

Specialization: Transport Engineering and Logistics

Report number: 2017.TEL.8185

Title: Optimizing the flow of export deliveries  
at Heineken Zoeterwoude

Author: S.W. Valk

Assignment: Masters thesis

Confidential: Yes

Initiator (university): Prof.dr.ir. R. Negenborn

Initiator (company): Ir. E. Kögeler (Heineken, Zoeterwoude)

Supervisor: Dr.ir. H. Veeke

Date: December 4, 2017



# Optimizing the flow of export deliveries at Heineken Zoeterwoude

The design of real-time delivery overview for  
export containers at the Zoeterwoude brewery  
of Heineken

by

S.W. Valk

to obtain the degree of Master of Science  
at the Delft University of Technology,  
to be defended publicly on December 4, 2017 at 14:00.

Report number: 2017.TEL.8185  
Student number: 1513427  
Project duration: October 4, 2016 – December 4, 2017  
Thesis committee: Dr. Ir. H. Veeke, TU Delft, supervisor  
Prof. Dr. Ir. R. Negenborn, TU Delft  
Ir. J.W. Frouws, TU Delft  
Ir. E. Kögeler, Heineken, supervisor

*This thesis is confidential and cannot be made public.*



# Preface

Before you lies the report “Optimizing the flow of export deliveries at Heineken Zoeterwoude”. This is written to finalize my MSc. study Transportation Engineering and Logistics at the Delft University of Technology.

I would like to thank Heineken for the opportunity to study their operation. My special appreciation goes to E. Kögeler for his guidance and helpful advice. Furthermore J. Schreuder, A. Dadi and the rest of the team at CS&L, I owe them my gratitude for their help and support.

At the TU delft I would like to thank H. Veeke, who was always ready to discuss and correct my work and R. Negenborn.

Finally I need to acknowledge the support of my parents during my studies. With their continuous question: “When are you graduating?”, being answered with: Monday the 4th of December 2017.

*S.W. Valk  
Delft, December 2017*



# Contents

<b>Glossary</b>	<b>xi</b>
<b>1 Introduction</b>	<b>1</b>
<b>2 Background</b>	<b>3</b>
2.1 Heineken International . . . . .	3
2.1.1 Strategy . . . . .	3
2.1.2 Zoeterwoude brewery . . . . .	4
2.1.3 From barley to sea-container . . . . .	5
2.2 CS&L shipping . . . . .	7
2.2.1 Overview . . . . .	7
2.2.2 Jargon . . . . .	7
2.2.3 Warehouse . . . . .	8
2.2.4 Inbound . . . . .	9
2.2.5 Domestic . . . . .	9
2.2.6 Export . . . . .	9
2.3 Key Performance Indicators . . . . .	10
2.3.1 Productivity & Cost . . . . .	10
2.3.2 Customer Satisfaction . . . . .	10
2.3.3 Organization & People . . . . .	11
2.3.4 Operational Excellence. . . . .	11
2.4 Detailed process . . . . .	12
2.4.1 Container call . . . . .	12
2.4.2 Warehouse Coordinators. . . . .	13
2.4.3 Operators . . . . .	14
2.4.4 OTA- truck driver . . . . .	15
2.5 Summary . . . . .	16
<b>3 Analysis</b>	<b>17</b>
3.1 Primary function and process . . . . .	17
3.1.1 Scope . . . . .	17
3.1.2 Throughput . . . . .	18
3.1.3 Requirements. . . . .	18
3.1.4 Performance . . . . .	18
3.2 Basic process. . . . .	19
3.2.1 Control . . . . .	19
3.3 PROPER model . . . . .	20
3.3.1 Detailed model . . . . .	20
3.3.2 Order flow . . . . .	20
3.4 Product Flow . . . . .	21
3.4.1 Other actions . . . . .	21
3.5 Concerns . . . . .	22
3.6 Blockade . . . . .	22
3.7 Loading bay occupation . . . . .	23
3.7.1 Truck pick-up . . . . .	24
3.8 Stand-still . . . . .	25
3.8.1 Buffer . . . . .	25
3.8.2 Container . . . . .	26
3.8.3 Operator . . . . .	27

3.9	Production Schedule . . . . .	28
3.10	Summary . . . . .	30
<b>4</b>	<b>Problem definition</b>	<b>31</b>
4.1	Blockade . . . . .	31
4.2	Loading bay occupation . . . . .	31
4.3	Stand-still . . . . .	31
4.3.1	Container-call . . . . .	31
4.3.2	Operator . . . . .	32
4.4	Schedule . . . . .	32
4.5	Summary . . . . .	32
<b>5</b>	<b>Concept</b>	<b>33</b>
5.1	Proposed solution . . . . .	33
5.1.1	Function. . . . .	33
5.1.2	Container call . . . . .	33
5.1.3	Work process . . . . .	34
5.2	Expected results . . . . .	34
5.3	Design requirements . . . . .	34
5.4	Concept design . . . . .	35
5.4.1	Server . . . . .	35
5.4.2	Task selection. . . . .	36
5.4.3	Loading algorithms . . . . .	36
5.4.4	Information displayed. . . . .	36
5.4.5	Visual . . . . .	37
5.5	Cost benefits . . . . .	37
5.6	Summary . . . . .	38
<b>6</b>	<b>Simulation model</b>	<b>39</b>
6.1	Modelling process . . . . .	39
6.2	Goal . . . . .	40
6.2.1	Additional bottling line . . . . .	40
6.3	Scope . . . . .	40
6.4	Framework . . . . .	40
6.5	Description of the model . . . . .	41
6.5.1	Processes. . . . .	41
6.5.2	Pallets generators . . . . .	42
6.5.3	Pallet movers . . . . .	43
6.5.4	Trucks . . . . .	44
6.5.5	Resources . . . . .	45
6.5.6	Crossdock, Staging Area and Storage . . . . .	45
6.6	Select delivery . . . . .	46
6.6.1	Priorities. . . . .	46
6.6.2	Loading algorithm . . . . .	47
6.7	Input parameters . . . . .	48
6.8	Summary . . . . .	48
<b>7</b>	<b>Verification &amp; validation</b>	<b>49</b>
7.1	Logging . . . . .	49
7.1.1	Creation log . . . . .	49
7.2	Replay. . . . .	50
7.3	Hand calculations. . . . .	50
7.3.1	Pallets produced . . . . .	50
7.3.2	Loading Time . . . . .	50
7.3.3	Truck . . . . .	51

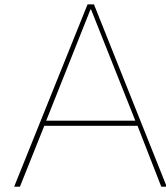
7.4	Face Validity . . . . .	51
7.5	Stand-still . . . . .	51
7.6	Degenerate Tests . . . . .	51
7.7	Extreme Conditions Test . . . . .	52
7.7.1	Start-up time . . . . .	52
7.8	Historical Data Validation. . . . .	53
7.8.1	Round trip times . . . . .	53
7.8.2	Pallet staytime . . . . .	54
7.8.3	Pallet-interval . . . . .	54
7.9	Internal Validity . . . . .	55
7.9.1	Simulation time . . . . .	55
7.10	Sensitivity Analysis . . . . .	56
7.10.1	Number of trucks . . . . .	56
7.10.2	Number of docked containers . . . . .	57
7.10.3	Container trigger . . . . .	58
7.10.4	Number of operators . . . . .	59
7.11	Summary . . . . .	59
<b>8</b>	<b>Simulation results</b>	<b>61</b>
8.1	Experimentation plan . . . . .	61
8.2	Task scheduling algorithm . . . . .	62
8.2.1	Stand-still percentage . . . . .	62
8.2.2	Loading bay occupation . . . . .	63
8.2.3	Pallets produced . . . . .	64
8.2.4	Response times . . . . .	65
8.2.5	Analysis of the results . . . . .	66
8.2.6	Discussion . . . . .	66
8.3	Line 52 . . . . .	67
8.3.1	Stand-still percentage . . . . .	67
8.3.2	Loading bay occupation . . . . .	67
8.3.3	Analysis of the results . . . . .	68
8.3.4	Discussion . . . . .	68
8.4	Summary . . . . .	68
<b>9</b>	<b>Implementation</b>	<b>69</b>
9.1	Introduction . . . . .	69
9.2	Background . . . . .	70
9.3	Implementation . . . . .	70
9.3.1	Overview Deliveries . . . . .	70
9.3.2	Status of the bottling line . . . . .	72
9.3.3	Exporting this data . . . . .	73
9.3.4	Displaying this data . . . . .	73
9.4	Risks . . . . .	73
9.4.1	Data loss . . . . .	73
9.4.2	Fallback . . . . .	74
9.5	Summary . . . . .	74
<b>10</b>	<b>Conclusion</b>	<b>75</b>
10.1	Further research & other recommendations. . . . .	76
	<b>Bibliography</b>	<b>77</b>
<b>A</b>	<b>Paper</b>	<b>79</b>
A.1	Introduction . . . . .	79
A.2	Process . . . . .	80
A.3	Analysis . . . . .	80
A.4	Concept . . . . .	81
A.5	Simulation. . . . .	81
A.6	Results . . . . .	82

A.7	Implementation . . . . .	82
A.8	Conclusion . . . . .	82
<b>B</b>	<b>Colonnes data</b>	<b>83</b>
B.1	Number of pallets produced . . . . .	83
B.1.1	Order type . . . . .	83
B.1.2	Conventional transport & Storage . . . . .	84
B.2	Pallet interval . . . . .	84
B.2.1	Simulation. . . . .	85
B.3	Production order . . . . .	86
B.4	Line 52 . . . . .	87
B.5	Simulation input parameters . . . . .	87
<b>C</b>	<b>Other variables</b>	<b>89</b>
C.1	Workload model . . . . .	89
<b>D</b>	<b>Conceptual model</b>	<b>91</b>
D.1	Legend . . . . .	91
D.2	Pallet source . . . . .	92
D.2.1	Simplification and assumption . . . . .	93
D.3	Operator . . . . .	94
D.3.1	Simplification and assumption . . . . .	94
D.4	Operator of the big forklift . . . . .	95
D.4.1	Simplification and assumption . . . . .	95
D.5	Truck . . . . .	96
D.5.1	Simplification and assumption . . . . .	96
D.6	Crossdock . . . . .	96
<b>E</b>	<b>Results</b>	<b>99</b>
E.1	Task scheduling algorithm . . . . .	99
<b>F</b>	<b>Simulation code</b>	<b>105</b>
F.1	Simulation Worker . . . . .	105

# Bibliography

- [1] Movement data. Movement data exports from WMS.
- [2] Consafe Logistics B.V. Cr547.4- automatische delivery/put planning adhv vulling van bufferbanen, June 2010.
- [3] Uniface B.V. Uniface documentation. <https://unifaceinfo.com/downloads/>.
- [4] Néill Byrne, Dr. Paul Liston, Dr. John Geraghty, and Dr. Paul Young. The potential role of open source discrete event simulation software in the manufacturing sector, 2012.
- [5] S Wali Haider, Colin L Moodie, and James R Buck. An investigation of the advantages of using a man-computer interactive scheduling methodology for job shops. *The International Journal Of Production Research*, 19(4):381–392, 1981.
- [6] Prof. Ir. J in 't Veld. *Bedrijfsinformatie*, 1971.
- [7] ABusch InBev. Ab inbev, 2015 annual report. <http://www.ab-inbev.com/investors/reports-and-filings.html>.
- [8] Renee Kroon, Jelmer van Lochem, Jacco Schreuder, and Gerard Star. *Verbetervoorstel put bezetting*, 2016.
- [9] Eric Kögeler. Interview, October 2016.
- [10] Makoto Matsumoto and Takuji Nishimura. Mersenne twister: a 623-dimensionally equidistributed uniform pseudo-random number generator. *ACM Transactions on Modeling and Computer Simulation (TOMACS)*, 8(1):3–30, 1998.
- [11] M. Nelson. *The Barbarian's Beverage: A History of Beer in Ancient Europe*. Taylor & Francis, 2004. ISBN 9780203309124.
- [12] Gert-Jan Nollen. Interview, March 2016.
- [13] Heineken NV. Heineken nv, 2015 annual report. [www.theheinekencompany.com/information-centre](http://www.theheinekencompany.com/information-centre).
- [14] Heineken NV. *Rapportage blokada dagen*, 2016.
- [15] Heineken NV. Internal KPI report Heineken Zoeterwoude, 2016.
- [16] Heineken NV. Internal safety report heineken zoeterwoude, 2016.
- [17] Heineken NV. *Lijnresultaten per week*, 2016.
- [18] OTA. Internal otacard log, 2016.
- [19] OTA. *Dashboard Heineken-Alpherium*, 2016.
- [20] SABMiller. Sabmiller, 2015 annual report. <http://www.ab-inbev.com/investors/sabmiller-historical/reports.html>.
- [21] Robert G Sargent. Verification and validation of simulation models. In *Proceedings of the 2011 Winter Simulation Conference*. winter simulation conference, 2011.
- [22] Ron van Galen. Basic design note voor de implementatie van de interface MES-WMS tbv aanpassing crossdockbanen (CSL Flexibility), 2016.

- 
- [23] Maneesh Varshney. <http://www.simjs.com>. <http://www.simjs.com>, 2016.
- [24] Hans PM Veeke. *Interdisciplinary modeling for logistics design*, 2003.
- [25] Hans PM Veeke, Jaap A Ottjes, and Gabriël Lodewijks. *The Delft systems approach: Analysis and design of industrial systems*. Springer Science & Business Media, 2008.
- [26] Omroep West. <https://www.omroepwest.nl/nieuws/2905930/Containerterminal-Alpherium-in-Alphen-aan-den-Rijn-zegt-sorry-tegen-omwonenden-n> 2016.



# Paper

## Optimizing the flow of export containers at Heineken Zoeterwoude

*Steven Valk*

---

This paper discusses improving the **C**ustomer **S**ervice & **L**ogistics department, CS&L, at Heineken Zoeterwoude. An analysis is made of CS&L, leading to the conclusion that there is a lack of real-time information from the packaging department. A proposed solution is to create a delivery overview for the operators, which displays the upcoming and ongoing deliveries. This enables the operators to schedule the task of loading of containers by supplying real-time information from packaging. A simulation tests the effect of the proposed solution. Concluding that the proposed overview has a positive effect on the performance of the system. However, it also identifies hurdles in creating the overview in practice, as the

---

### A.1. Introduction

Heineken Zoeterwoude is the largest brewery in Europe. The **C**ustomer **S**ervice & **L**ogistics department, CS&L, is responsible for handling the pallet flow from any of the fifteen bottling lines, resembled by "Shipping" in figure A.1.

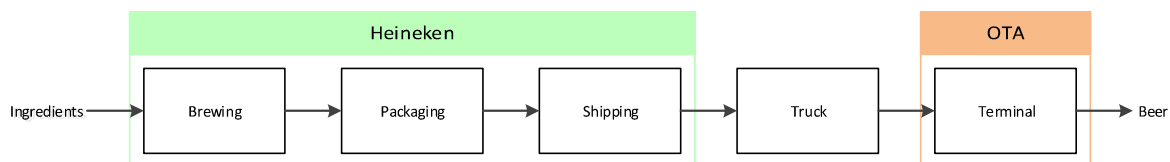


Figure A.1: The process steps of CS&L, loading of pallets into containers.

These bottling lines fill bottles or other products with beer and pack these onto a pallet for further handling. It is the job of CS&L to receive these pallets and load these in containers, storage or ship these towards domestic warehouses.

The main research question of this paper is:

How to improve the process of export deliveries of CS&L department at Heineken Zoeterwoude?

## A.2. Process

The process of CS&L starts when it receives a pallet from a bottling line, as seen in figure A.2. [REDACTED] of the [REDACTED] bottling lines are relevant for exporting, but this will be soon expanded to [REDACTED]. The pallets which are produced are first stored in an automated pallet buffer or crossdock, before they are loaded into a container and shipped. The pallets from the different bottling lines do not mix as they are different products destined for their own deliveries.

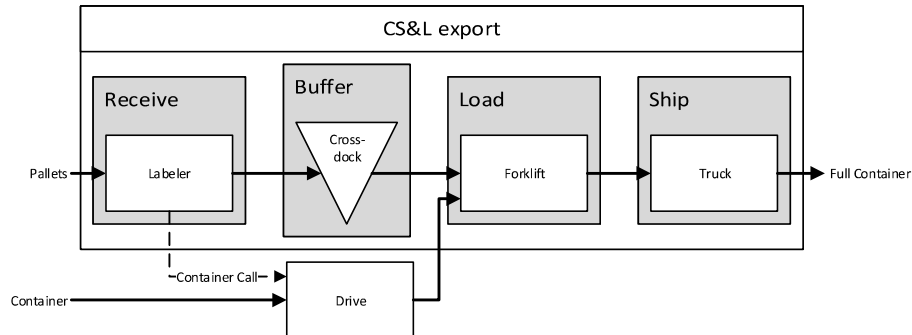


Figure A.2: The process steps of CS&L, loading of pallets into containers.

A delivery is a container load of a specific product which is shipped all over the world.

The containers are automatically called from **Overslag Terminal Alpen**, OTA, a local terminal in Alpen on the Rhine. This inland container terminal is approximately [REDACTED] minutes away from the brewery. OTA is tasked with shipping containers from and to Rotterdam port via barges and shuttling these containers on request to the brewery[18]. The shuttle service transports empty containers to the brewery and takes full containers back.

It is the task of the **warehouse coordinator**, WHC, to manage the operations of CS&L and therefore the container call process. The containers are called when a certain number of pallets is received for a delivery. The trigger point is usually set at around [REDACTED] minutes in advance, which is usually about [REDACTED] pallets of production.

## A.3. Analysis

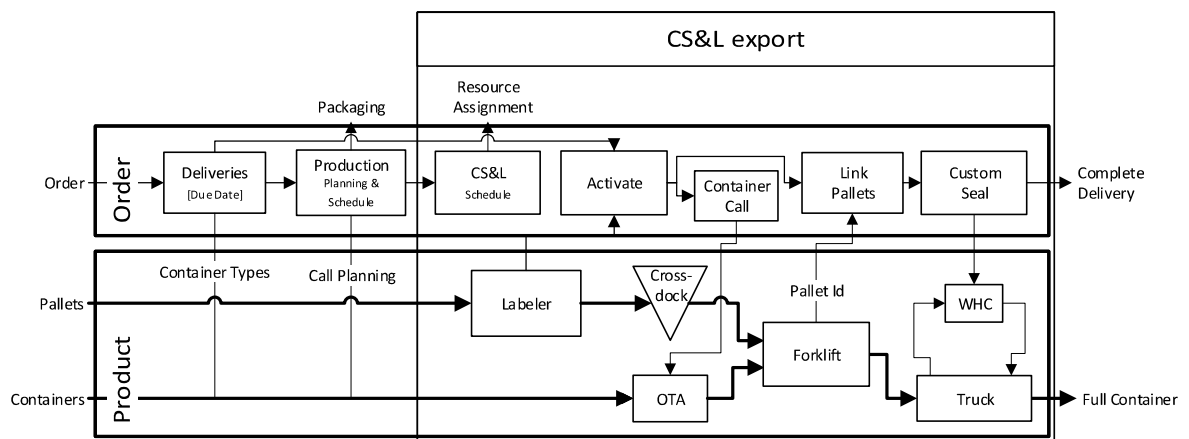


Figure A.3: The PROPER model of CS&L, with the order and product flow.

An analysis is made of the system using the PROPER[24] model, which highlighted several concerns: The most important concern is stand-still, which is when a pallet from packaging isn't handled in time, resulting in a halted packaging line[15]. Another concern is the loading bay occupation. With the expected growth more containers have to be handled with the same number of bays. Several problems are identified:

- There is a significant offset between the schedule of the packaging department and the actual production, which causes problems in expected work load and makes the actual schedule irrelevant for the CS&L coordinator[1][18].
- The operator is unable to schedule the task of loading containers as he lacks the information needed.
- The container trigger is based upon a trigger which does not account for the upcoming production and needs to be actively managed by the coordinator.
- The coordinator has a limited overview of the upcoming production, resulting in uncertainty and therefore higher margins in the container call.
- There is a large margin where the container is already at the loading bay, but not yet being loaded. A container is on average docked for ■ minutes, of which about ■ minutes of this time can be accounted to the time before loading. By optimising the container trigger a reduction in this margin should be possible[8][19]

It is concluded that a constant factor is the lack of real-time information about the upcoming production from the packaging lines.

### A.4. Concept

A proposed solution is to make a delivery-overview which displays deliveries for which products are being filled and expected to be or already received by CS&L.

This overview enables the operators to schedule the loading of containers and be less dependent on experience.

By enabling task scheduling the stand-still should be reduced. By given the operators an overview the dependency on experience is reduced as the information is clearly visible, increasing flexibility in operator pool. This also enables operators to be held partly responsible for the performance of CS&L as a whole.

The overview and its data could later also be used to improve the container call process from OTA, as additional information for the coordinator and enable live KPI's.

### A.5. Simulation

A simulation is made to asses whether the influence of task scheduling the process of loading containers has a significant influence on the stand-still and other concerns. A follow up on this question; which loading algorithm is best suited for the delivery overview? Six different loading algorithms were created,, based on different characteristics, which order the loading tasks for the operator.

- Random, selects a random loading task.
- Container FIFO selects the oldest container.
- Pallet FIFO the delivery with the oldest pallet available.



Figure A.4: Example of a delivery overview.

- Pallets on crossdock, selects the task based on the available number of pallet spaces before the crossdock is full.
- Line speed prioritizes the fastest bottling lines over slower ones.
- And finally "First full" uses knowledge about production breaks to estimate which bottling line needs to be prioritised.

## A.6. Results

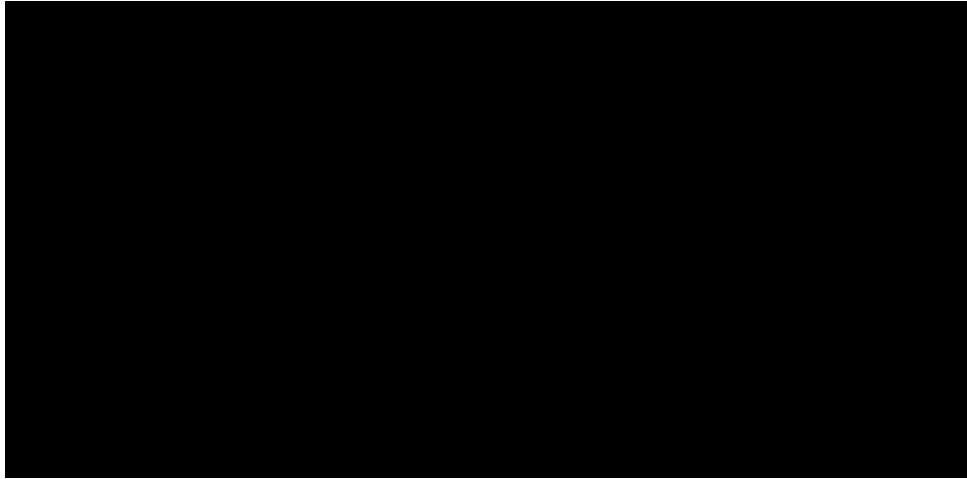


Figure A.5: The results of a simulation run, with default input comparing the different algorithms, lowest is best.

As expected task scheduling of the loading process has a significant influence on the stand-still of the system. In the reference run, which orders the tasks at random, the stand-still is ██████, this is reduced to ██████ with the algorithm "First Full".

## A.7. Implementation

The implementation of the overview is difficult as there are several hurdles to overcome[12]. There is an digital interface between the informational system of CSL and the packaging department. The informational system of CS&L is capable of processing the data for an overview. However obtaining the correct information of the bottling lines is difficult, as the informational system is designed to control the process and not track the products. A proposed update to informational system of packaging in which charge tracking is implemented could help. Until this is realised the implementation of the overview is difficult or infeasible. An alternative approach would be to create a delivery overview with only data from CS&L. This approach would lead to a limited scope, as there is no information on the status of the pallets from the packaging lines.

Table A.1: The average stand-still for different algorithms.

Scenario	Stand-still
Random	<span style="background-color: black; color: black;">██████</span>
Container FIFO	<span style="background-color: black; color: black;">██████</span>
Pallet FIFO	<span style="background-color: black; color: black;">██████</span>
Pallets on crossdock	<span style="background-color: black; color: black;">██████</span>
Line speed	<span style="background-color: black; color: black;">██████</span>
First Full	<span style="background-color: black; color: black;">██████</span>

## A.8. Conclusion

By supplying real-time data from packaging the export operations of CS&L can be improved. It is proposed to show this information in the form of the delivery overview, which shows the upcoming deliveries based on real-time information from the packaging lines. This enables operators to task schedule the loading of containers, reducing stand-still. In the simulation stand-still is reduced from ██████ to ██████.