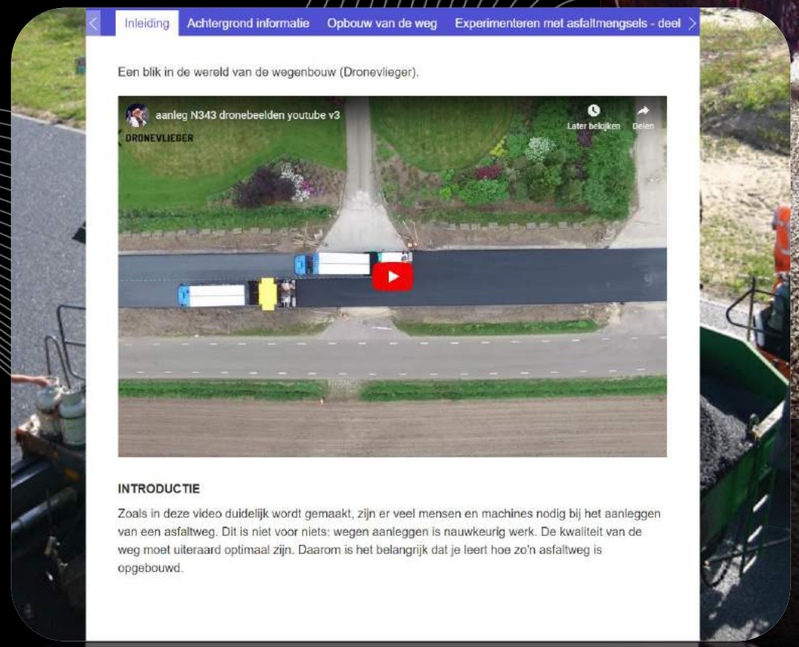
DE ACHTERGROND

- Veel ontwikkelingen vanuit ASPARi
- Onderbelicht in het onderwijs
- De slag is al gemaakt in het mbo
- Nu nog in het hbo...

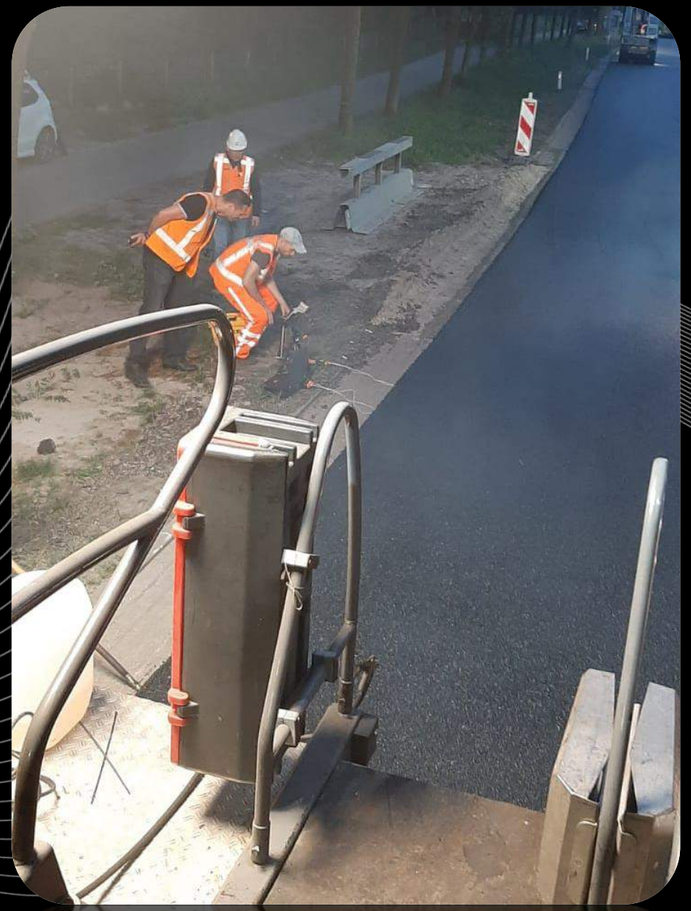




VOORTGANG

EÉN JAAR IN DE WEGENBOUW

- Heel veel literatuur
  - Asfalt
  - Hoe werkt de wegenbouw
  - Literatuurstudie
  - Kennis vanuit ASPARi
- Veel plekken bezocht
- Interviews uitgevoerd
- Stakeholdersmeetings

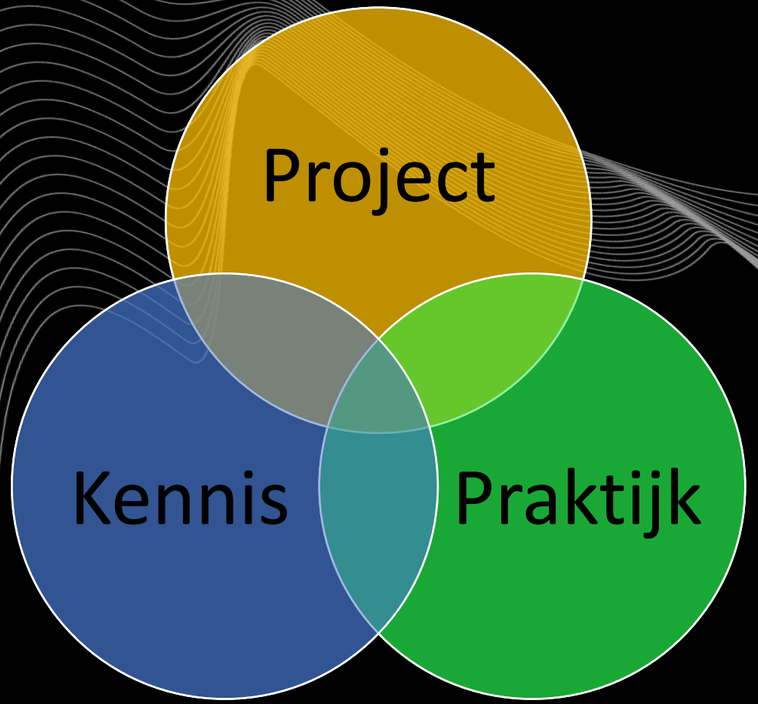


HET DESIGN

- Minor voor het HBO
    - Volledige minor gegeven bij Avans Hogeschool
    - Toevoeging aan een bestaande minor Hogeschool Arnhem en Nijmegen
- In het kader van lifelong learning zijn de lesmaterialen ook beschikbaar voor werknemers

HET DESIGN

- Modulaire minor
  - Aanpasbaar naar de wensen van de docenten/studenten en voorkennis
  - Modules kunnen ingezet worden om onderwijs te verbeteren naast de minor
  - Modulaire vorm staat toe de materialen eenvoudiger te onderhouden
- De minor zal uit twee blokken bestaan



BLOK 1 (KORT)

OVERZICHT

- De asfaltcyclus
- Samenhang tussen de verschillende stappen
- Interpreteren van wensen van opdrachtgevers

BLOK 2 (LANG)

OPLOSSEN

- Variabiliteit in het wegenbouwproces
  - Meerdere casussen
- Toepassen van nieuwe technologieën
- Data interpreteren, evalueren en rapporteren vanuit metingen
- Verbanden kunnen leggen tussen data, werkmethodes en schades
- Rapportage creëren

LEERDOELEN

- De leerling is in staat uit te leggen waarom het wegenbouwproces variabel is.
- De leerling is in staat uit te leggen hoe nieuwe technologieën toegepast kunnen worden om deze variabiliteit te meten en terug te dringen.
- De leerling is in staat om data afkomstig vanuit ASPARi metingen te interpreteren en evalueren

WAAR WILLEN WE HEEN?

WAT WORDT ER OPGELEVERD

Technische kennis wordt omgezet naar concrete lesmaterialen.

- Lesmaterialen asfalt op modulebasis
  - Video’s, plaatjes, grafieken
  - Simulaties
  - Teksten
- Lesplan voor de minor
- Digitale Leeromgeving voor de minor
- Assessment (Opdrachten, presentatie, verslagen, calculaties, ...)

WAAR WILLEN WE HEEN?

- Alle stakeholders zijn akkoord met modulaire opbouw en onderwerpen
- Modules opbouwen
- Lesplan en minor in elkaar zetten en voorzichtig testen
- Mbo-lesmaterialen worden als ondersteunende materialen gebruikt

WAAR WILLEN WE HEEN?

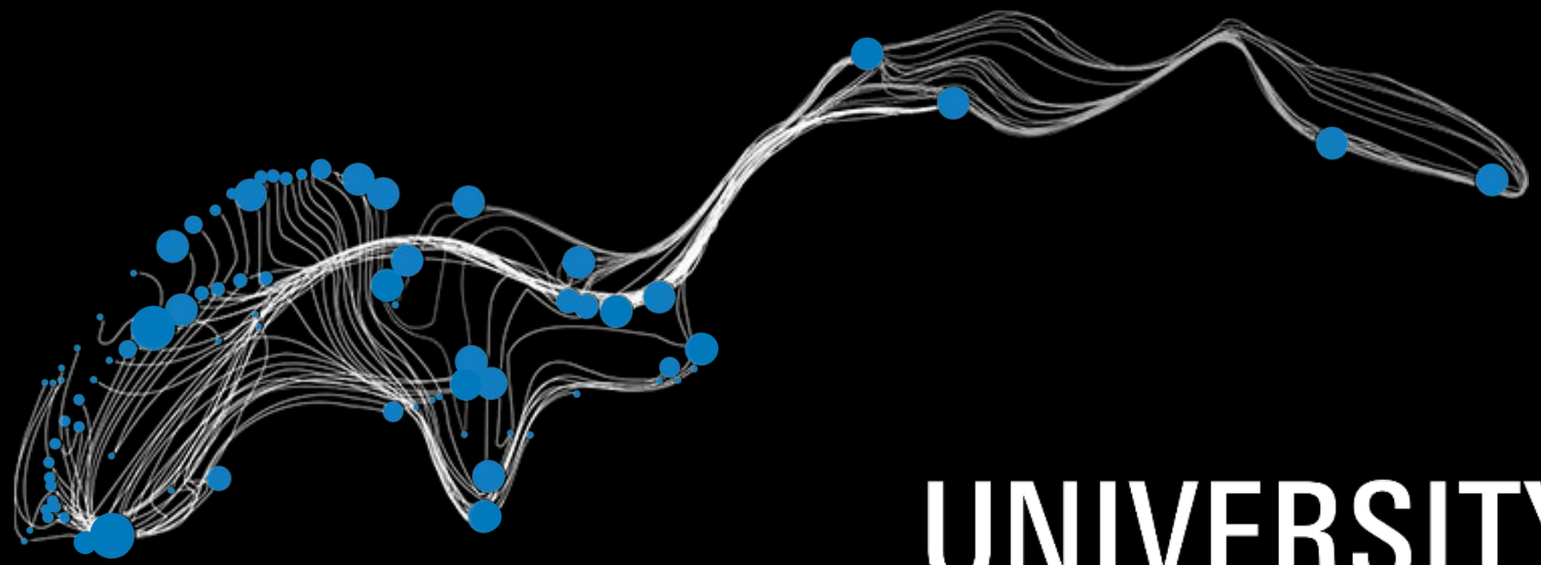
- Kleine pilottests met hbo-studenten, hbo-docenten en ASPARi.
- September 2020 implementatie op het hbo (definitieve pilottest)
    - Valideren
    - Evalueren

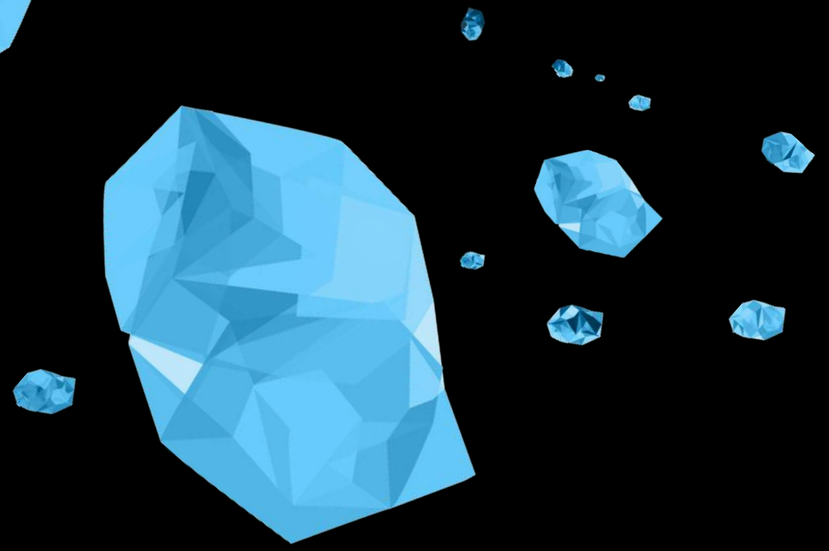
WAAR WILLEN WE HEEN?

- Als onderwijskundige heb ik niet alle asfaltwijsheid in pacht...
- Aantal bedrijven hebben al toegezegd te ondersteunen

b.t.m.ernst@utwente.nl

06-53906450





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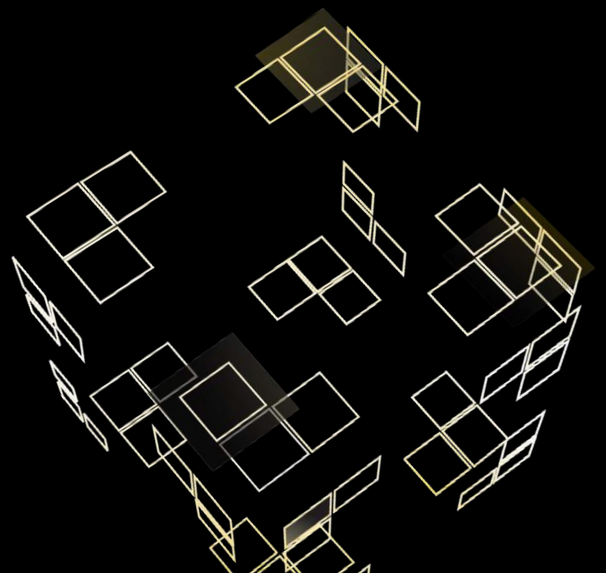

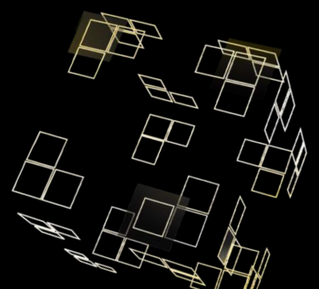

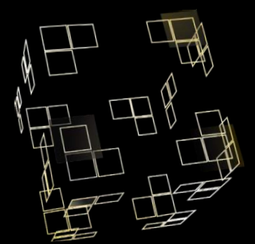

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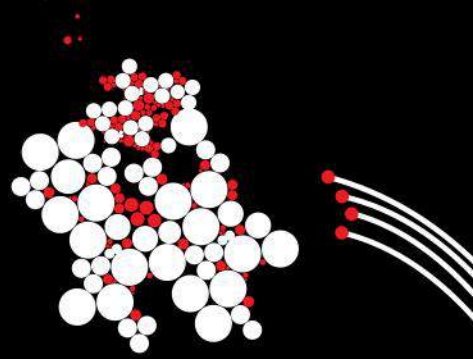
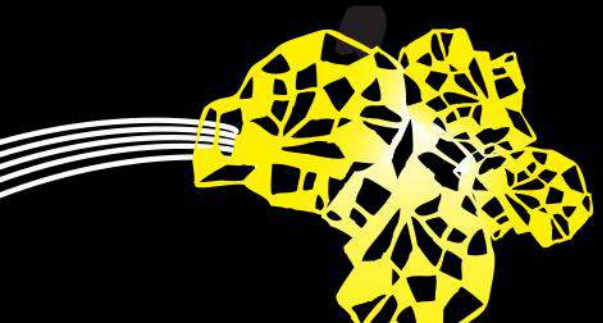


MODERNIZING THE PQI METHOD

DENIS MAKAROV - AFSHIN JAMSHIDI



December 2019

OUTLINE

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- Introduction (background)
- Current situation
- Alternatives
- Current results

INTRODUCTION

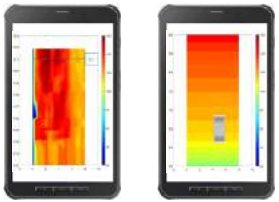
Level 0

No automation

Transition

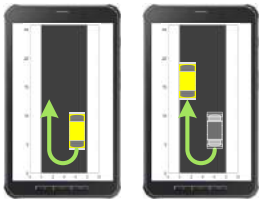
Level 1

Operator assistance with raw process related information (no guidance, engaged control)



Level 2

Operator guidance during paving and compaction operations



Level 3

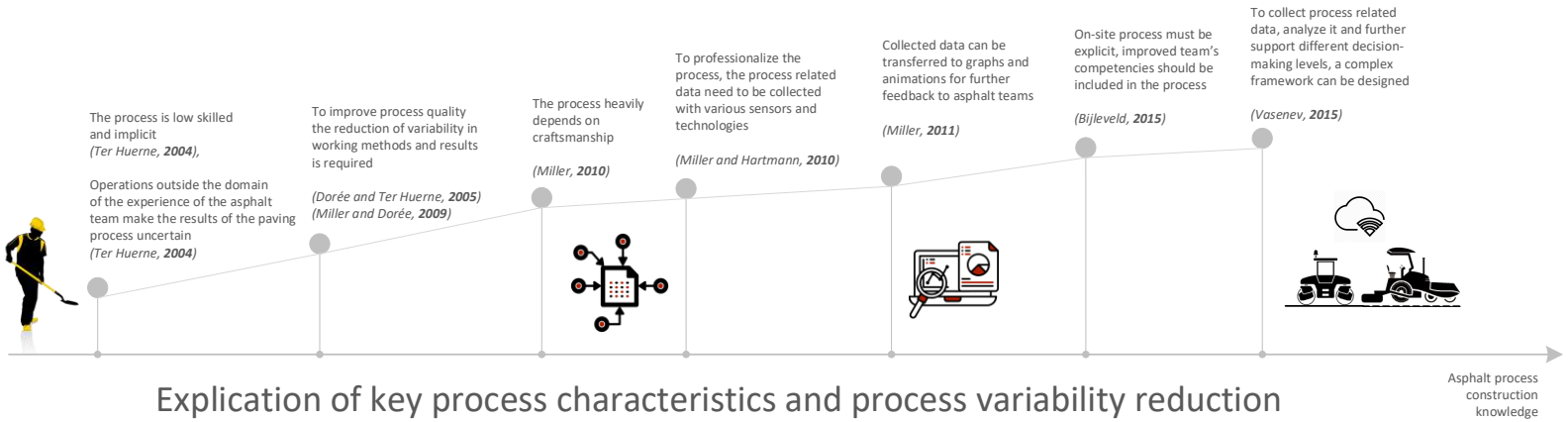
Semi-autonomous construction operations, disengaged control of machine operators

Level 4

Autonomous construction operations, disengaged monitoring of machine operators

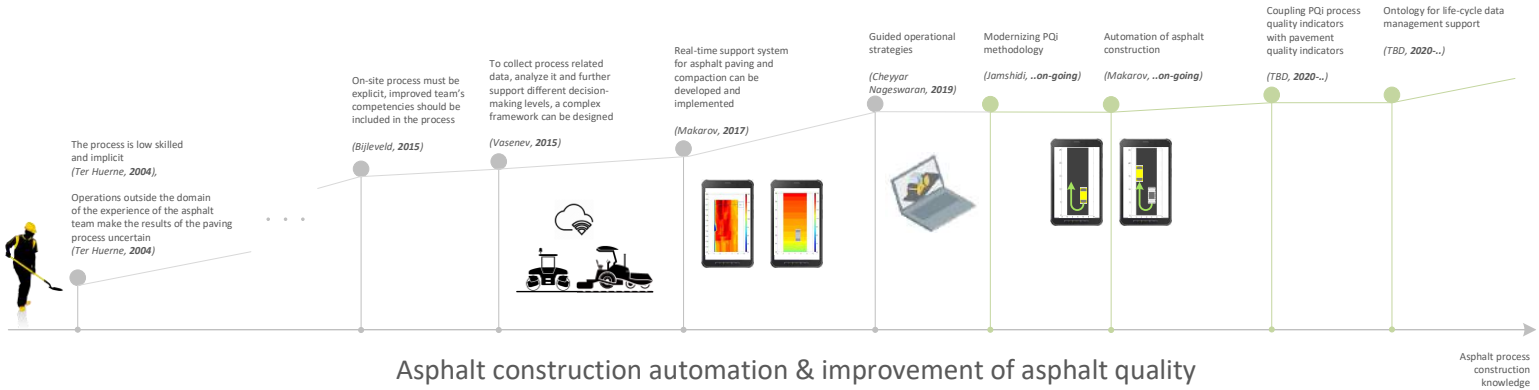
INTRODUCTION

ASPARI HISTORY



INTRODUCTION

ASPARI VISION



Asphalt construction automation & improvement of asphalt quality

INTRODUCTION

CURRENT PQI SYSTEM

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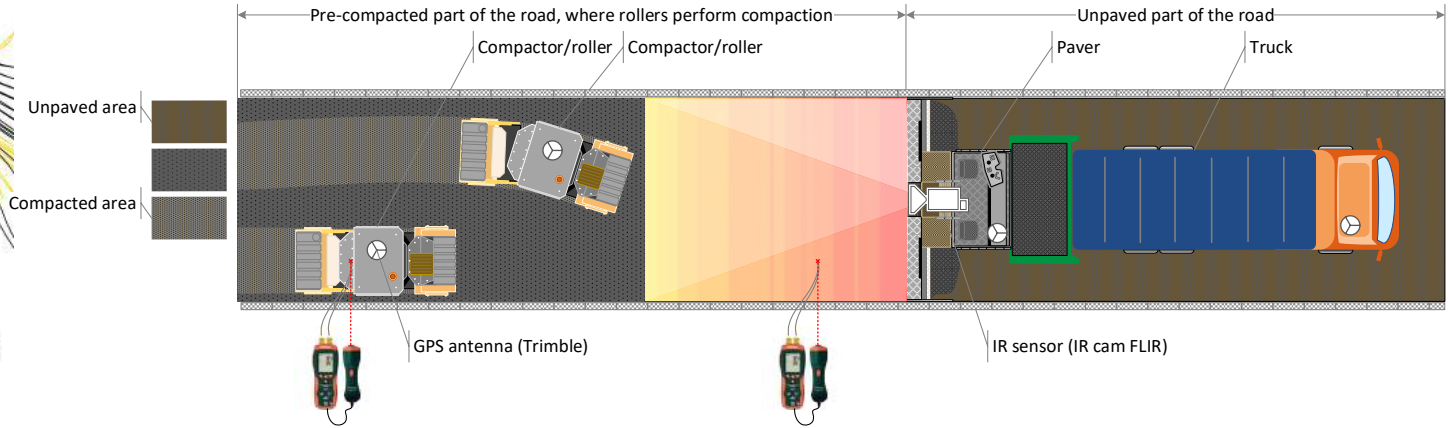

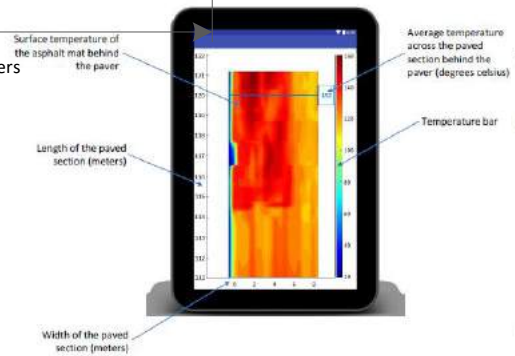

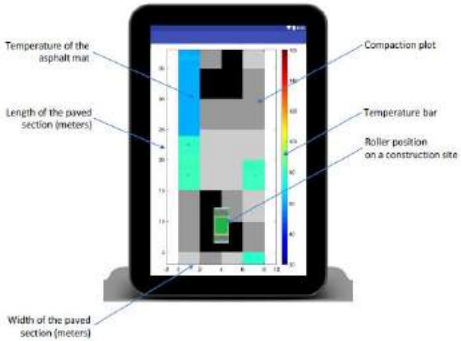

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CURRENT PROBLEMS

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- Offline → no stable assistance to operators in real time
- Interoperability issue → interoperability issue and sensor dependency
- Expensive → low technology penetration
- Cumbersome installation → low technology penetration

POSSIBLE SOLUTION

Modernizing Process Control system in pavement operations by:

- Develop real-time support structure of PQi measurement
- Develop data structure to achieve sensor independence, extensibility and scalability
- Explore and develop alternative solutions (i.e., sensors and methods) to enhance PQi methodology (cheaper, more accurate, more usable and less intrusive)

PROPOSED SYSTEM

ONTOLOGY/DATABASE

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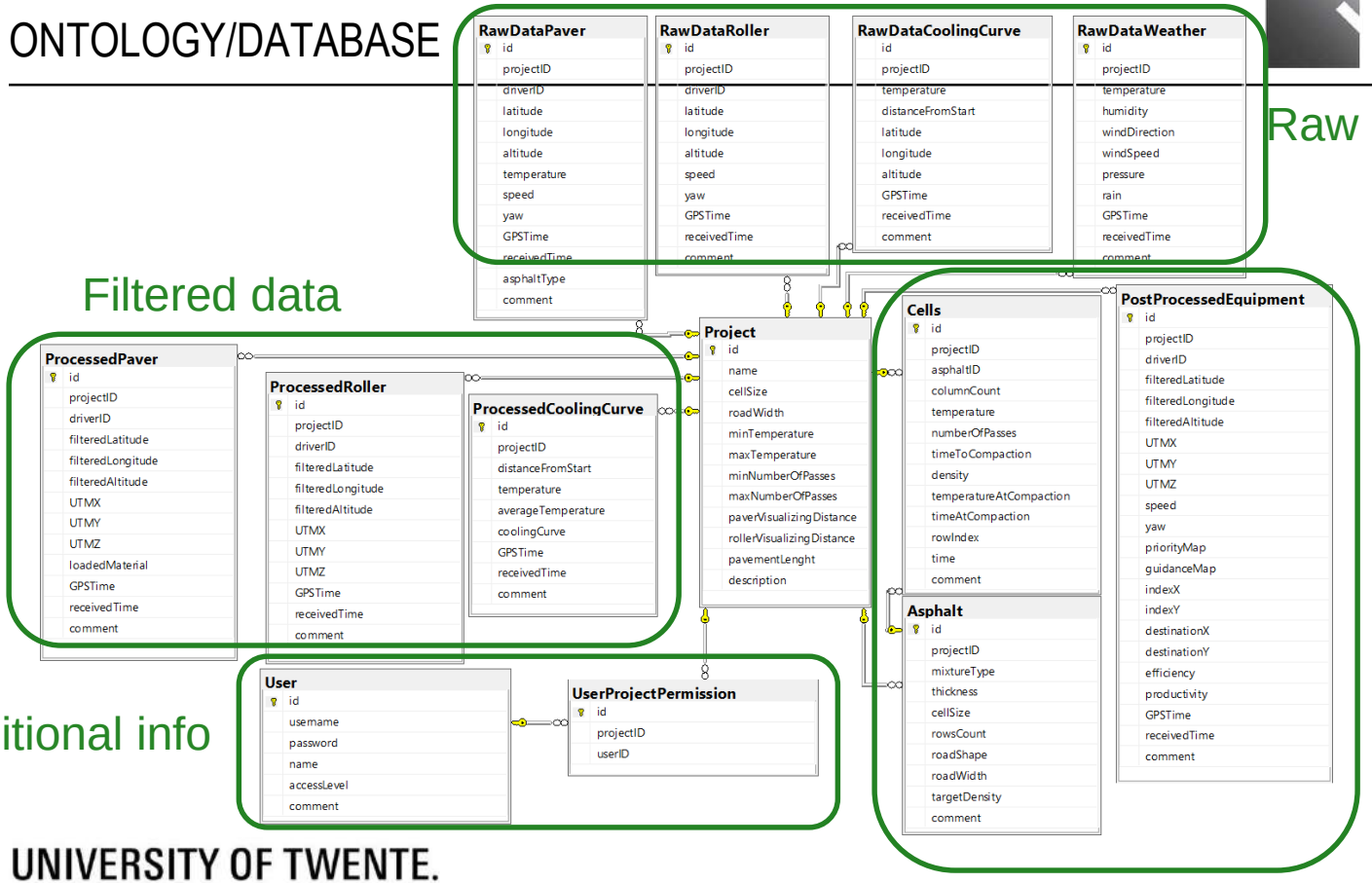
Raw data

Filtered data

Final output

Additional info



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PROPOSED SYSTEM

CONCEPTUAL DESIGN

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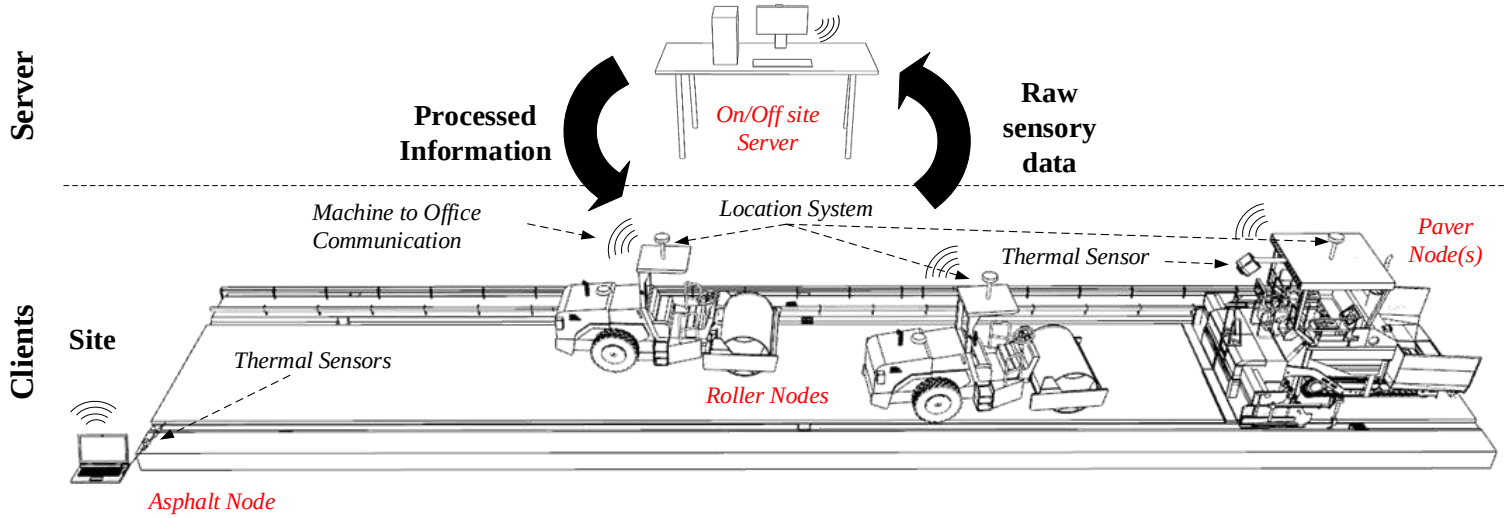
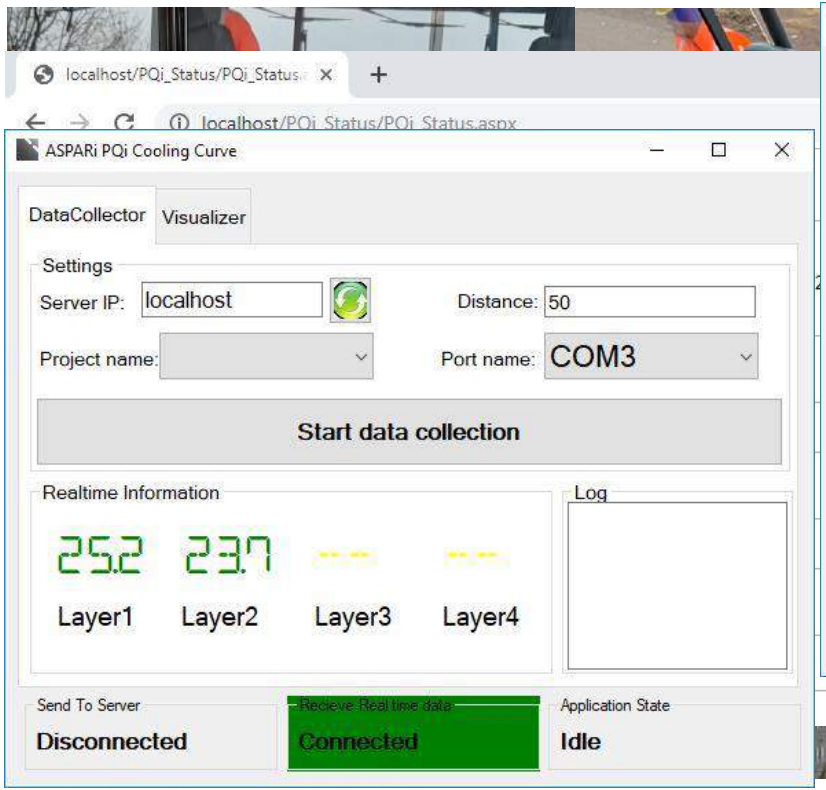
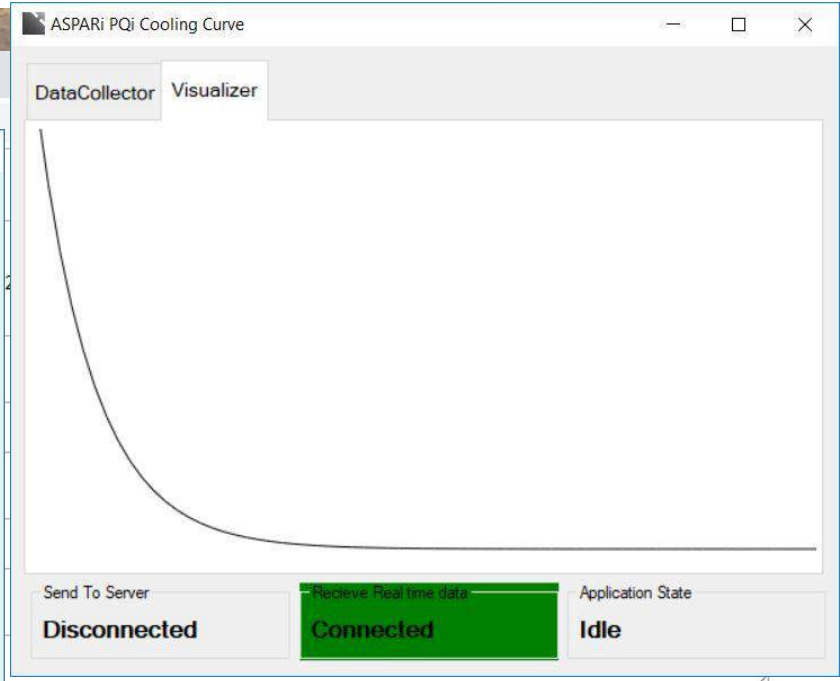
- Soft real time thin client server



PROPOSED SYSTEM

VISUALIZATION RESULTS





PROPOSED SYSTEM

LOCATION SENSOR ALTERNATIVES

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Sensor/device application	Option	Advantages	Disadvantages	Roughly estimated price (€)
Gathering equipment positioning on site (locations)	Drone with image processing solution	❖ Cheap to scale ❖ Can cover a big area	❖ Capacity of drone's battery ❖ Necessity in operator ❖ Site's preparation before drone's usage during construction activities	5.000
	Ublox	❖ Cheap	❖ Low accuracy	100
	BLE	❖ Cheap ❖ Possible usage in tunnels and dense areas	❖ Low accuracy in distances more than 5 meters ❖ Site's preparation before usage during construction activities	5
	Ultra-wide band	❖ Possible usage in tunnels and dense areas	❖ Low accuracy ❖ Complex synchronization between sensors	
	Lidar	❖ High accuracy	❖ Expansive	10.000
	DGPS	❖ High accuracy ❖ Ready for application	❖ Expansive ❖ Low accuracy in dense areas	5.000
	RTK	❖ High accuracy ❖ Ready for application	❖ Expansive ❖ Necessity of RTK server ❖ Low accuracy in dense areas	7.000

PROPOSED SYSTEM

TEMPERATURE SENSOR ALTERNATIVES

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Sensor/device application	Option	Advantages	Disadvantages	Roughly estimated price (€)
Obtaining asphalt surface temperatures	Temperature line scanner (paver)	❖ High accuracy	❖ Expansive ❖ Complex installation procedure	50.000
	IR thermal camera (paver)	❖ Cheap	❖ Can only measure initial temperatures due to restricted field of view (by the predefined mounting place on a paver)	7.000
	IR thermal camera (drone)	❖ Cheap ❖ Can measure wider area of asphalt layer with changes of surface layer temperatures in real-time	❖ Capacity of drone's battery ❖ Necessity in operator	2.000
Obtaining asphalt core temperatures	Thermocouple	❖ Cheap	❖ Laborious setup and re-setup during construction activities	50
	Fiber optic	❖ Can capture data after pavement finished	❖ Hard to install ❖ Expansive	10.000
Machine 2 machine communication	WIFI	❖ No extra payments for usage	❖ Small coverage area	200
	GSM	❖ Large coverage	❖ Monthly fees according to the data usage	500

PROPOSED SYSTEM

DRONE RESULTS

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- Demo

DISCUSSION

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PROMOTEN CIVIELE TECHNIEK IN HET MBO

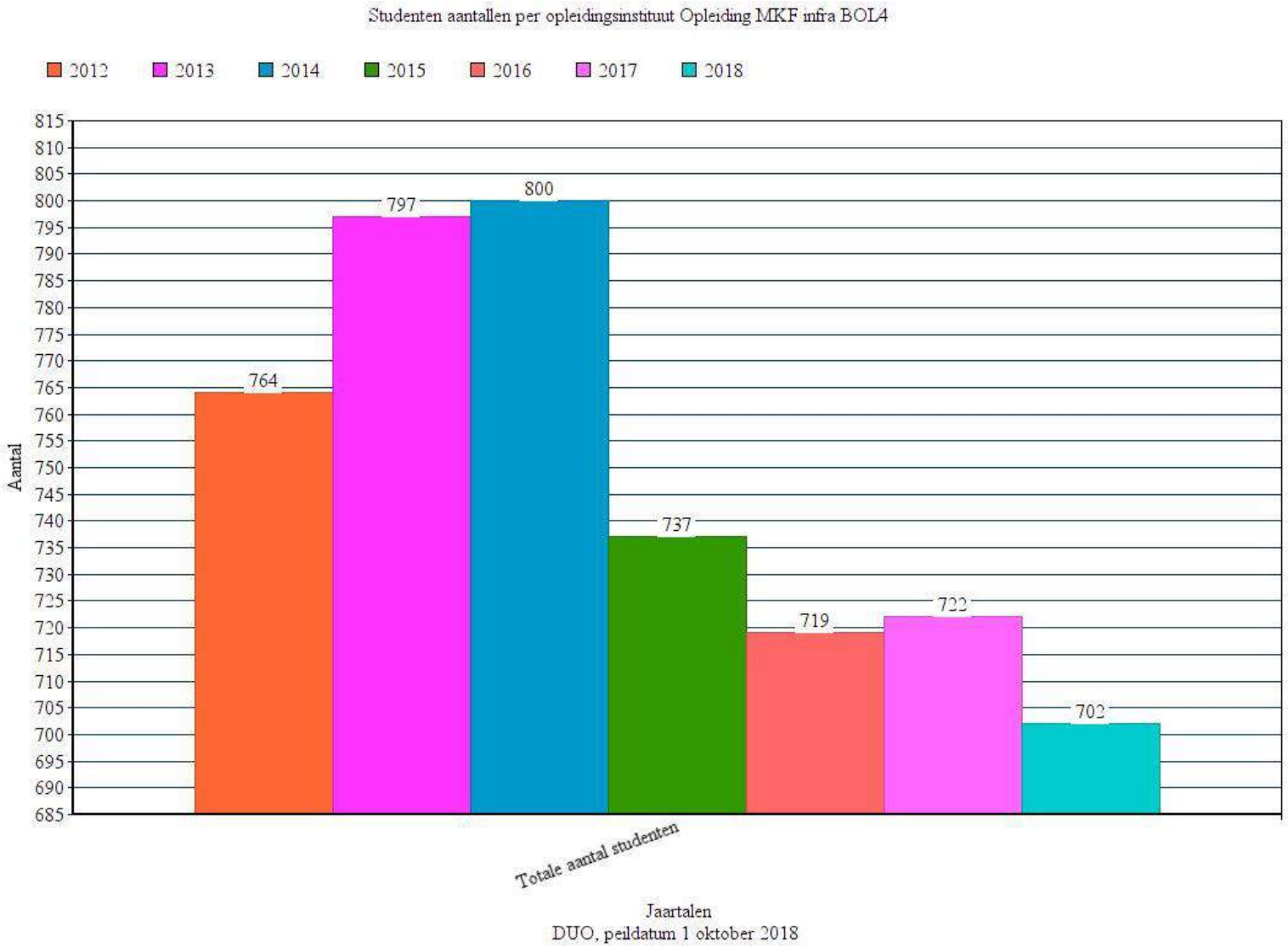
JANINE PROFIJT – ONDERWIJSKUNDIGE

INLEIDING

- Aanleiding
- Hoofd- en deelvragen
- Aspecten die een rol spelen
- Initiatieven promotie
- Acties die bijdragen
- Conclusie
- Keuzedeel

AANLEIDING

- Nieuw onderwijs ontwikkeld
- Studenten aantallen versus Werkgelegenheid
- Verantwoordelijkheid



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HOOFD- EN DEELVRAGEN

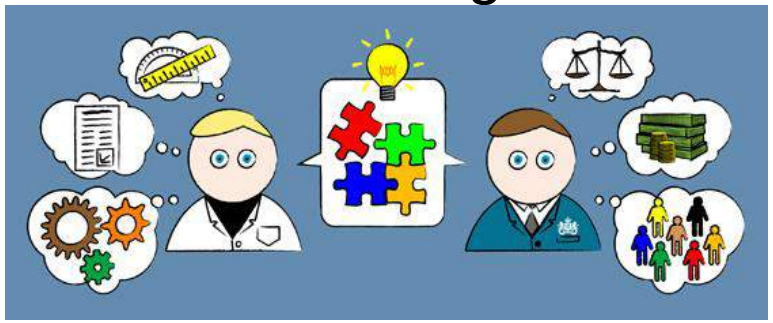
Hoe zorgen de infrasector en het onderwijs ervoor dat de mbo opleidingen op het gebied van civiele techniek een hogere aanmeldingspercentage krijgen?

1. Welke aspecten spelen een rol bij het kiezen van een studie voor jongeren tussen de 14-16 jaar?
2. Welke initiatieven op het gebeid van promotie van het vak en de opleidingen zijn er geweest of spelen nu?
3. Welke acties kunnen in de toekomst bijdragen aan het verhogen van het aantal studenten die kiezen voor de opleidingen in civiele techniek

ASPECTEN DIE EEN ROL SPELEN

1. Economische modellen

2. Statusverwerkingsmodellen



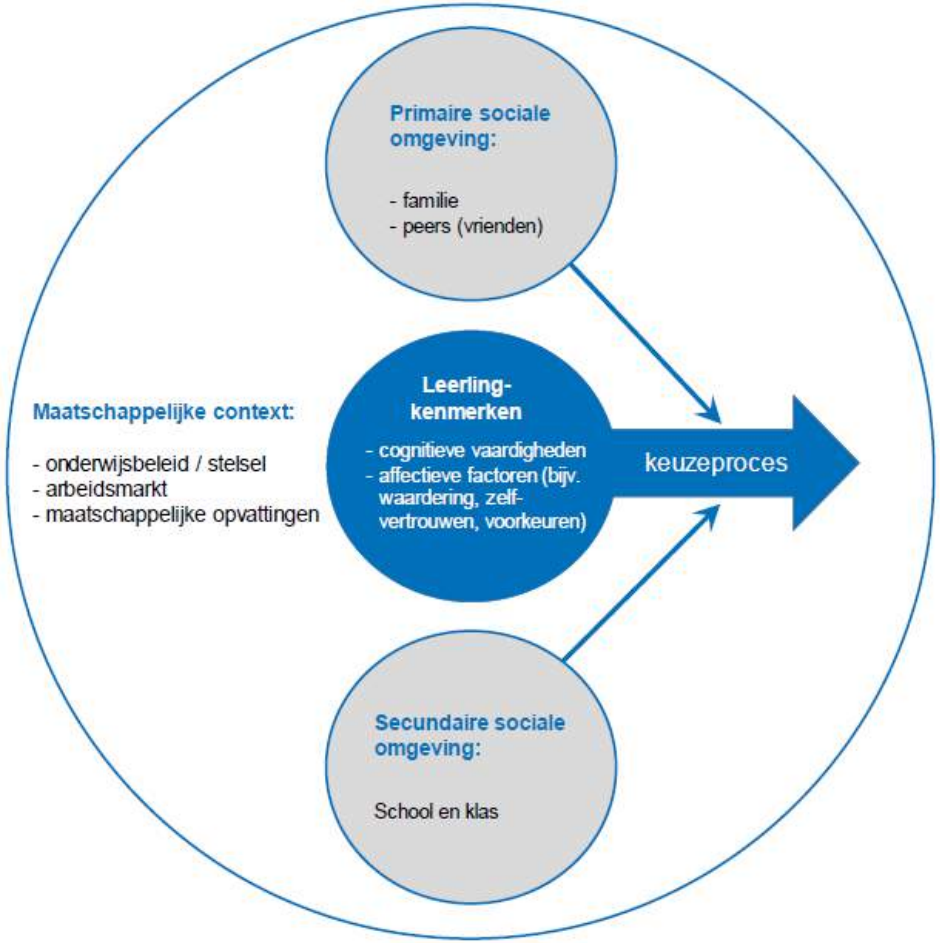
3. Combinatiemodellen

ASPECTEN DIE EEN ROL SPELEN

Combinatie model 1

- Individuele kenmerken
- Contextuele kenmerken
- Kenmerken van de school
- Karakter eigenschappen school

COMBINATIEMODEL 2



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ASPECTEN DIE EEN ROL SPELEN

- Interesse in vakgebied
- Carrièreperspectief
- Beïnvloeding door anderen
- School
- Locatie (Van der Ploeg, 2016)

- Open dagen + studie informatie

INITIATIEVEN

- Instellingen en instanties
  - Bv jegaathetmaken
- Techniekpact
- Opleidingsbedrijven
- Mbo scholen
- RIF
- Aannemers
- Samenwerkingsverbanden
- Samenwerken tussen docenten
- Promotiefilm
- Conclusie: vaak geen samenwerking tussen scholen, bedrijven en overheid

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WELKE ACTIES KUNNEN BIJDRAGEN?

- Teksten standaardiseren op websites
- Decanen informeren
- Open dagen
- Meer samenwerking tussen bedrijven, scholen en de overheid
- Onderwijsontwikkeling

CONCLUSIES

Hoe zorgen de infrasector en het onderwijs ervoor dat de mbo opleidingen op het gebied van civiele techniek een hogere aanmeldingspercentage krijgen?

- Samenwerking bedrijven, scholen en overheid
- Initiatieven delen
- Decanen informeren
- Open dagen
- Informatie op websites

KEUZEDEEL INNOVATIES IN DE ASFALTWEGENBOUW

- Producten gereed
  - basis
  - keuzedeel

- Examen voor niveau 2/3 en niveau 4
- Toekomstgericht
- Afronden januari-februari

VRAGEN/OPMERKINGEN

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OUTREACH ACTIVITEITEN IN 2019

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Opdrachtgeversdag 2019
& High Tech, Low Cost project

CAPSA 2019 in Zuid Afrika

ISARC 2019, Banff, Canada

Aachener Straßenbau- und Verkehrstage 2019

Donnerstag
21/11/2019

Eröffnung der Fachausstellung

11:00 Uhr *Eröffnung der begleitenden Fachausstellung*

Begrüßung

12:00 Uhr *Dipl.-Ing. Winfried Krux*
Forschungsvereinigung SETAC e. V.

Univ.-Prof. Dr.-Ing. habil. Markus Oeser
Institut für Straßenwesen, RWTH Aachen University

Zukunftsweisende Bauprozesse

Moderation: *LRDir Dr.-Ing. Lutz Pinkofsky*
Bundesanstalt für Straßenwesen (BASt)
Bergisch Gladbach

12:15 Uhr **Wie ist die Effizienz? Kommunikation und Data Science für die Baustelle von Morgen**
Johannes Lipp, M.Sc.
Lehrstuhl für Informationsmanagement im Maschinenbau
RWTH Aachen University

12:40 Uhr **Prozesssicherheit im Asphaltbau (und CO^2-Reduzierung) durch innovative Technik**
Dipl.-Ing. Martin Fliegl
Fliegl Bau- und Kommunaltechnik GmbH
Mühldorf an der Inn

13:05 Uhr **Asphalt Process Control - Digitalization and Lessons learnt in the Netherlands**
Dr. ir. Seirgei Miller
University of Twente
Enschede (Niederlande)

13:30 Uhr **Diskussion**

13:45 Uhr **Kaffeepause**

Neue Bauweisen - von der Innovation in die Praxis

Moderation: *Univ.-Prof. Dr.-Ing. habil. Markus Oeser*
Institut für Straßenwesen
RWTH Aachen University

14:20 Uhr **Praktische Umsetzung von PU-Asphalt**
Dipl.-Ing. Lukas Renken
ISAC GmbH
Aachen

14:45 Uhr **Asphalteinlagen für die Straßensanierung - Regelwerk sowie Möglichkeiten und Grenzen bei Planung und Verwendung**
Dipl.-Ing. Lars Kodritsch

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Moderation: *Dipl*
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15:25 Uhr *Jon*
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15:30 Uhr *Ale*
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15:40 Uhr **Ka**

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16:10 Uhr **Rhe**
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16:35 Uhr **Ger**
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17:25 Uhr **Dis**

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17:40 Uhr **Bau**
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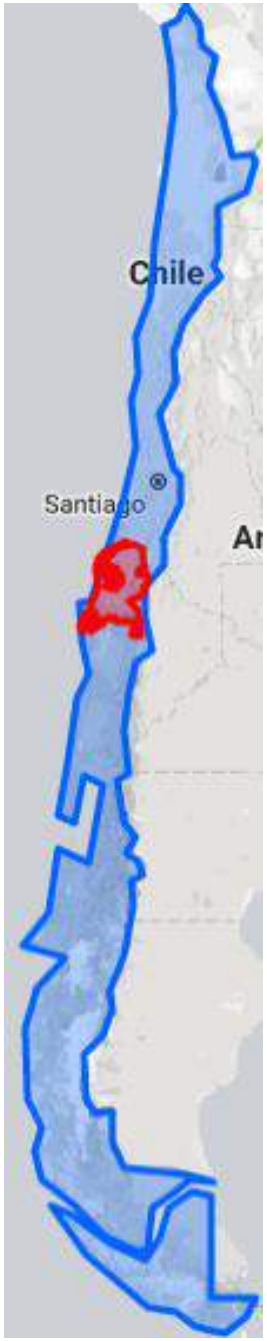
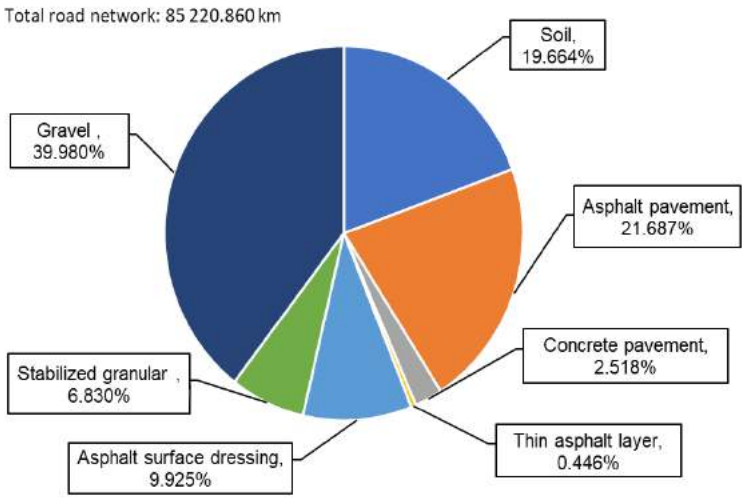
19:30 Uhr AB

ASPARi in Chili





Chilean Highway Agency, 2017

Importance of improvement the quality of low-volume roads

Experimentation with Drone

Continuous improvement

Trucks logistics

Establishing optimal compaction strategies

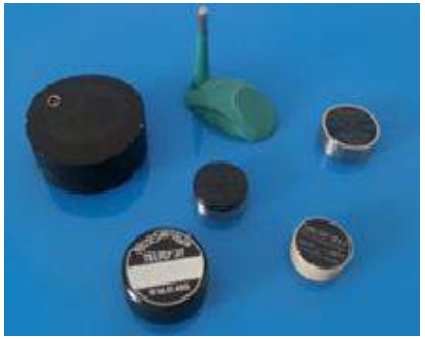
Different weather conditions and geometries (hills & curves)

Active work with the asphalt crew

As a result currently we have:

Enthusiasm of the authority

New phase → incorporating asphalt surface dressings



RWS WORKSHOP

ERVARINGEN MET SENSOREN IN ASFALT … EEN PRAKTISCHE BENADERING

In de toekomst

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