

CAPS – SCUSY Exercise

Greenfield terminal

Institut für Seeverkehrswirtschaft und Logistik
Institute of Shipping Economics and Logistics

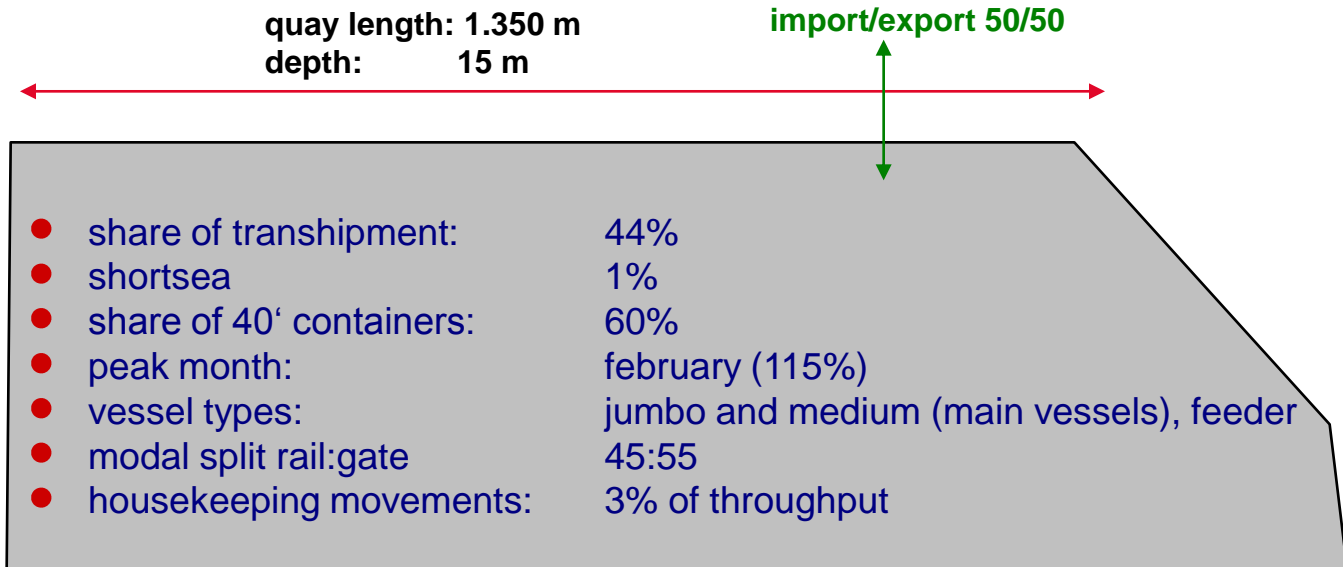
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Planning of greenfield terminals

- Example



Standard vessel types

- Main vessels



Jumbo

- (A) J1800
- (B) J2200



Medium

- (A) M550
- (B) M900
- (C) M1200

- Feeder vessels (transshipment 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]		security distance [m]	% of throughput
							arrival	departure		
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]		security distance [m]	% of throughput
							arrival	departure		
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%

- **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 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
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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
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	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

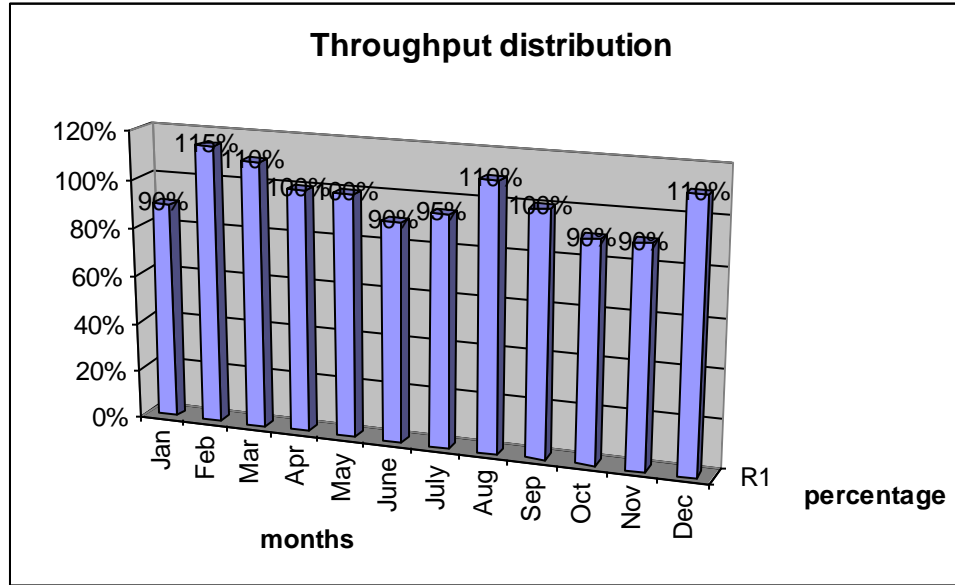
- feeder vessels

Feeder

type	length [m]	width [m]	draught [m]	handled boxes	moves/hr aver.	cranes/vessel aver.	docking time [hr]		security distance [m]	% of throughput
							arrival	departure		
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!

	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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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

EXIT [Icons] Finished Run 10/10

Configuration Quay definition STS cranes

Project
 Quay definition
 Vessel types
 Container flow
 Vessel schedule
 Yard definition
 Apply and close
 Apply
 Cancel

New
 +
 -
 zoom all
 undo
 redo

90,0° 1350,0m 113,1° 324m 154,1° 101m 92,9° 400m 1472m

Quay A
 1350m
 15,0m
 25m

Zoom: 34,2% Usable Length: 1350m

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

File Input Simulation Output Window Help

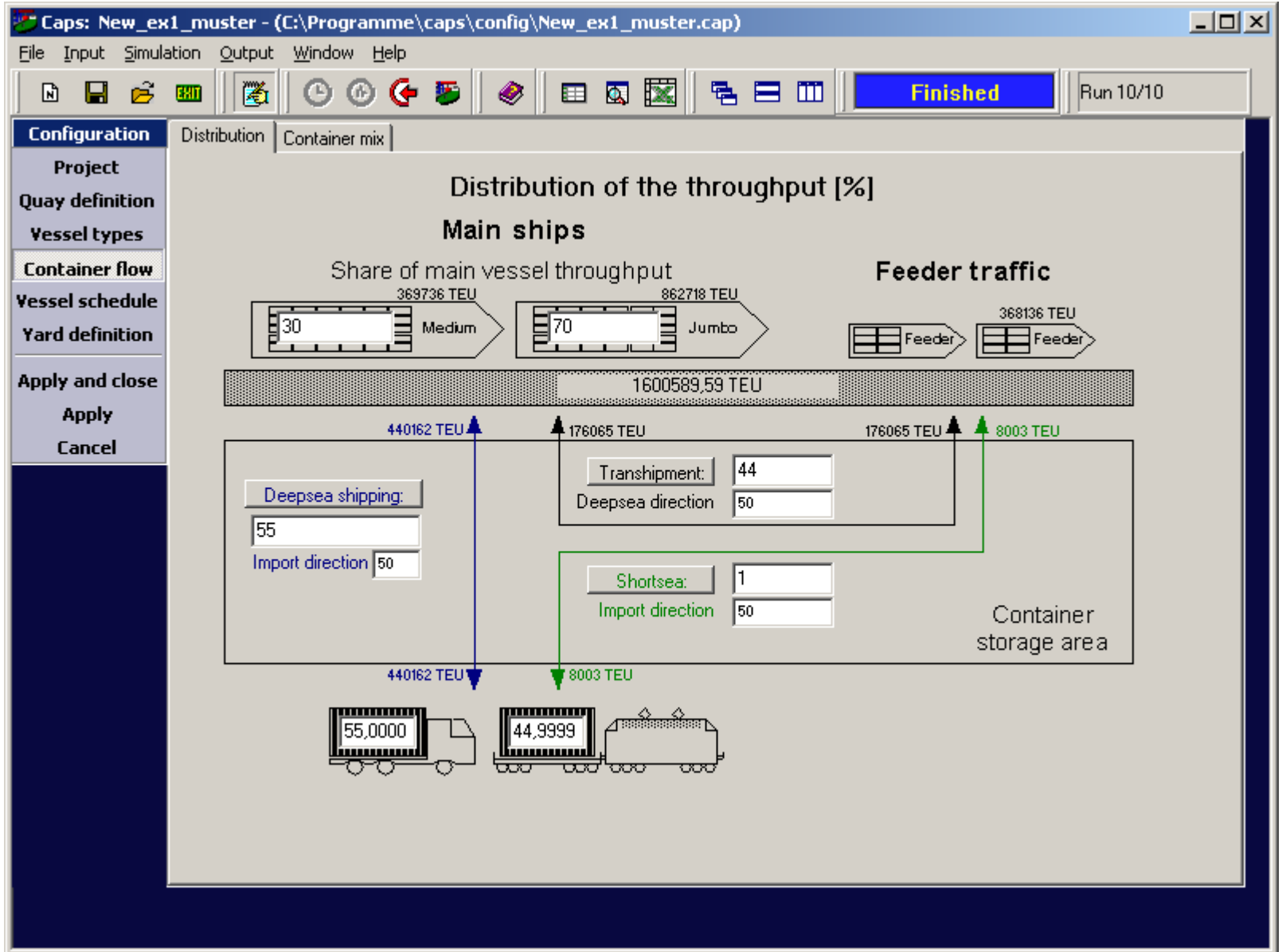
Configuration | Quay definition | STS cranes

Ship to shore crane classes			Ship to shore cranes				
Name	moves/hr	no.	Name	Left	Right	Multi	STSC-Class
QC	max	1	default	0	1350	yes	QC

>> Add >>

0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300

Throughput



Container-Mix

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

File Input Simulation Output Window Help

Finished Run 10/10

Configuration Distribution Container mix

Project
 Quay definition
 Vessel types
Container flow
 Vessel schedule
 Yard definition
 Apply and close
 Apply
 Cancel

Container mix [%]

Name	Probability	Size 1	Size 2	Size 3
Standard	79,00%	1,00 (40,0%)	2,00 (60,0%)	2,25 (0,0%)
reefer	7,00%	1,00 (40,0%)	2,00 (60,0%)	2,25 (0,0%)
mtv	12,00%	1,00 (40,0%)	2,00 (60,0%)	2,25 (0,0%)
oversize	1,00%	1,00 (40,0%)	2,00 (60,0%)	2,25 (0,0%)
hazardous	1,00%	1,00 (40,0%)	2,00 (60,0%)	2,25 (0,0%)

Add type Delete type Clear all

Color

Name	Probability	TEU
Standard	79,00	1,00
		2,00
		2,25

Vessel types - Jumbo

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

Ship types
 Jumbo Medium Feeder

Subclass
 A B C D E
 16,9% 83,1% 0,0% 0,0% 0,0%

Subclass probability

Length [m]
 min
 max

Width [m]
 min
 max

Draught [m]
 min
 max

Max. waiting time [hours]

Volume [TEU] - (In+Out)
 min
 exp
 max
 av

Priority (1=top)

Cranes per vessel
 min
 exp
 max
 av

Crane performance [moves/hr]
 min
 exp
 max
 av

Docking times [min]
 arrival
 departure

Security distance [m]

Cranes
 default

Quay segments
 Quay A

Vessel types - Medium

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

File Input Simulation Output Window Help

Run 10/10

Configuration

Project

Quay definition

Vessel types

Container flow

Vessel schedule

Yard definition

Apply and close

Ship types

Jumbo Medium Feeder

Subclass

A	B	C	D	E
29,0%	17,7%	53,3%	0,0%	0,0%

Subclass probability

29,00

Volume [TEU] - (In+Out)

min 680

exp 880

max 1080

av 880,00

Docking times [min]

arrival 60

departure 60

Security distance [m]

30

Priority (1=top)

2

Cranes per vessel

min 2,00

exp 3,00

max 4,00

av 3,00

Cranes

default

Length [m]

min 250

max 310

Width [m]

min 32

max 38

Draught [m]

min 12,50

max 12,50

Crane performance [moves/hr]

min 18,50

exp 20,50

max 22,50

av 20,50

Quay segments

Quay A

Max. waiting time [hours]

4

Vessel types - Feeder

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

File Input Simulation Output Window Help

Configuration

Project

Quay definition

Vessel types

Container flow

Vessel schedule

Yard definition

Apply and close

Apply

Cancel

Ship types

Jumbo Medium **Feeder**

Subclass

A	B	C	D	E
66.4%	33.6%	0.0%	0.0%	0.0%

Subclass probability

66.40

Volume [TEU] - (In+Out)

min 254

exp 304

max 354

av 304,00

Priority (1=top)

3

Docking times [min]

arrival 60

departure 30

Security distance [m]

15

Cranes

default

Length [m]

min 80

max 120

Width [m]

min 17

max 18

Draught [m]

min 6,00

max 7,00

Max. waiting time [hours]

8

Cranes per vessel

min 1,00

exp 1,50

max 2,00

av 1,50

Crane performance [moves/hr]

min 14,00

exp 14,00

max 15,00

av 14,33

Quay segments

Quay A

Stacking areas

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

File Input Simulation Output Window Help

Ready

Configuration Stacking Areas Dwell times

Project

Quay definition

Vessel types

Container flow

Vessel schedule

Yard definition

Stacking area	Capacity	Utilization	Cntr types
standard	0 TEU	80,0%	1
reefer	0 TEU	80,0%	1
mtv	0 TEU	90,0%	1
oversize	0 TEU	90,0%	1
hazardous	0 TEU	80,0%	1

Add area Delete area Clear all

Name: standard

Total capacity: 0 TEU

max. utilization: 80,0 %

Container types:

- Standard
- reefer
- mty
- oversize
- hazardous

Apply and close

Apply

Cancel

Dwell times

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

File Input Simulation Output Window Help

Run 10/10

Configuration Stacking Areas Dwell times

Project

Quay definition

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

Vessel types

Container flow

Vessel schedule

Yard definition

Apply and close

Apply

Cancel

Transshipment

	min.	exp.	max.
Import	3,00	4,00	5,00
Export	3,00	4,00	5,00

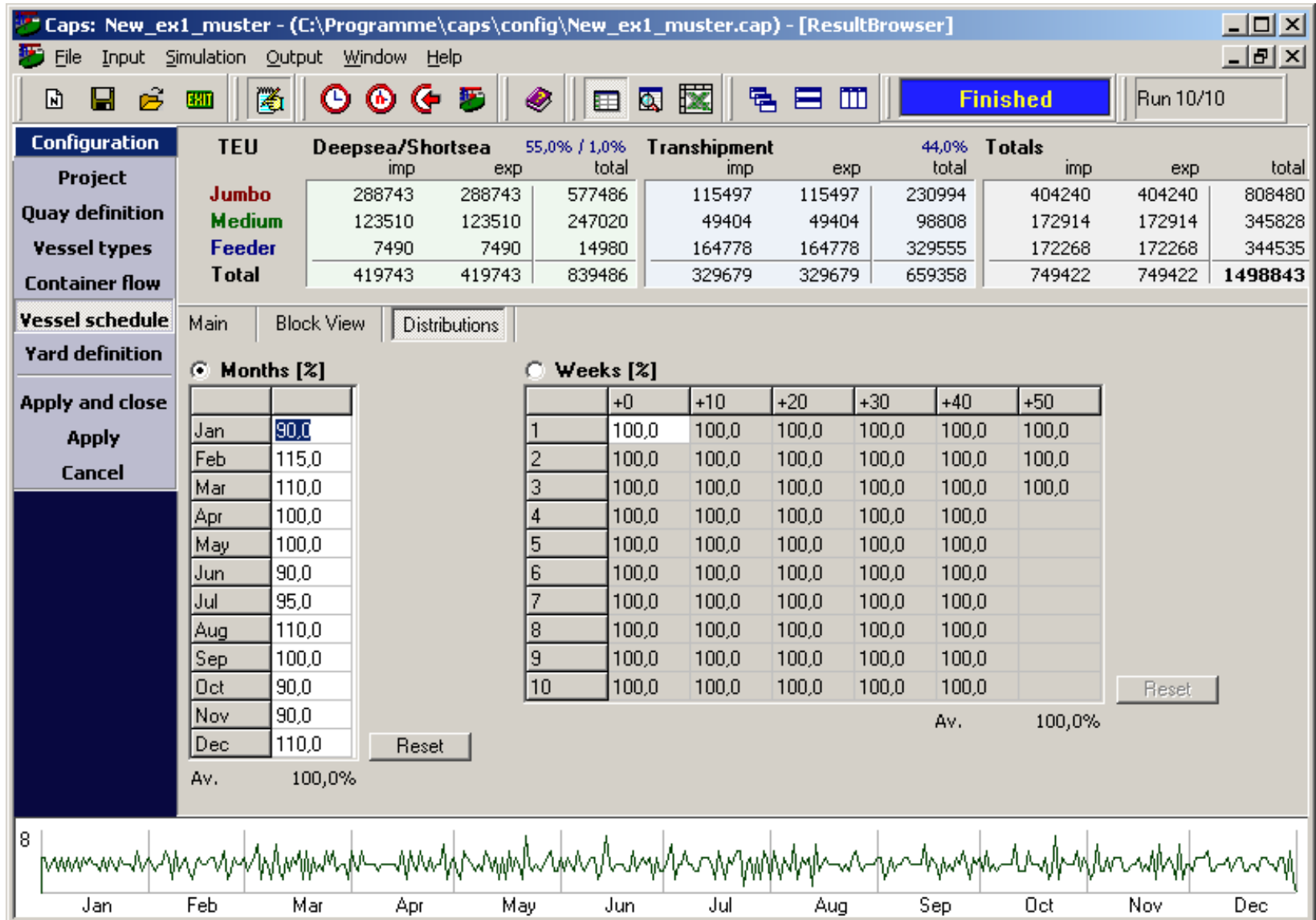
Gate

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



Generate Schedule

Yearly Throughput TEU

Weekday distribution of vessel arrivals

	Mon	Tue	Wed	Thu	Fri	Sat	Sun	av./day	per week	per year
Feeder	14,29	14,29	14,29	14,29	14,29	14,29	14,29	2,81	19,73	1026
Medium	14,29	14,29	14,29	14,29	14,29	14,29	14,29	0,62	4,35	226
Jumbo	14,29	14,29	14,29	14,29	14,29	14,29	14,29	0,65	4,56	237

Set fixed day time

Vessel schedule

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

File Input Simulation Output Window Help

Finished Run 10/10

Configuration	TEU	Deepsea/Shortsea 55.0% / 1.0%			Transhipment 44.0%			Totals			Vessels
		imp	exp	total	imp	exp	total	imp	exp	total	
Project	Jumbo	288743	288743	577486	115497	115497	230994	404240	404240	808480	237
Quay definition	Medium	123510	123510	247020	49404	49404	98808	172914	172914	345828	226
Vessel types	Feeder	7490	7490	14980	164778	164778	329555	172268	172268	344535	1026
Container flow	Total	419743	419743	839486	329679	329679	659358	749422	749422	1498843	1489

Vessel schedule: Main | Block View | Distributions

Name	Day	Type	Prio...	TEU	Cycle
Jumbo (A) 75	-7	Jumbo (A)	1	2880	once
Jumbo (A) 353	4	Jumbo (A)	1	2880	once
Jumbo (A) 508	11	Jumbo (A)	1	2880	once
Jumbo (A) 746	21	Jumbo (A)	1	2880	once
Jumbo (A) 970	30	Jumbo (A)	1	2880	once
Jumbo (A) 1138	37	Jumbo (A)	1	2880	once
Jumbo (A) 1416	49	Jumbo (A)	1	2880	once
Jumbo (A) 1732	62	Jumbo (A)	1	2880	once
Jumbo (A) 1791	64	Jumbo (A)	1	2880	once
Jumbo (A) 2063	75	Jumbo (A)	1	2880	once
Jumbo (A) 2295	85	Jumbo (A)	1	2880	once
Jumbo (A) 2513	94	Jumbo (A)	1	2880	once
Jumbo (A) 2800	106	Jumbo (A)	1	2880	once
Jumbo (A) 2905	111	Jumbo (A)	1	2880	once
Jumbo (A) 3165	121	Jumbo (A)	1	2880	once
Jumbo (A) 3384	131	Jumbo (A)	1	2880	once
Jumbo (A) 3671	142	Jumbo (A)	1	2880	once
Jumbo (A) 3844	150	Jumbo (A)	1	2880	once
Jumbo (A) 3977	155	Jumbo (A)	1	2880	once
Jumbo (A) 4221	165	Jumbo (A)	1	2880	once
Jumbo (A) 4415	173	Jumbo (A)	1	2880	once
Jumbo (A) 4743	187	Jumbo (A)	1	2880	once
Jumbo (A) 4890	193	Jumbo (A)	1	2880	once
Jumbo (A) 5076	201	Jumbo (A)	1	2880	once

Generic Properties | Arrival Time

Volume [TEU] Ct. types

Length [m] StSC Perfor. [mv/hr]

Width [m] Waiting time [hours]

Draught [m] Priority

StSC Number

File... Generate... Add blank ship Add random ship Delete Clear all

Result, page1

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

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24.10.2006 12:58

New_ex1_muster - Result from 10 simulation runs

Total volume **1495242.70** TEU Total volume (including rejected ships): 1500091.80 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	30.20	8.60	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%
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*excludes rejected ships

Result, page2

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

File Input Simulation Output Window Help

Finished Run 10/10

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New_ex1_muster - Result from 10 simulation runs

Statistic

Quay length	Quay util.		no. of used StSC	
	av.	max.	av.	max.
1350m	31.59%	95.19%	4.92	19

Yard utilisation

Stack name	maximum	average	over capacity	over max. util.	below max. util.
standard	0.00%	0.00%	0.00%	0.00%	0.00%
reefer	0.00%	0.00%	0.00%	0.00%	0.00%
mtv	0.00%	0.00%	0.00%	0.00%	0.00%
oversize	0.00%	0.00%	0.00%	0.00%	0.00%
hazardous	0.00%	0.00%	0.00%	0.00%	0.00%

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	91.62	112.48	107.99	102.88	99.48	91.24	94.98	108.89	100.58	89.50	90.31	110.78
Medium	92.03	114.31	110.49	102.69	100.35	91.88	93.12	107.15	105.37	92.24	82.70	108.49
Jumbo	88.93	115.02	113.83	97.69	104.16	83.32	103.74	104.25	103.18	93.35	83.04	109.87
Total	90.26	114.28	111.73	100.03	102.22	87.10	99.30	105.98	103.09	92.21	84.63	109.76

→ STEP 3

Result, page3

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

File Input Simulation Output Window Help

Finished Run 10/10

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New_ex1_muster - Result from 10 simulation runs

Expected/real allocation of StSC to vessel types

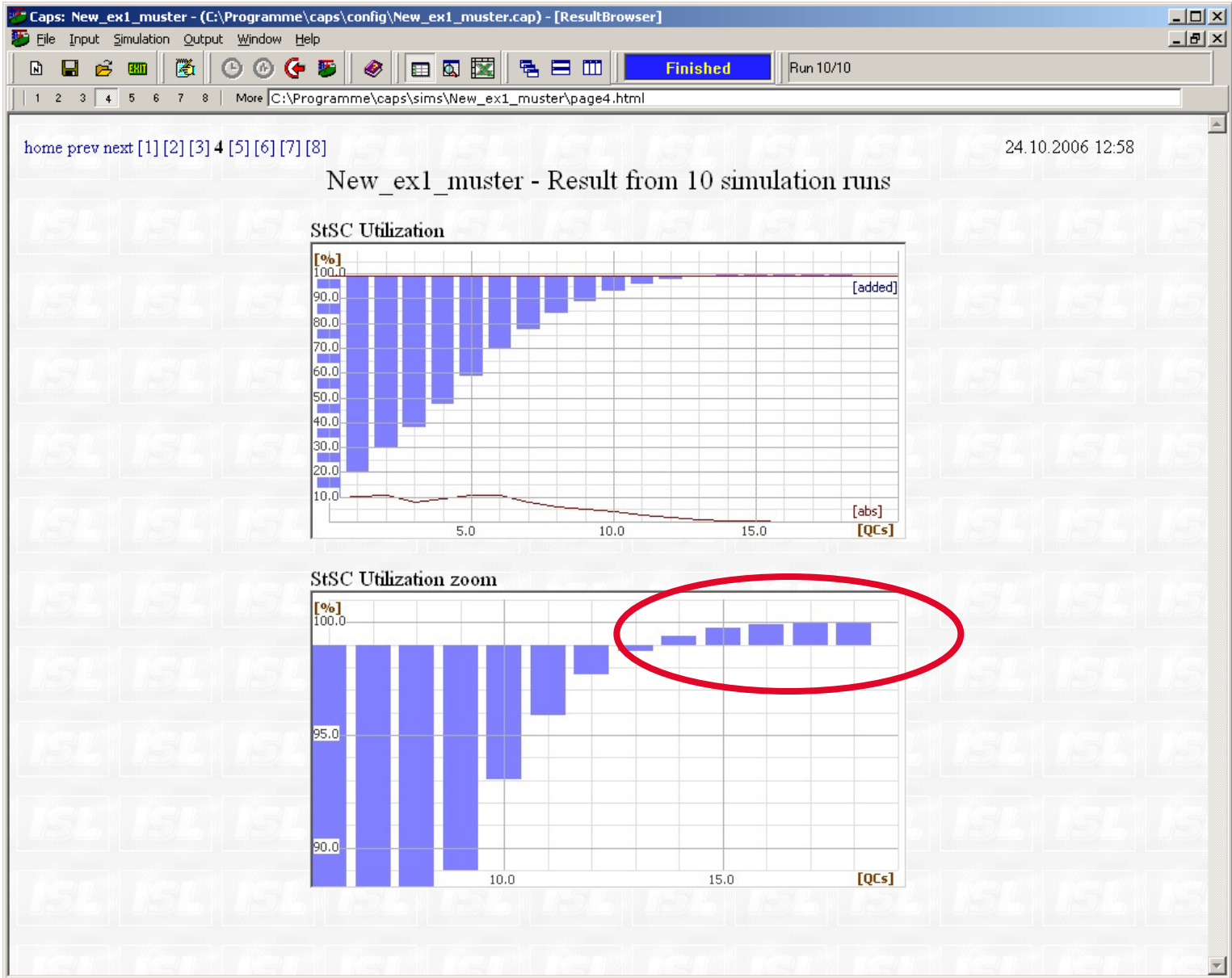
%	1	2	3	4	5	6
Jumbo	0.00	0.00	0.00	51.18	48.82	0.00
Medium	0.00	5.48	47.37	47.15	0.00	0.00
Feeder	49.58	50.42	0.00	0.00	0.00	0.00

StSC Performance

	min value	max value	Performance min	Performance avg	Performance max
Jumbo	25.00	30.00	25.18	27.82	29.90
Medium	18.50	24.50	18.51	21.58	24.42
Feeder	14.00	15.00	14.00	14.33	14.99



Result, page4



Result, page5

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

File Input Simulation Output Window Help

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New_ex1_muster - Result from 10 simulation runs

simultaneous utilization of StSC [% of time]			StSC total moves	
no. of StSC	Share of time	Availability	StSC	Moves
0	9.20%	9.20%	default	934523,80
1	10.31%	19.51%		
2	10.69%	30.19%		
3	7.92%	38.11%		
4	9.54%	47.65%		
5	11.03%	58.69%		
6	10.89%	69.57%		
7	8.13%	77.70%		
8	6.30%	84.00%		
9	5.03%	89.03%		
10	4.02%	93.05%		
11	2.83%	95.87%		
12	1.82%	97.69%		
13	1.02%	98.72%		
14	0.68%	99.40%		
15	0.35%	99.76%		
16	0.17%	99.93%		
17	0.06%	99.99%		
18	0.01%	100.00%		

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\sim\New_ex1_muster\page6.html

home prev next [1] [2] [3] [4] [5] **6** [7] [8] 24.10.2006 12:58

New_ex1_muster - Result from 10 simulation runs

standard yard utilization

Y-axis: [% time] (0.0 to 90.0)
X-axis: [TEU] (6000.0 to 20000.0)

Calculated Values

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

→ STEP 3

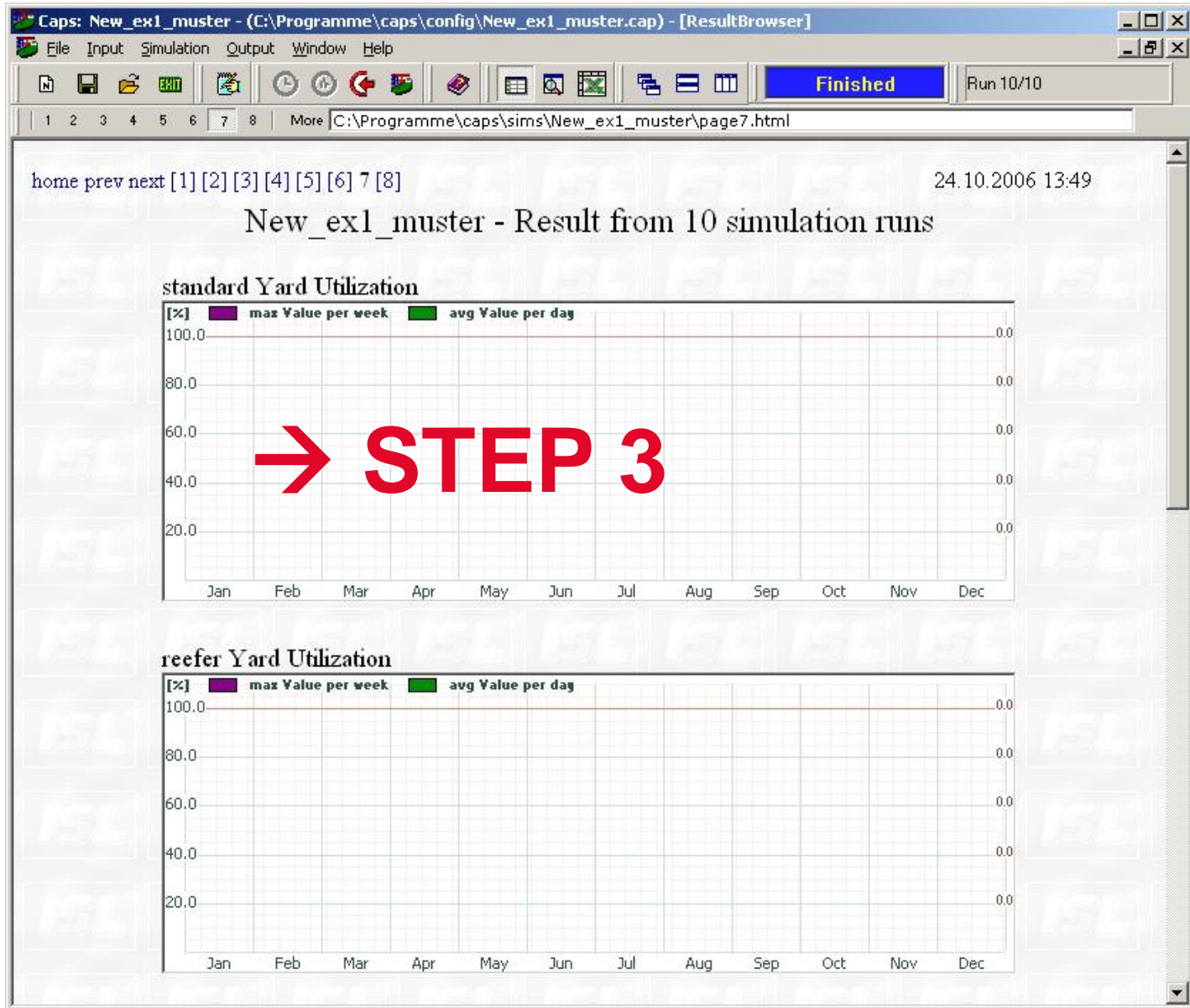
reefer yard utilization

Y-axis: [% time] (0.0 to 90.0)
X-axis: [TEU] (600.0 to 1400.0)

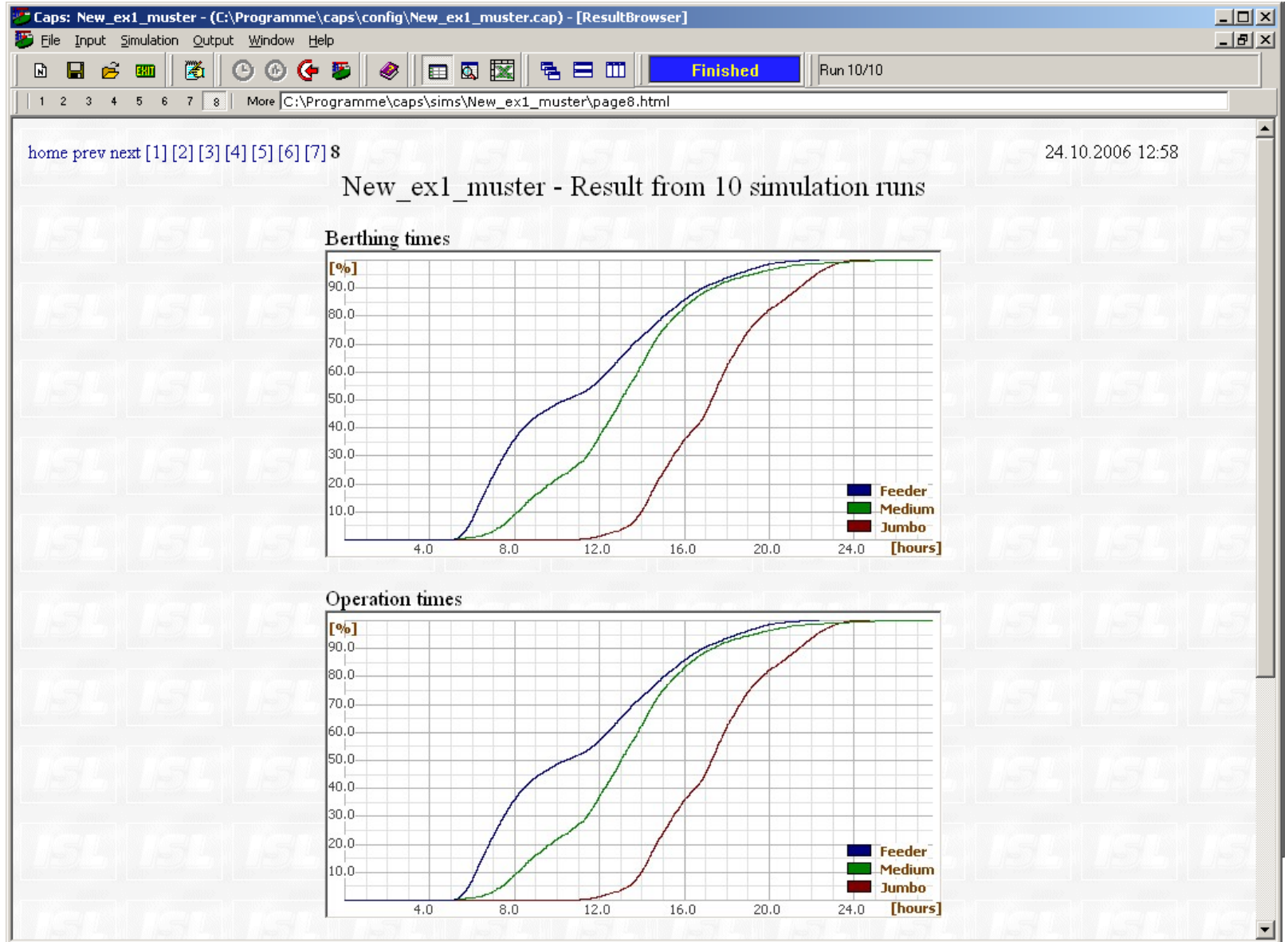
Calculated Values

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

Result, page7



Result, page8



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

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

File Input Simulation Output Window Help

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			Ship to shore cranes				
Name	moves/hr	no.	Name	Left	Right	Multi	STSC-Class
QC	max	12	QC1	0	1350	no	QC
			QC2	0	1350	no	QC
			QC 3	0	1350	no	QC
			QC 4	0	1350	no	QC
			QC 5	0	1350	no	QC
			QC 6	0	1350	no	QC
			QC 7	0	1350	no	QC
			QC 8	0	1350	no	QC
			QC 9	0	1350	no	QC
			QC 10	0	1350	no	QC
			QC 11	0	1350	no	QC
			QC 12	0	1350	no	QC

0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300

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

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%													
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*excludes rejected ships

STS utilisation, 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\sim\New_ex2_muster\page5.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

simultaneous utilization of StSC [% of time]			StSC total moves	
no. of StSC	Share of time	Availability	StSC	Moves
0	8.50%	8.50%	QC1	87262,60
1	10.57%	19.07%	QC2	74439,10
2	9.99%	29.06%	QC 3	78119,20
3	7.82%	36.89%	QC 4	79343,10
4	9.54%	46.43%	QC 5	69658,10
5	11.47%	57.90%	QC 6	63211,90
6	10.69%	68.58%	QC 7	62614,40
7	8.44%	77.02%	QC 8	69972,80
8	7.02%	84.04%	QC 9	82786,80
9	5.72%	89.76%	QC 10	85241,70
10	4.25%	94.01%	QC 11	84049,20
11	3.03%	97.04%	QC 12	96961,40
12	2.96%	100.00%		

STS Definition, 11 cranes



Caps: New_ex2_muster11 - (C:\Programme\caps\config\New_ex2_muster11.cap)

File Input Simulation Output Window Help

Finished Run 10/10

Configuration

Quay definition STS cranes

Project Ship to shore crane classes

Quay definition

Name	moves/hr	no.
QC	max	11

>> Add >>

Ship to shore cranes

Name	Left	Right	Multi	STSC-Class
QC1	0	1350	no	QC
QC2	0	1350	no	QC
QC 3	0	1350	no	QC
QC 4	0	1350	no	QC
QC 5	0	1350	no	QC
QC 6	0	1350	no	QC
QC 7	0	1350	no	QC
QC 8	0	1350	no	QC
QC 9	0	1350	no	QC
QC 10	0	1350	no	QC
QC 11	0	1350	no	QC

Clone Delete Clear Sort

Name: QC 11

op range min.: 0

op range max.: 1350

unlimited amount

Assignments

	A	B	C	D	E
Jumbo	X	X	X	X	X
Medium	X	X	X	X	X
Feeder	X	X	X	X	X

0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300

Throughput, 11 cranes

Caps: New_ex2_muster11 - (C:\Programme\caps\config\New_ex2_muster11.cap) - [ResultBrowser]

File Input Simulation Output Window Help

Finished Run 10/10

1 2 3 4 5 6 7 8 More C:\Programme\caps\sim\New_ex2_muster11\page1.html

home prev next 1 [2] [3] [4] [5] [6] [7] [8] 24.10.2006 13:32

New_ex2_muster11 - Result from 10 simulation runs

Total volume: 1490330.30 TEU Total volume [including rejected ships]: 1501045.40 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	34.60	10.80	11:31:42	38:44:58	11:16:06	22:47:42	00:06:11	03:01:37	07:59:33	335.71	521.00	209.84	327	1.45	14.33
	3.37%	1.05%	Berthing without waiting time: 96.63%												

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	5.80	3.30	14:00:44	28:15:55	13:56:14	28:15:55	00:02:47	01:46:36	03:40:30	1534.16	2424.00	958.85	1515	3.21	21.59
	2.57%	1.46%	Berthing without waiting time: 97.43%												

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	1.50	0.60	18:02:46	33:31:32	18:01:23	33:31:32	00:00:16	00:42:08	01:45:39	3417.32	4241.00	2135.83	2652	4.33	27.85
	0.63%	0.25%	Berthing without waiting time: 99.37%												

Total	2.81%	0.99%													
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*excludes rejected ships

STS utilisation, 12 cranes

Caps: New_ex2_muster11 - (C:\Programme\caps\config\New_ex2_muster11.cap) - [ResultBrowser]

File Input Simulation Output Window Help

Run 10/10

home prev next [1] [2] [3] [4] 5 [6] [7] [8] 24.10.2006 13:32

New_ex2_muster11 - Result from 10 simulation runs

simultaneous utilization of StSC [% of time]			StSC total moves	
no. of StSC	Share of time	Availability	StSC	Moves
0	8.35%	8.35%	QC1	90015,10
1	9.97%	18.32%	QC2	80025,60
2	10.07%	28.39%	QC 3	83602,20
3	7.88%	36.28%	QC 4	85757,40
4	9.50%	45.77%	QC 5	75421,60
5	11.31%	57.09%	QC 6	69989,80
6	11.03%	68.12%	QC 7	78828,00
7	9.12%	77.24%	QC 8	89425,50
8	7.21%	84.45%	QC 9	90165,20
9	6.24%	90.69%	QC 10	88823,40
10	4.29%	94.98%	QC 11	99416,00
11	5.02%	100.00%		

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

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

File Input Simulation Output Window Help

Run 10/10

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%
mtv	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\sim\New_ex1_muster\page6.html

home prev next [1] [2] [3] [4] [5] **6** [7] [8] 24.10.2006 12:58

New_ex1_muster - Result from 10 simulation runs

standard yard utilization

Y-axis: [% time] (10.0 to 90.0)
X-axis: [TEU] (6000.0 to 20000.0)

Calculated Values

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

reefer yard utilization

Y-axis: [% time] (10.0 to 90.0)
X-axis: [TEU] (600.0 to 1400.0)

Calculated Values

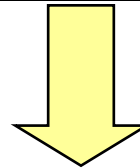
Yard occupation [TEU]		
Min.	Av.	Max.
419.00	927.73	1554.00
Given operational capacity: 80.00%		



CAPS → SCUSY



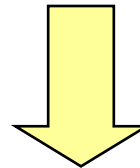
- throughput capacity: 1.500.000 TEU
- no. of required STS cranes: 12
- required stacking capacity:
 - standard: 17.000 TEU
 - reefer: 1.350 TEU
 - MTYs: 7.300 TEU



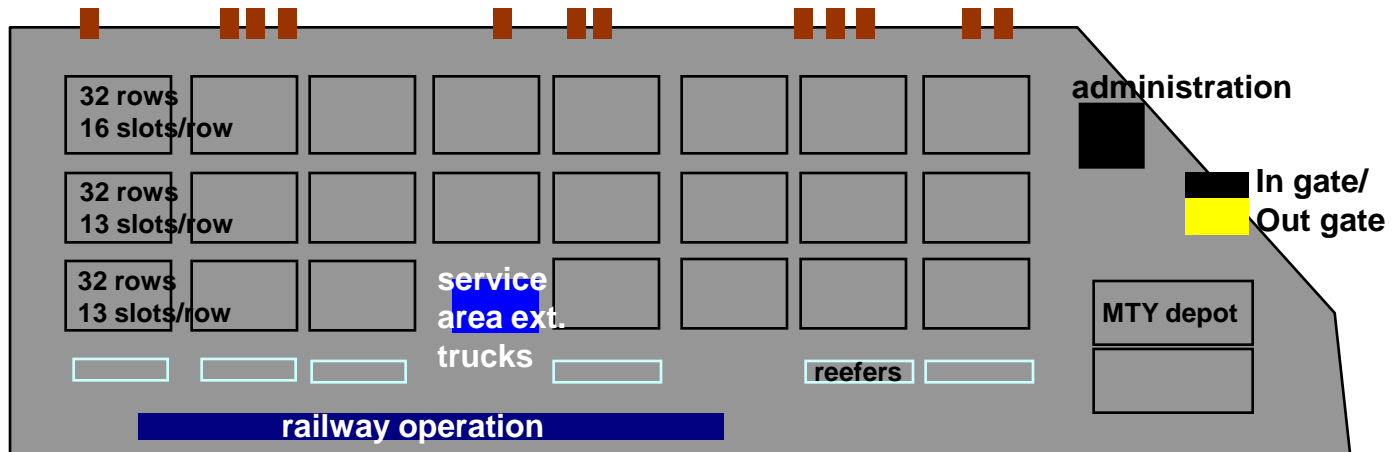
layout design for different stacking systems, e. g.

- straddle carrier
- RTG operation
- RMG operation

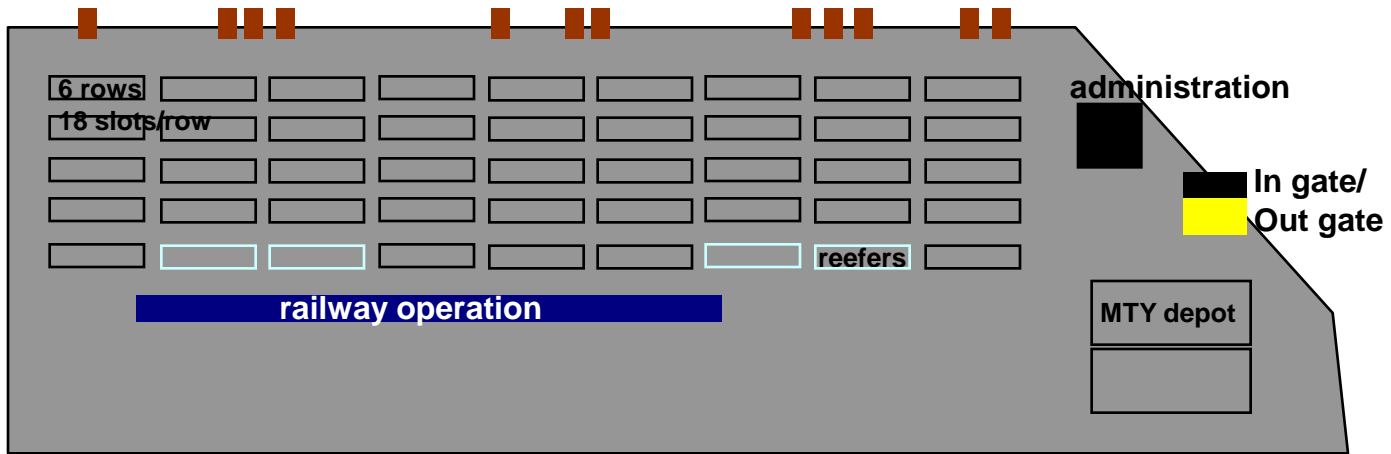
resp. combination of different stacking systems



Layout: Straddle carrier operation

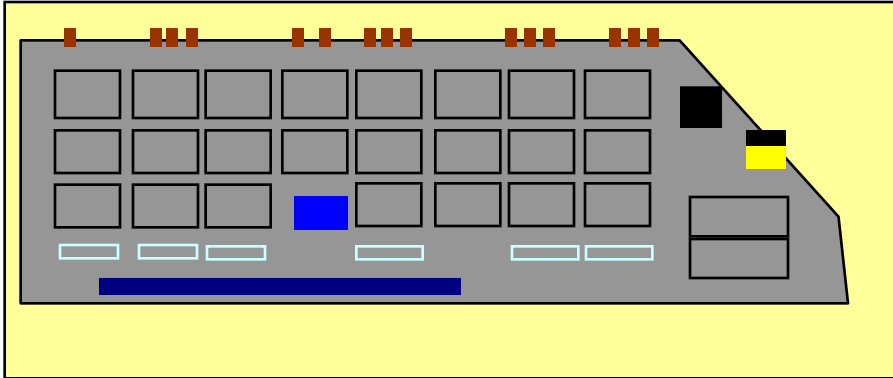


- standard: $32 \text{ rows} * 16 \text{ slots/row} * 8 \text{ blocks} \rightarrow 4.096 \text{ GS}$
 $32 \text{ rows} * 13 \text{ slots/row} * 15 \text{ blocks} \rightarrow 6.240 \text{ GS}$
 $10.340 \text{ GS} * 2\text{-high} = 20.680 \text{ TEU}$
- reefers: $32 \text{ rows} * 4 \text{ slots/row} * 6 \text{ blocks} \rightarrow 768 \text{ GS} * 2\text{-high} = 1.536 \text{ TEU}$
- MTYs: $26 \text{ rows} * 45 \text{ slots/row} * 2 \text{ blocks} \rightarrow 2.340 \text{ GS} * 4\text{-high} = 9.360 \text{ TEU}$

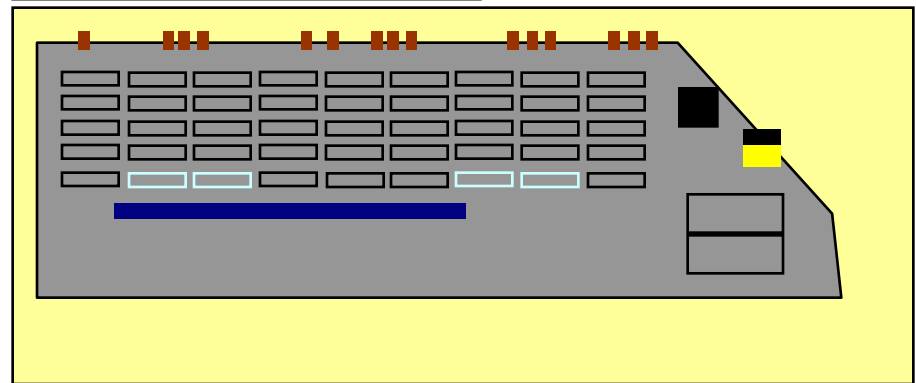


- standard: $6 \text{ rows} * 18 \text{ slots/row} * 41 \text{ blocks} \rightarrow 4.428 \text{ GS} * 4\text{-high} = 17.712 \text{ TEU}$
- reefers: $6 \text{ rows} * 18 \text{ slots/row} * 4 \text{ blocks} \rightarrow 432 \text{ GS} * 4\text{-high} = 1.728 \text{ TEU}$
- MTYs: $26 \text{ rows} * 45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

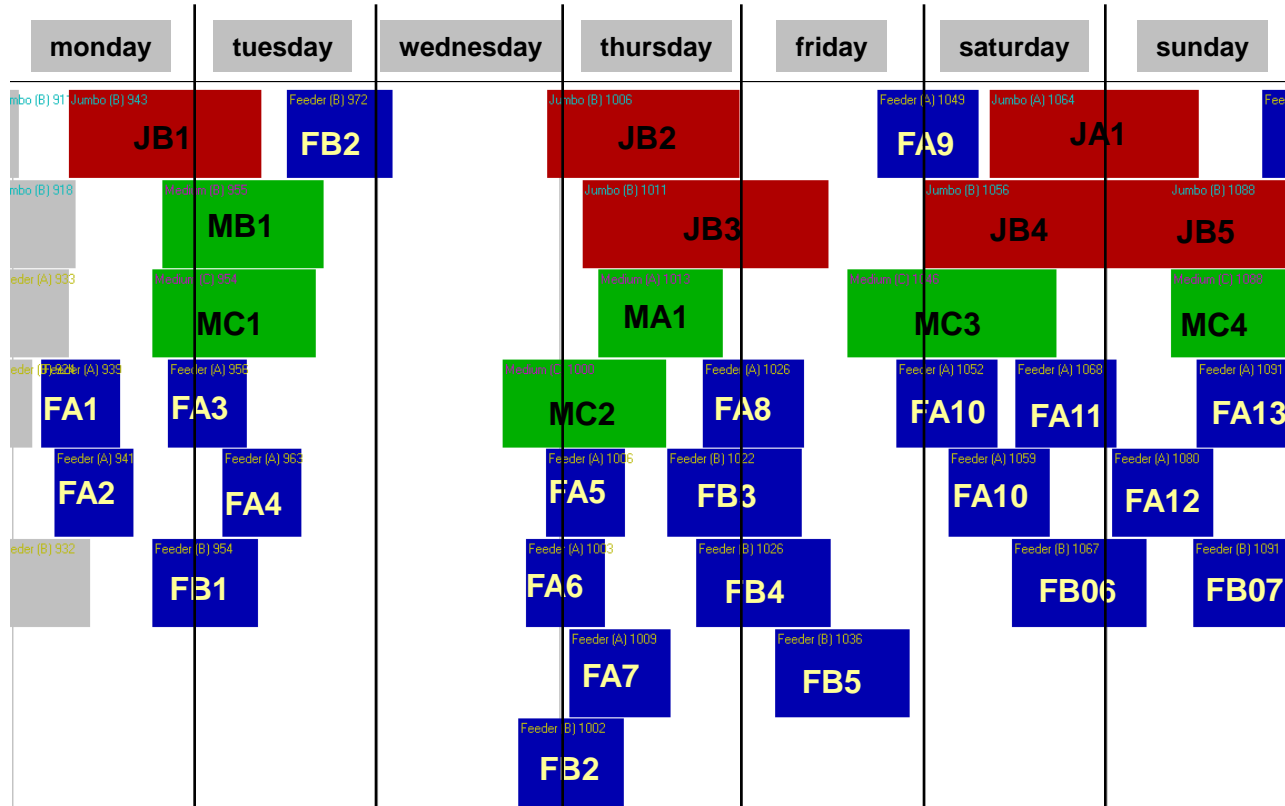
Straddle carrier operation



RTG operation



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



ToDo

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

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