

# UNIVERSITY OF TWENTE.

## SPOEDPOST COMPUTERSIMULATIE

MARTIJN KOOT



5 OCTOBER 2019



## ► Ziekenhuis wil spookbeeld zoals in Randstad voorkomen

# MST zet meer artsen in voor spoedeisende hulp

Om te voorkomen dat de spoedpost van ziekenhuis MST overvol raakt, files in de wachtkamer ontstaan en patiënten moeten overnachten, omdat ze nergens anders terecht kunnen, krijgen de artsen op de spoedeisende hulp in Enschede versterking.

Josien Kodde  
Enschede

Sinds gisteren springen dagelijks een chirurg en een internist bij. Het spookbeeld dat in sommige ziekenhuizen in de Randstad al realiteit is, wil MST voorkomen. Een dichtslibbende spoedpost, urenlang wachten in de wachtkamer of nog erger: een tijdelijke opvangstop. Zo'n stop is zelfs onmogelijk, omdat MST de officiële sta-

tus van 'level 1 traumacentrum' heeft. Dat betekent dat verkeersslachtoffers met ernstig verkeersletsel of ander trauma in het ziekenhuis in Enschede terecht moeten kunnen. Simpelweg, omdat dit het enige traumacentrum in de regio is.

„De druk op onze spoedpost is groot”, zegt Bert Beishuizen. Hij is medisch manager acute zorg. Het aantal patiënten dat dagelijks binnenkomt - een kleine honderd - is niet veel gegroeid ten opzichte van vijf jaar terug. „Maar de complexiteit is wel vele malen groter.” Zo groot, dat sinds gisteren een driemanschap de leiding krijgt. Op werkdagen van 11.00 tot 19.00 uur, de drukste uren, zijn behalve de arts ook een internist en een chirurg permanent aanwezig. „Tot 1

oktober kon de arts van de spoedeisende hulp twee collega's oproepen als dat nodig was. Maar vanaf nu zijn ze permanent en exclusief toegevoegd aan de bezetting van de spoedeisende hulp”, zegt bedrijfskundig manager Heidi Pot-Witbreuk.

### Traumapatiënten

De nieuwe werkwijze moet de wachttijd bekorten. Nu komt het voor dat bezoekers meer dan twee uur in de wachtkamer zitten. Dat zijn patiënten die niet direct hulp nodig hebben. Het leidt soms tot onbegrip. De reden van de lange wachttijd is dat traumapatiënten altijd voorgaan.

Een tweede reden waarom MST de capaciteit uitbreidt, is dat dit zorgt voor nog betere medische

zorg. Met name voor kwetsbare ouderen die aan meerdere ziekten lijden. De 65-plussers vormen ongeveer een kwart van de populatie op de spoedpost.

„Als de dokters gezamenlijk, maar ieder vanuit hun eigen specialisme, naar de patiënt kijken, is een betere en meer complete diagnose te stellen. Je voorkomt dat de oudere zijn verhaal vaker moet vertellen”, aldus Pot.

De nieuwe werkwijze is vorig jaar twee maanden in een proef getest. Die verliep zo goed, dat is besloten hiermee door te gaan. De extra personeelskosten worden voor de helft door het ziekenhuis betaald. De andere helft betaalt het medisch stafbestuur. Dit bestuur van de medisch specialisten is zelfstandig en heeft een eigen budget.

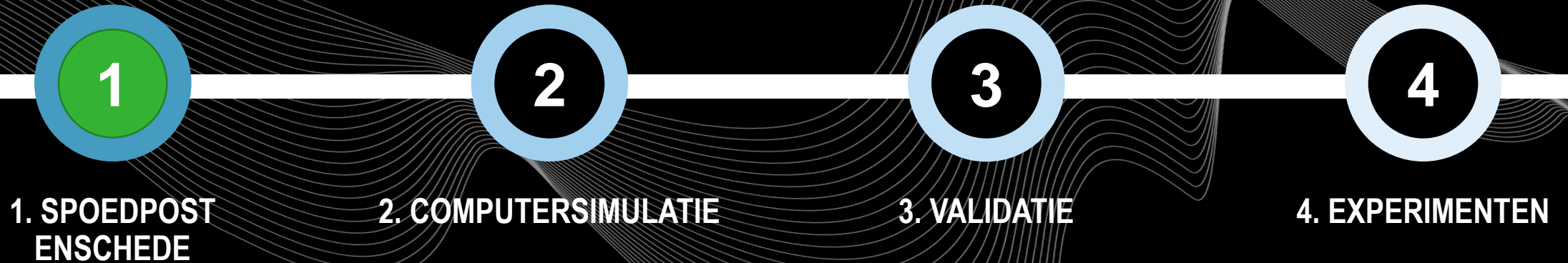


Een mobiele 'wasstraat' voor honden

► Pagina 6

In hartje Hengelo staat bijna 1 op de 3 winkels leeg

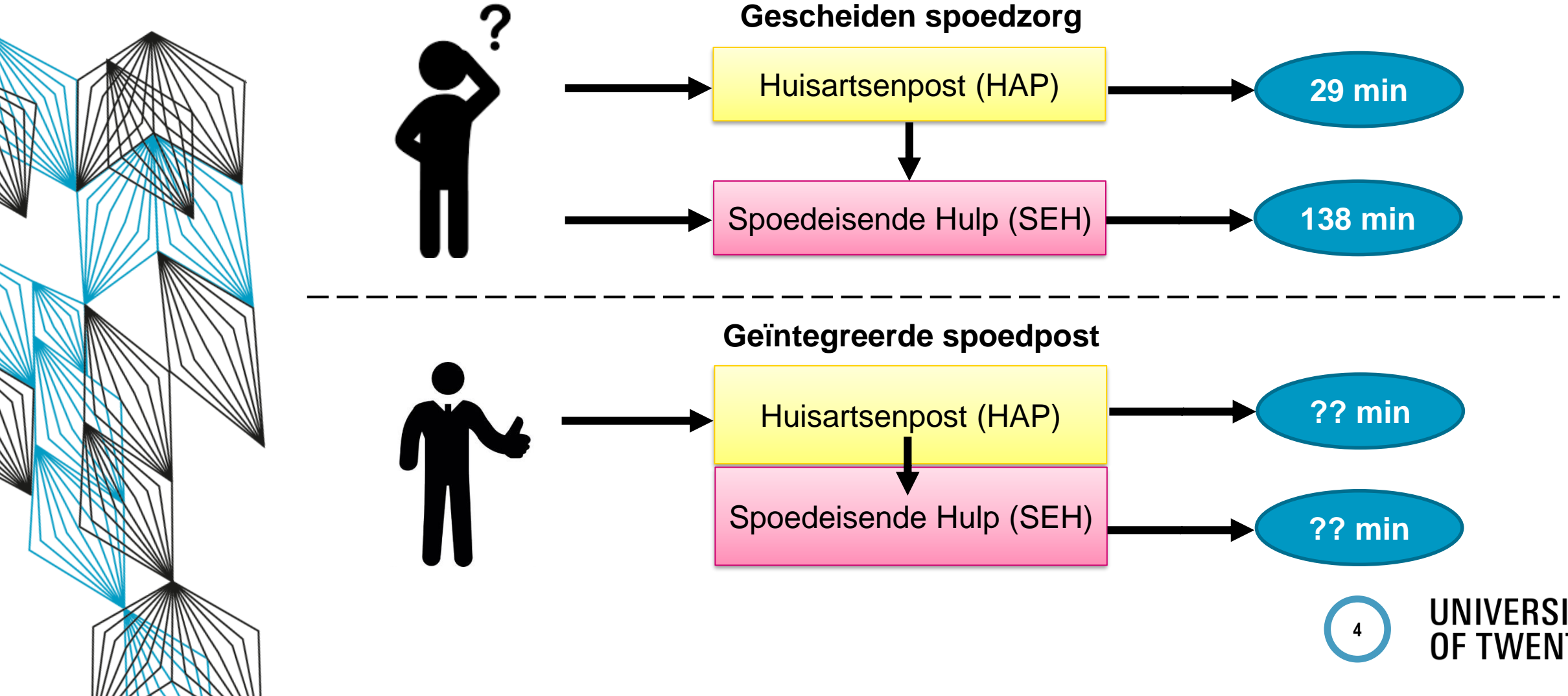
# IN THIS PRESENTATION:





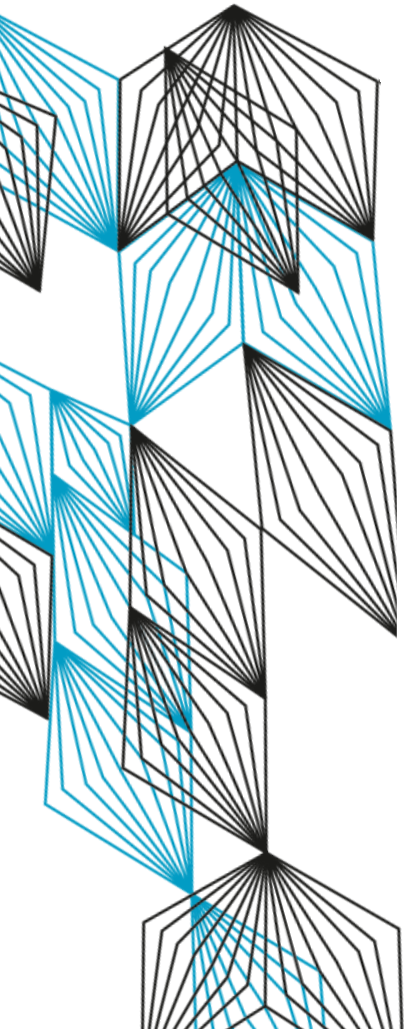
# 1. SPOEDPOST ENSCHEDE

## A. HET PROBLEEM VAN ZELFVERWIJZERS



# 1. SPOEDPOST ENSCHEDE

## B. DE NIEUWE SPOEDPOST



*c) Hoofdingang nieuwe ziekenhuis*

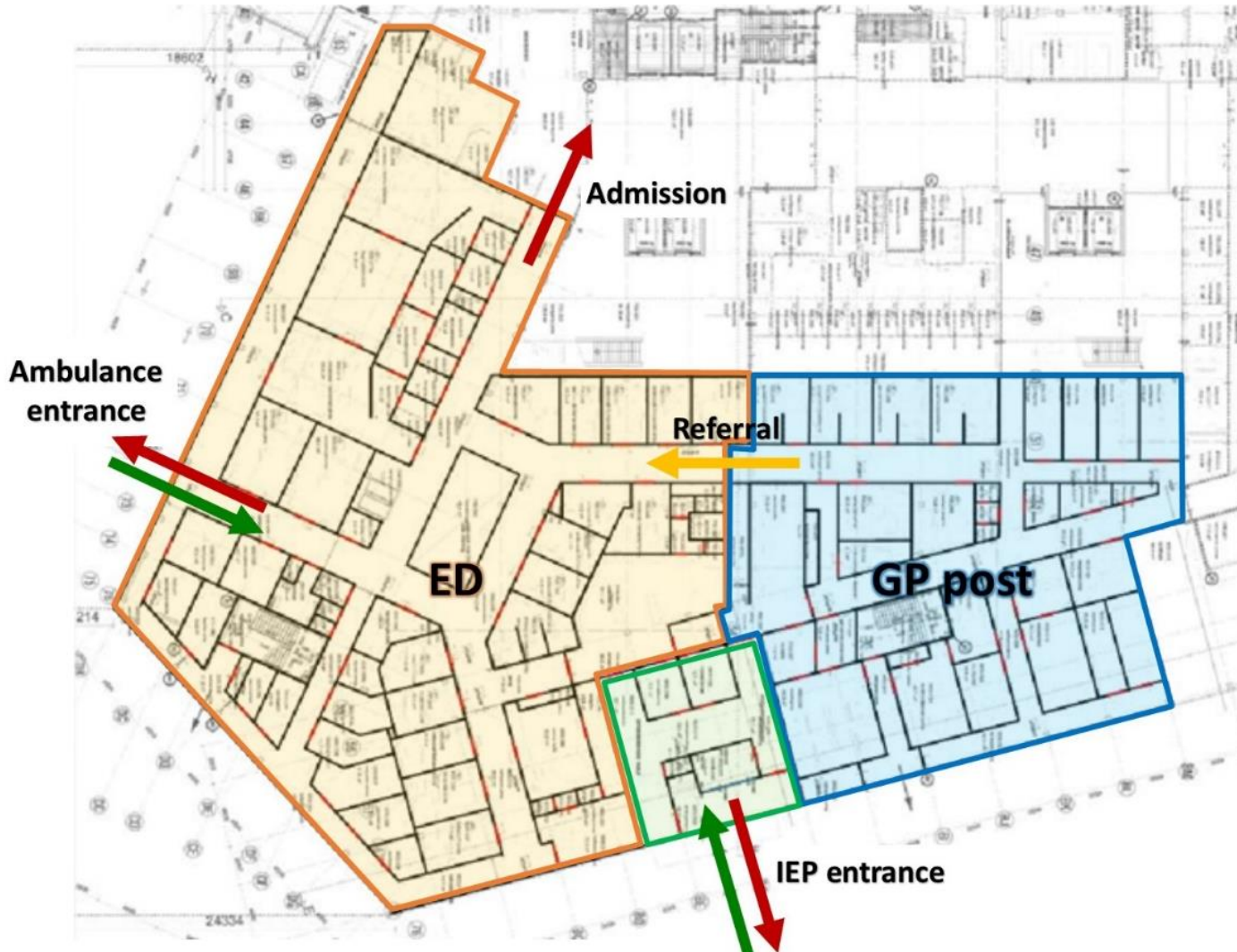


*d) Speedpost ingang, inclusief HAP en SEH.*



# 1. SPOEDPOST ENSCHEDE

## B. DE NIEUWE SPOEDPOST



### HAP instroom:

- Telefonisch
- Zelfverwijzer

### SEH instroom:

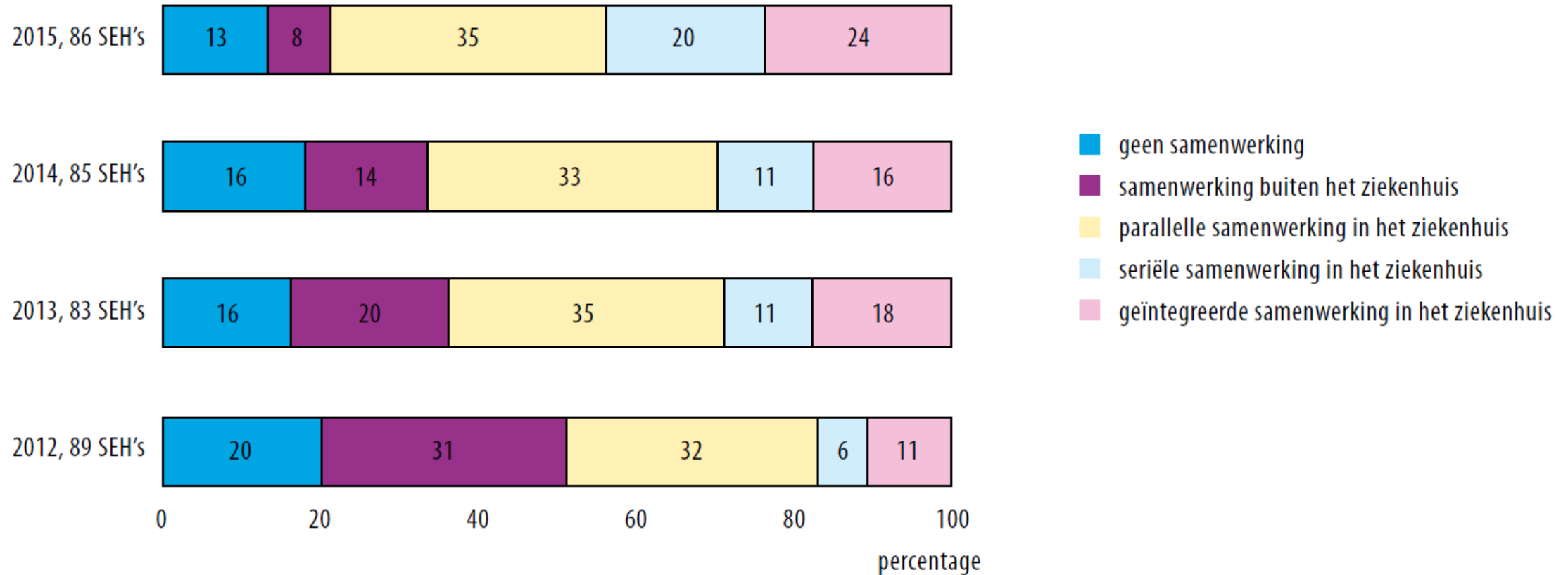
- Externe verwijzer
- HAP verwijzer
- (Zelfverwijzer)

### Uitstroom:

- Ziekenhuisopname
- Huis

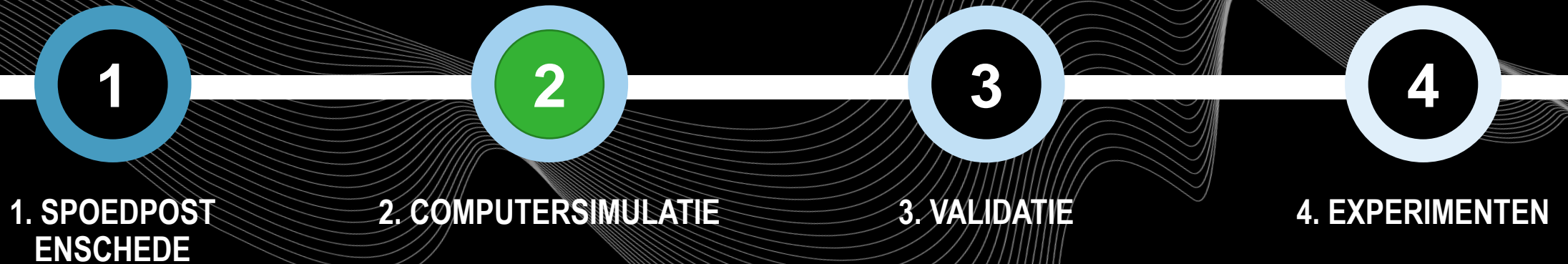
# 1. SPOEDPOST ENSCHEDE

## C. VERSCHILLENDE SAMENWERKINGSVORMEN



**Bron:** Gaakeer, M. I., Gips, E., Huijsman, R., Veugelers, R., & Patka, P. (2016). National developments in emergency departments in the Netherlands: numbers and origins of patients in the period from 2012 to 2015. *Nederlands tijdschrift voor geneeskunde*, 160, D970-D970.

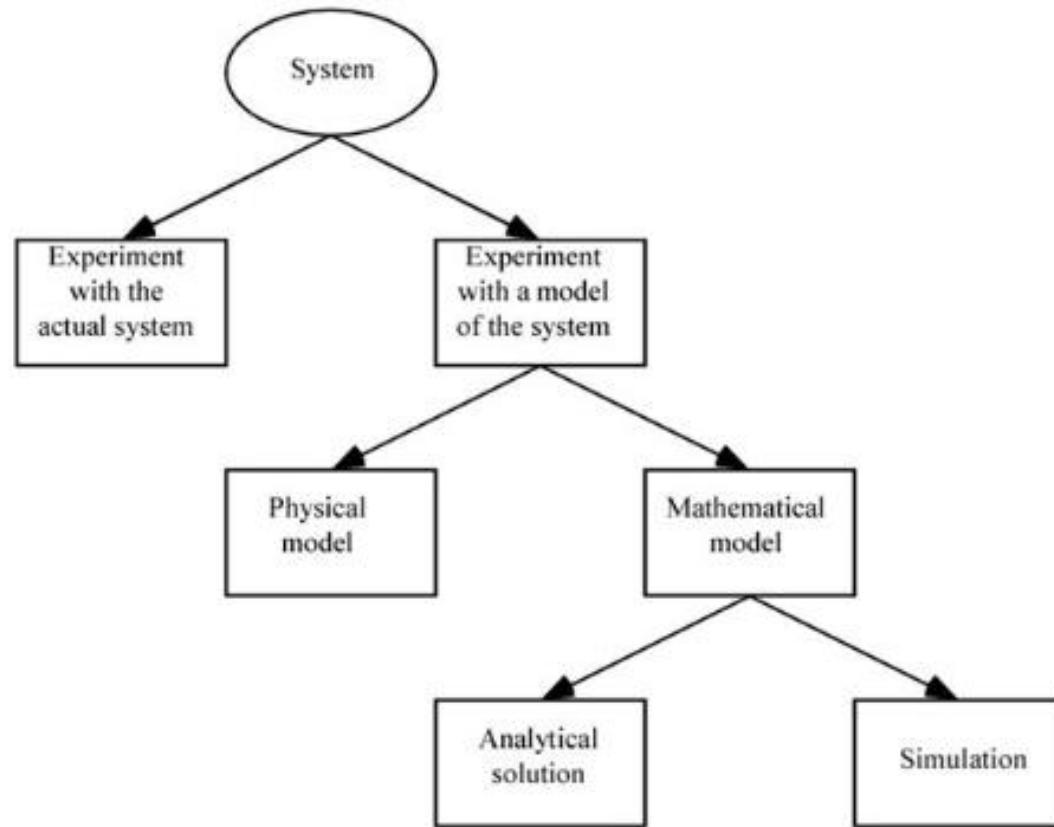
# IN THIS PRESENTATION:





# 2. COMPUTERSIMULATIE

## A. SYSTEM ANALYSIS



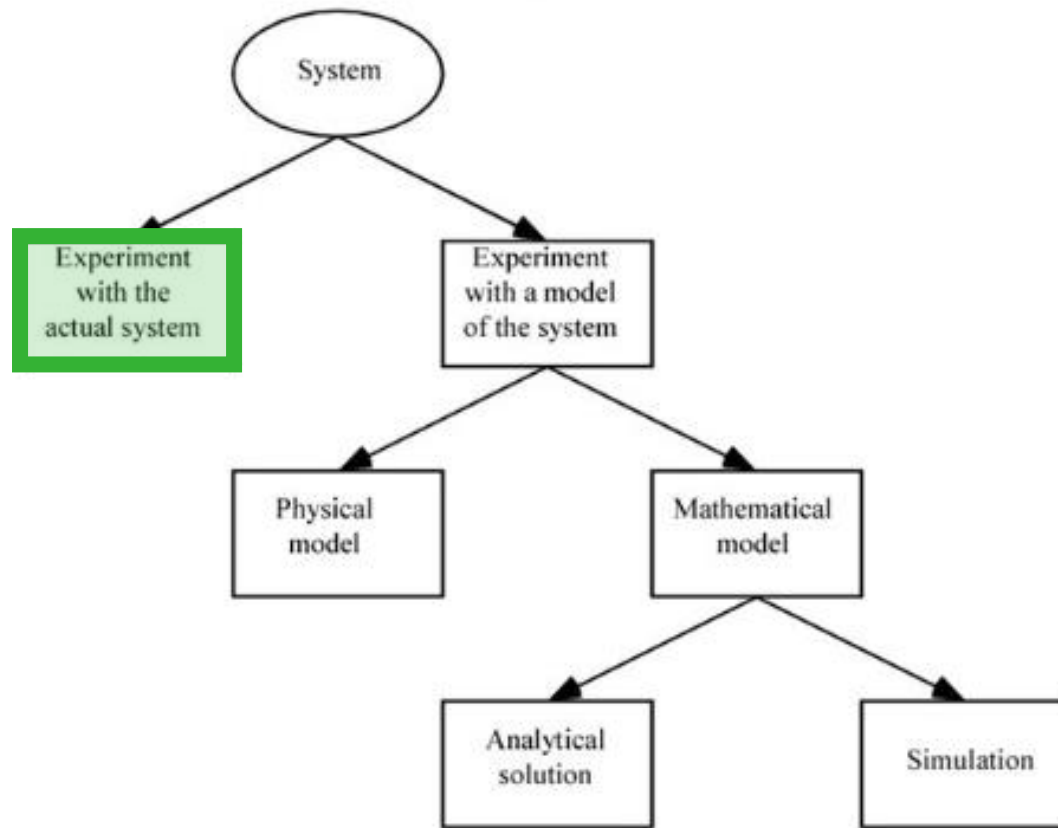
### System definition (Law, 2015):

*“A system is defined to be a collection of entities, e.g., people or machines, that act and interact together toward the accomplishment of some logical end”.*

Bron: Law, A. M. (2015). *Simulation Modeling and Analysis (5th ed.)*. New York: McGraw-Hill Education.

# 2. COMPUTERSIMULATIE

## A. SYSTEM ANALYSIS



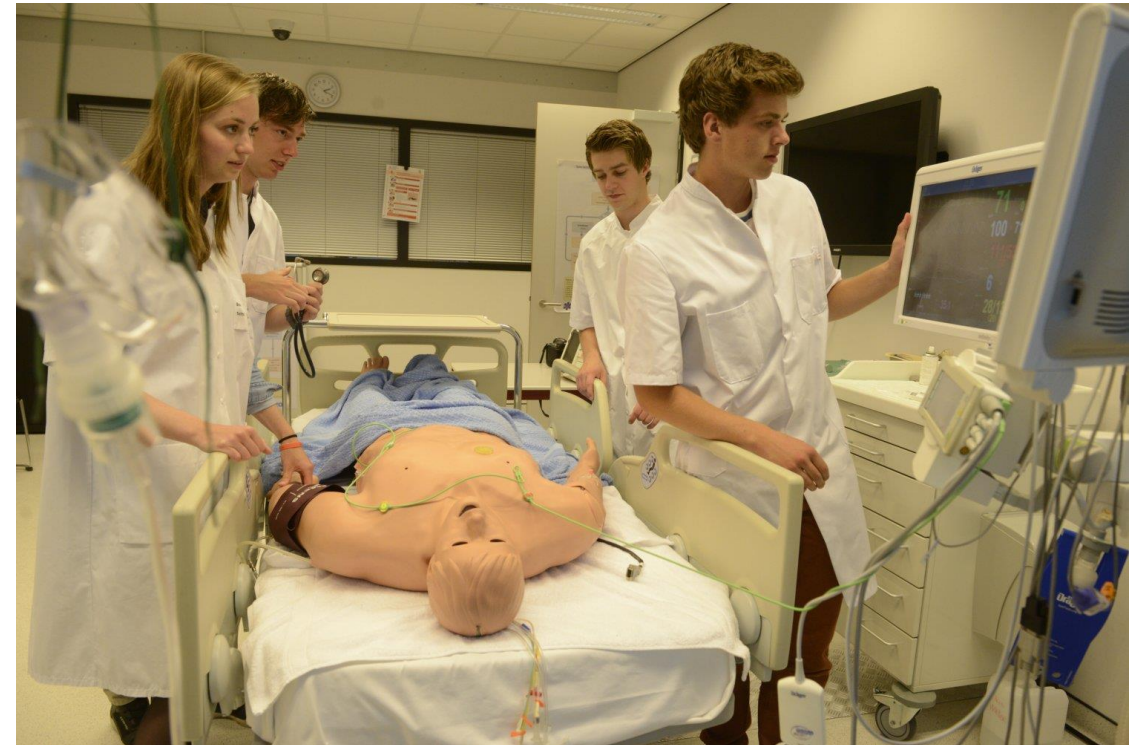
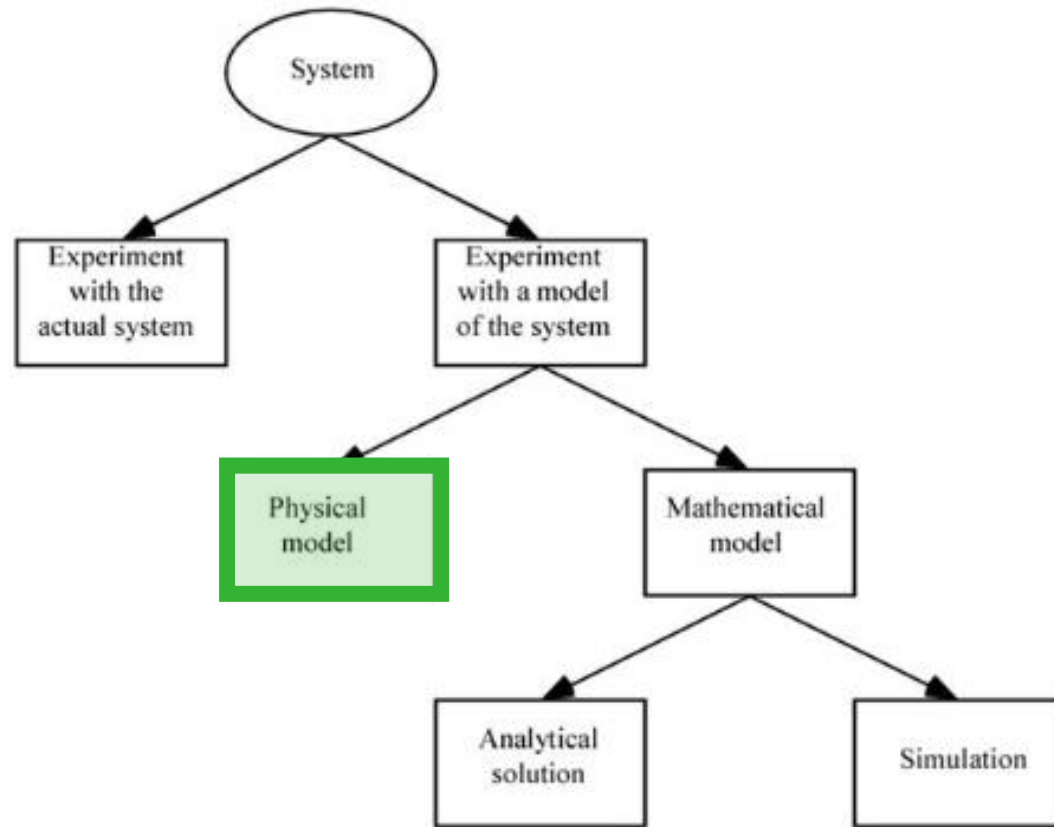
Bron: Law, A. M. (2015). *Simulation Modeling and Analysis (5th ed.)*. New York: McGraw-Hill Education.





# 2. COMPUTERSIMULATIE

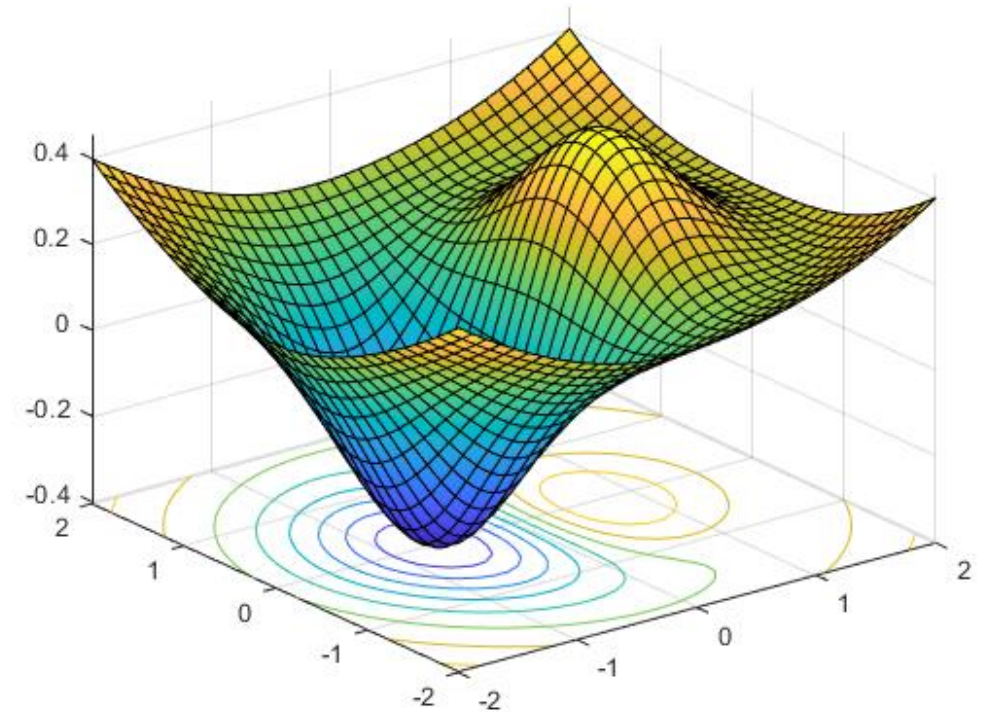
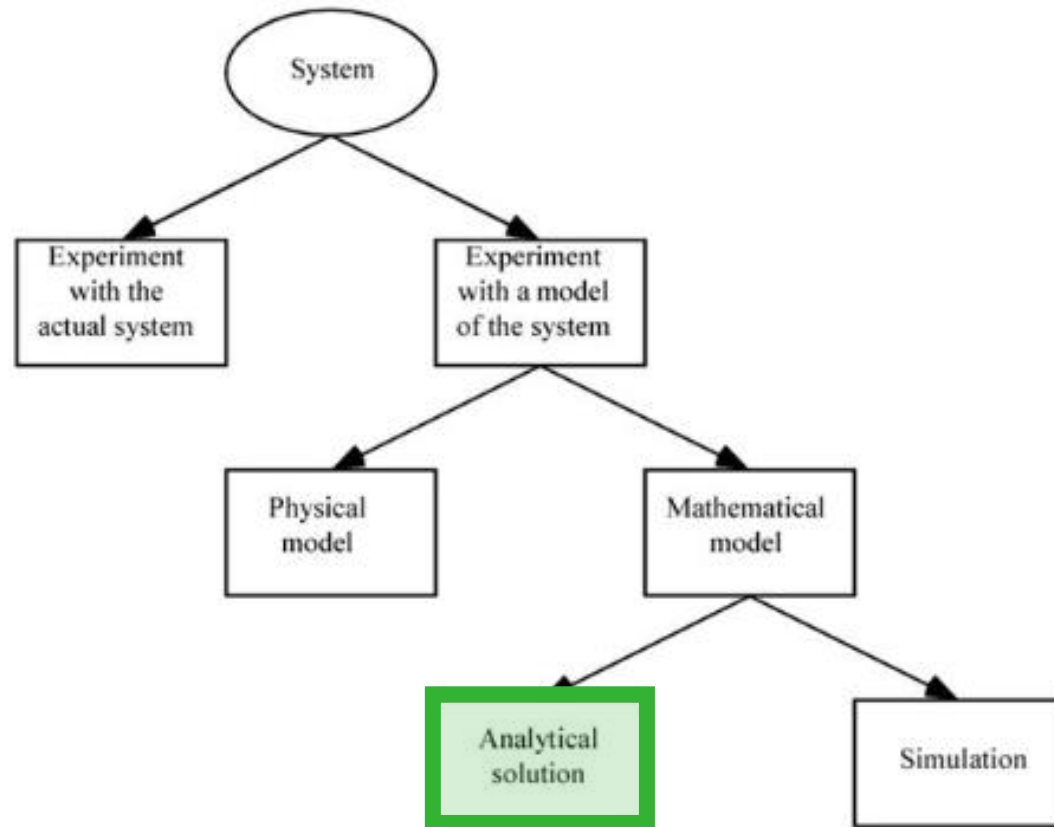
## A. SYSTEM ANALYSIS



Bron: Law, A. M. (2015). *Simulation Modeling and Analysis (5th ed.)*. New York: McGraw-Hill Education.

# 2. COMPUTERSIMULATIE

## A. SYSTEM ANALYSIS

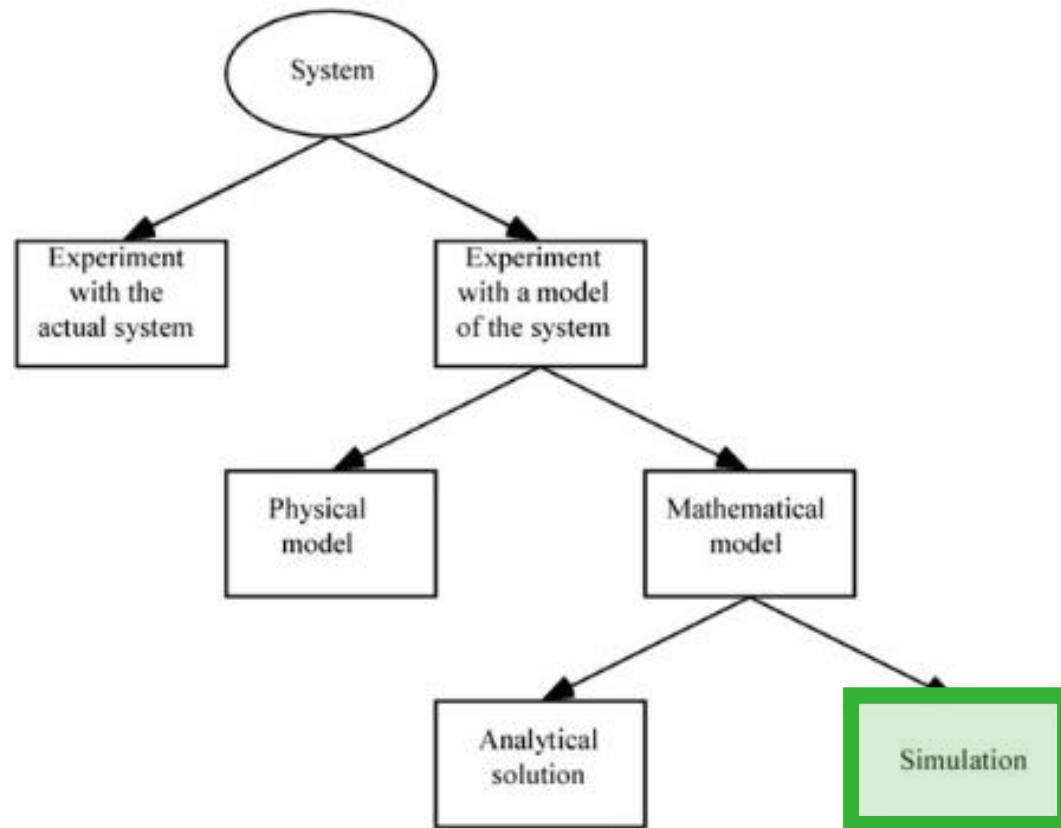


Bron: Law, A. M. (2015). *Simulation Modeling and Analysis (5th ed.)*. New York: McGraw-Hill Education.



# 2. COMPUTERSIMULATIE

## A. SYSTEM ANALYSIS

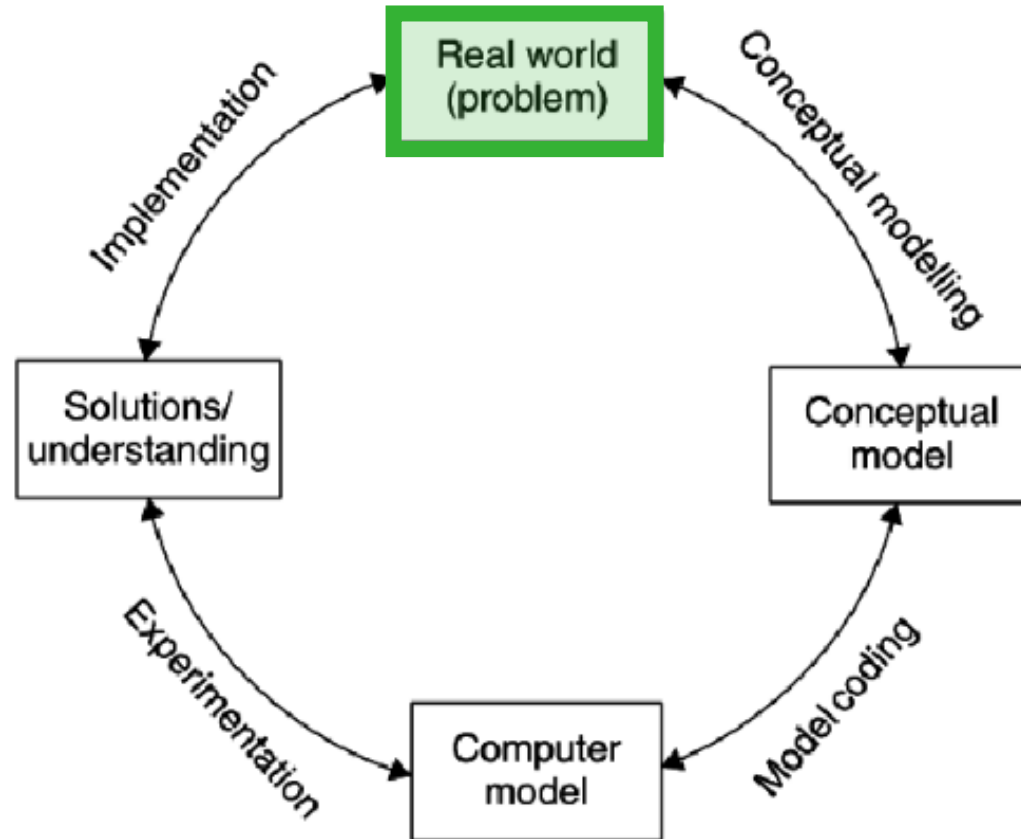
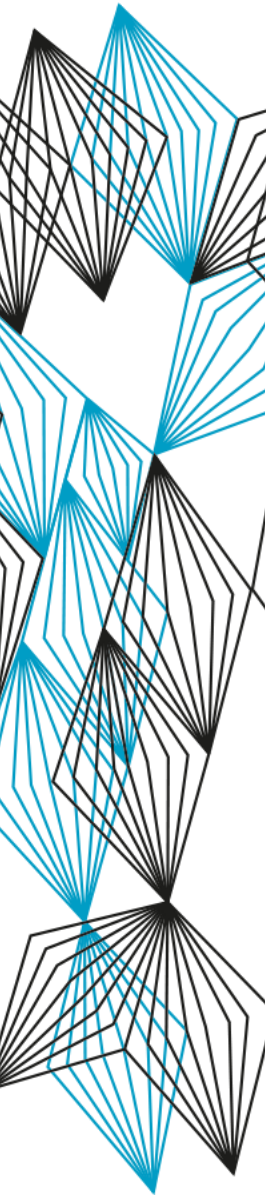


The image shows a simulation interface for a hospital. On the left is a detailed floor plan of a hospital building with various rooms and corridors. On the right are two control panels. The top panel, titled 'Simulation statistics', displays 'Main KPIs' such as ARRIVALS\_TOTAL=0, LOS\_TOTAL=0.0000, and GPpostOpened=true. The bottom panel, titled 'Experimental factors', lists various simulation parameters and their settings, such as 'Urgency priority: 10:00 minutes' and 'Patient frequency: Allow U1 patients only'.

Bron: Law, A. M. (2015). *Simulation Modeling and Analysis (5th ed.)*. New York: McGraw-Hill Education.

# 2. COMPUTERSIMULATIE

## B. SIMULATIE CYCLUS

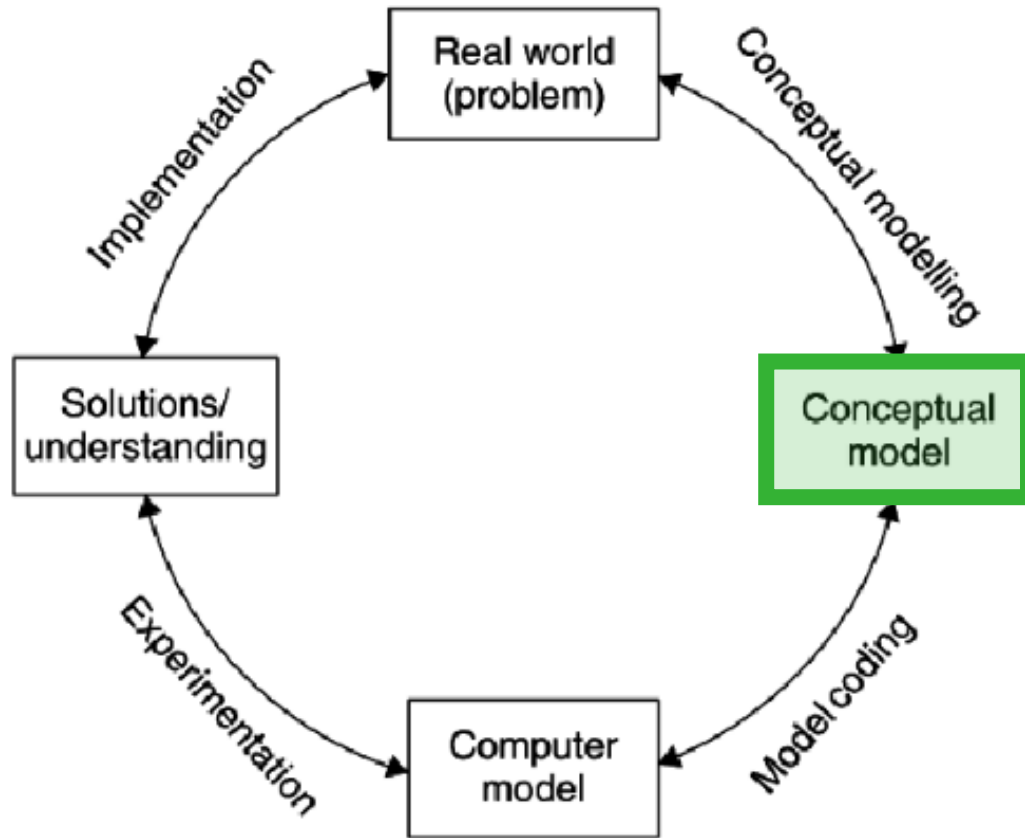
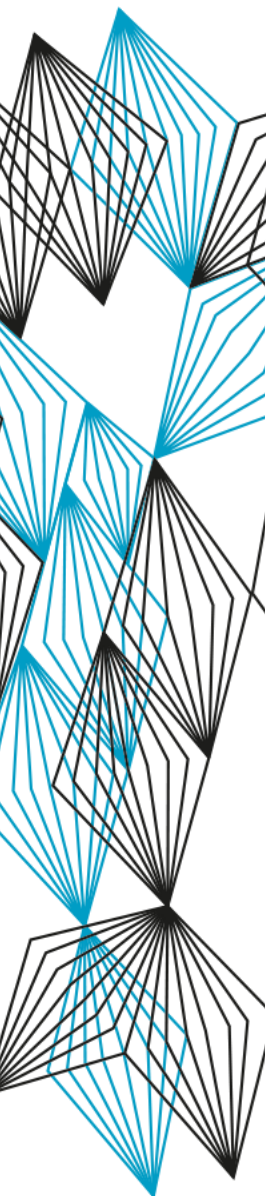


Bron: Robinson, S. (2004). *Simulation: The Practice of Model Development and Use*. Chichester: Wiley.

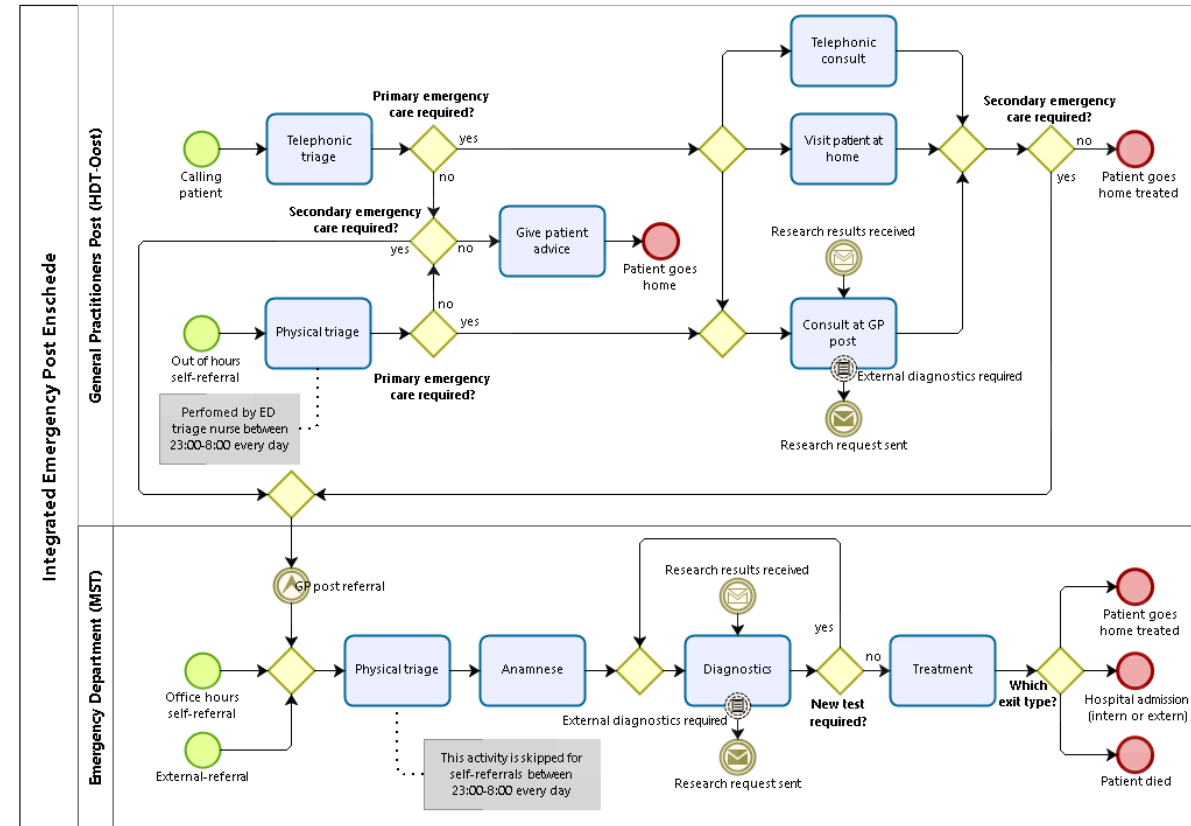


# 2. COMPUTERSIMULATIE

## B. SIMULATIE CYCLUS

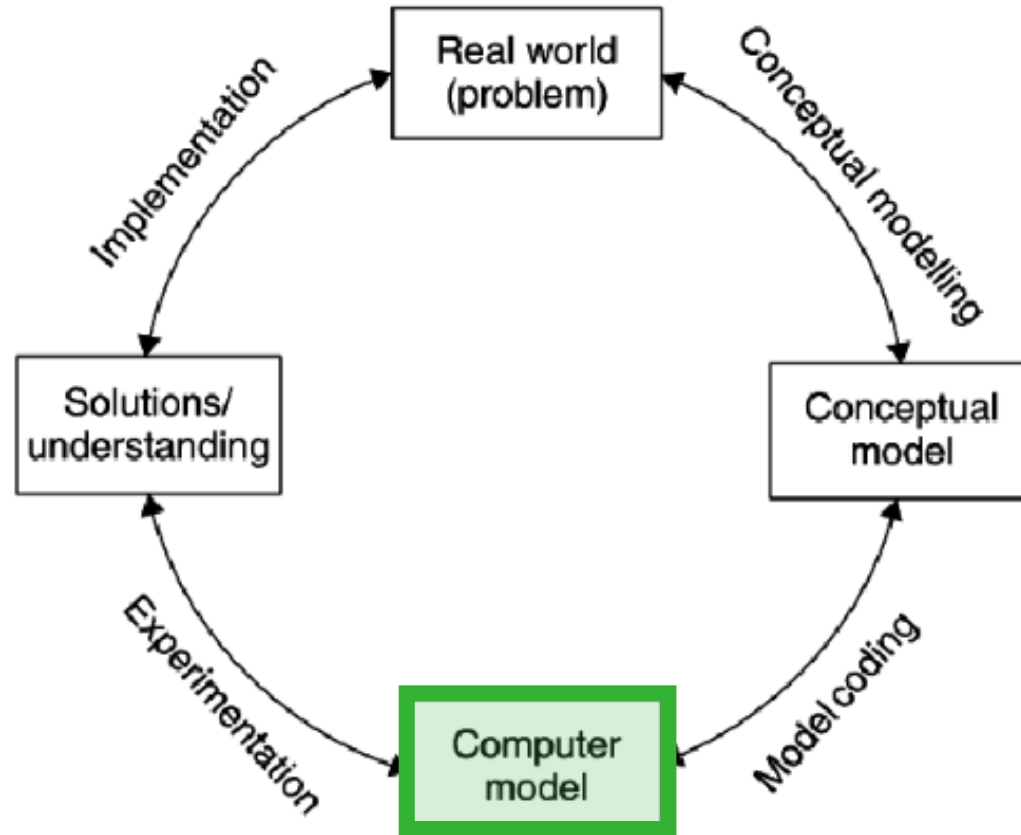
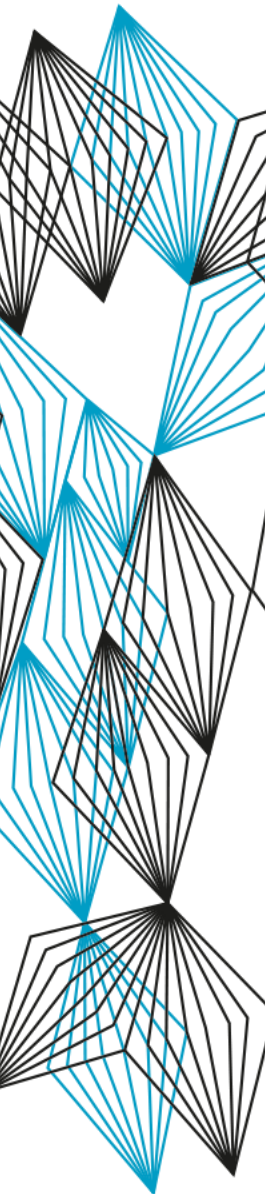


Bron: Robinson, S. (2004). *Simulation: The Practice of Model Development and Use*. Chichester: Wiley.



# 2. COMPUTERSIMULATIE

## B. SIMULATIE CYCLUS



| Main KPIs              |                   |  |
|------------------------|-------------------|--|
| ARRIVALS_TOTAL=1086    | Dag=Sunday        |  |
| LOS_TOTAL=1:19:42.5367 | Uur=12-13         |  |
|                        | GPpostOpened=true |  |

| Entrance KPIs           | GP post KPIs         | ED KPIs              |
|-------------------------|----------------------|----------------------|
| ARRIVALS_ENTRANCE=692   | ARRIVALS_GP=339      | ARRIVALS_ED=446      |
| LOS_ENTRANCE=27:50.9397 | LOS_GP=22:58.3272    | LOS_ED=2:13:25.1384  |
|                         | UTILIZATION_GP=0.291 | UTILIZATION_ED=0.299 |
|                         | SERVICE_KPI_GP=0.95  | SERVICE_KPI_ED=0.94  |

**Experimental factors**

- GP post experimental factors:
  - New roster GP evening (+0)
  - New roster GP night (-1)
  - Apply dedicated patient visits
- ED experimental factors:
  - Apply triage ED treatment room
  - Apply dedicated medical specialist
  - Apply direct hospital admission
  - Increase authority ED doctor
  - New roster ED doctor
  - New roster RES1
  - New roster RES2
  - New roster RES3
  - New roster RES4
- GP experimental factors:
  - Apply collaboration triage
  - Apply room sharing

```

return render_template("index.html")
18
19
20 @app.route("/portfolio")
21 def about():
22     return render_template("portfolio.html")
23
24 @app.route("/projects")
25 def about():
26     return render_template("projects.html")
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28 @app.route("/contact")
29 def about():
30     return render_template("contact.html")
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32 @app.route("/about")
33 def about():
34     return render_template("about.html")
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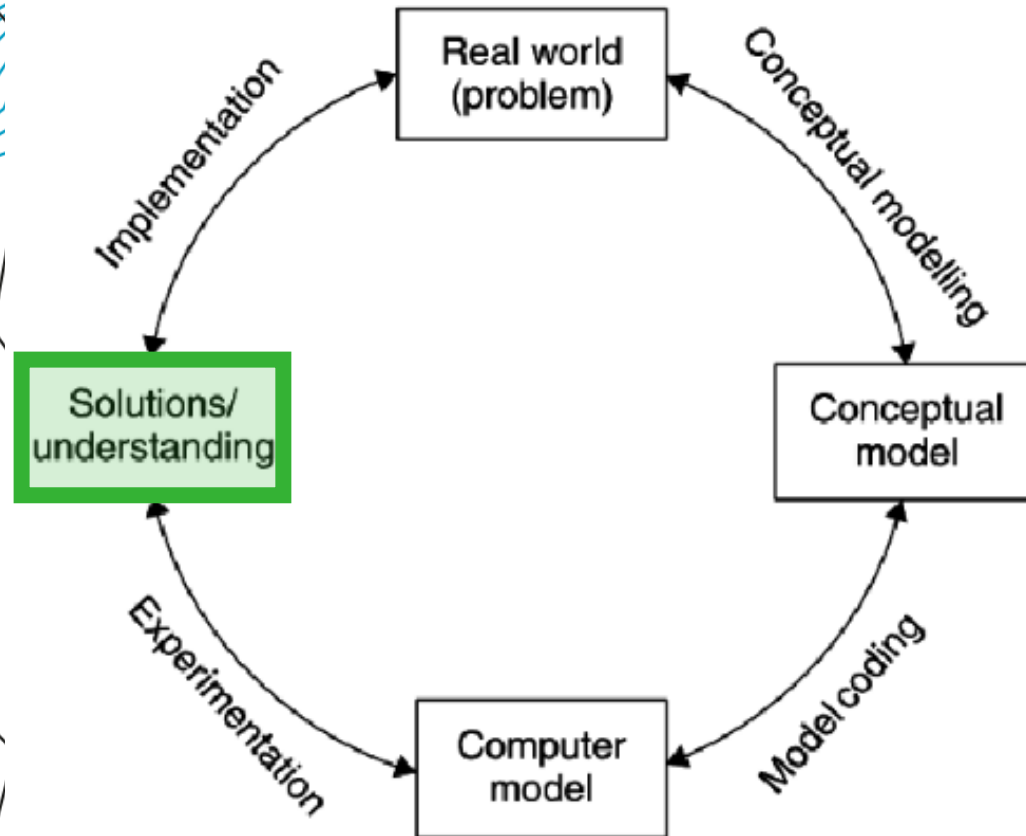
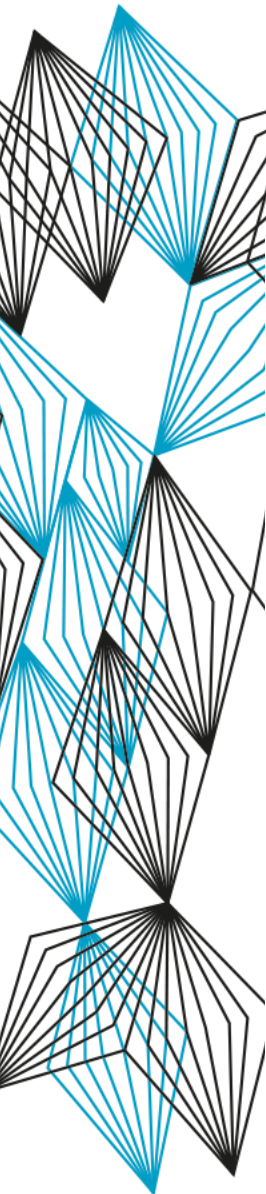
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Bron: Robinson, S. (2004). *Simulation: The Practice of Model Development and Use*. Chichester: Wiley.



# 2. COMPUTERSIMULATIE

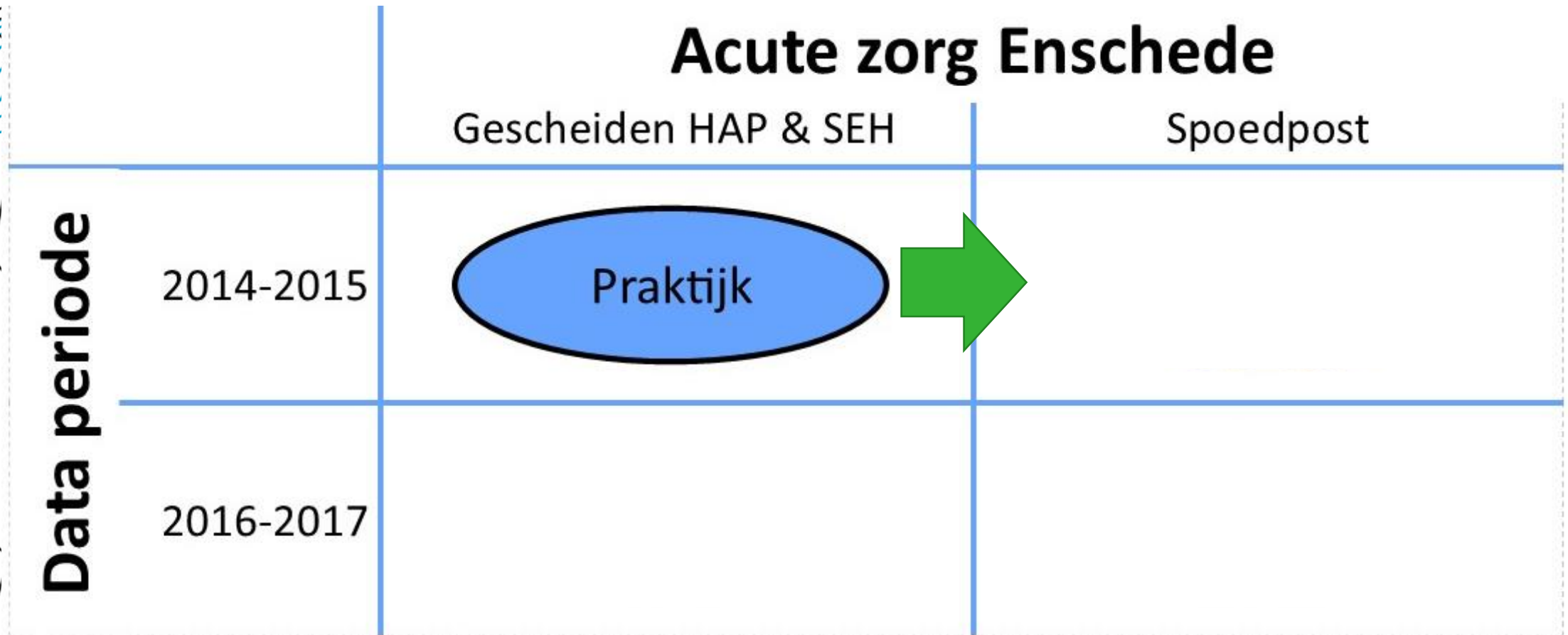
## B. SIMULATIE CYCLUS



Bron: Robinson, S. (2004). *Simulation: The Practice of Model Development and Use*. Chichester: Wiley.

# 2. COMPUTERSIMULATIE

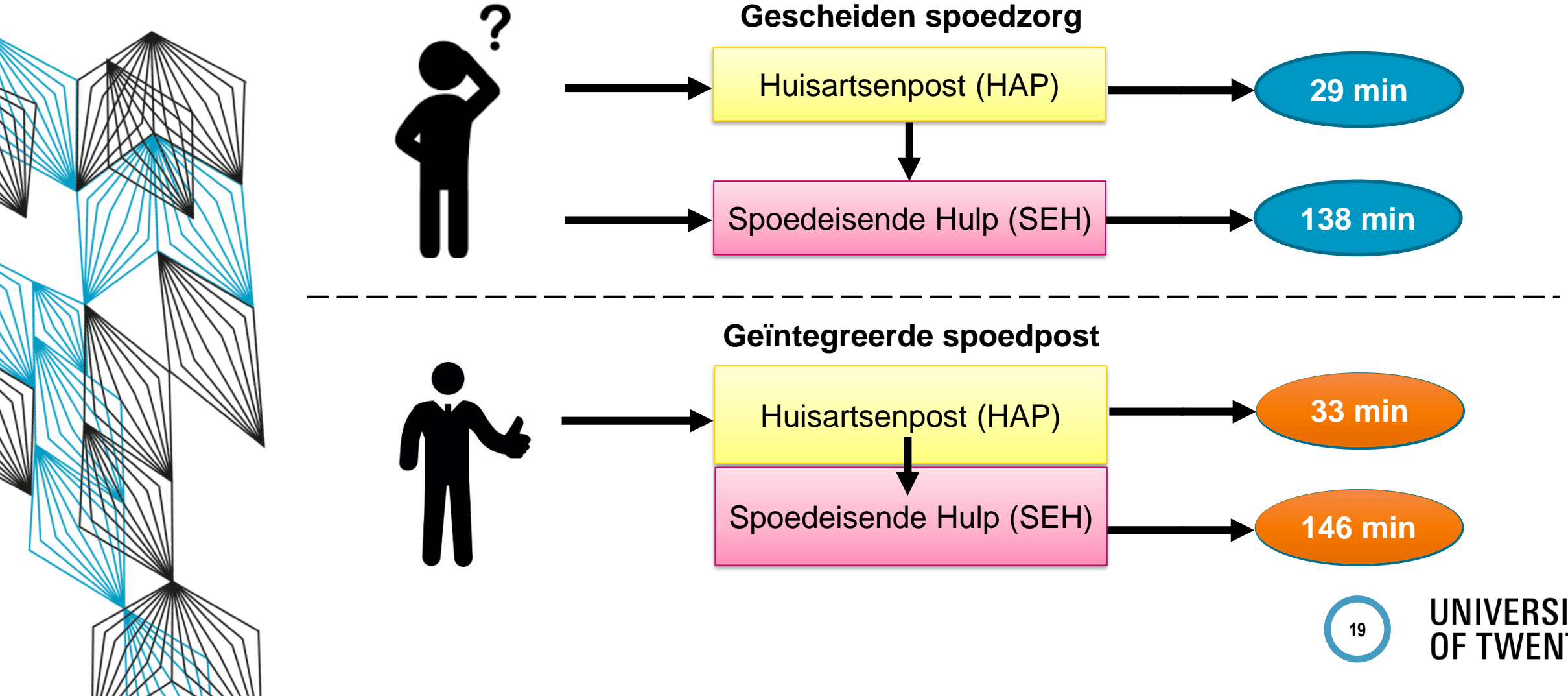
## C. SPOEDPOST SIMULATIE



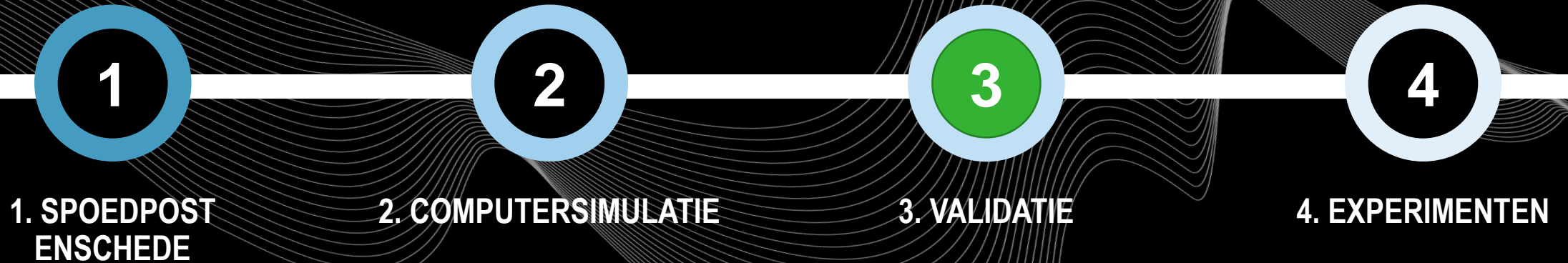


# 2. COMPUTERSIMULATIE

## C. SPOEDPOST SIMULATIE



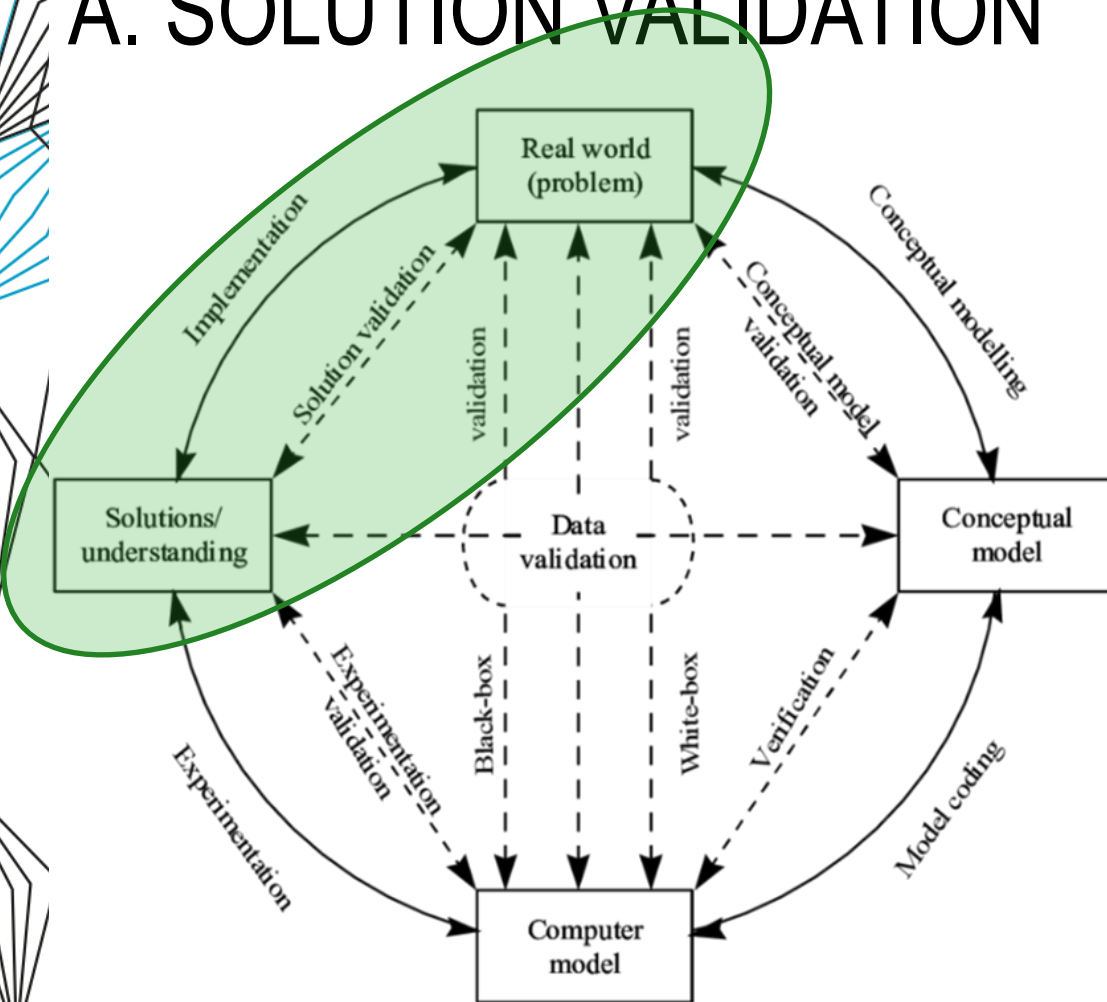
# IN THIS PRESENTATION:





# 3. VALIDATIE

## A. SOLUTION VALIDATION



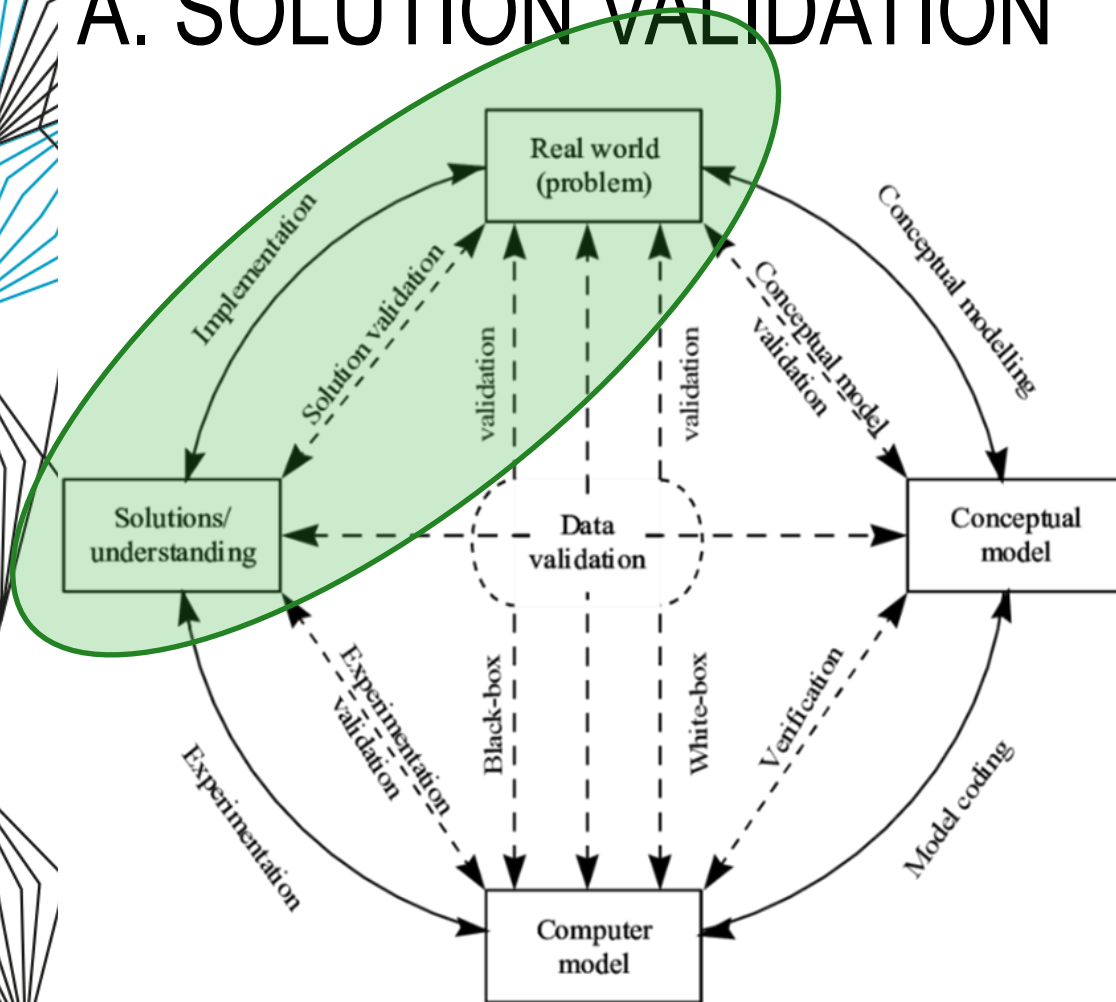
### Solution validation (Robinson, 2004):

*“Determining whether the results obtained by the simulation model are sufficiently accurate in comparison with the real-world’s performances.”*

Bron: Robinson, S. (2004). *Simulation: The Practice of Model Development and Use*. Chichester: Wiley.

# 3. VALIDATIE

## A. SOLUTION VALIDATION



**Solution validation:**  
“Aanbevolen oplossing

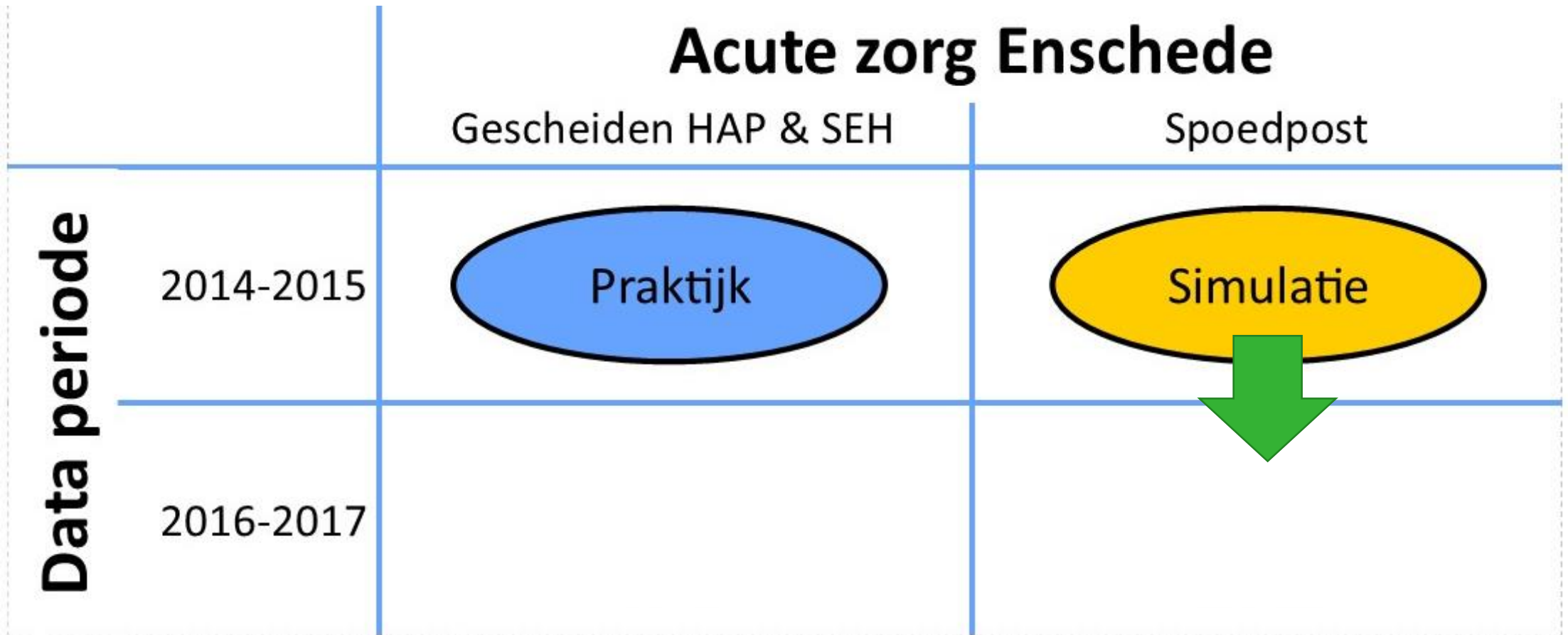
**VS**

Daadwerkelijke verbeteringen

Bron: Robinson, S. (2004). *Simulation: The Practice of Model Development and Use*. Chichester: Wiley.

# 3. VALIDATIE

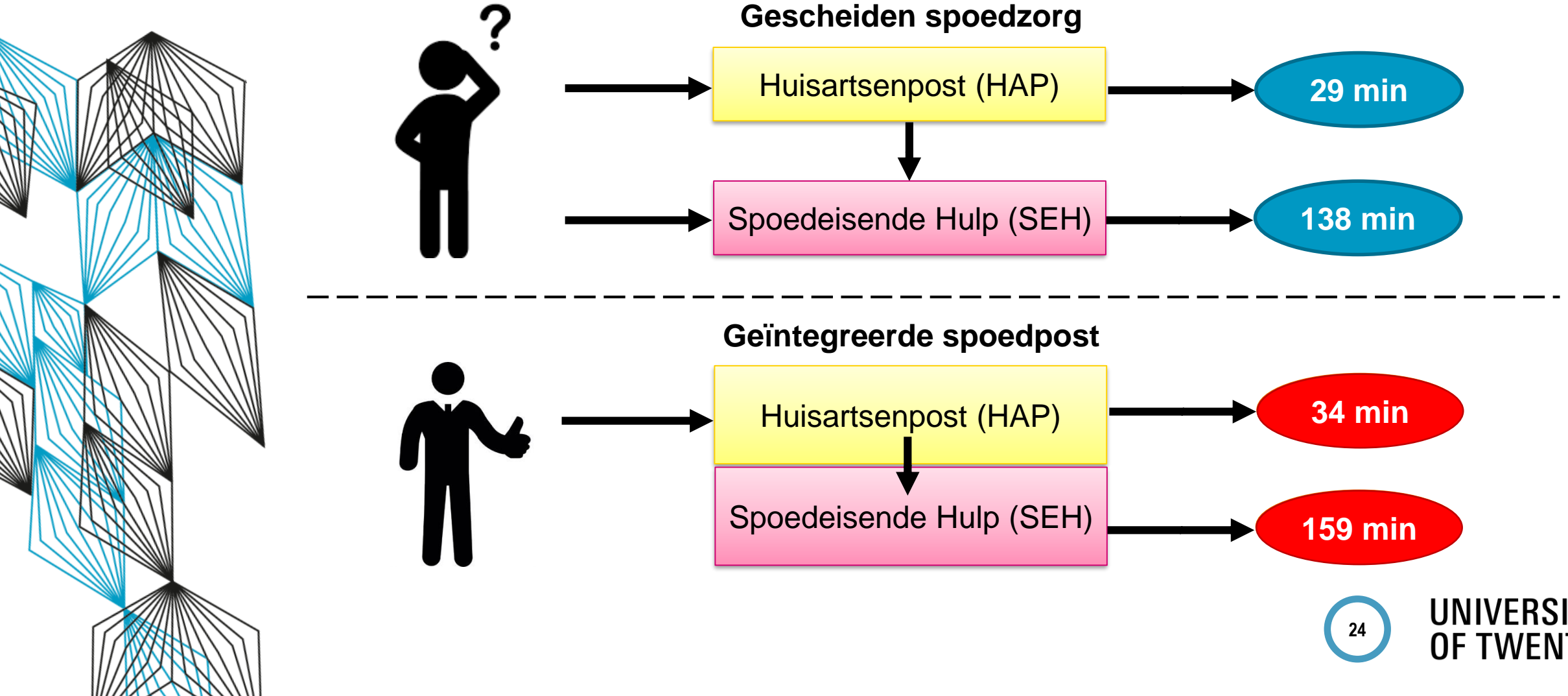
## B. OBSERVATIE STUDIE





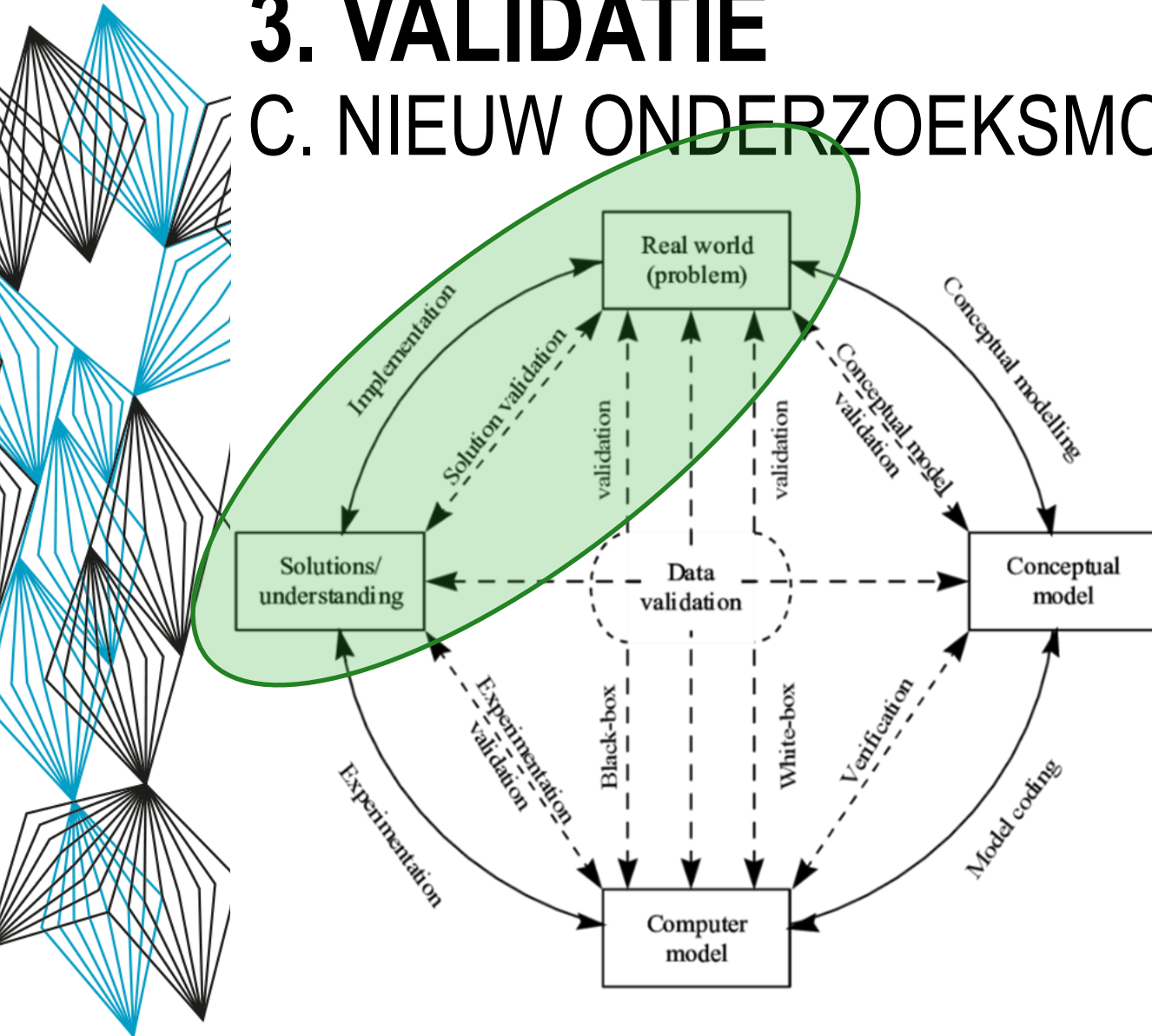
# 3. VALIDATIE

## B. OBSERVATIE STUDIE



# 3. VALIDATIE

## C. NIEUW ONDERZOEKSMODEL



Totaal vergelijkingen:  
 $m * n * q$

≠ 2 vergelijkingen

### 1. Data wijzigingen:

➤ aantal data sets  $m$

### 2. Model wijzigingen:

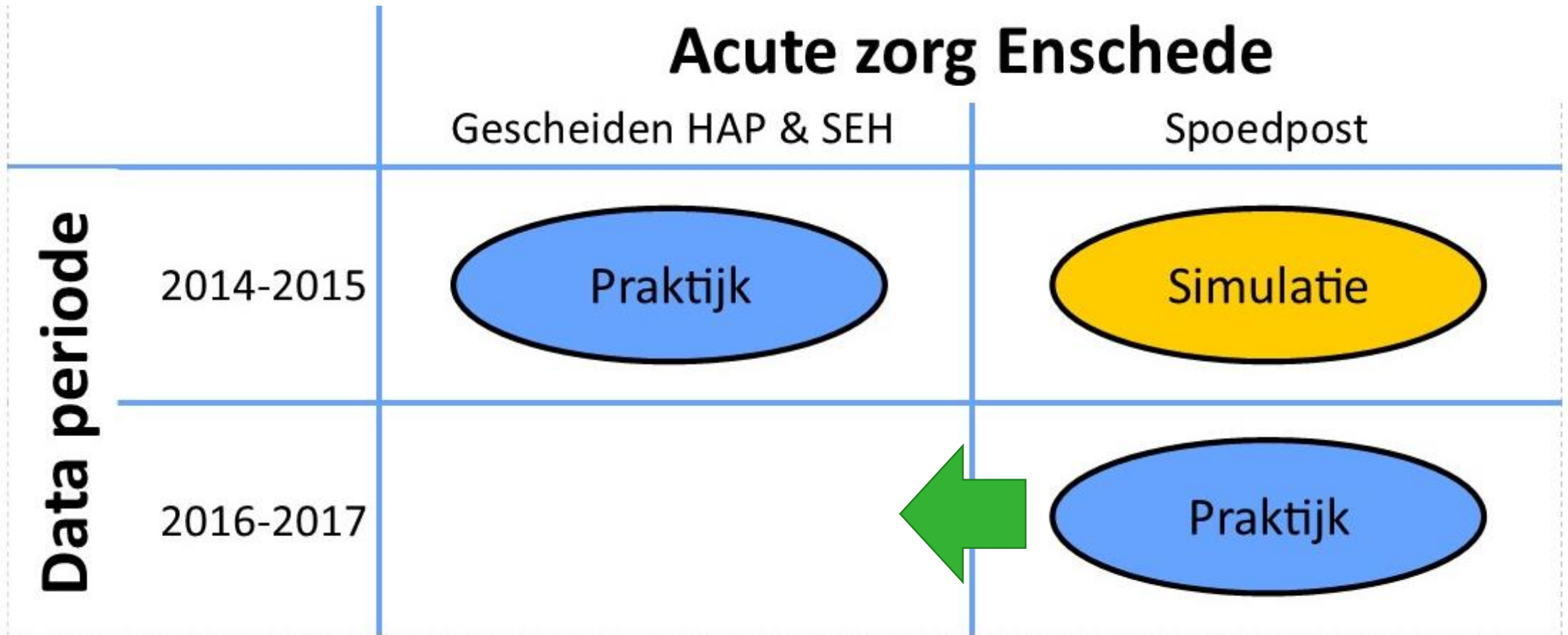
➤ aantal processen  $n$

### 3. Configuratie wijzigingen:

➤ aantal experimenten  $q$

# 3. VALIDATIE

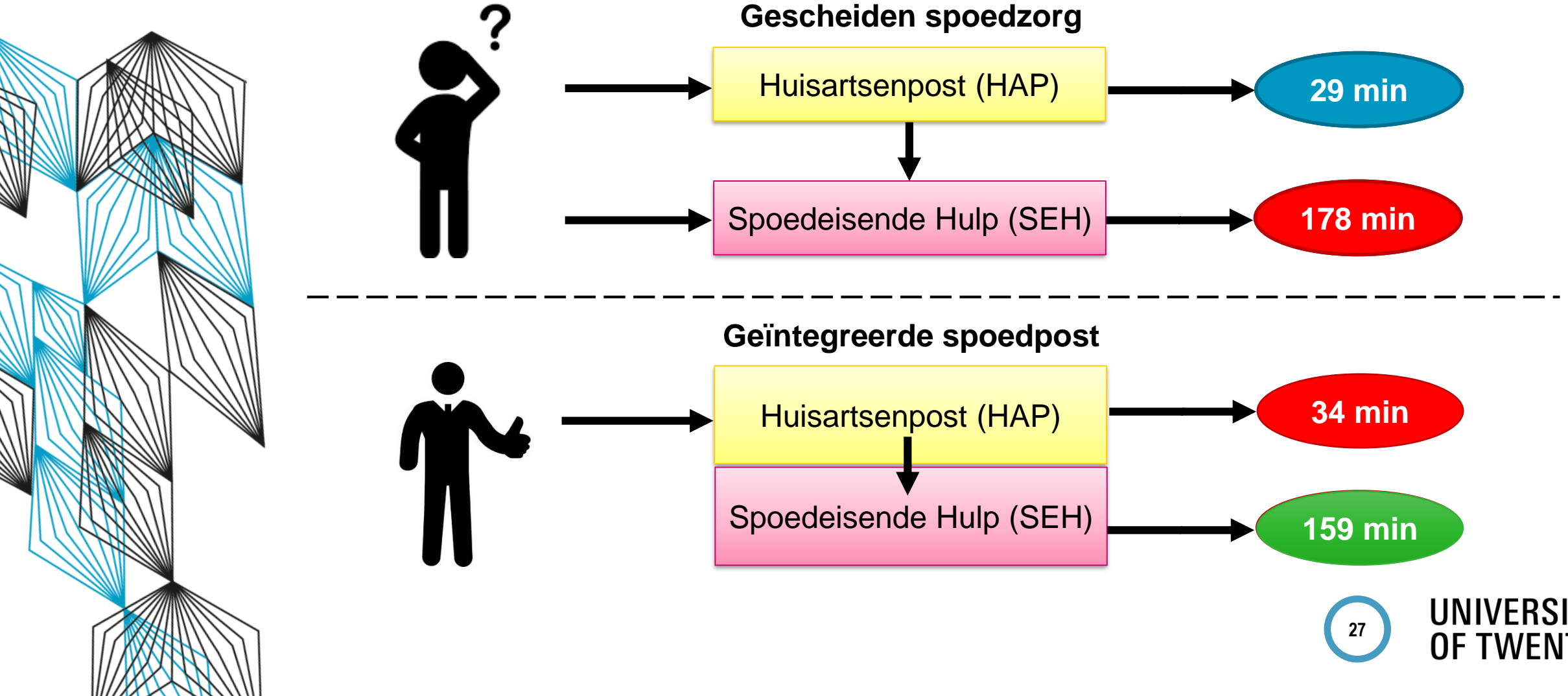
## D. OMGEKEERD SIMULEREN (CETERIS PARIBUS)



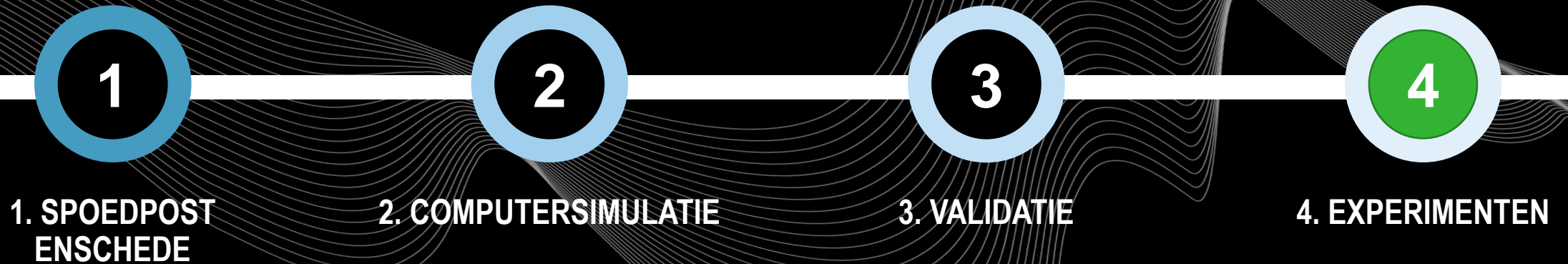


# 3. VALIDATIE

## D. OMGEKEERD SIMULEREN (CETERIS PARIBUS)



# IN THIS PRESENTATION:



# 4. EXPERIMENTEN

## A. TERUG NAAR HET SIMULATIEMODEL



### Simulation statistics

#### Main KPIs

ARRIVALS\_TOTAL=0

LOS\_TOTAL=0.0000

Dag=Saturday

Uur=6-7

GPpostOpened=true

#### Entrance KPIs

ARRIVALS\_ENTRANCE=0

LOS\_ENTRANCE=0.0000

#### GP post KPIs

ARRIVALS\_GP=0

LOS\_GP=0.0000

UTILIZATION\_GP=0.000

SERVICE\_KPI\_GP=0.95

#### ED KPIs

ARRIVALS\_ED=0

LOS\_ED=0.0000

UTILIZATION\_ED=0.000

SERVICE\_KPI\_ED=0.94

### Experimental factors

#### GP post experimental factors

Apply dedicated patient visits

New roster GP

Urgency priority: 10:00 minutes

Patient frequency: Allow U1 patients only

Urgency priority: Allow 50% of GP capacity

#### ED experimental factors

Apply triage ED treatment room

Apply dedicated medical specialist

Apply direct hospital admission

Increase authority ED doctor

New roster ED doctor

New roster RES1

New roster RES2

New roster RES3

New roster RES4

#### IEP experimental factors

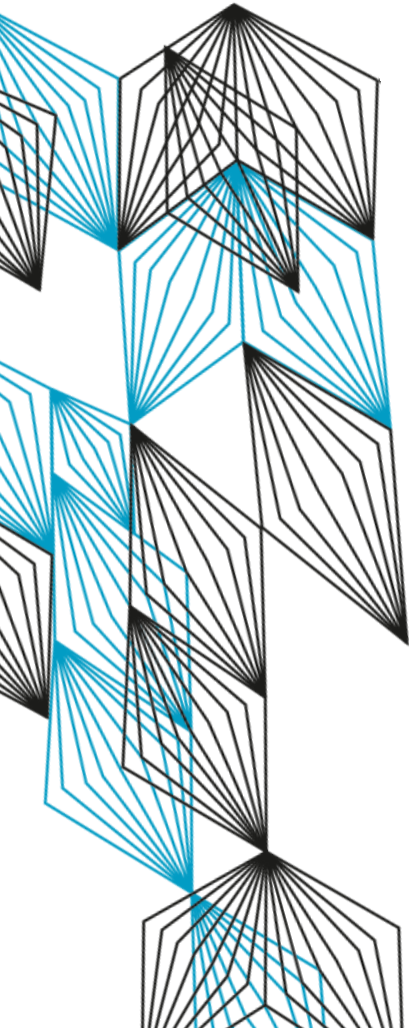
Apply collaboration triage

Apply room sharing



# 4. EXPERIMENTEN

## B. RESULTATEN



| LOS comparisons               | Appointment strategy - Experimental settings |              |               |                 |                    |                |             |               |             | GP post KPIs |              |             |          |                     |                |                 |            |
|-------------------------------|--|--------------|---------------|-----------------|--------------------|----------------|-------------|---------------|-------------|--------------|--------------|-------------|----------|---------------------|----------------|-----------------|------------|
|                               | Experiment ID                                | SlotDuration | SlotFrequency | UrgencyPriority | NewRosterEveningGP | GP/visitBuffer | NewRosterSA | NewRosterRES1 | NewRosterSP | LOS total    | LOS entrance | LOS GP post | LOS ED   | Utilization GP post | Utilization ED | Service GP post | Service ED |
| Original settings             | -  | 00:10:00     | 0,5           | U1 only         | FALSE              | 1              | FALSE       | FALSE         | FALSE       | 01:23:44     | 00:23:18     | 00:33:41    | 02:38:12 | 36%                 | 29%            | 97%             | 92%        |
| Baseline settings             | -  | 00:10:00     | 0,5           | U1 only         | FALSE              | 1              | FALSE       | FALSE         | FALSE       | 01:21:59     | 00:25:49     | 00:37:30    | 02:20:40 | 40%                 | 31%            | 95%             | 94%        |
| Top 5 minimum LOS total       | 80   | 00:10:00     | 0,5           | U1-U2           | TRUE               | 1              | TRUE        | TRUE          | TRUE        | 01:01:20     | 00:18:26     | 00:26:02    | 01:47:15 | 36%                 | 27%            | 99%             | 93%        |
|                               | 176  | 00:10:00     | 0,75          | U1-U2           | TRUE               | 1              | TRUE        | TRUE          | TRUE        | 01:01:27     | 00:18:13     | 00:26:08    | 01:47:50 | 36%                 | 27%            | 99%             | 94%        |
|                               | 32   | 00:10:00     | 0,5           | U1 only         | TRUE               | 1              | TRUE        | TRUE          | TRUE        | 01:01:33     | 00:18:38     | 00:25:44    | 01:47:44 | 36%                 | 27%            | 99%             | 94%        |
|                               | 560  | 00:12:00     | 0,75          | U1-U2           | TRUE               | 1              | TRUE        | TRUE          | TRUE        | 01:01:35     | 00:18:57     | 00:26:11    | 01:46:55 | 37%                 | 27%            | 99%             | 94%        |
|                               | 128  | 00:10:00     | 0,75          | U1 only         | TRUE               | 1              | TRUE        | TRUE          | TRUE        | 01:01:36     | 00:18:26     | 00:25:58    | 01:48:04 | 36%                 | 27%            | 99%             | 94%        |
| Top 5 minimum LOS entrance    | 121  | 00:10:00     | 0,75          | U1 only         | TRUE               | 1              | FALSE       | FALSE         | FALSE       | 01:11:28     | 00:18:04     | 00:25:46    | 02:15:14 | 36%                 | 30%            | 99%             | 93%        |
|                               | 176  | 00:10:00     | 0,75          | U1-U2           | TRUE               | 1              | TRUE        | TRUE          | TRUE        | 01:01:27     | 00:18:13     | 00:26:08    | 01:47:50 | 36%                 | 27%            | 99%             | 94%        |
|                               | 25   | 00:10:00     | 0,5           | U1 only         | TRUE               | 1              | FALSE       | FALSE         | FALSE       | 01:11:41     | 00:18:14     | 00:25:41    | 02:15:33 | 36%                 | 30%            | 99%             | 93%        |
|                               | 171  | 00:10:00     | 0,75          | U1-U2           | TRUE               | 1              | FALSE       | TRUE          | FALSE       | 01:07:37     | 00:18:16     | 00:26:18    | 02:04:02 | 36%                 | 29%            | 99%             | 93%        |
|                               | 173  | 00:10:00     | 0,75          | U1-U2           | TRUE               | 1              | TRUE        | FALSE         | FALSE       | 01:05:04     | 00:18:17     | 00:26:20    | 01:57:07 | 37%                 | 29%            | 99%             | 93%        |
| Top 5 minimum LOS GP post     | 525  | 00:12:00     | 0,75          | U1 only         | TRUE               | 3              | TRUE        | FALSE         | FALSE       | 01:09:01     | 00:25:32     | 00:24:02    | 01:56:15 | 35%                 | 29%            | 95%             | 93%        |
|                               | 1001   | 00:15:00     | 0,5           | U1 only         | TRUE               | 3              | FALSE       | FALSE         | FALSE       | 01:16:52     | 00:26:58     | 00:24:16    | 02:14:37 | 35%                 | 30%            | 96%             | 93%        |
|                               | 1097   | 00:15:00     | 0,75          | U1 only         | TRUE               | 3              | FALSE       | FALSE         | FALSE       | 01:16:31     | 00:26:29     | 00:24:16    | 02:14:31 | 35%                 | 30%            | 96%             | 93%        |
|                               | 762  | 00:13:00     | 0,75          | U1-U2           | TRUE               | 3              | FALSE       | FALSE         | TRUE        | 01:16:53     | 00:26:36     | 00:24:19    | 02:15:15 | 35%                 | 30%            | 96%             | 93%        |
|                               | 1004   | 00:15:00     | 0,5           | U1 only         | TRUE               | 3              | FALSE       | TRUE          | TRUE        | 01:11:37     | 00:26:54     | 00:24:19    | 02:00:22 | 35%                 | 29%            | 96%             | 93%        |
| Top 5 minimum LOS ED          | 464  | 00:12:00     | 0,5           | U1-U2           | TRUE               | 1              | TRUE        | TRUE          | TRUE        | 01:01:37     | 00:18:55     | 00:26:35    | 01:46:34 | 37%                 | 27%            | 99%             | 94%        |
|                               | 1032   | 00:15:00     | 0,5           | U1-U2           | FALSE              | 3              | TRUE        | TRUE          | TRUE        | 01:13:25     | 00:32:49     | 00:33:12    | 01:46:43 | 37%                 | 27%            | 99%             | 94%        |
|                               | 560  | 00:12:00     | 0,75          | U1-U2           | TRUE               | 1              | TRUE        | TRUE          | TRUE        | 01:01:35     | 00:18:57     | 00:26:11    | 01:46:55 | 37%                 | 27%            | 99%             | 94%        |
|                               | 72   | 00:10:00     | 0,5           | U1-U2           | FALSE              | 3              | TRUE        | TRUE          | TRUE        | 01:11:34     | 00:30:04     | 00:32:47    | 01:47:06 | 37%                 | 27%            | 94%             | 94%        |
|                               | 1024   | 00:15:00     | 0,5           | U1-U2           | FALSE              | 2              | TRUE        | TRUE          | TRUE        | 01:13:11     | 00:31:40     | 00:34:30    | 01:47:11 | 38%                 | 27%            | 94%             | 94%        |
| Top 5 maximum GP post service | 25   | 00:10:00     | 0,5           | U1 only         | TRUE               | 1              | FALSE       | FALSE         | FALSE       | 01:11:41     | 00:18:14     | 00:25:41    | 02:15:33 | 36%                 | 30%            | 99%             | 94%        |
|                               | 462  | 00:12:00     | 0,5           | U1-U2           | TRUE               | 1              | TRUE        | FALSE         | TRUE        | 01:04:01     | 00:18:35     | 00:25:49    | 01:54:17 | 36%                 | 29%            | 99%             | 93%        |
|                               | 314  | 00:11:00     | 0,75          | U1 only         | TRUE               | 1              | FALSE       | FALSE         | TRUE        | 01:11:50     | 00:18:38     | 00:26:25    | 02:14:42 | 36%                 | 30%            | 99%             | 94%        |
|                               | 218  | 00:11:00     | 0,5           | U1 only         | TRUE               | 1              | FALSE       | FALSE         | TRUE        | 01:11:49     | 00:18:42     | 00:26:21    | 02:14:35 | 36%                 | 30%            | 99%             | 93%        |
|                               | 704  | 00:13:00     | 0,75          | U1 only         | TRUE               | 1              | TRUE        | TRUE          | TRUE        | 01:01:54     | 00:19:09     | 00:25:45    | 01:47:48 | 36%                 | 27%            | 99%             | 93%        |
| Top 5 maximum ED service      | 67   | 00:10:00     | 0,5           | U1-U2           | FALSE              | 3              | FALSE       | TRUE          | FALSE       | 01:18:13     | 00:29:08     | 00:35:30    | 02:03:48 | 37%                 | 29%            | 94%             | 94%        |
|                               | 254  | 00:11:00     | 0,5           | U1-U2           | FALSE              | 2              | TRUE        | FALSE         | TRUE        | 01:12:46     | 00:26:39     | 00:35:14    | 01:54:17 | 38%                 | 29%            | 96%             | 94%        |
|                               | 417  | 00:12:00     | 0,5           | U1 only         | TRUE               | 2              | FALSE       | FALSE         | FALSE       | 01:14:11     | 00:22:14     | 00:25:36    | 02:14:55 | 35%                 | 30%            | 98%             | 94%        |
|                               | 466  | 00:12:00     | 0,5           | U1-U2           | TRUE               | 2              | FALSE       | FALSE         | TRUE        | 01:13:23     | 00:22:01     | 00:25:02    | 02:13:44 | 35%                 | 30%            | 98%             | 94%        |
|                               | 521  | 00:12:00     | 0,75          | U1 only         | TRUE               | 3              | FALSE       | FALSE         | FALSE       | 01:16:44     | 00:26:19     | 00:24:46    | 02:14:52 | 35%                 | 30%            | 95%             | 94%        |

Best LOS HAP: -28.6%

Beste LOS SEH: -33.3%

# 4. EXPERIMENTEN

## C. AANBEVELINGEN

### Optimaliseer uitnodigingsstrategie

- Bepaal geschikte service levels
- Wachtijd versus service level

### Uitbreiding capaciteit

- Pas werkroosters aan op daadwerkelijke vraag
- -1 huisarts gedurende nachtdienst
- +1 huisarts gedurende avonddienst

### Creëer wachtrij voor visite rijden

Huidige DLT SEH = **34 min**

Beste reductie  
**-33.3%**

Optimale DLT SEH = **24 min**

# 4. EXPERIMENTEN

## C. AANBEVELINGEN

### Nieuwe werkroosters

- Maak roosters obv werkdrukke
- Verhoog capaciteit bottlenecks:
  - +1 SEH dokter
  - +1 arts assistent chirurgie/orthopedie
- Directe beschikbaarheid medisch specialist

### Onderzoek samenwerking

- Directe ziekenhuisopname
- Gezamenlijke triage HAP & SEH

### Fysieke triage in behandelkamer

- Kortere wachttijd door snellere allocatie verpleegkundige
- +1 extra kamer

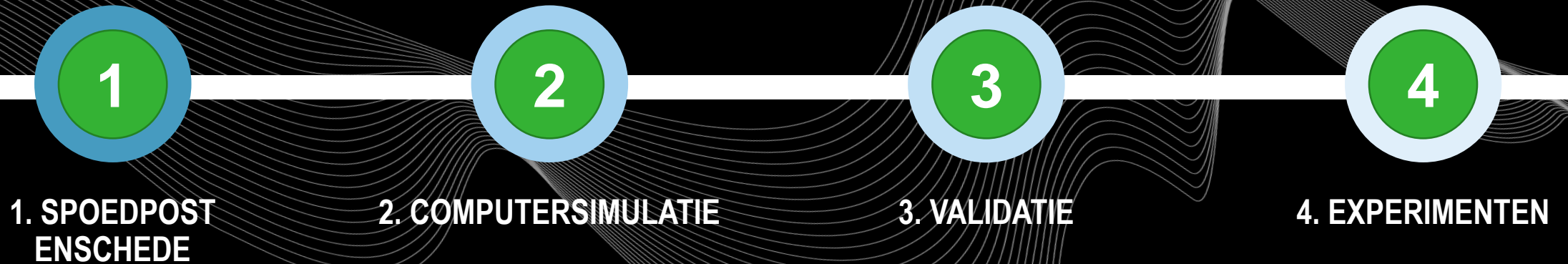
Huidige DLT SEH = **159 min**

Beste reductie  
**-33.3%**

Optimale DLT SEH = **107 min**



# IN THIS PRESENTATION:














# 5. CONCLUSIES

## CONTACT



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