Institut für Seeverkehrswirtschaft und Logistik
Institute of Shipping Economics and Logistics

CAPS – SCUSY Exercise
Greenfield terminal

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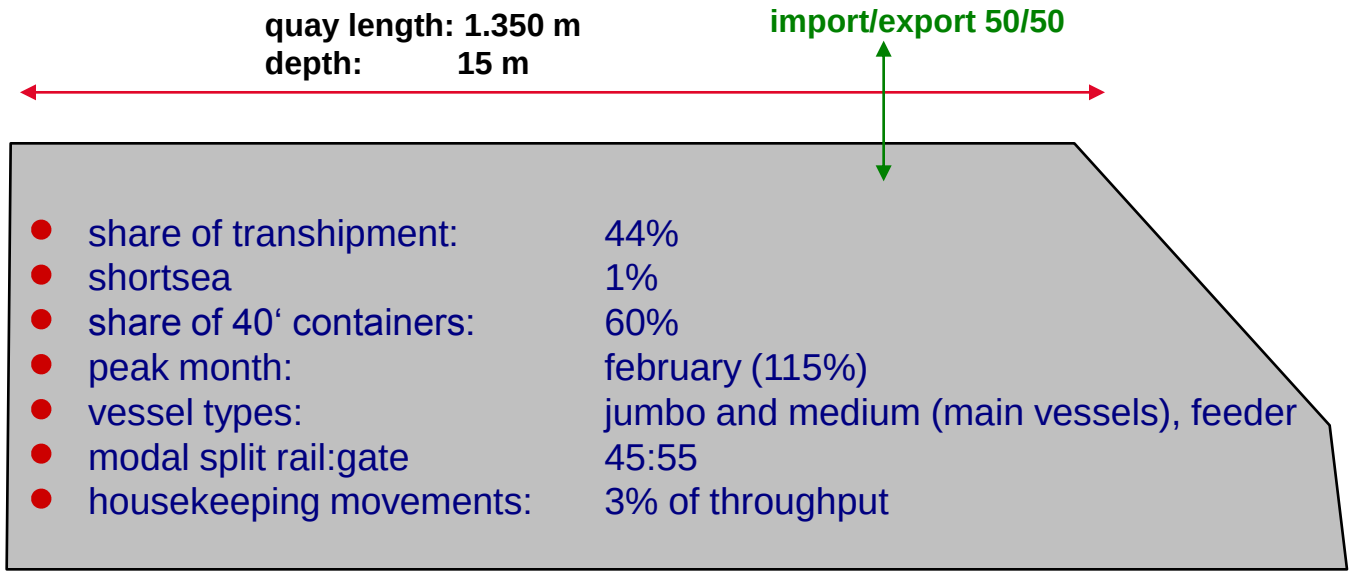
Planning of greenfield terminals

- **Example**



Standard vessel types

- **Main vessels**

Jumbo

- A J1800
- B J2200

Medium

- A M550
- B M900
- C M1200

- **Feeder vessels (transhipment plus shortsea)**

Feeder

- A F190
- B F250

Standard vessel types: main vessels

- **main vessels**

Jumbo

type	length [m]	width [m]	draught [m]	handled boxes	moves/hr aver.	cranes/vessel aver.	docking time [hr] arrival	docking time [hr] departure	security distance [m]	% of throughput
J1800	250/300	35/40	14/15	1800	27	4,50	1,00	1,00	30,00	10,00%
J2200	280/320	35/40	14/15	2200	28	4,50	1,00	1,00	30,00	60,00%

Medium

type	length [m]	width [m]	draught [m]	handled boxes	moves/hr aver.	cranes/vessel aver.	docking time [hr] arrival	docking time [hr] departure	security distance [m]	% of throughput
M550	250/310	32/38	12,5/12,5	550	20,5	3,00	1,00	1,00	30,00	5,00%
M900	250/310	32/38	12,5/12,5	900	20,5	3,00	1,00	1,00	30,00	5,00%
M1200	280/310	32/38	12,5/12,5	1200	22,5	3,67	1,00	1,00	30,00	20,00%

Standard vessel types: main vessels II

- Jumbo vessels have to be handled with first priority, vessels of type Medium with second priority
- Jumbo vessels have a maximum waiting time of two hours; Medium vessels do not wait longer than four hours

Calculation of vessel subclass probability

80% probability of subclass A → 8 from 10 Jumbos are from subclass A

Exercise :

Type / subclass	% of throughput	handled boxes
Jumbo A	10 %	1,800
Jumbo B	60%	2,200
Medium A	5 %	550
Medium B	5%	900
Medium C	20%	1,200

Calculation of vessel subclass probability

80% probability of subclass A → 8 from 10 Jumbos are from subclass A

Exercise :

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Jumbo A	10 %	1,800
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Medium A	5 %	550
Medium B	5%	900
Medium C	20%	1,200

Calculation: Suppose 1 mio boxes throughput

Type / subclass	throughput of type/subclass	no. arrivals	subclass probability
Jumbo A	100,000		
Jumbo B			
Medium A			
Medium B			
Medium C			

Calculation of vessel subclass probability

80% probability of subclass A → 8 from 10 Jumbos are from subclass A

Exercise :

Type / subclass	% of throughput	handled boxes
Jumbo A	10 %	1,800
Jumbo B	60%	2,200
Medium A	5 %	550
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Medium C	20%	1,200

Calculation: Suppose 1 mio boxes throughput

Type / subclass	throughput of type/subclass	no. arrivals	subclass probability
Jumbo A	100,000	55.55	
Jumbo B			
Medium A			
Medium B			
Medium C			

Calculation of vessel subclass probability

80% probability of subclass A → 8 from 10 Jumbos are from subclass A

Exercise :

Type / subclass	% of throughput	handled boxes
Jumbo A	10 %	1,800
Jumbo B	60%	2,200
Medium A	5 %	550
Medium B	5%	900
Medium C	20%	1,200

Calculation: Suppose 1 mio boxes throughput

Type / subclass	throughput of type/subclass	no. arrivals	subclass probability
Jumbo A	100,000	55.55	16.9
Jumbo B	600,000	272,72	
Medium A			
Medium B			
Medium C			

Calculation of vessel subclass probability

80% probability of subclass A → 8 from 10 Jumbos are from subclass A

Exercise :

Type / subclass	% of throughput	handled boxes
Jumbo A	10 %	1,800
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Medium A	5 %	550
Medium B	5%	900
Medium C	20%	1,200

Calculation: Suppose 1 mio boxes throughput

Type / subclass	throughput of type/subclass	no. arrivals	subclass probability
Jumbo A	100,000	55.55	16.9
Jumbo B	600,000	272,72	83.1
Medium A	50,000	90,90	29.0
Medium B	50,000	55,56	17.7
Medium C	200,000	166,67	53.2

Standard vessel types: feeder vessels

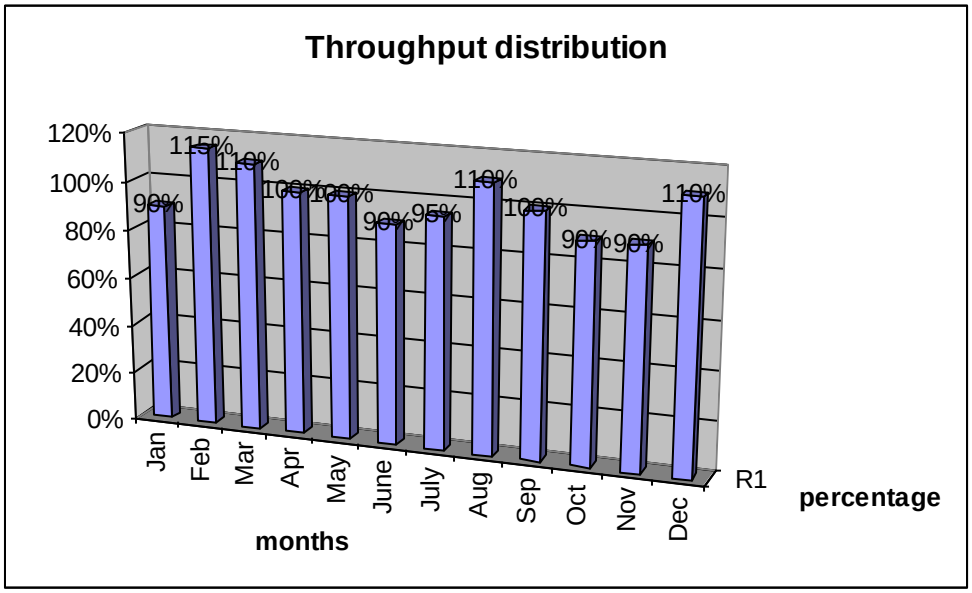
- **feeder vessels**

Feeder

type	length [m]	width [m]	draught [m]	handled boxes	moves/hr aver.	cranes/vessel aver.	docking time [hr] arrival	docking time [hr] departure	security distance [m]	% of throughput
F190	80/120	17/18	6/7	190	14,33	1,50	1,00	0,50	15,00	60%
F250	110/150	17/18	6/7	250	14,33	1,50	1,00	0,50	15,00	40,00%

- **Feeder vessels have lowest priority and longest waiting time (eight hours are acceptable)**

Throughput distribution



- **There is no special distribution over the weekdays!**

Container mix

	share	dwell time (days) import	export
• reefer boxes:	7%	4	3
• mty boxes:	12%	15	15
• oversize:	1%	4	4
• hazardous	1%	5	5
• standard	79%	4	4

Case study – simulation procedure

step 1 → **Determination of the maximum possible throughput under optimal conditions for the quay, i.e.**
- **no. of STS cranes unlimited**
- **no. of slots unlimited**

step 2 → **Determination of the quay crane requirement:**
- **basis: maximum throughput from step 1**
- **no. of STS cranes limited**
- **allocation of STS cranes to quay sections**
- **definition of crane ranges**
- **no. of slots still unlimited**

step 3 → **Determination of the slot requirement:**
- **basis: maximum throughput from step 1**
  no. of cranes from step 2
- **approaching to slot requirement**

Case study – simulation procedure

step 1 → **Determination of the maximum possible throughput under optimal conditions for the quay, i.e.**
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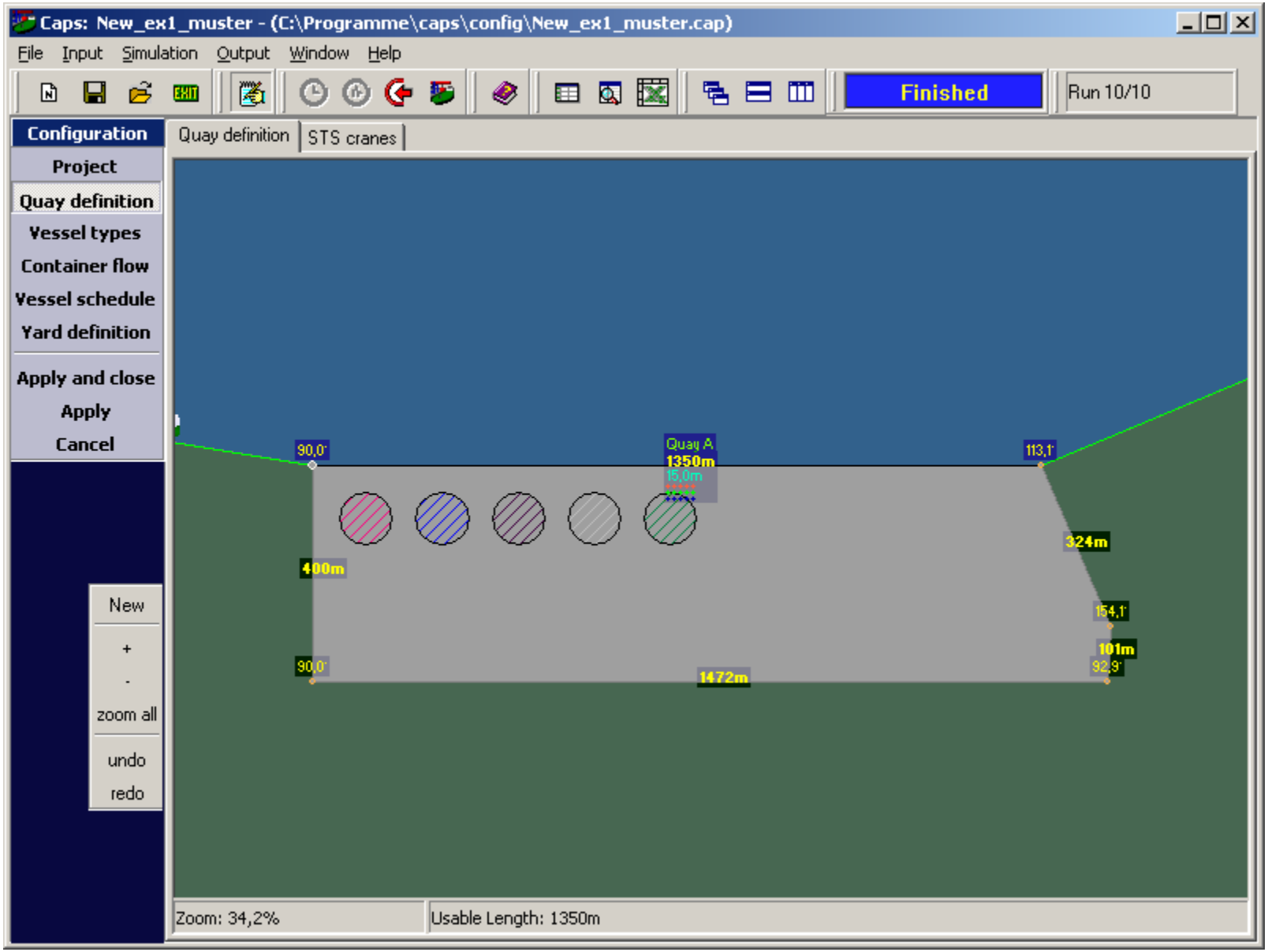
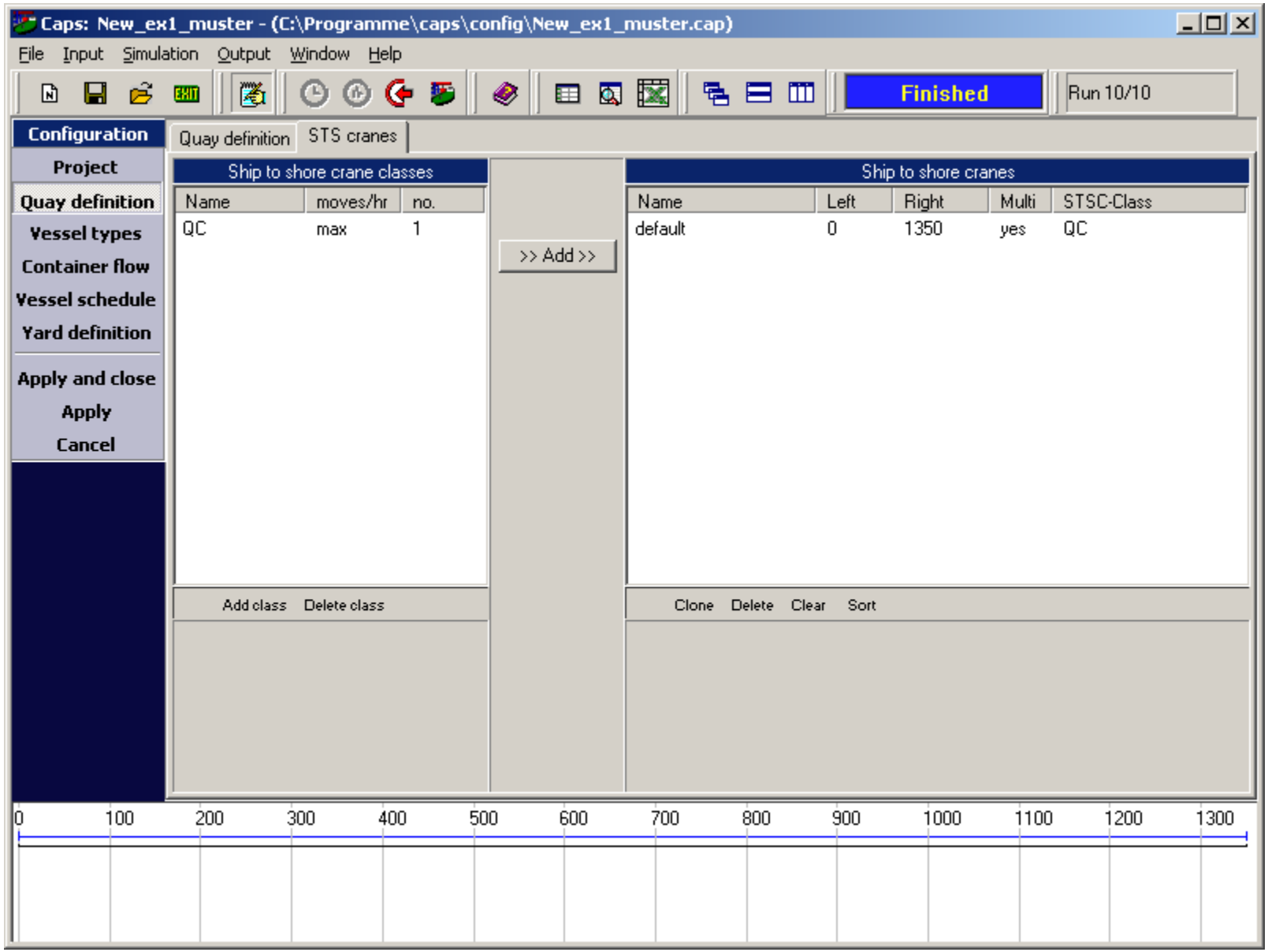
- **definition of crane ranges**
- **no. of slots still unlimited**

step 3 → **Determination of the slot requirement:**
- **basis: maximum throughput from step 1**
  no. of cranes from step 2
- **approaching to slot requirement**

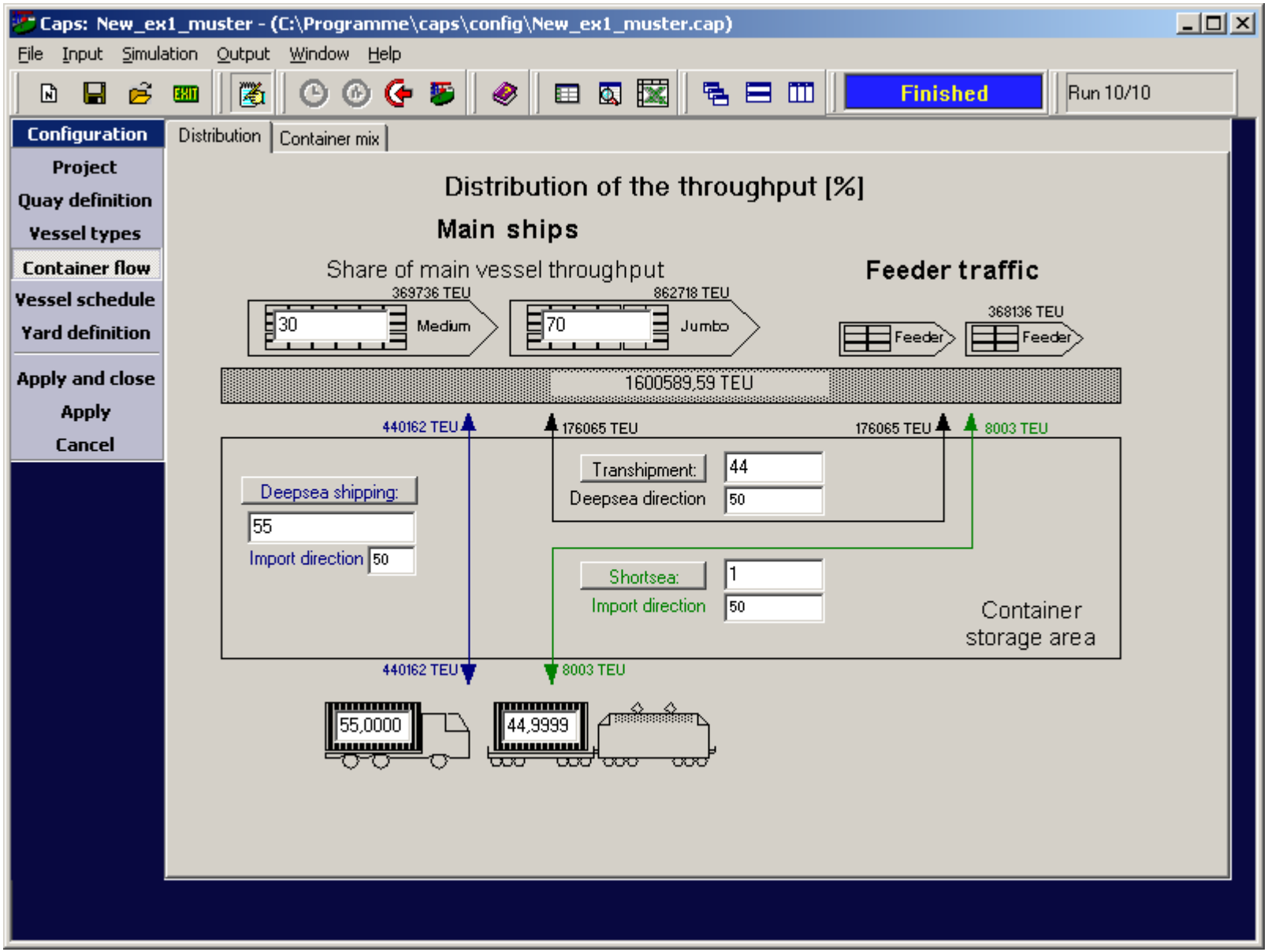
Layout


Caps: New_ex1_muster - (C:\Programme\caps\config\New_ex1_muster.cap)
File Input Simulation Output Window Help
Finished
Run 10/10
Configuration
Project
Quay definition
Vessel types
Container flow
Vessel schedule
Yard definition
Apply and close
Apply
Cancel
New
+
-
zoom all
undo
redo
Quay definition
STS cranes
90,0°
Quay A
1350m
15,0m
113,1°
324m
400m
154,1°
101m
92,9°
90,0°
1472m
Zoom: 34,2%
Usable Length: 1350m

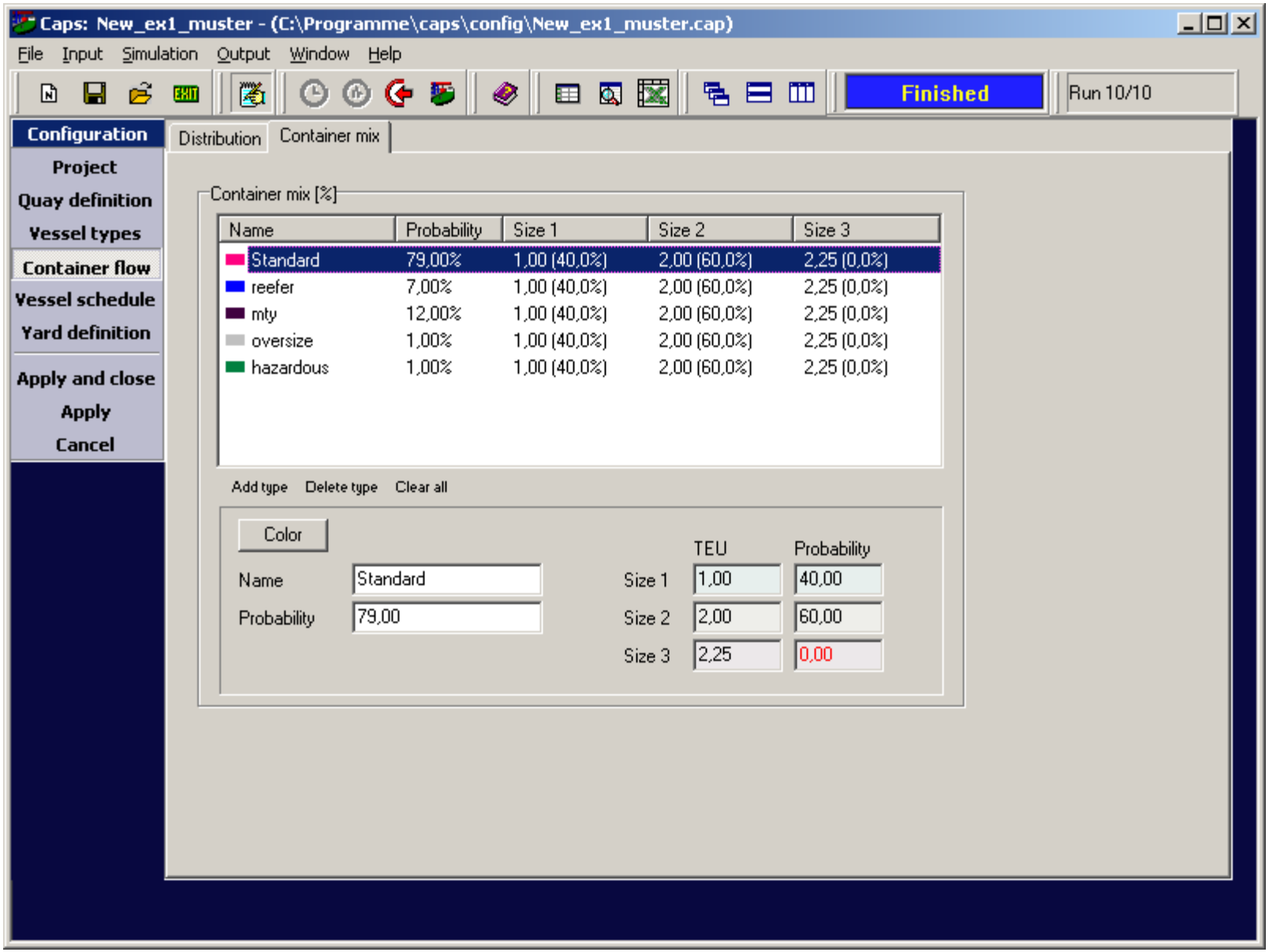
STS-Cranes


Caps: New_ex1_muster - (C:\Programme\caps\config\New_ex1_muster.cap)
File Input Simulation Output Window Help
Finished
Run 10/10
Configuration
Project
Quay definition
Vessel types
Container flow
Vessel schedule
Yard definition
Apply and close
Apply
Cancel
Quay definition
STS cranes
Ship to shore crane classes
Name moves/hr no.
QC max 1
Add class Delete class
>> Add >>
Ship to shore cranes
Name Left Right Multi STSC-Class
default 0 1350 yes QC
Clone Delete Clear Sort
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300

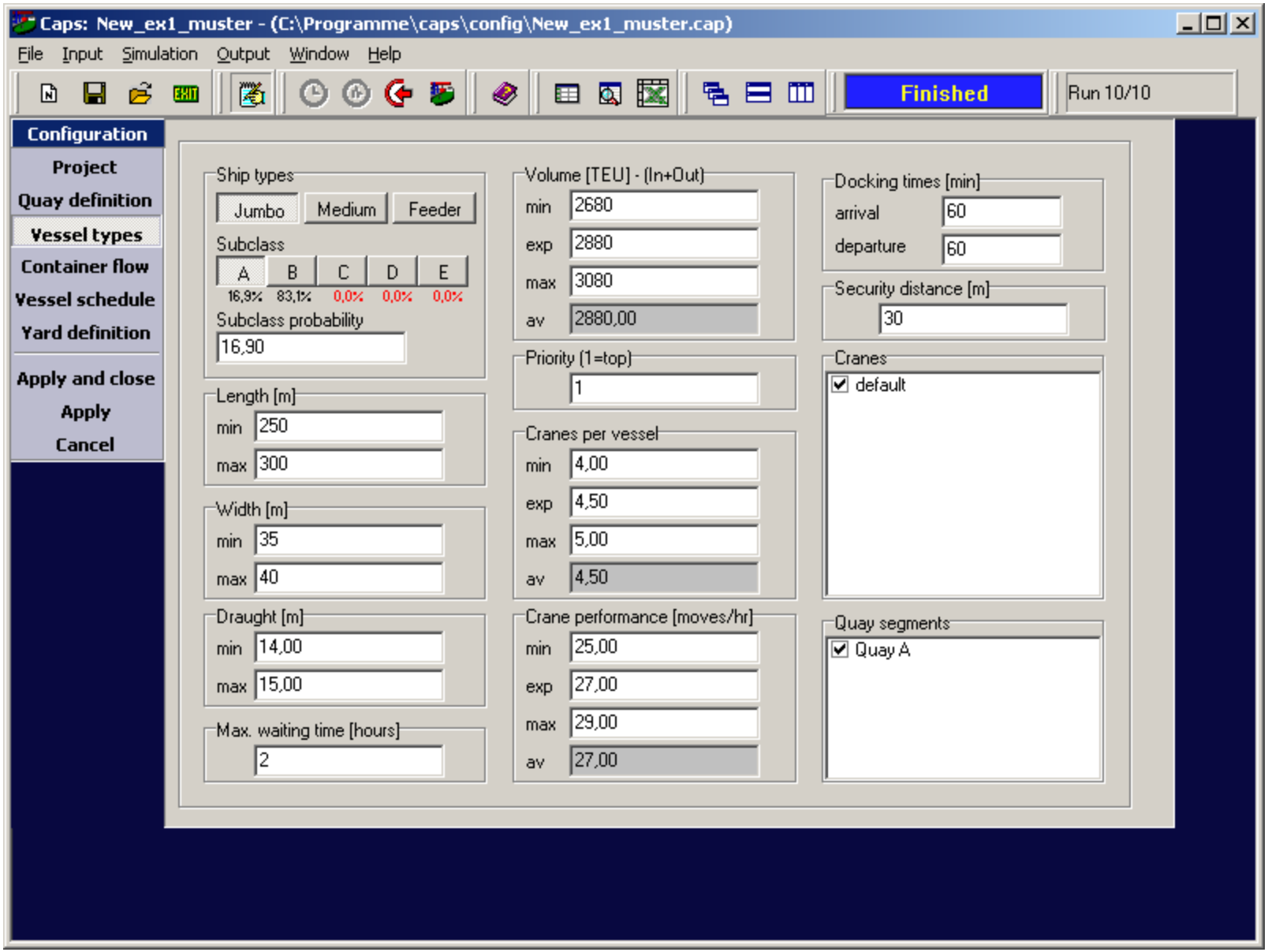
Throughput


Caps: New_ex1_muster - (C:\Programme\caps\config\New_ex1_muster.cap)
File Input Simulation Output Window Help
Finished
Run 10/10
Configuration
Project
Quay definition
Vessel types
Container flow
Vessel schedule
Yard definition
Apply and close
Apply
Cancel
Distribution
Container mix
Distribution of the throughput [%]
Main ships
Share of main vessel throughput
369736 TEU
30
Medium
862718 TEU
70
Jumbo
Feeder traffic
368136 TEU
Feeder
Feeder
1600589,59 TEU
440162 TEU
176065 TEU
176065 TEU
8003 TEU
Deepsea shipping:
55
Import direction 50
Transhipment:
44
Deepsea direction
50
Shortsea:
1
Import direction
50
Container storage area
440162 TEU
8003 TEU
55,0000
44,9999

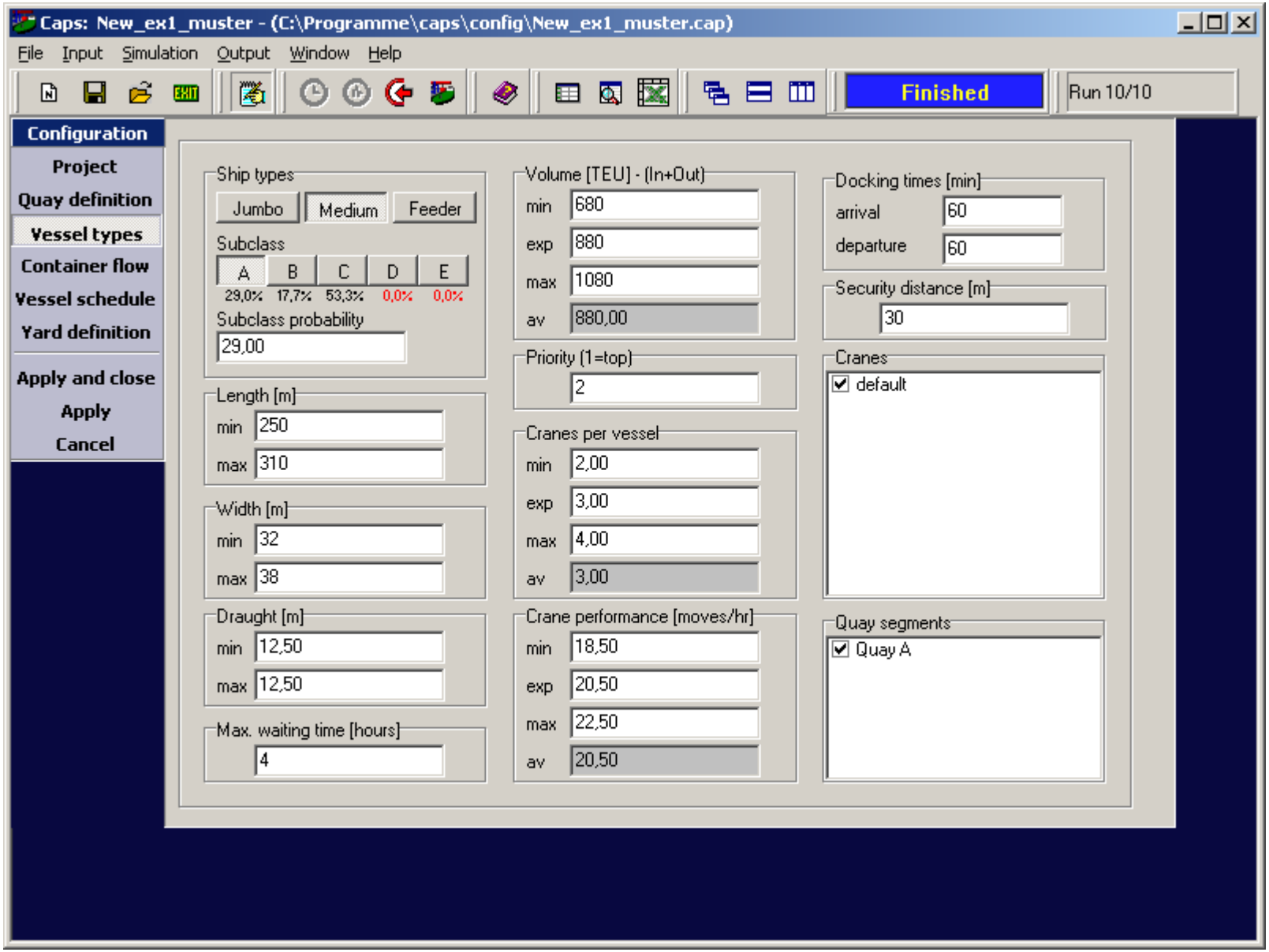
Container-Mix



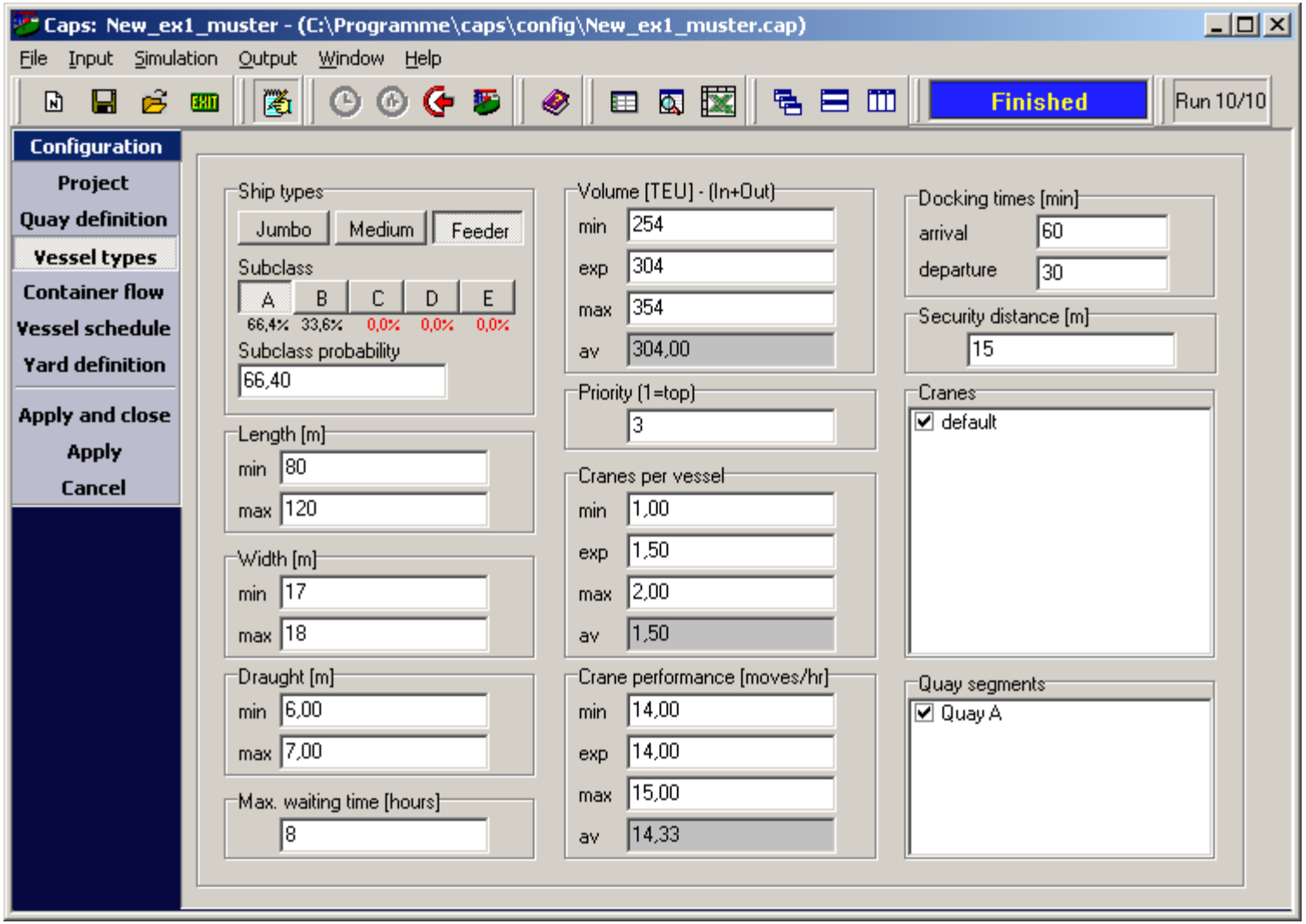
Vessel types - Jumbo



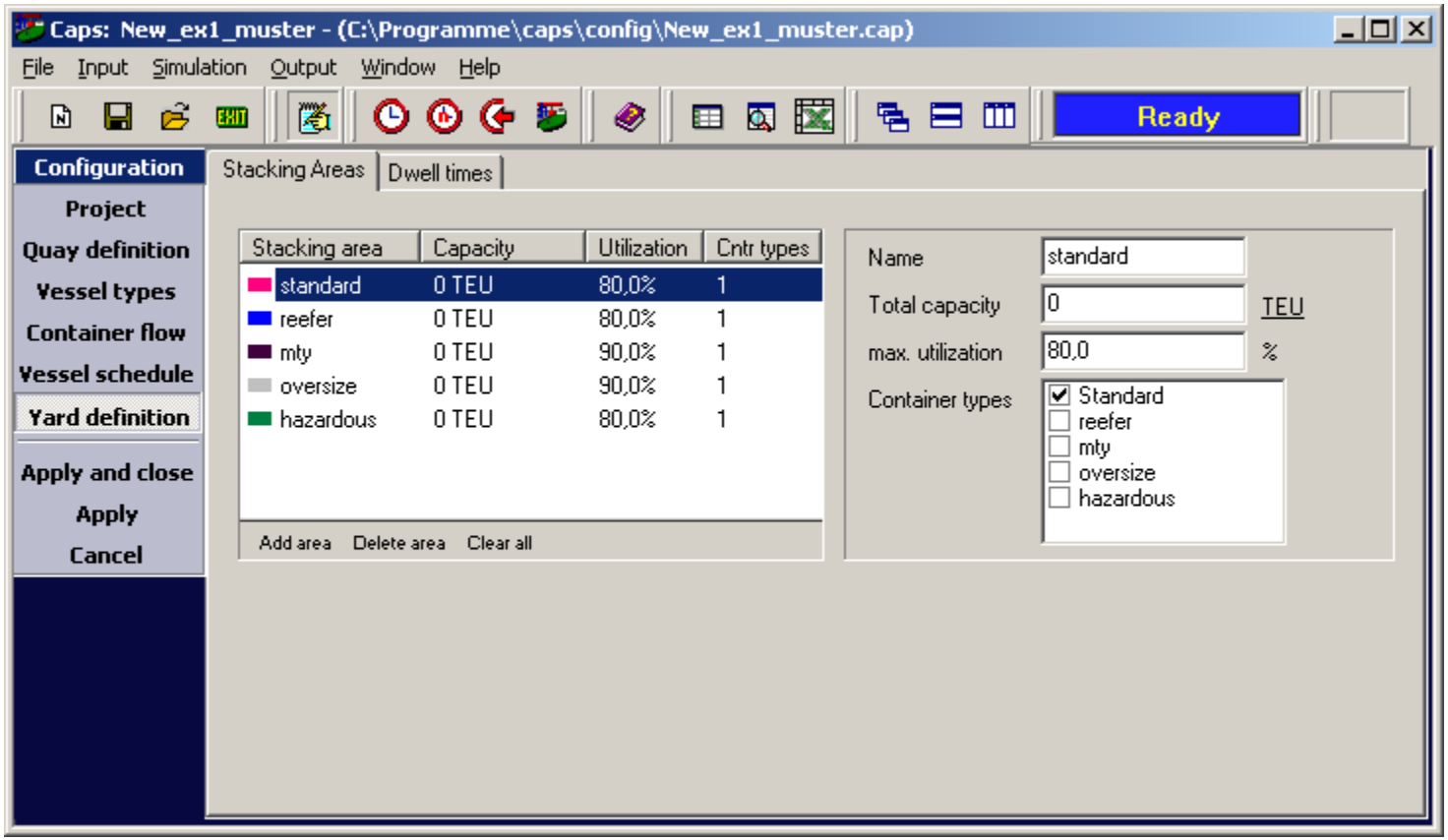
Vessel types - Medium



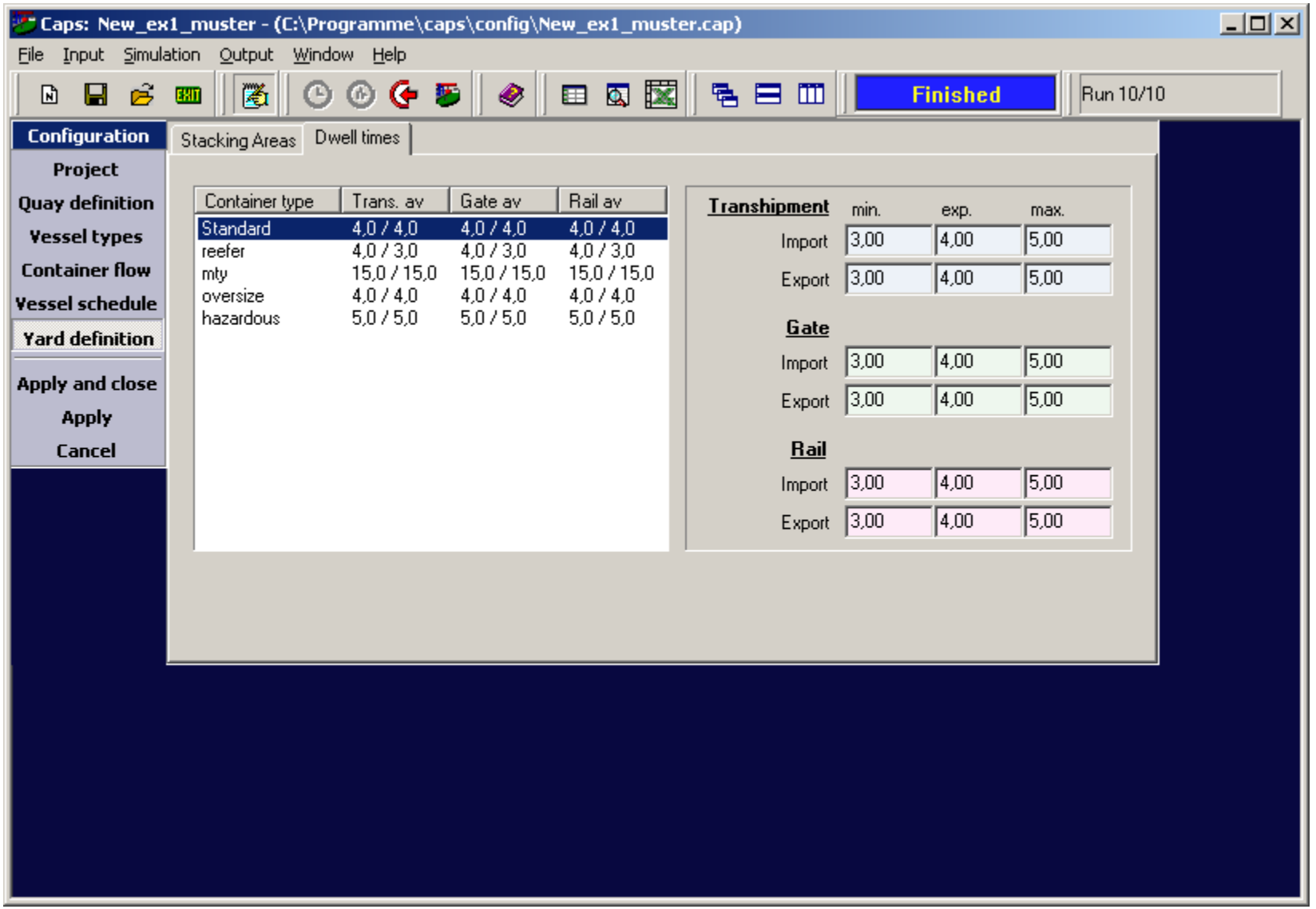
Vessel types - Feeder



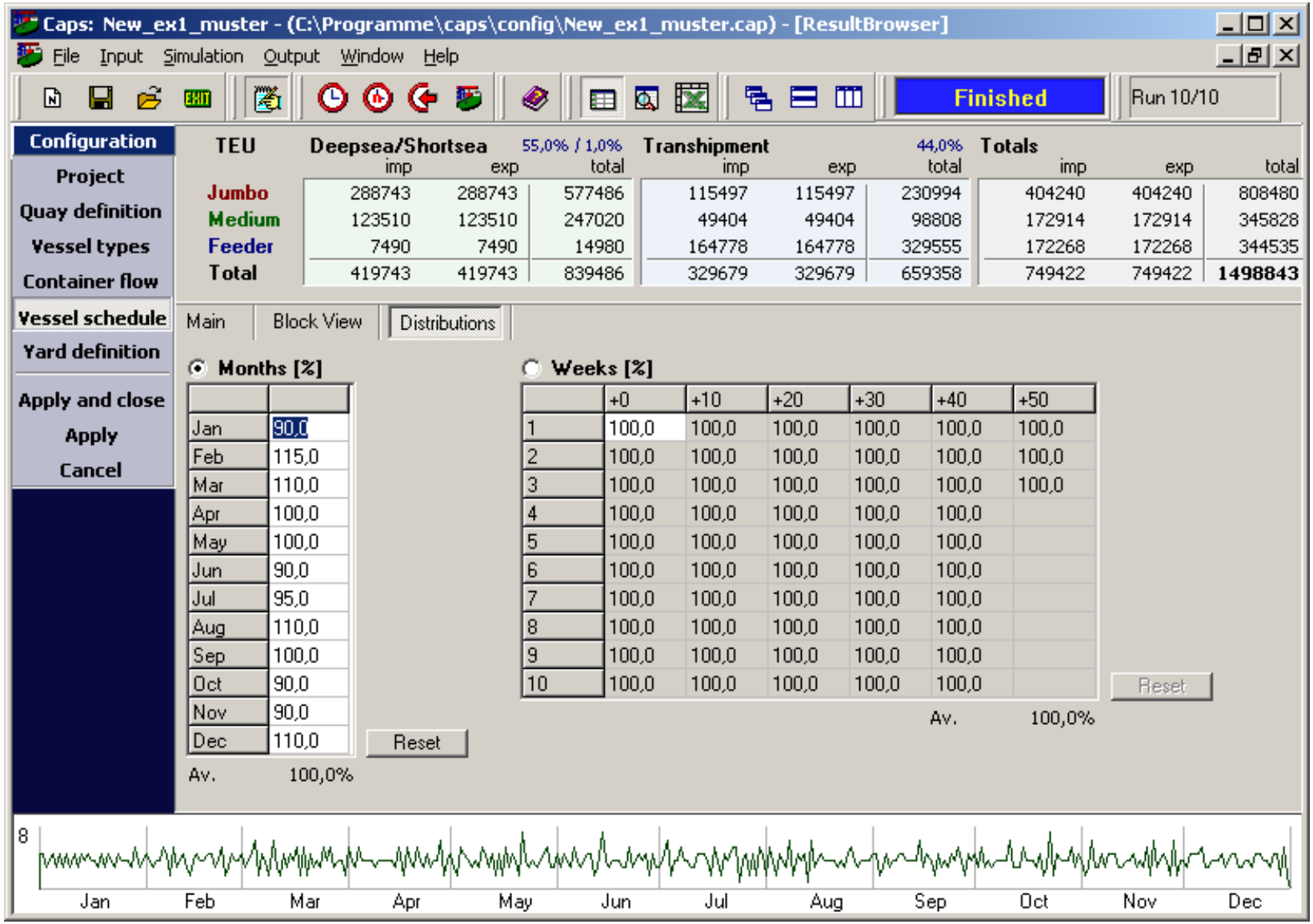
Stacking areas



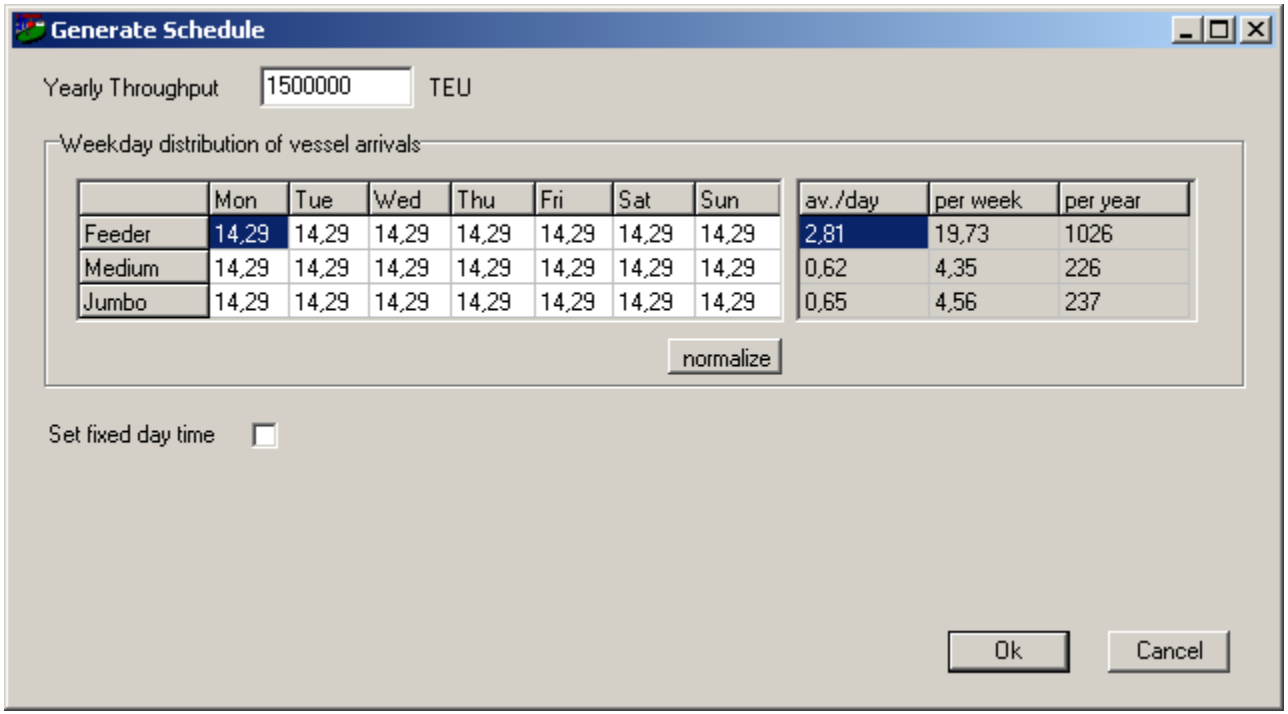
Dwell times


Caps: New_ex1_muster - (C:\Programme\caps\config\New_ex1_muster.cap)
File Input Simulation Output Window Help
Finished
Run 10/10
Configuration
Project
Quay definition
Vessel types
Container flow
Vessel schedule
Yard definition
Apply and close
Apply
Cancel
Stacking Areas
Dwell times
Container type | Trans. av | Gate av | Rail av
Standard | 4,0 / 4,0 | 4,0 / 4,0 | 4,0 / 4,0
reefer | 4,0 / 3,0 | 4,0 / 3,0 | 4,0 / 3,0
mty | 15,0 / 15,0 | 15,0 / 15,0 | 15,0 / 15,0
oversize | 4,0 / 4,0 | 4,0 / 4,0 | 4,0 / 4,0
hazardous | 5,0 / 5,0 | 5,0 / 5,0 | 5,0 / 5,0
Transhipment min. exp. max.
Import 3,00 4,00 5,00
Export 3,00 4,00 5,00
Gate
Import 3,00 4,00 5,00
Export 3,00 4,00 5,00
Rail
Import 3,00 4,00 5,00
Export 3,00 4,00 5,00

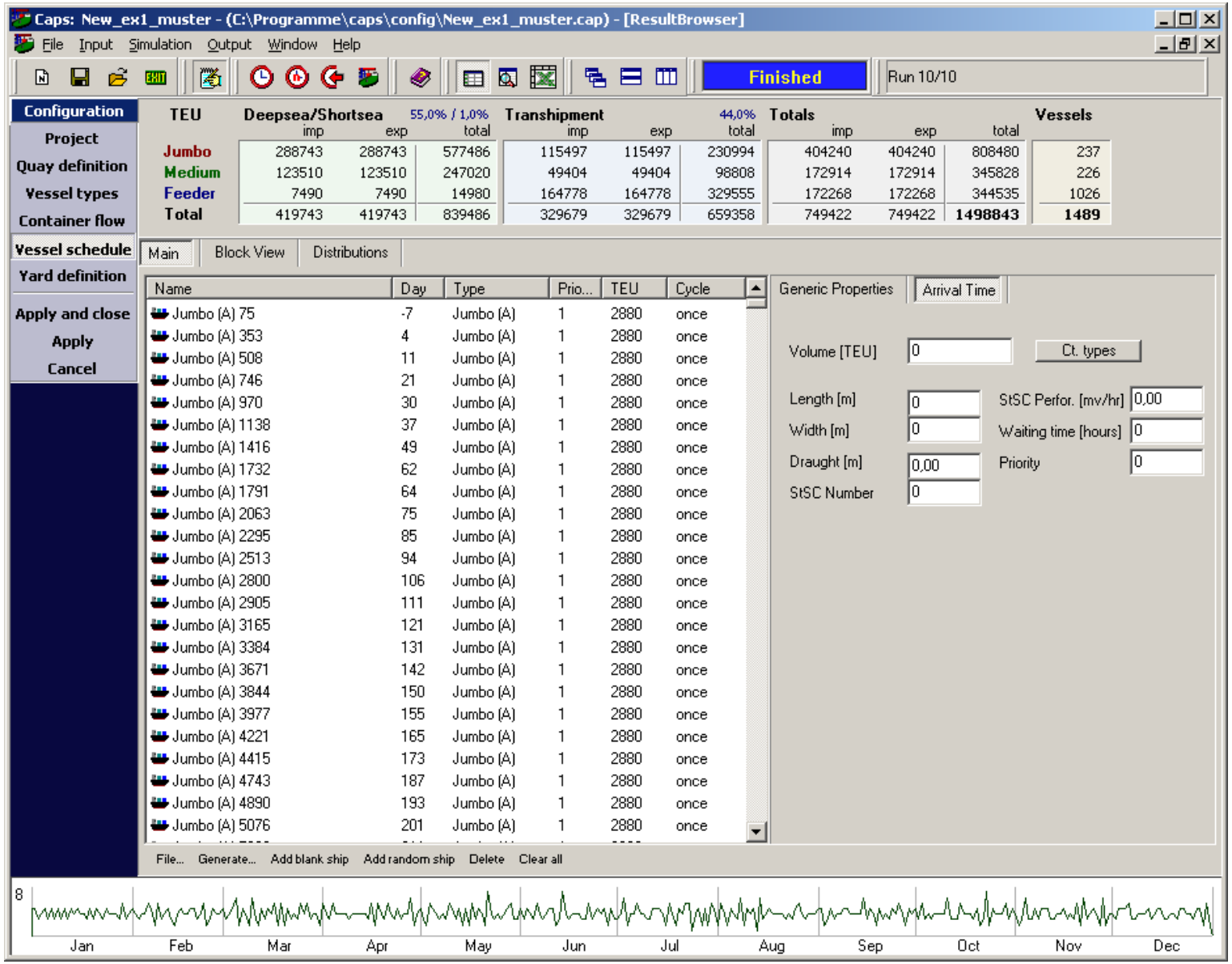
Yearly distribution



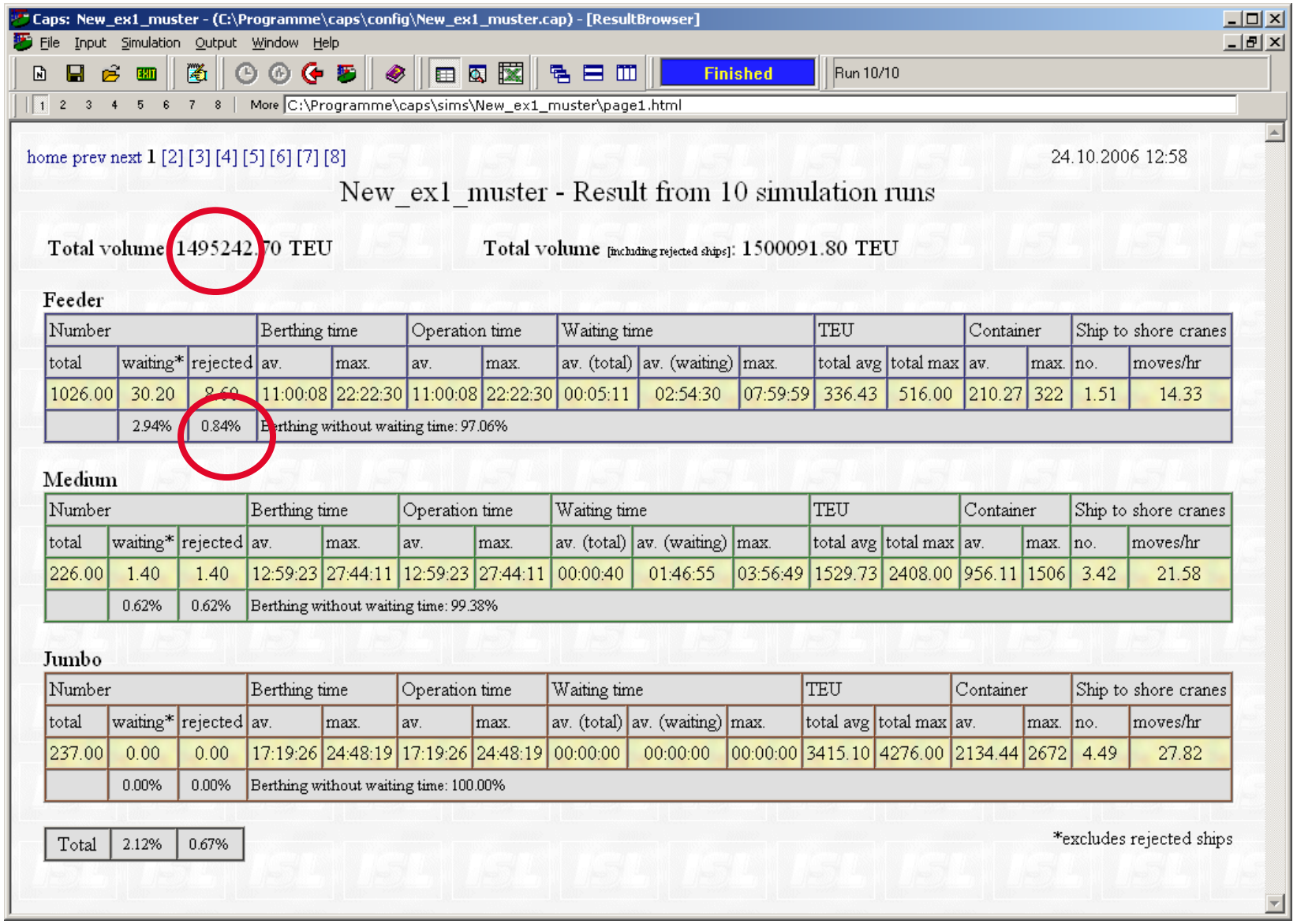
Generation


Generate Schedule
Yearly Throughput
1500000
TEU
Weekday distribution of vessel arrivals
Mon Tue Wed Thu Fri Sat Sun
Feeder 14,29 14,29 14,29 14,29 14,29 14,29 14,29
Medium 14,29 14,29 14,29 14,29 14,29 14,29 14,29
Jumbo 14,29 14,29 14,29 14,29 14,29 14,29 14,29
av./day per week per year
2,81 19,73 1026
0,62 4,35 226
0,65 4,56 237
normalize
Set fixed day time
Ok
Cancel

Vessel schedule



Result, page1



Feeder

Number			Berthing time		Operation time		Waiting time			TEU		Container		Ship to shore cranes	
total	waiting*	rejected	av.	max.	av.	max.	av. (total)	av. (waiting)	max.	total avg	total max	av.	max.	no.	moves/hr
1026.00	30.20	8.69	11:00:08	22:22:30	11:00:08	22:22:30	00:05:11	02:54:30	07:59:59	336.43	516.00	210.27	322	1.51	14.33
	2.94%	0.84%	Berthing without waiting time: 97.06%												

Medium

Number			Berthing time		Operation time		Waiting time			TEU		Container		Ship to shore cranes	
total	waiting*	rejected	av.	max.	av.	max.	av. (total)	av. (waiting)	max.	total avg	total max	av.	max.	no.	moves/hr
226.00	1.40	1.40	12:59:23	27:44:11	12:59:23	27:44:11	00:00:40	01:46:55	03:56:49	1529.73	2408.00	956.11	1506	3.42	21.58
	0.62%	0.62%	Berthing without waiting time: 99.38%												

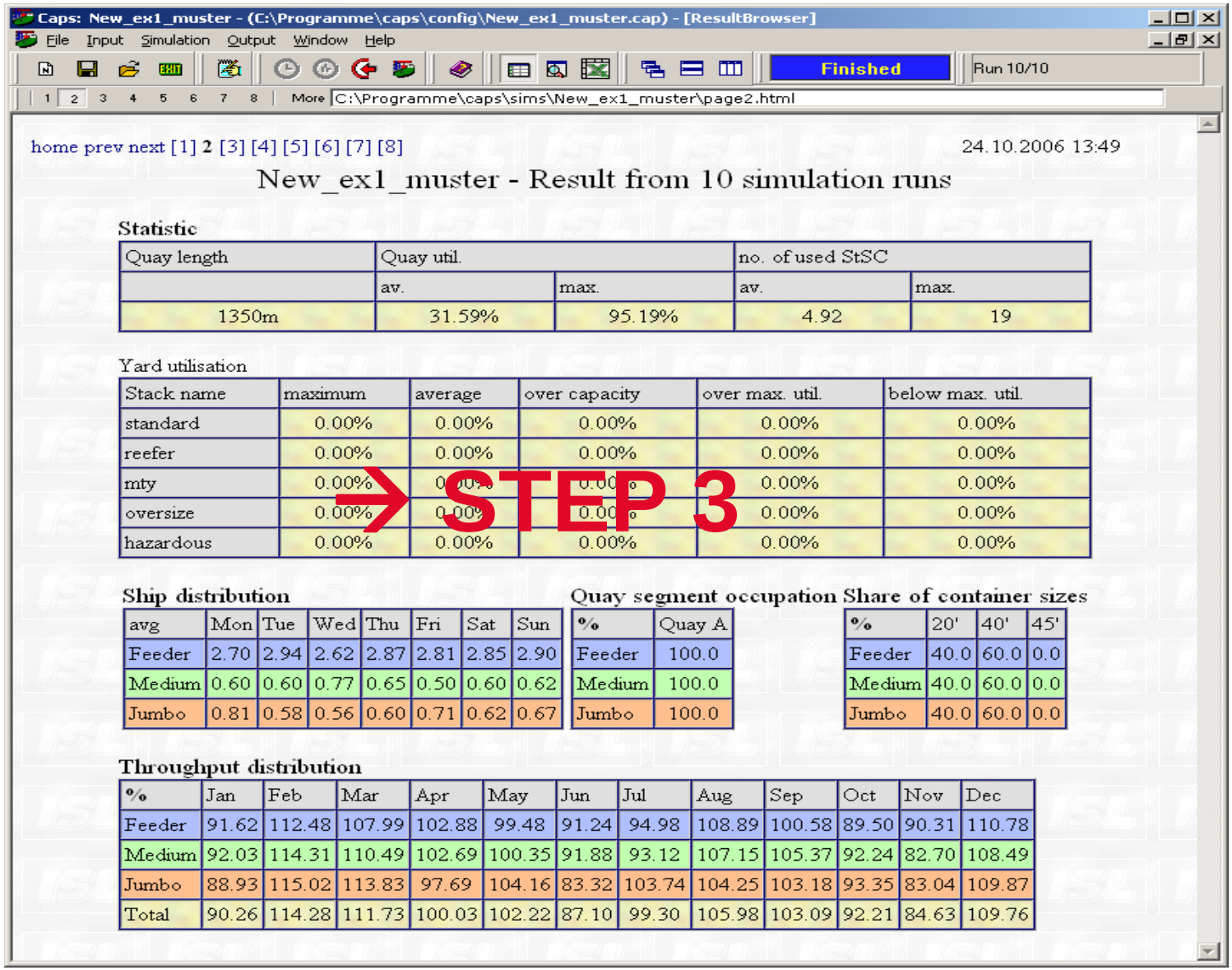
Jumbo

Number			Berthing time		Operation time		Waiting time			TEU		Container		Ship to shore cranes	
total	waiting*	rejected	av.	max.	av.	max.	av. (total)	av. (waiting)	max.	total avg	total max	av.	max.	no.	moves/hr
237.00	0.00	0.00	17:19:26	24:48:19	17:19:26	24:48:19	00:00:00	00:00:00	00:00:00	3415.10	4276.00	2134.44	2672	4.49	27.82
	0.00%	0.00%	Berthing without waiting time: 100.00%												

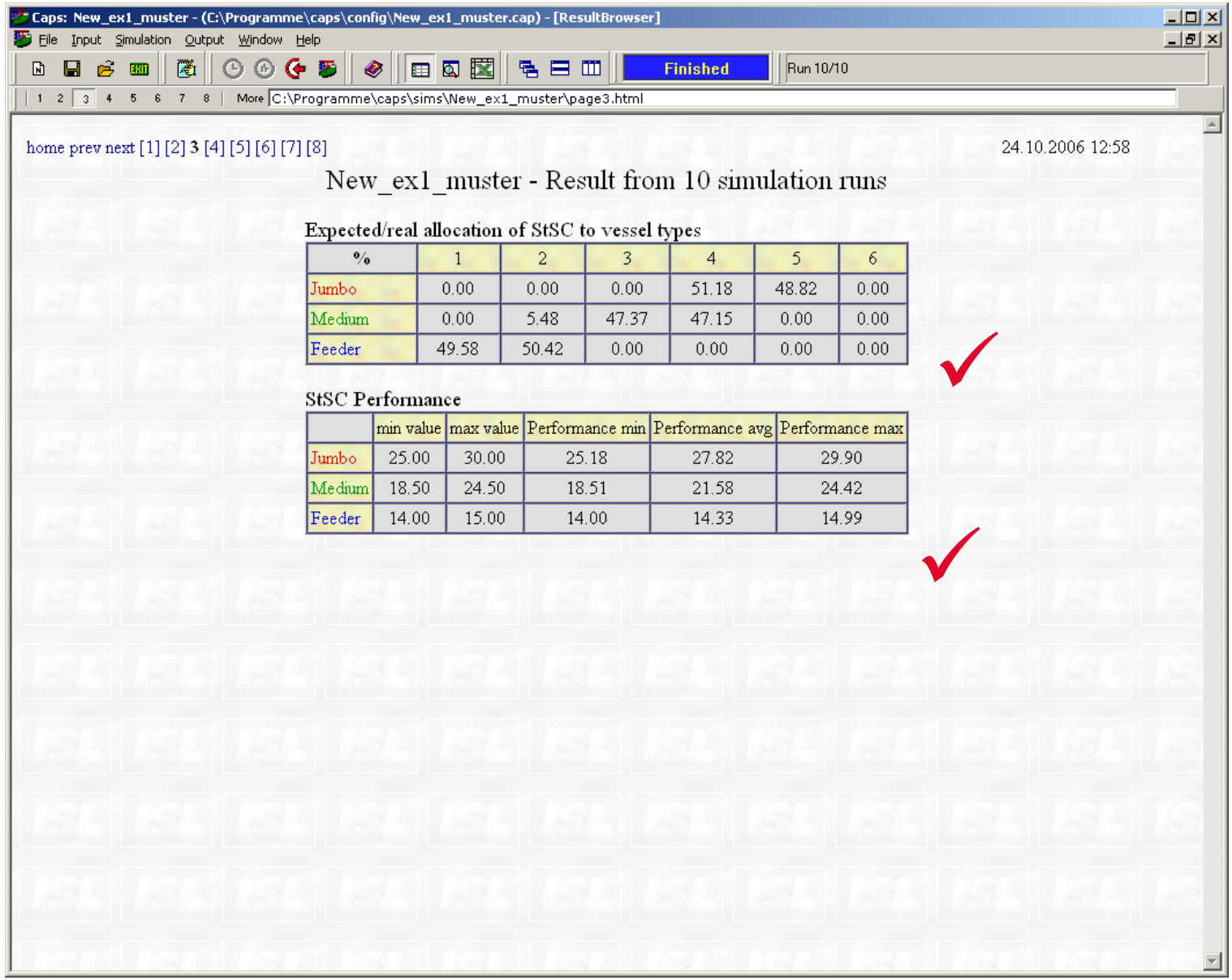
Total	2.12%	0.67%

*excludes rejected ships

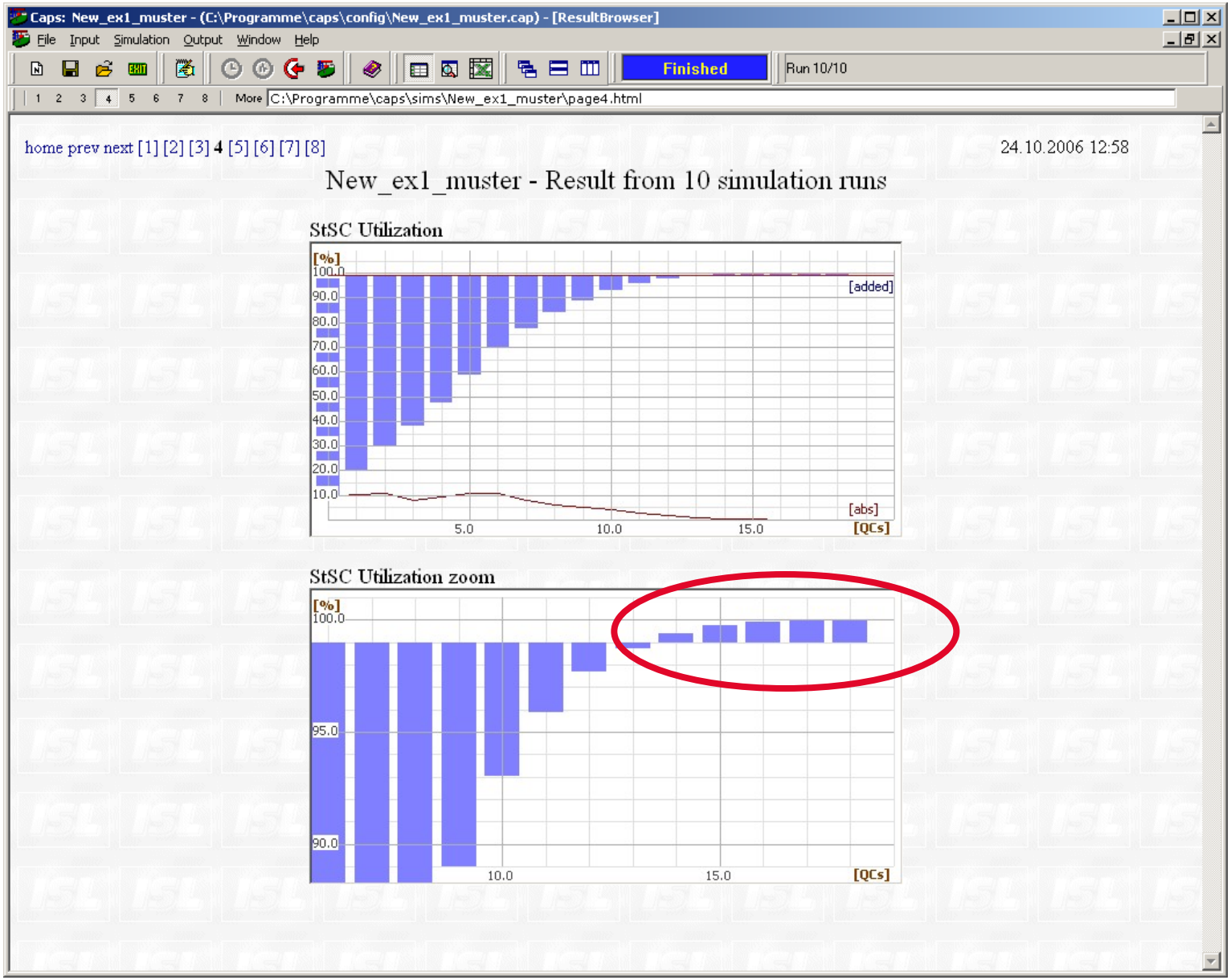
Result, page2



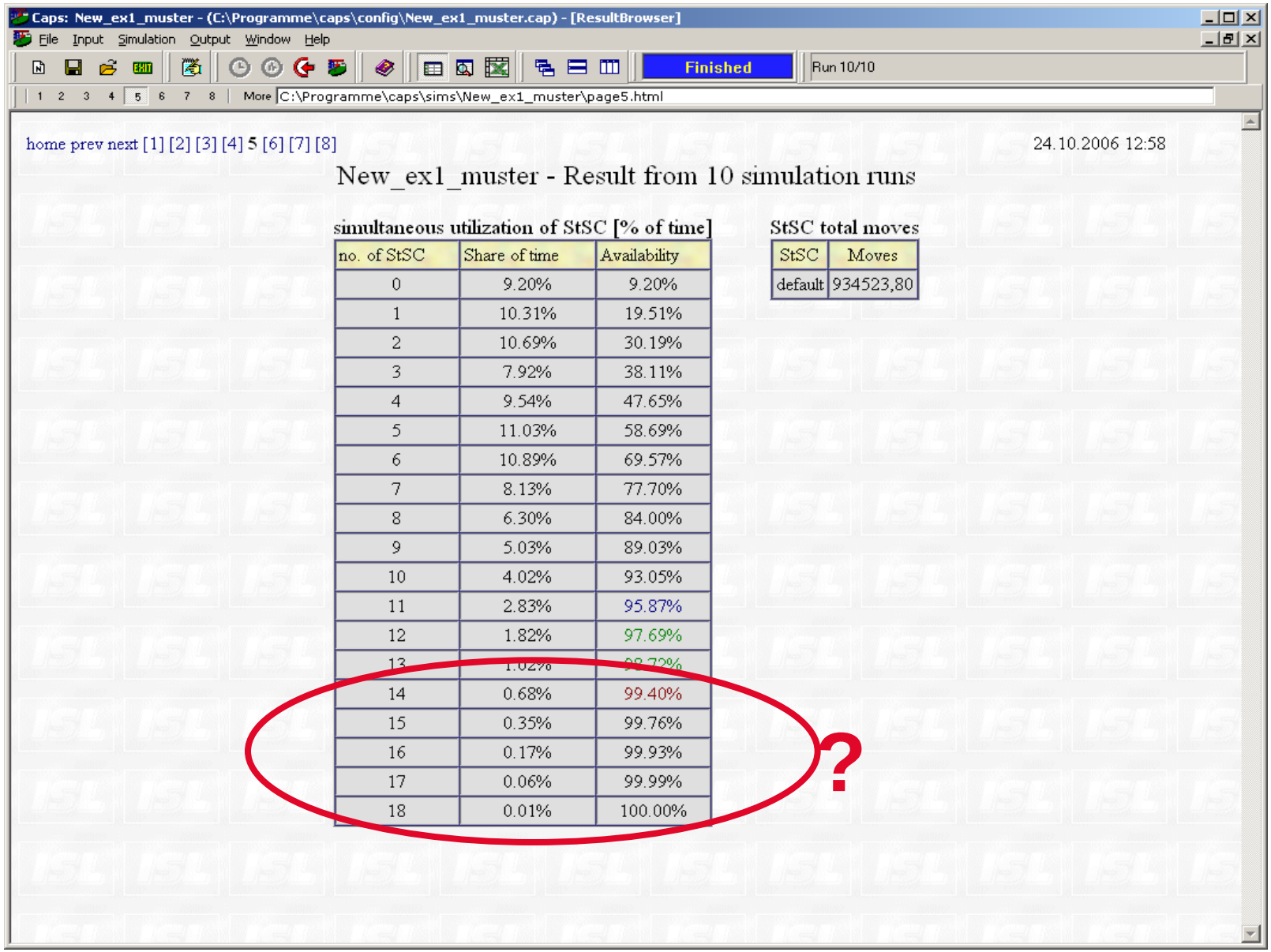
Result, page3



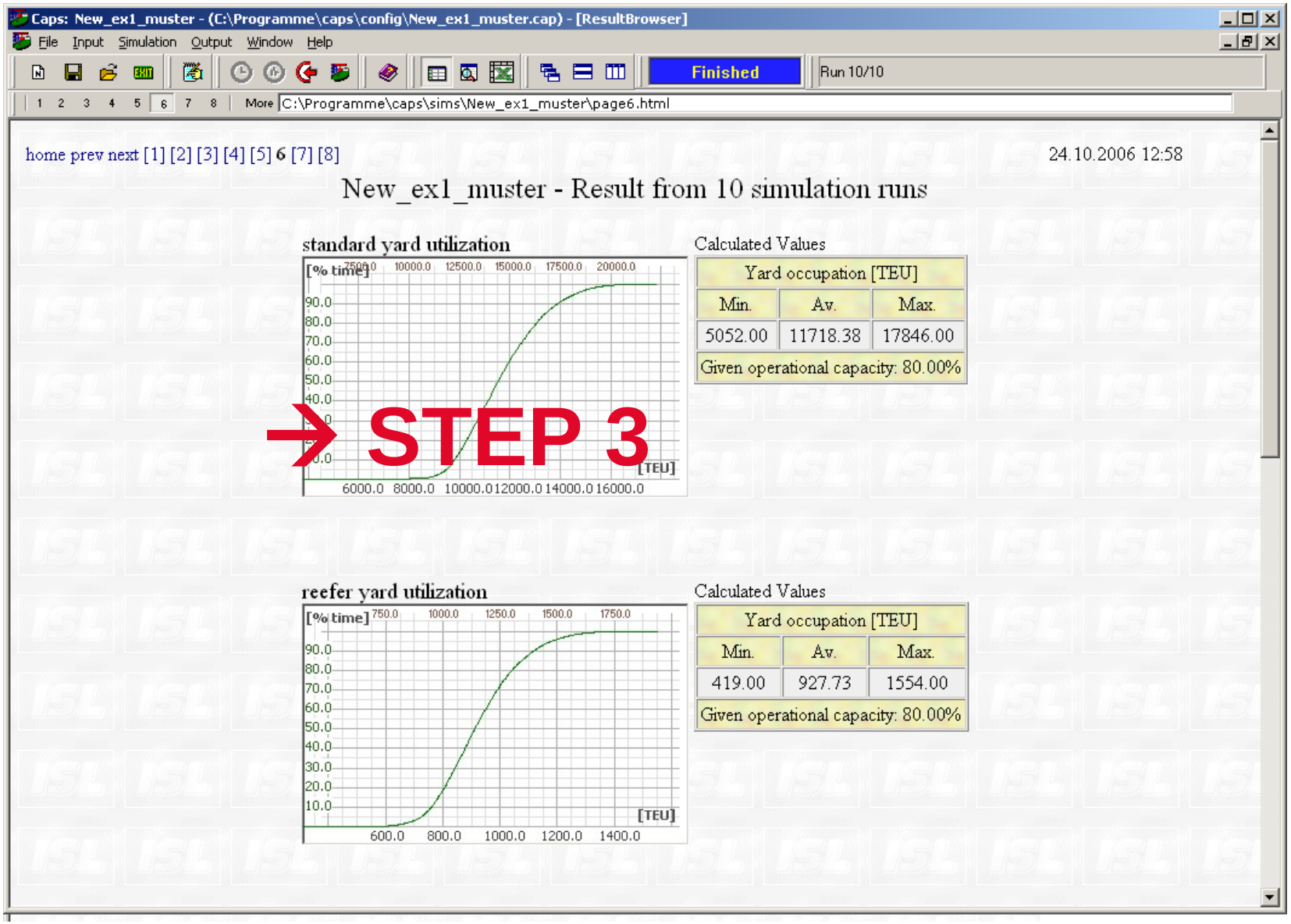
Result, page4



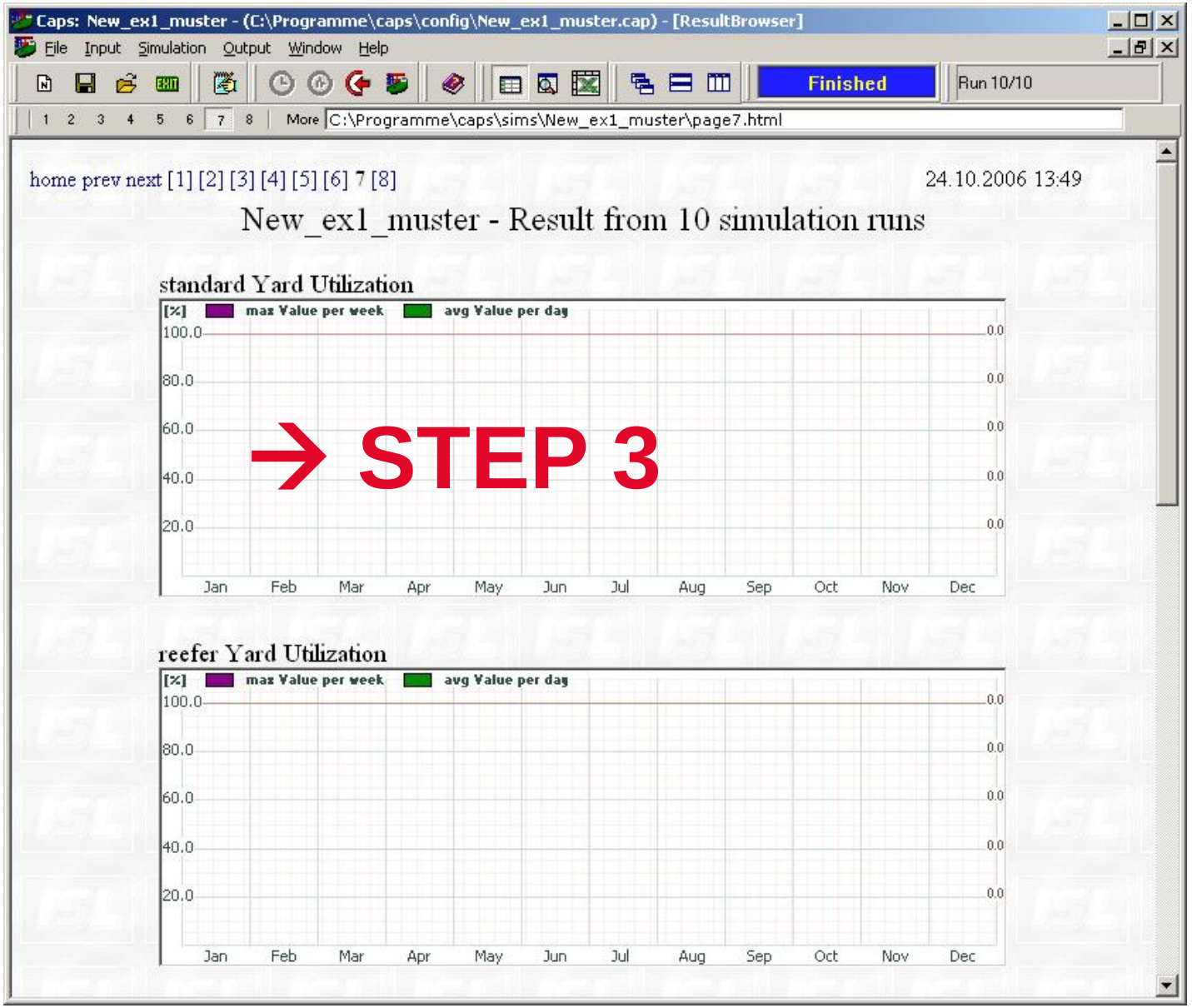
Result, page5



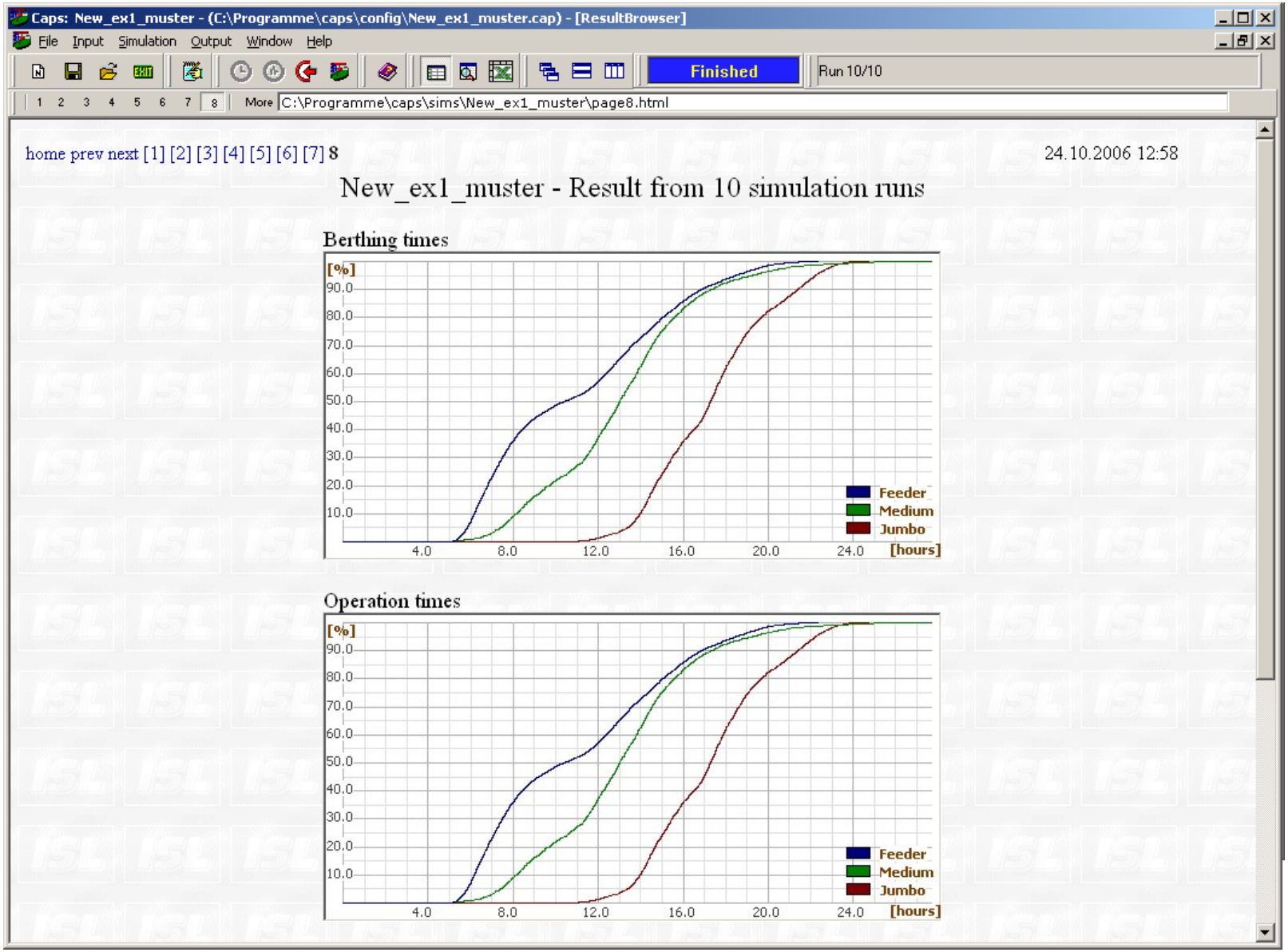
Result, page6



Result, page7



Result, page8



Case study – simulation procedure

step 1 →

Determination of the maximum possible throughput under optimal conditions for the quay, i.e.
- no. of STS cranes unlimited
- no. of slots unlimited

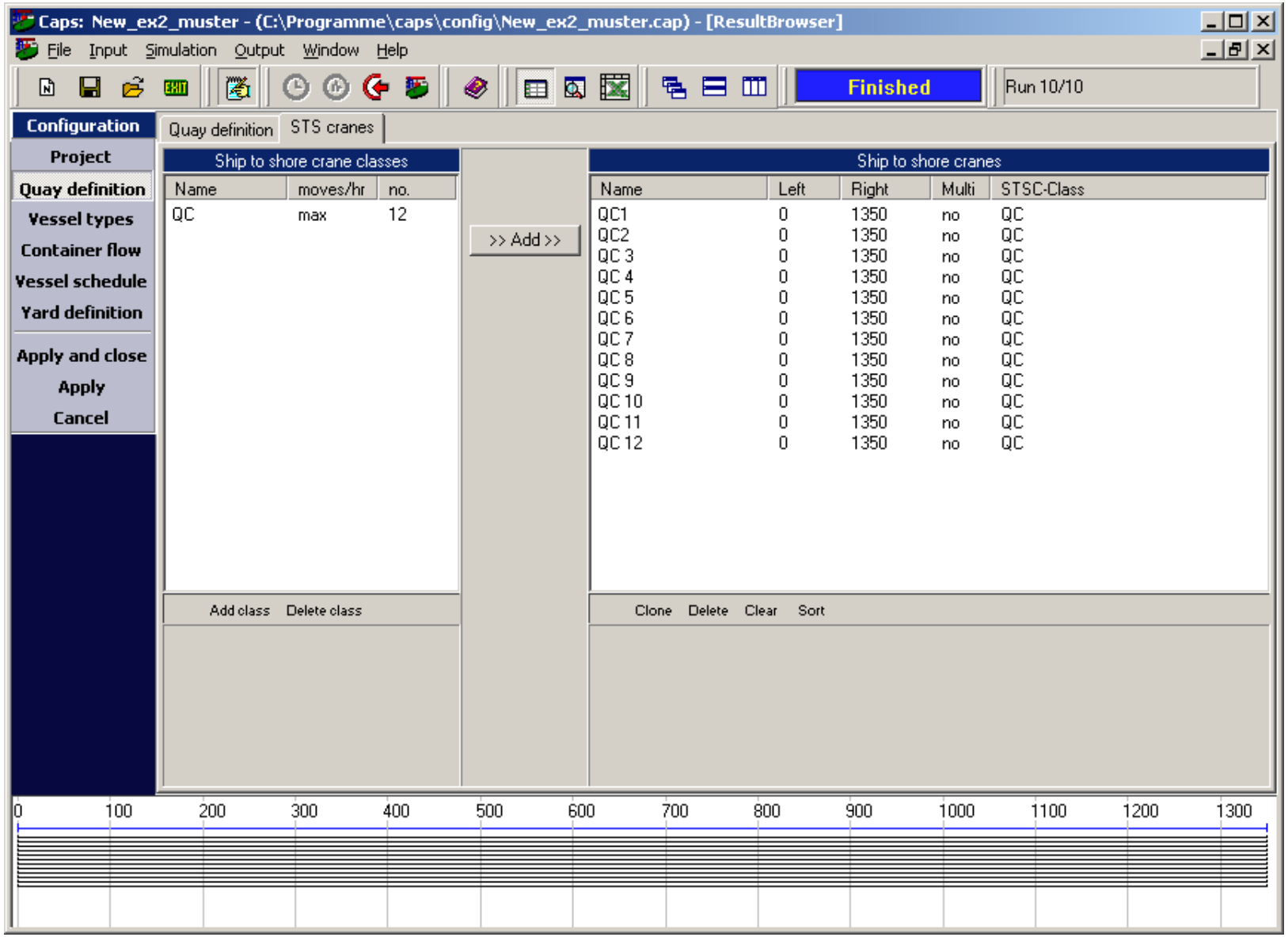
step 2 →

Determination of the quay crane requirement:
- **basis: maximum throughput from step 1**
- **no. of STS cranes limited**
- **allocation of STS cranes to quay sections**
- **definition of crane ranges**
- **no. of slots still unlimited**

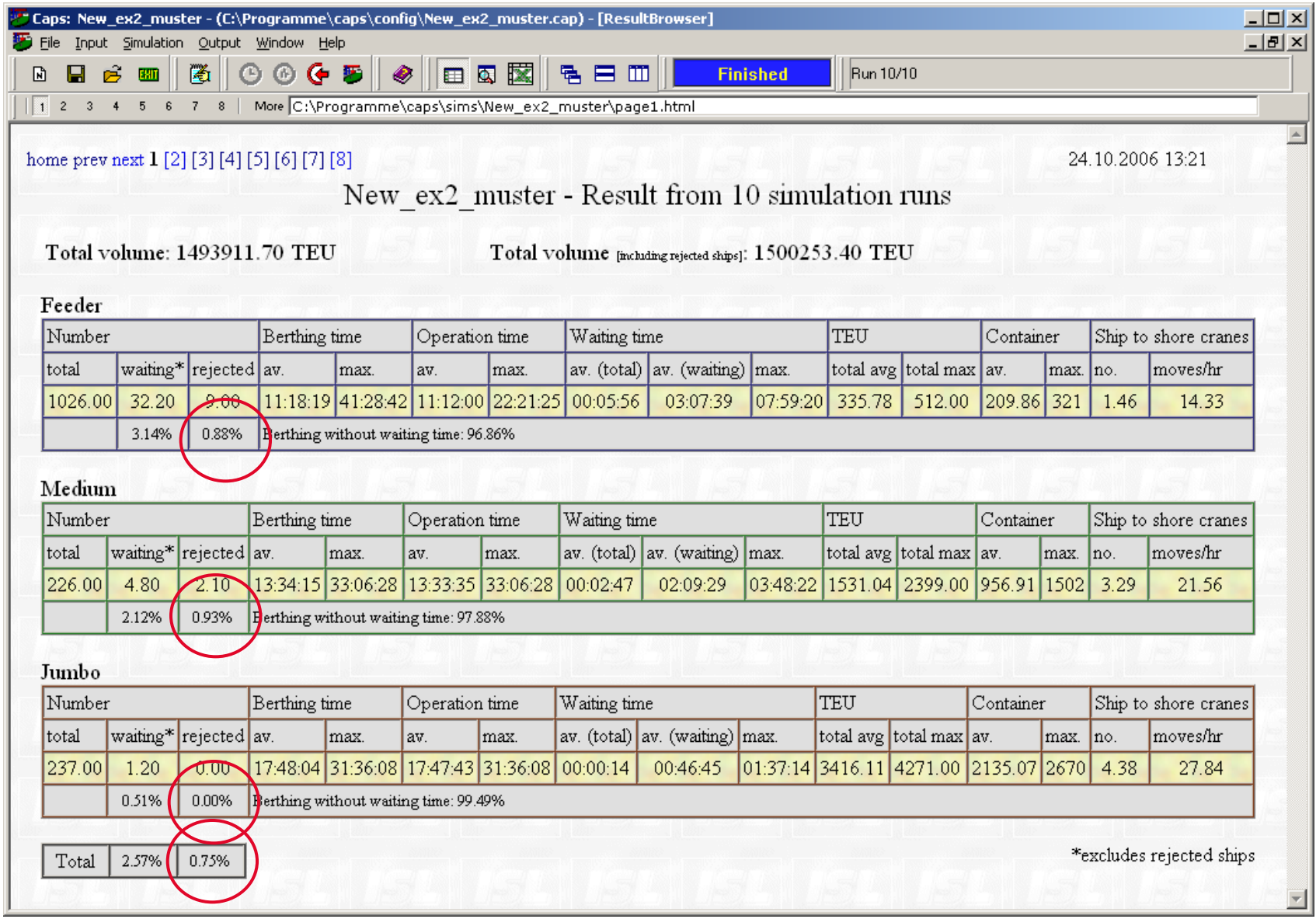
step 3 →

Determination of the slot requirement:
- basis: maximum throughput from step 1
  no. of cranes from step 2
- approaching to slot requirement

STS Definition, 12 cranes



Throughput, 12 cranes



Caps: New_ex2_muster - (C:\Programme\caps\config\New_ex2_muster.cap) - [ResultBrowser]

File Input Simulation Output Window Help

Finished | Run 10/10

1 2 3 4 5 6 7 8 | More | C:\Programme\caps\sims\New_ex2_muster\page1.html

home prev next 1 [2] [3] [4] [5] [6] [7] [8] 24.10.2006 13:21

New_ex2_muster - Result from 10 simulation runs

Total volume: 1493911.70 TEU Total volume [including rejected ships]: 1500253.40 TEU

Feeder

Number			Berthing time		Operation time		Waiting time			TEU		Container		Ship to shore cranes	
total	waiting*	rejected	av.	max.	av.	max.	av. (total)	av. (waiting)	max.	total avg	total max	av.	max.	no.	moves/hr
1026.00	32.20	9.00	11:18:19	41:28:42	11:12:00	22:21:25	00:05:56	03:07:39	07:59:20	335.78	512.00	209.86	321	1.46	14.33
	3.14%	0.88%	Berthing without waiting time: 96.86%												

Medium

Number			Berthing time		Operation time		Waiting time			TEU		Container		Ship to shore cranes	
total	waiting*	rejected	av.	max.	av.	max.	av. (total)	av. (waiting)	max.	total avg	total max	av.	max.	no.	moves/hr
226.00	4.80	2.10	13:34:15	33:06:28	13:33:35	33:06:28	00:02:47	02:09:29	03:48:22	1531.04	2399.00	956.91	1502	3.29	21.56
	2.12%	0.93%	Berthing without waiting time: 97.88%												

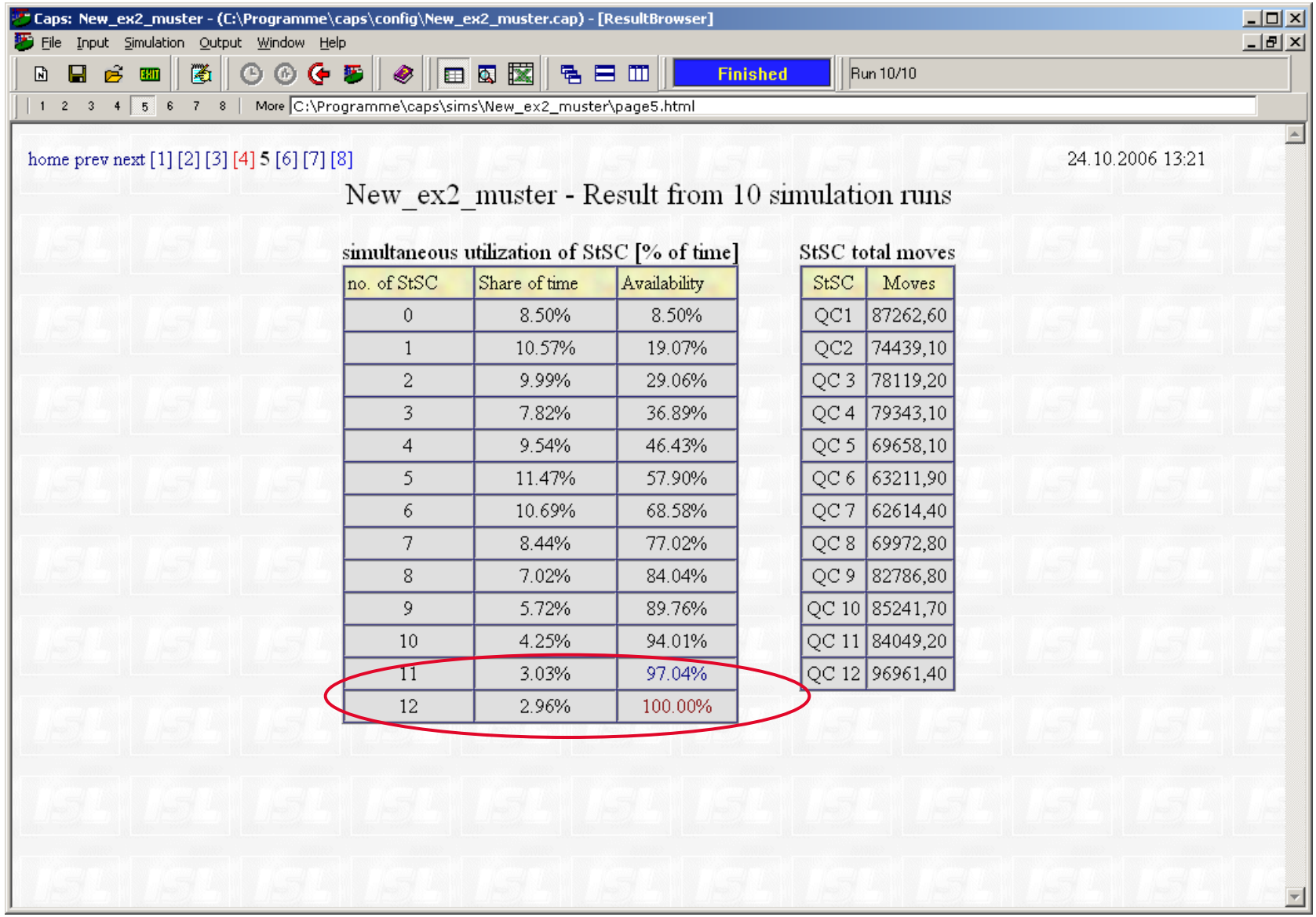
Jumbo

Number			Berthing time		Operation time		Waiting time			TEU		Container		Ship to shore cranes	
total	waiting*	rejected	av.	max.	av.	max.	av. (total)	av. (waiting)	max.	total avg	total max	av.	max.	no.	moves/hr
237.00	1.20	0.00	17:48:04	31:36:08	17:47:43	31:36:08	00:00:14	00:46:45	01:37:14	3416.11	4271.00	2135.07	2670	4.38	27.84
	0.51%	0.00%	Berthing without waiting time: 99.49%												

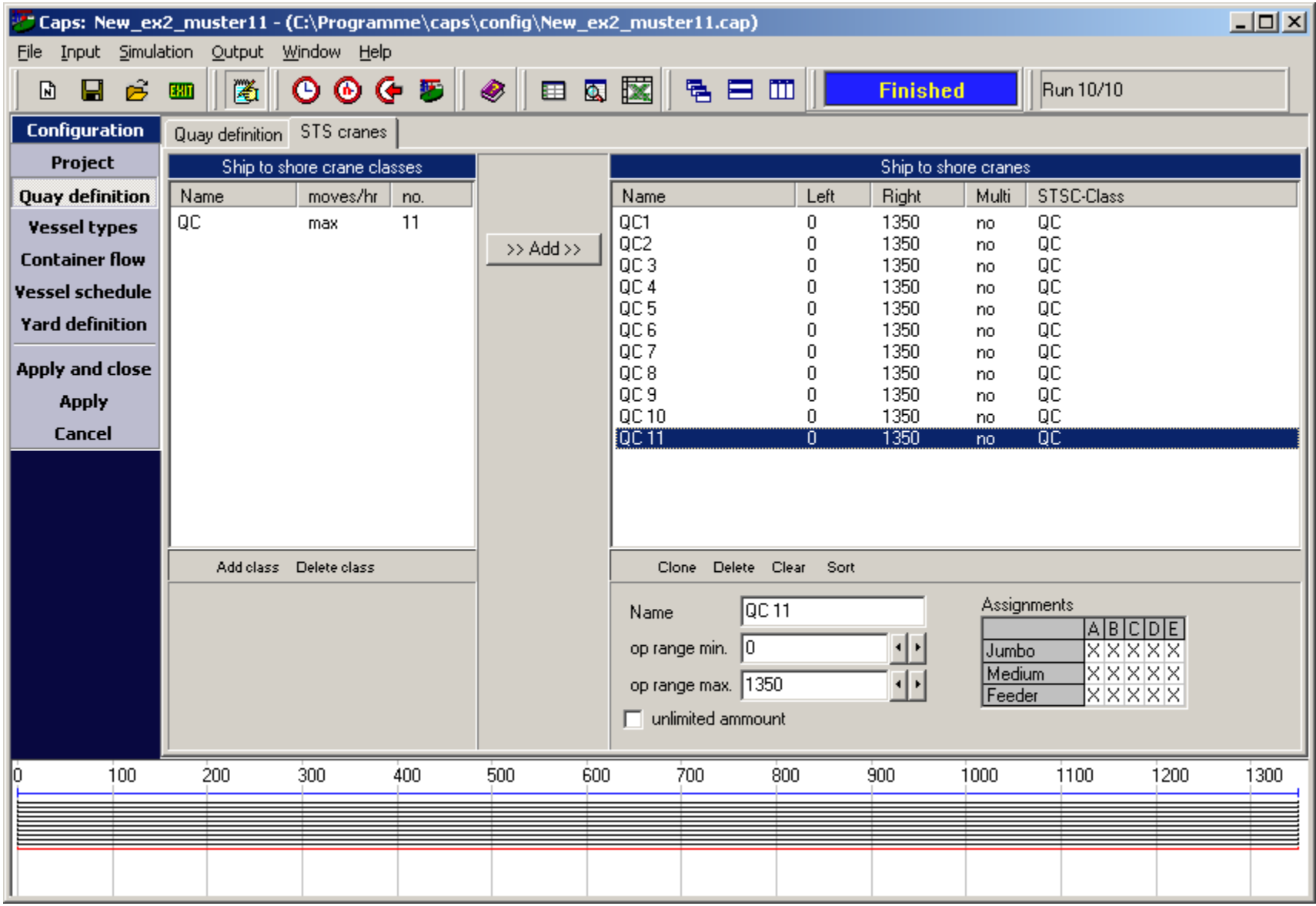
Total	2.57%	0.75%

*excludes rejected ships

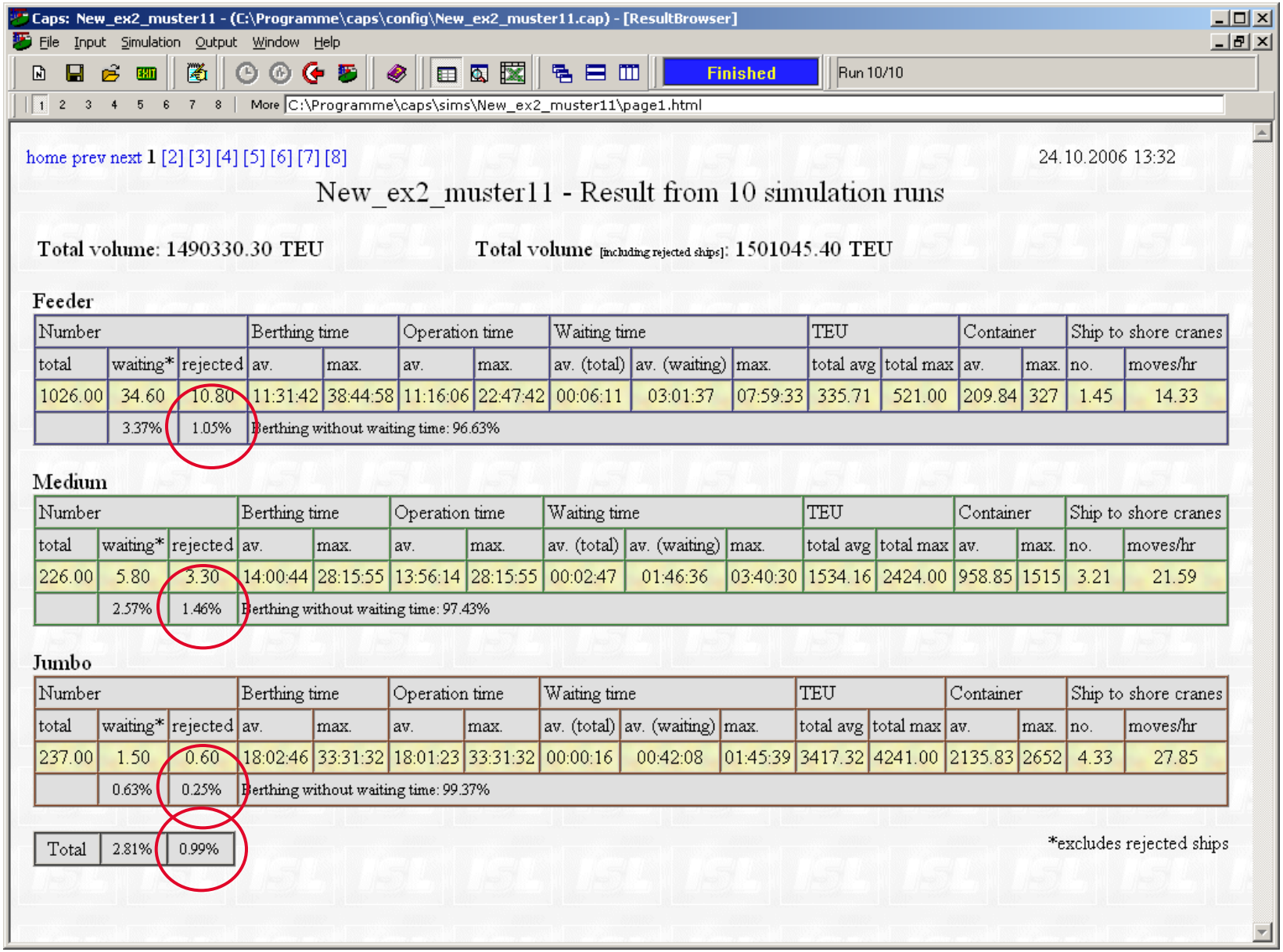
STS utlisation, 12 cranes



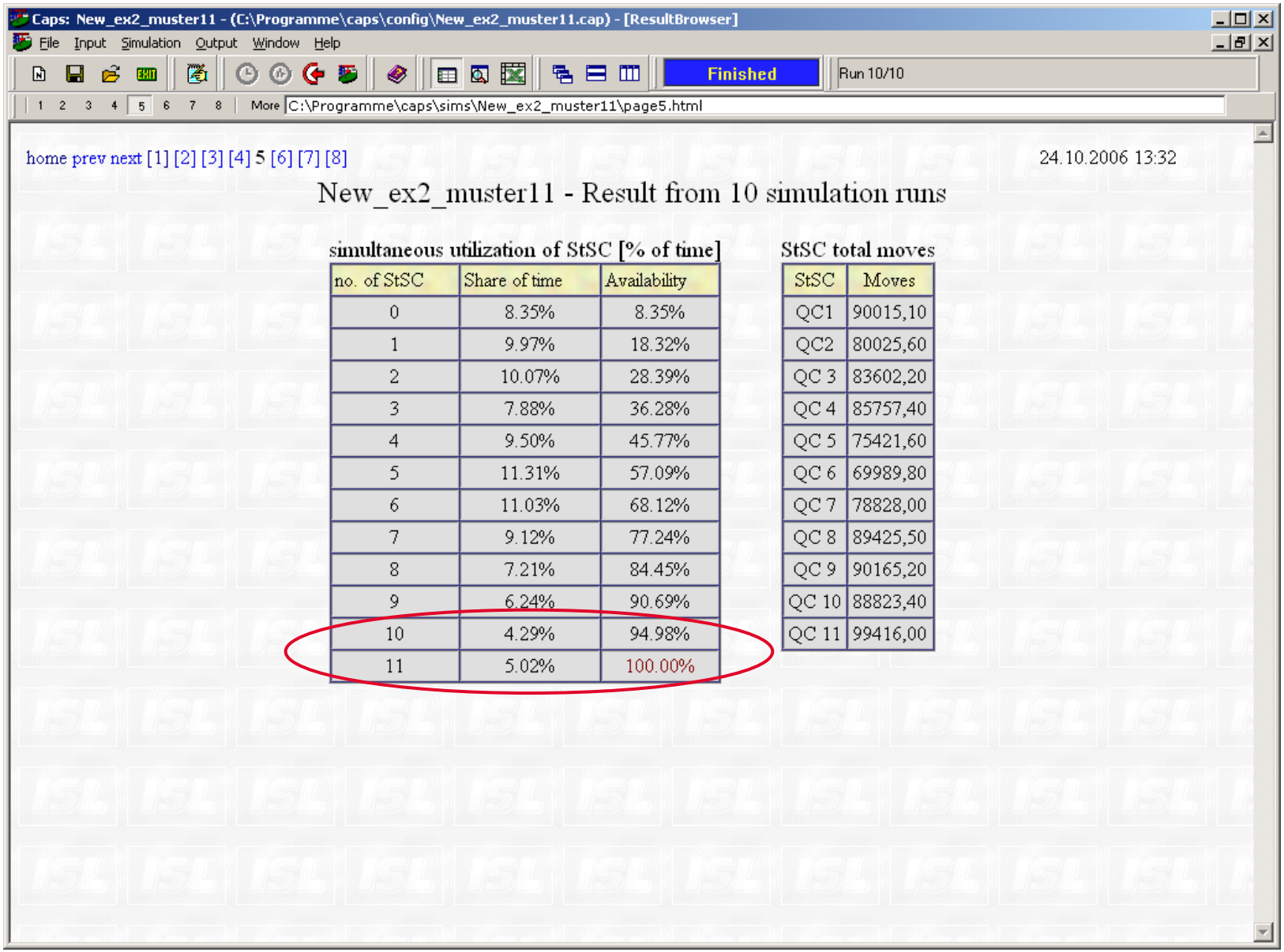
STS Definition, 11 cranes



Throughput, 11 cranes



STS utlisation, 12 cranes



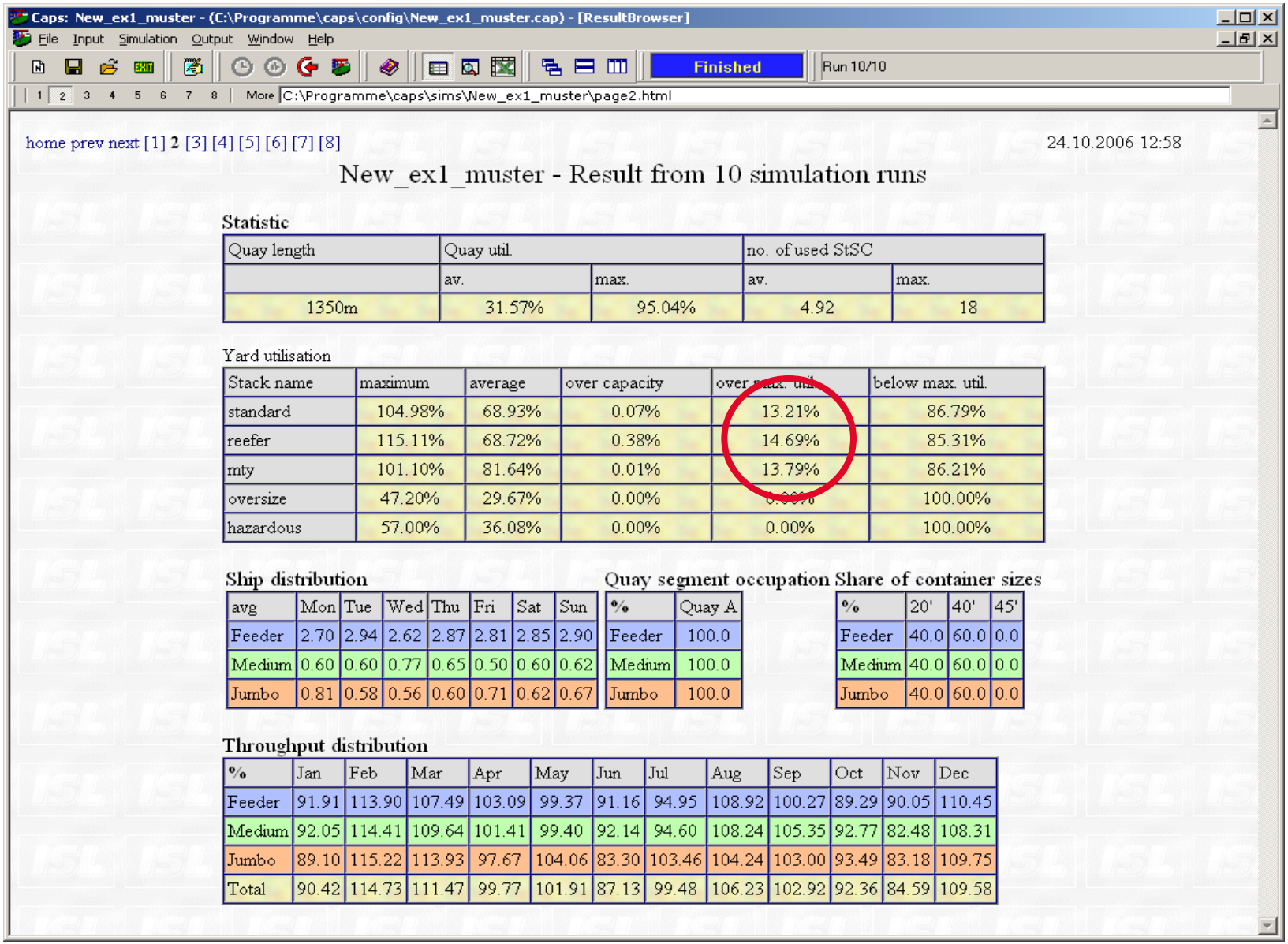
Case study – simulation procedure

step 1 → Determination of the maximum possible throughput under optimal conditions for the quay, i.e.
- no. of STS cranes unlimited
- no. of slots unlimited

step 2 → Determination of the quay crane requirement:
- basis: maximum throughput from step 1
- no. of STS cranes limited
- allocation of STS cranes to quay sections
- definition of crane ranges
- no. of slots still unlimited

step 3 → **Determination of the slot requirement:**
- **basis: maximum throughput from step 1**
  no. of cranes from step 2
- **approaching to slot requirement**

Result, page2



home prev next [1] **2** [3] [4] [5] [6] [7] [8]

24.10.2006 12:58

New_ex1_muster - Result from 10 simulation runs

Statistic

Quay length	Quay util.		no. of used StSC	
	av.	max.	av.	max.
1350m	31.57%	95.04%	4.92	18

Yard utilisation

Stack name	maximum	average	over capacity	over max. util.	below max. util.
standard	104.98%	68.93%	0.07%	13.21%	86.79%
reefer	115.11%	68.72%	0.38%	14.69%	85.31%
mty	101.10%	81.64%	0.01%	13.79%	86.21%
oversize	47.20%	29.67%	0.00%	0.00%	100.00%
hazardous	57.00%	36.08%	0.00%	0.00%	100.00%

Ship distribution

avg	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Feeder	2.70	2.94	2.62	2.87	2.81	2.85	2.90
Medium	0.60	0.60	0.77	0.65	0.50	0.60	0.62
Jumbo	0.81	0.58	0.56	0.60	0.71	0.62	0.67

Quay segment occupation

%	Quay A
Feeder	100.0
Medium	100.0
Jumbo	100.0

Share of container sizes

%	20'	40'	45'
Feeder	40.0	60.0	0.0
Medium	40.0	60.0	0.0
Jumbo	40.0	60.0	0.0

Throughput distribution

%	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Feeder	91.91	113.90	107.49	103.09	99.37	91.16	94.95	108.92	100.27	89.29	90.05	110.45
Medium	92.05	114.41	109.64	101.41	99.40	92.14	94.60	108.24	105.35	92.77	82.48	108.31
Jumbo	89.10	115.22	113.93	97.67	104.06	83.30	103.46	104.24	103.00	93.49	83.18	109.75
Total	90.42	114.73	111.47	99.77	101.91	87.13	99.48	106.23	102.92	92.36	84.59	109.58

Result, page6

Caps: New_ex1_muster - (C:\Programme\caps\config\New_ex1_muster.cap) - [ResultBrowser]

File Input Simulation Output Window Help

Finished | Run 10/10

1 2 3 4 5 6 7 8 More C:\Programme\caps\sims\New_ex1_muster\page6.html

home prev next [1] [2] [3] [4] [5] 6 [7] [8]

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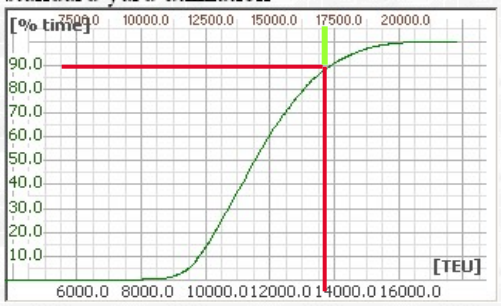
New_ex1_muster - Result from 10 simulation runs

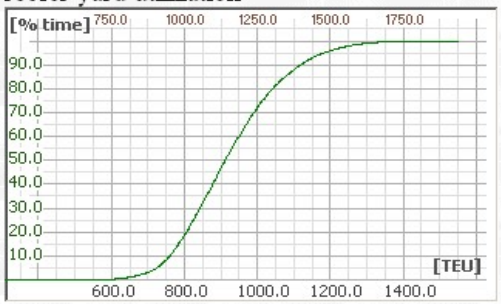
standard yard utilization



Calculated Values

Yard occupation [TEU]		
Min.	Av.	Max.
5052.00	11718.38	17846.00
Given operational capacity: 80.00%		

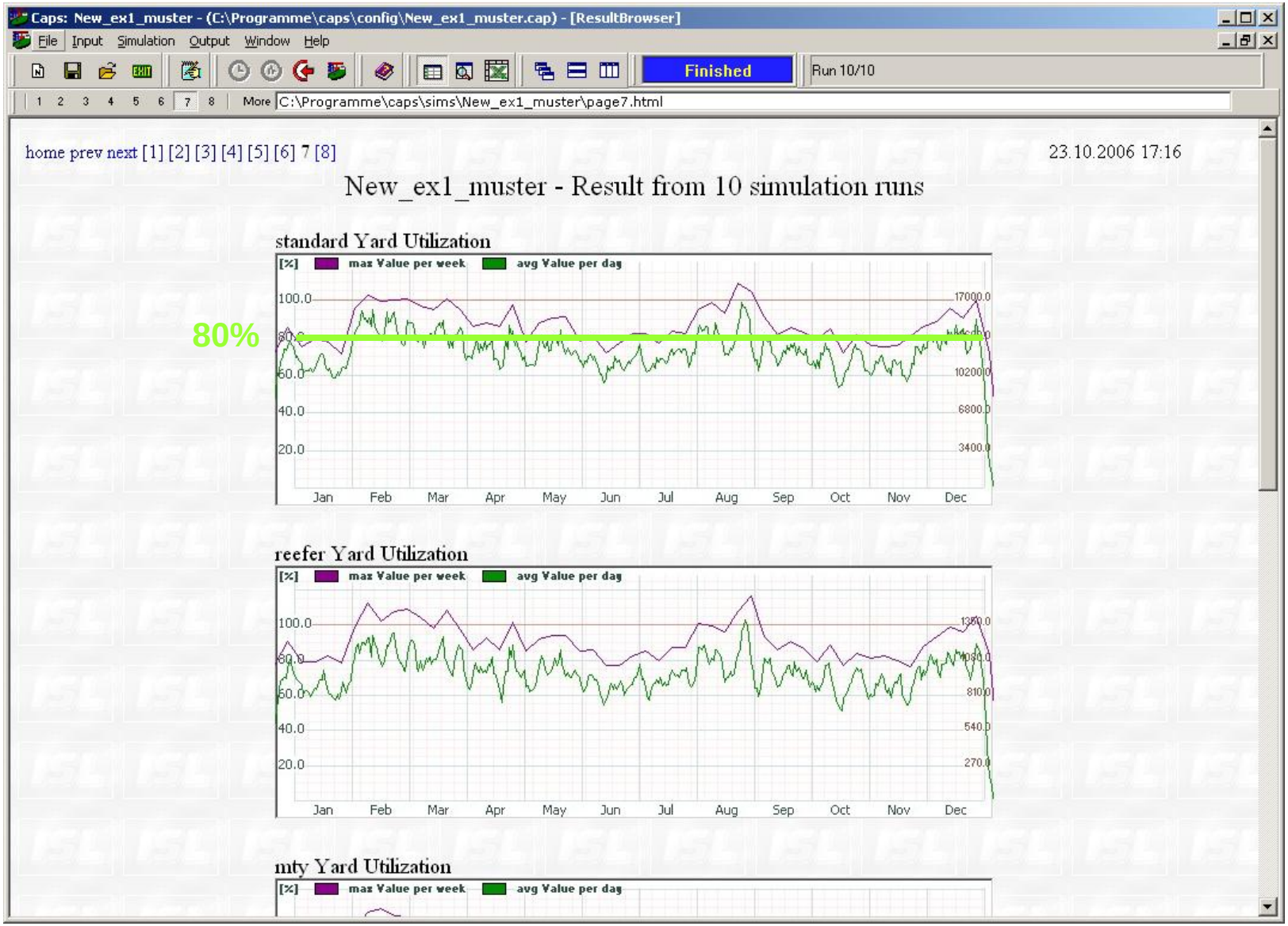
reefer yard utilization



Calculated Values

Yard occupation [TEU]		
Min.	Av.	Max.
419.00	927.73	1554.00
Given operational capacity: 80.00%		

Result, page7



CAPS → SCUSY

CAPS

- throughput capacity: 1.500.000 TEU
- no. of required STS cranes: 12
- required stacking capacity: standard: 17.000 TEU
  reefer: 1.350 TEU
  MTYs: 7.300 TEU

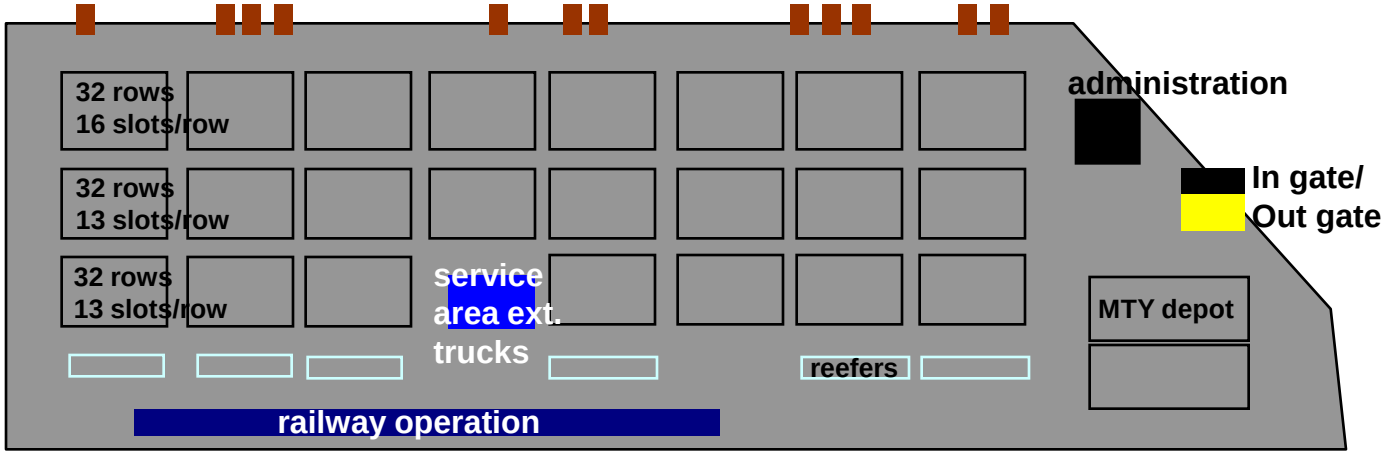
layout design for different stacking systems, e. g.

- straddle carrier
- RTG operation
- RMG operation

resp. combination of different stacking systems

SCUSY

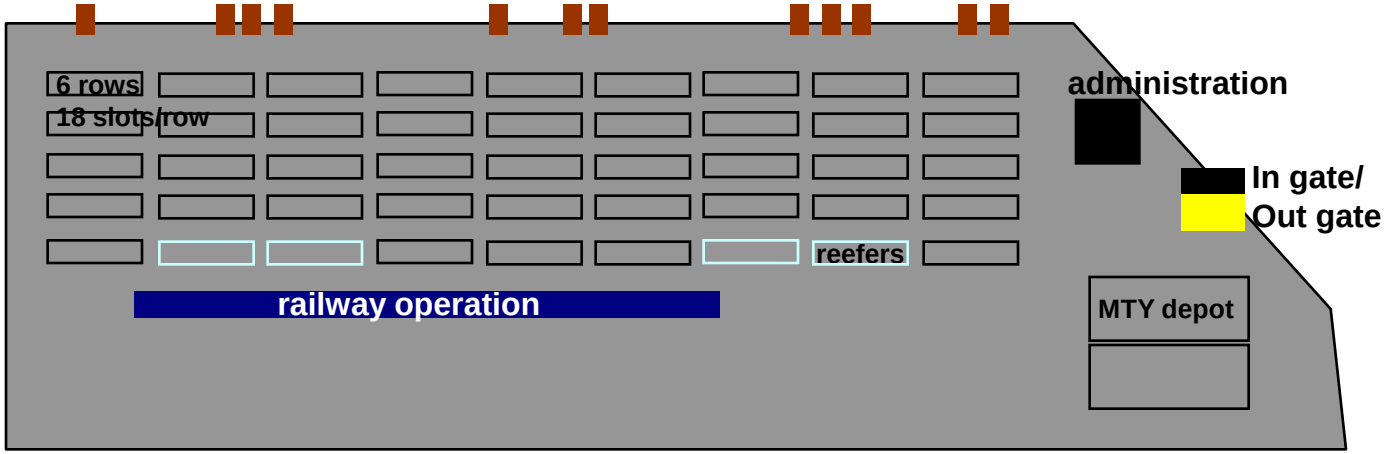
Layout: Straddle carrier operation



- **standard:** 32 rows * 16 slots/row * 8 blocks ➔ 4.096 GS
  32 rows * 13 slots/row * 15 blocks ➔ 6.240 GS
  10.340 GS * 2-high = 20.680 TEU

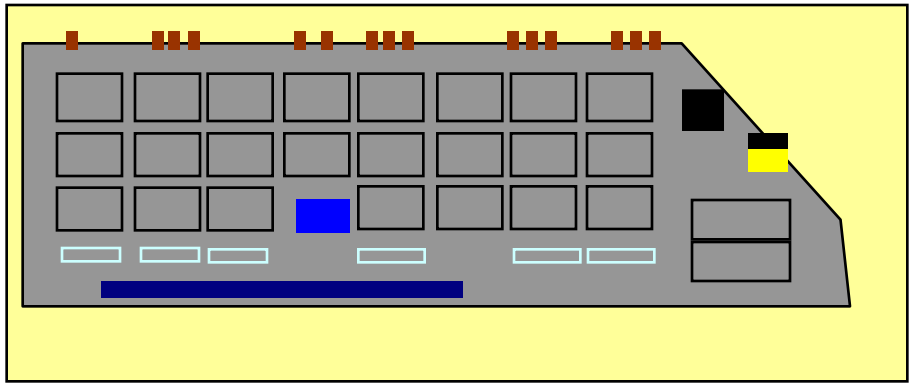
- **reefers:** 32 rows * 4 slots/row * 6 blocks ➔ 768 GS * 2-high = 1.536 TEU

- **MTYs:** 26 rows * 45 slots/row * 2 blocks ➔ 2.340 GS * 4-high = 9.360 TEU

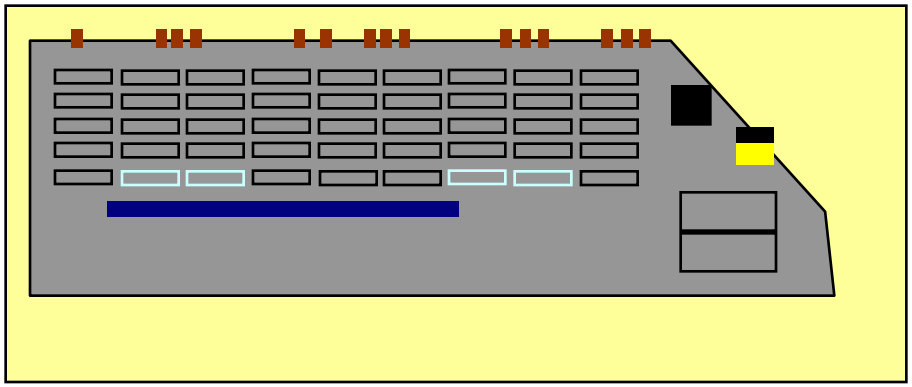


- **standard: 6 rows * 18 slots/row * 41 blocks ➔ 4.428 GS * 4-high = 17.712 TEU**
- **reefers: 6 rows * 18 slots/row * 4 blocks ➔ 432 GS * 4-high = 1.728 TEU**
- **MTYs: 26 rows * 45 slots/row * 2 blocks ➔ 2.340 GS * 4-high = 9.360 TEU**

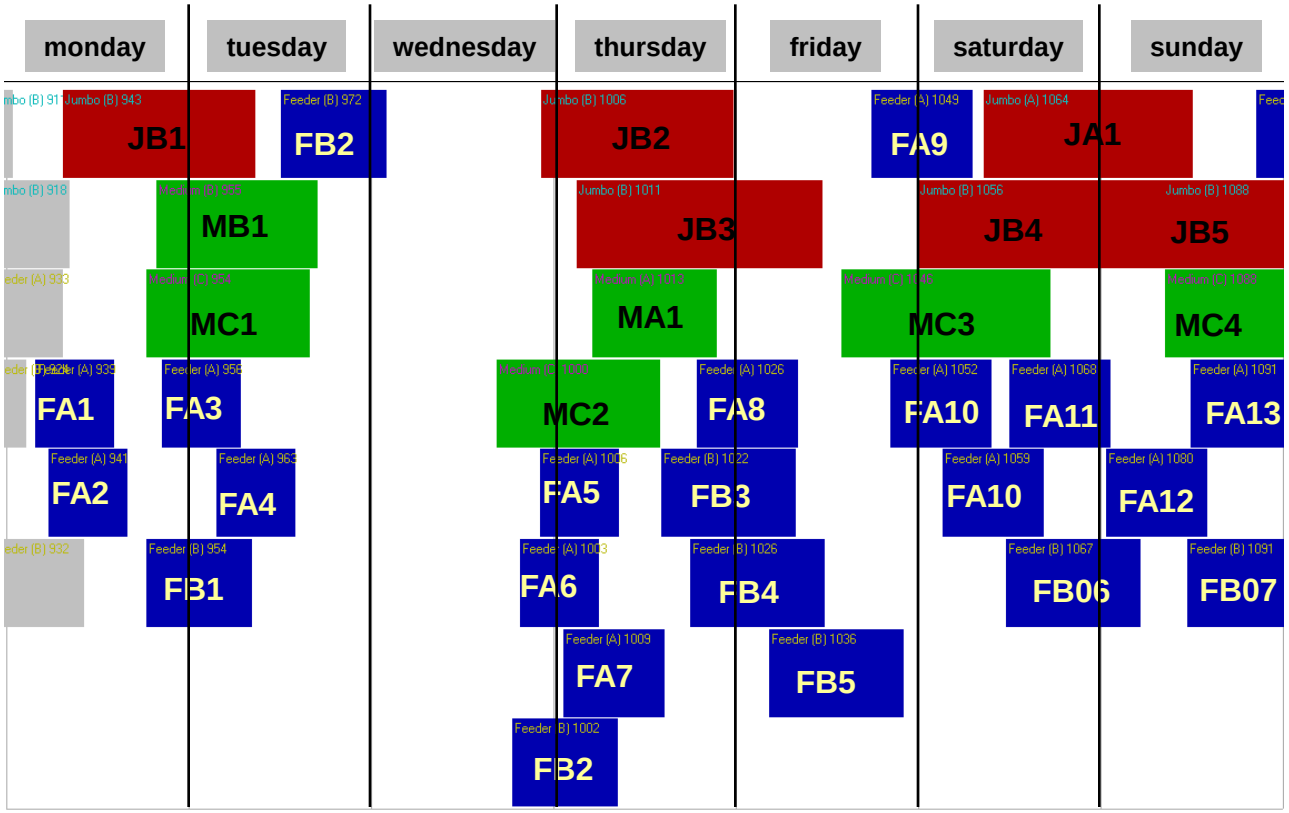
Straddle carrier operation



RTG operation



Which of these operation systems is suitable to operate a maximum volume of 1.5 mill. TEU (productivity, costs)?


monday
tuesday
wednesday
thursday
friday
saturday
sunday
Jumbo (B) 943
JB1
Feeder (B) 972
FB2
Jumbo (B) 1005
JB2
Feeder (A) 1049
FA9
Jumbo (A) 1064
JA1
Jumbo (B) 1011
JB3
Jumbo (B) 1056
JB4
Jumbo (B) 1088
JB5
Medium (B) 963
MB1
Medium (C) 954
MC1
Medium (A) 1013
MA1
Medium (C) 1045
MC3
Medium (C) 1088
MC4
Feeder (A) 939
FA1
Feeder (A) 956
FA3
Medium (C) 1000
MC2
Feeder (A) 1026
FA8
Feeder (A) 1052
FA10
Feeder (A) 1068
FA11
Feeder (A) 1091
FA13
Feeder (A) 941
FA2
Feeder (A) 963
FA4
Feeder (A) 1006
FA5
Feeder (B) 1022
FB3
Feeder (A) 1059
FA10
Feeder (A) 1080
FA12
Feeder (B) 954
FB1
Feeder (A) 1003
FA6
Feeder (B) 1026
FB4
Feeder (B) 1067
FB06
Feeder (B) 1091
FB07
Feeder (A) 1009
FA7
Feeder (B) 1036
FB5
Feeder (B) 1002
FB2

ToDo

- Rail / truck throughput
- Copy devices from demo project
- Run projects
- Comparison

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