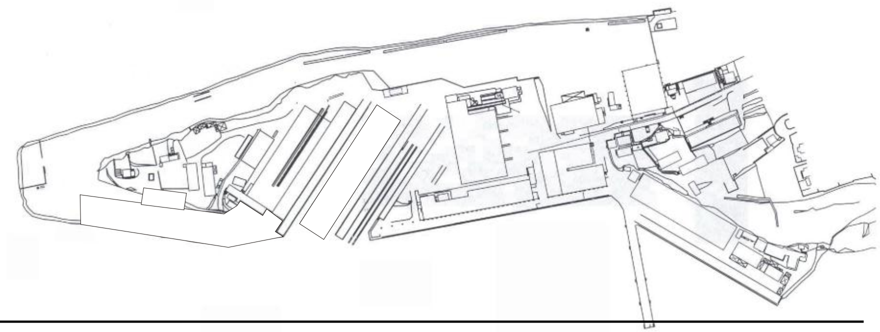
3rd INTERNATIONAL SHIP DESIGN & NAVAL ENGINEERING CONGRESS



ACTION PLAN FOR RESTRUCTURING THE TECHNOLOGY OF A MEDIUM SIZED SHIPYARD

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Project requirements
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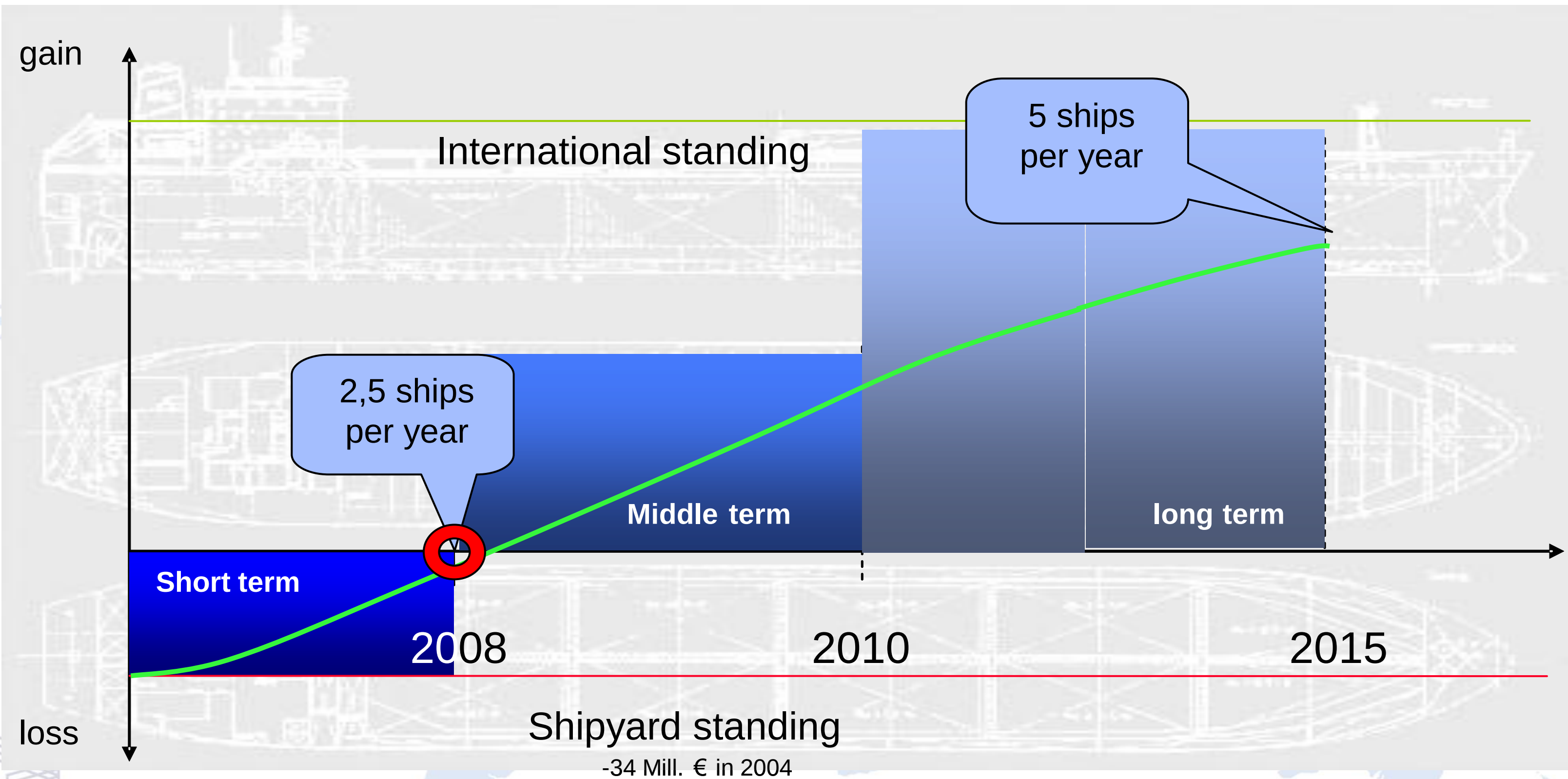
Project requirements

Definition of achievable project results



→ The minimum aim for is to produce 4 ships per year in one shift

Project requirements
Applied methods

Analysis Fields	Description	Applied method for the analysing phase: Simulation	Input-Output relation	Benchmark	Planning table	Value Stream	Question-naire
1	Analysis applying lean principles					x	
2	Analysis bottlenecks / improvable processes		x				(x)
3	Analysis crane capacity and technology	x	x				(x)
4	Analysis communication and information flow					x	
5	Analysis core competencies						x
6	Analysis Micro Panel Line		x	x			
7	Analysis organization of work		x				(x)
8	Analysis outfitting performance		x	x			
9	Analysis of payment methods			x			
10	Analysis process orientation					x	
11	Analysis second slipway	x	x				
12	Analysis spatial structures and flow				x		
13	Analysis welding speed and quality			x			
14	Analysis of new outfitting place					x	

14 analysis fields will be analysed with the methods:

- Shop floor simulation
- Input-output relation
- Benchmark
- Planning Table
- Value stream
- Questionnaire

Analysis of functional and spatial structures
Agenda

Analysis of functional and spatial structures

Introduction: Steel throughput per ship II

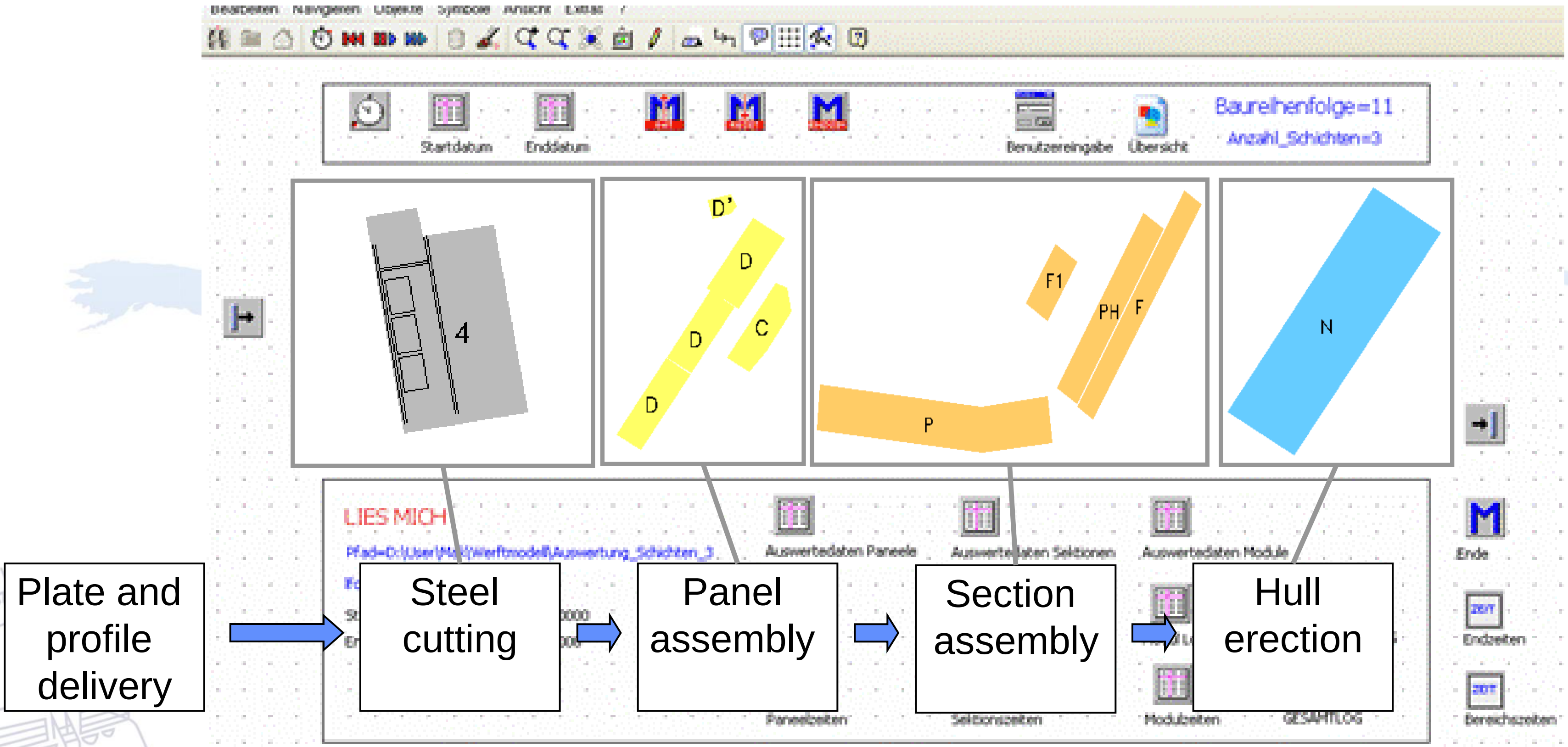
	abs. weights per workplace [t]	abs. weight propotion [%]
Plate fabrication	144,0	1,4%
Profile fabrication	9252,1	86,9%
T1-T5 (Panel line)	1393,9	13,1%
	2713,7	25,5%
PH (Section assembly)	688,7	6,5%
	5346,6	50,2%
F (Section assembly)	905,3	8,5%
	7359,5	69,1%
F1 (Section assembly)	1377,4	12,9%
	3316,7	31,2%
P (Section assembly)		
C (Micro panel)		
D (Micro panel)	0,0	0,0%
	62,4	0,6%
hull erection	10645,95	

- The steel throughput for one ship is approx. 10646 tons based on the reference sections
- This value does match with the questionnaire

→**Our model of reference section is sufficient for further investigations**

Analysis of functional and spatial structures

Simulation: Introduction into the shipyards simulation model



Method for simulation and optimisation of the production in the shipyard especially for the valuation of special concepts

Analysis of functional and spatial structures

Simulation: Introduction *prerequisites of the different workshops*

Steel cutting and bending

- simulating with 3 shifts (pure working time)
- plate cutting
  - consists of 3 parallel workstations
  - buffer for plates is 10 sections
  - crane for the transportation of plates from buffer to panel assembly
- profile cutting
  - 1 workstation (representing the cutting robots)
- plate bending
  - 1 workstation (including all plate bending facilities from the shipyard)
- profile bending
  - only relevant for one reference section → has an low overall influence on simulation time → currently not included in the model

Analysis of functional and spatial structures

Simulation: Introduction *prerequisites of the different workshops*

panel assembly

- consists of 5 serial workstations representing the 5 stages of assembly
- every stations needs 1/5 of the assembly duration (1/5 of 32h)
- profile portal tests if profiles from profile cutting are ready and available
- simulating with 2 shifts (pure working time)

section assembly

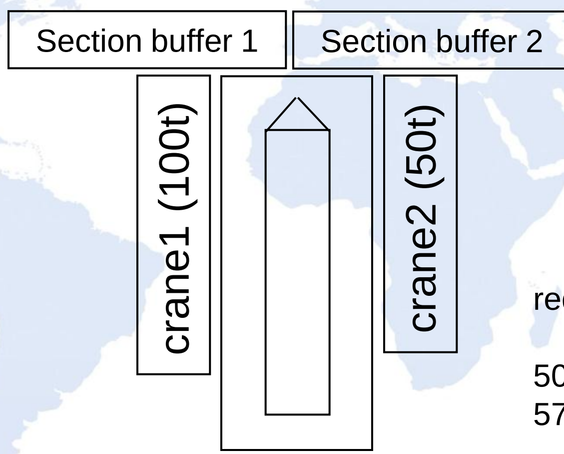
- maximum of sections which can be assembled parallel: 30
- average space requirement per section: 216m² (calculated from the section fabrication table)
- simulating with 1 shift (pure working time)
- curved sections and micro-panels are currently included in the section assembly with the simulation model

Analysis of functional and spatial structures

Simulation: Introduction *prerequisites of the different workshops*

slipway

- maximum of sections which can be assembled parallel: 2
- sections are allocated to section buffer 1 (starboard) or section buffer 2 (port) according to their weight:
    - up to 50t → section buffer 2 is used
    - up to 85t → section buffer 1 (port) OR workspace2 (starboard) is used
    - up to 100t → only section buffer 1 is used

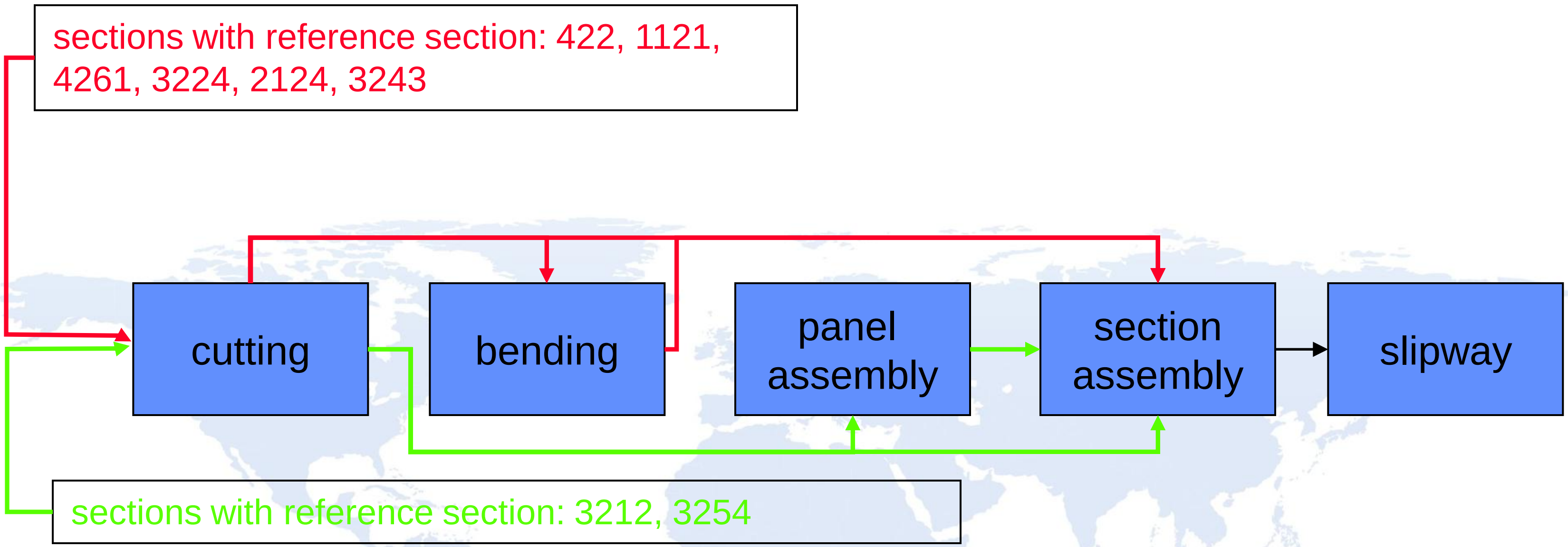


request for crane:
< 50 t → crane2
50 – 57 t → crane1
57 – 85 t → crane2 & crane1

- simulating with 1 shift (pure working time)

Analysis of functional and spatial structures

Simulation: Introduction *simulation flow model*



- parts from plate or profile cutting are transported to panel assembly or section assembly; plates that have to be bended are send to plate bending
- in the panel assembly plates and profiles are assembled to panels
- in the section assembly the fabricated plates and panels are assembled to sections

Analysis of functional and spatial structures

Simulation: Introduction *prerequisites of the production data of sections*

general prerequisites

- simulating with 170 sections
- sections 4581 to 4584 are only handled as one section with reference section number 422
- section 3413 with a weight of 190t is spitted into two sections (3413 and 3414)
- section 1161 is spitted into three sections (1161, 1162 and 1163)
- order of production according to order of sections is based on information of assembly tree of the ship no. 315

steel cutting and bending

- the simulation is section oriented:
  - all parts of one section (profiles and panels) are summarized to three working packages (profile cutting, plate cutting, plate bending)
  - → three parts to simulate the assembly duration in cutting and bending in simulation model

panel assembly

- assembling of two parts coming from plate and profile cutting

section assembly

- assembling of third part (from plate bending) with panels coming from panel assembly

Analysis of functional and spatial structures

Simulation: Analyse the bottlenecks

Simulation of the execution time for each shop in consideration of one berth

.Modelle.WERFTABLAUF.tab_Duration_times

	string 1	time 2	time 3	time 4	time 5	time 6	time 7
string	Object	Start_Plate_cutting	Start_plate_bending	Start_Panelline	Start_assembly_section	Start_assembly_slipway	End_assembly_slipway
1	315	0.0000	2:14:02:00.0000	3:13:02:00.0000	2:14:01:00.0000	21:06:02:00.0000	164:07:01:00.0000
2	316	127:16:33:00.0000	134:17:46:00.0000	133:10:35:00.000	132:22:34:00.0000	164:07:02:00.0000	294:07:01:00.0000
3	317	257:14:49:00.0000	264:16:02:00.0000	263:08:51:00.000	262:20:50:00.0000	294:07:02:00.0000	424:07:01:00.0000
4	318	387:13:05:00.0000	394:14:18:00.0000	393:07:07:00.000	392:19:06:00.0000	424:07:02:00.0000	554:07:01:00.0000
5							
6							
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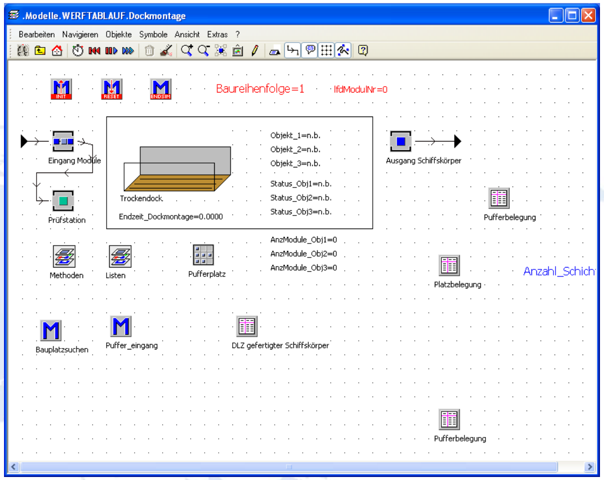
9							
10							
11							



<u>Conclusion:</u>

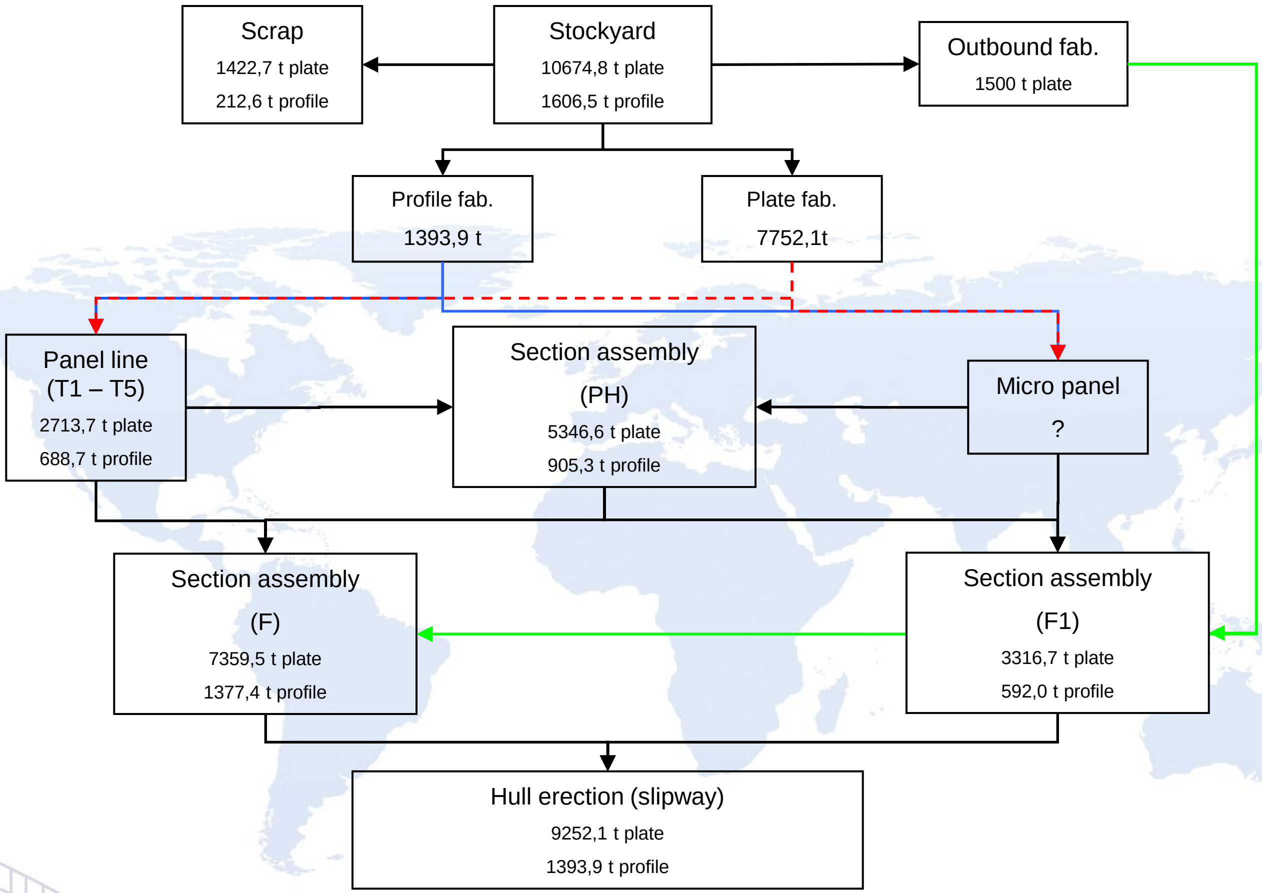
→Duration time on the berth is 130 days → This matches with the project schedule of the shipyard

→Bottleneck in the steel fabrication is the plate and profile fabrication → they determine the panel and the section assembly processes

→The cranes on berth are another bottleneck, especially the 100 t crane

Analysis of functional and spatial structures

Input-output relations: *steel input and output*



Analysis of functional and spatial structures

Input-output relations: Demands on the capacity

Estimation on capacity demands for each workshop due to the aimed output of the shipyard

1 ship

workplaces		1121	2124	3212	3224	3243	3254	4261	422		
Plate fabrication	0	159,924	566,5256	3376,59	1692,096	1796,79	1220,492	154,468	285,198	9252,08	
Profile fabrication	0	5,464	86,752	557,718	302,036	0	349,496	40,26	52,144	1393,87	
hull erection	0	165,388	653,2776	3934,31	1994,132	1796,79	1569,988	194,728	337,342	10645,95	t/year

2,2 ships (per anno)

workplaces		1121	2124	3212	3224	3243	3254	4261	422		
Plate fabrication		351,833	1246,356	7428,5	3722,611	3952,94	2685,082	339,83	627,436	20354,58	
Profile fabrication		12,0208	190,8544	1226,98	664,4792	0	768,8912	88,572	114,717	3066,51	
hull erection		363,854	1437,211	8655,48	4387,09	3952,94	3453,974	428,402	742,152	23421,10	t/year

2,5 ships (per anno)

workplaces		1121	2124	3212	3224	3243	3254	4261	422		
Plate fabrication		399,81	1416,314	8441,48	4230,24	4491,98	3051,23	386,17	712,995	23130,21	
Profile fabrication		13,66	216,88	1394,3	755,09	0	873,74	100,65	130,36	3484,68	
hull erection		413,47	1633,194	9835,77	4985,33	4491,98	3924,97	486,82	843,355	26614,88	t/year

4 ships (per anno)

workplaces		1121	2124	3212	3224	3243	3254	4261	422		
Plate fabrication		639,696	2266,102	13506,4	6768,384	7187,16	4881,968	617,872	1140,79	37008,33	
Profile fabrication		21,856	347,008	2230,87	1208,144	0	1397,984	161,04	208,576	5575,48	
hull erection		661,552	2613,11	15737,2	7976,528	7187,16	6279,952	778,912	1349,37	42583,81	t/year

→ The demand of capacities in consideration of 4 ships per year shows that the shipyard has to manufacture a steel throughput of approx. 37.008 t plates and 5.575 t profiles

Analysis of functional and spatial structures

Input-output relations: Analysis of the bottlenecks *berth cranes 2*

Balancing the capacity

The cranes have to meet the following capacity demands:

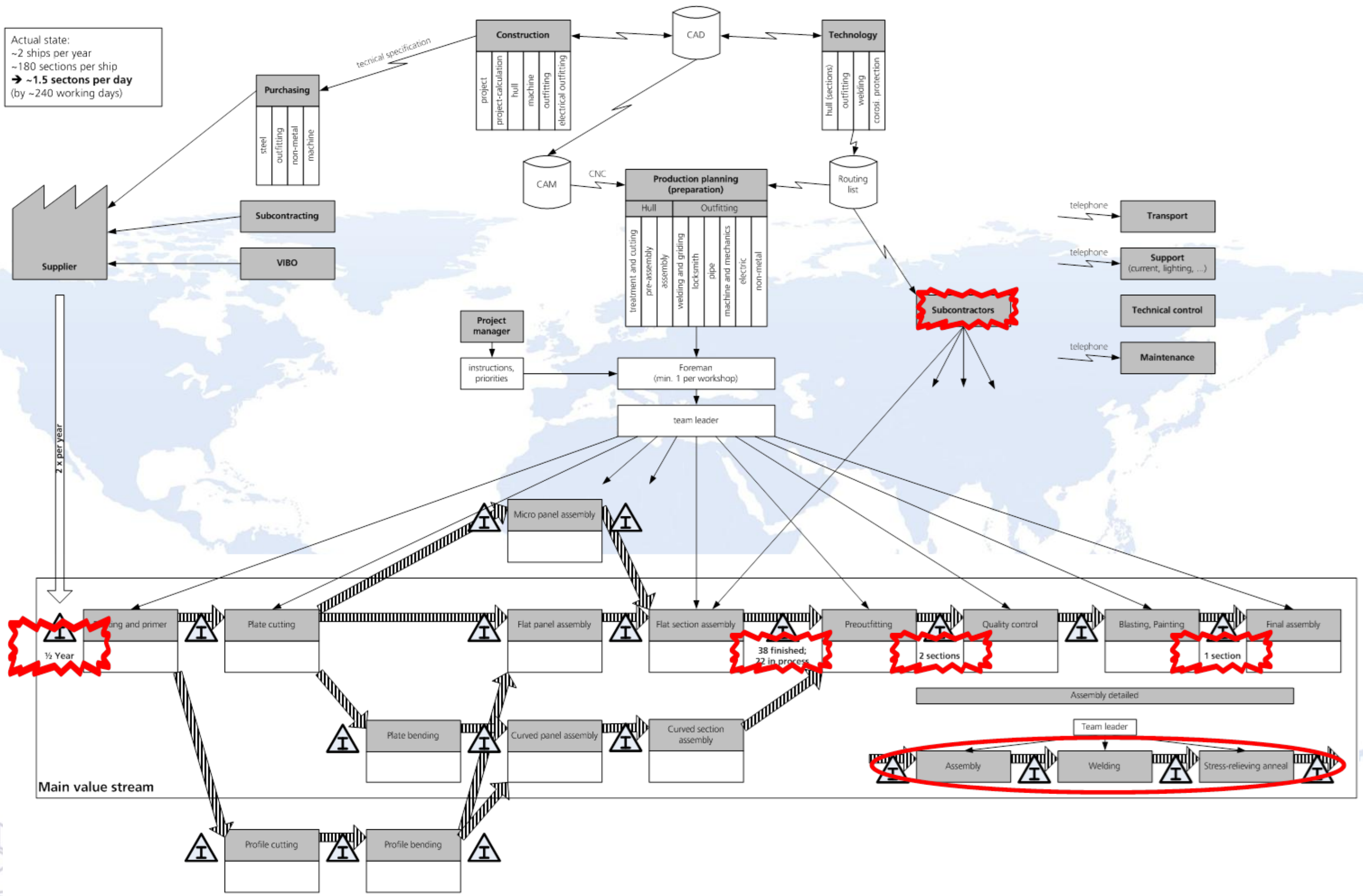
Ships per year	Work hours on berth		Other utilisation		Overall work time		Utilisation ratio	
	starboard h/year	portside h/year	starboard	portside	starboard h/year	portside h/year	starboard	portside
1	57	310			668	620	32%	32%
2,2	125	682	70% = 1344h	60% = 1152h	1469	1834	77%	96%
2,5	142	775			1669	2084	87%	**109%**
4	227	1240			2671	3335	**139%**	**174%**

For an annual production of 2,5 ships the portside-crane just exceeds its capacity limit

The aimed production of 4 ships per year exceeds the portside-cranes capacity for more than 70% and the starboard-cranes capacity approx. 40%

Analysis of functional and spatial structures

Value stream: Analysis



Analysis of functional and spatial structures

Value stream: Analysis – *material flow and process orientation*

Problems due to function-orientation:

- Big inventory buffers → long lead times
- Imbalances in the timing of operations are hidden → bottlenecks are hidden
- Feedback from later operations to earlier operations is delayed → when a defect is discovered it is not clear when or why it was produced
- Low motivation for improvement → problems are not eliminated
- Extra handling is necessary → e.g. for sorting
- Extra floor space is needed → blocked ways of transportation
- Extra inventory costs money → chance to raise money for necessary investments

Analysis of functional and spatial structures

Value stream: Analysis – *5S and continuous improvement*

- There is no accountability for orderliness and cleanliness
- There are no standards how the production area and the workplaces have to look like
- Obviously the responsibilities are not clearly defined (worker or maintenance)
- Waste and scrap disposal is badly organized, no defined places for dustbins and scrap containers

→ **result: additional steering and work expenditure and very messy production area**

- No standard process for handling improvement suggestions
- No responsible person to assess, decide and control the implementation of improvement suggestions
- Same situation for simplification of design (design for manufacturing)

→**result: many problems are obvious but nobody feels responsible for their elimination**

Analysis of functional and spatial structures
Overall results 1

Analysis Fields	Description	Results
1	Analysis applying lean principles	1. Push priciples applied on the shipyard increasing the inventory buffers and the duration time
2	Analysis bottlenecks / improvable processes	1. A bottleneck is the crane capacity of the steel fabrication and the 100t crane on the berth -> new transport or positioning systems
3	Analysis crane capacity and technology	1.The crane in plate and profile fabrication can handle 25000t this means approx. 2,5 ships 2. The crane on the berth could handle approx. 2,5 ships
4	Analysis communication and information flow	1. On the shipyard does not exist any information system. The applied CAD or CAM systems do not work together
5	Analysis core competencies	1. Analysis is not done -> Brodotorgir has to define the scope of the analysis
6	Analysis Micro Panel Line	1. Detailed analysis is not done -> Currently no investment into a Micro Panel Line is recommended by Fraunhofer
7	Analysis organization of work	1. Ratio white collar to blue collar is to high -> white collars could handle the workload of 4 ships 2. Following the lean principiles

Analysis of functional and spatial structures
Overall results 2

Analysis Fields	Description	Results
8	Analysis outfitting performance	1. Outfitting performance should be improved -> pipe outfitting
9	Analysis of payment methods	1. Payment methods (especially for subcontractors) is improvable -> budgeting
10	Analysis process orientation	1. All processes are functional oriented. The proces-ses are not arranged according the material flow
11	Analysis second slipway	1. Capacity of the first berth is able to produce 4 ships
12	Analysis spatial structures and flow	1. the structure of spatials and the material flow are developed due to different steps of accomodation to the modernization of workshops. A workflow in one direction is not possible
13	Analysis welding speed and quality	1. Quality assurance should be improved -> establish existing measurement system 2. Mechanic welding systems should be established in section assembly -> investment in technology
14	Analysis of new outfitting place	1. To improve the capability of the outfitting workshops up to an international standard an new outfitting workshops with new facilities is nessecary. 2. Untypical outfitting tasks should be outsourced (Pipe fabrication, ventilation, electrician)

Results of the concept phase
Agenda

Results of the concept phase
Introduction

Analysis fields

1. Analysis applying Lean principles
2. Analysis bottlenecks
3. Analysis crane capacity and technology
4. Analysis information and communication flow
5. Analysis core competencies
6. Analysis Micro Panel Line
7. Analysis of new outfitting place
8. Analysis organization of work
9. Analysis outfitting performance
10. Analysis of payment methods
11. Analysis process orientation
12. Analysis second berth
13. Analysis spatial structures and flow
14. Analysis welding speed quality

The analysis fields have been analysed with the applied methods simulation, input-output relation, value stream, planning table, benchmark and questionnaire

Concept fields

short	middle	long	**term**
'07	'08	´10	year

Concepts for accuracy control

Concepts for part fabrication

Concepts for panel fabrication

Concepts for pipe outfitting

Concepts for section assembly

Concepts for ring & final assembly

Concepts for organisation

Concepts for design requirements

Results of the concept phase

Overview of the solutions

	Short term concepts 2007	**Mid term concepts 2008-2009**	**Long term concepts >2010**
Solution 1 Accuracy control and shrinkage management	•Implementation of measurement tasks and techniques •Development of accuracy control / production	▪Introduction of mechanised welding (BUGO-Mat) ▪Implementation of shrinkage management	
Solution 2 Part fabrication	•Retrofitting the plate bending facility •Production maintenance	•Investments in new cutting building •Relocation of plate and profile fabrication	•Upgrade profile bending
Solution 3 Panel fabrication	•Improve the egg box integration (Process design) •Implementation of open section assembly on the panel line	•Relocation of the panel line •Introducing a mechanised micro panel fabrication	•Upgrading the flat panel fabrication
Solution 4 Outfitting	•Implementation of new design principles and modern pipe connections •Increasing final documentation of pre-outfitting (Simultaneous Engineering)	•Subcontracting pipe fabrication •Relocation and elimination of outfitting workshops •New 35t crane	

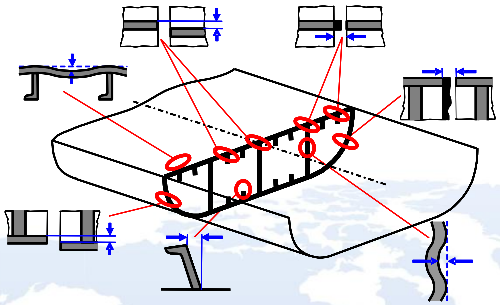
Results of the concept phase
Overview of the solutions

	Short term concepts 2007	**Mid term concepts 2008-2009**	**Long term concepts >2010**
Solution 5 Section assembly	•Reorganisation of the areas		•Closed section assembly building with a 160t crane
Solution 6 Ring and final assembly		•New 160t crane •Enlarge the launching berth	•Installation of a transportation and positioning system •Introducing ring section assembly •Improve the ring section pre-outfitting
Solution 7 Organisation	•Implementation of steady collection procedures of production times for ERP, PPC and Simulation •Implementation of a shop floor simulation •Implementation of matrix organisation •Clearing the workshops	•Change the payment method for subcontractors	
Solution 8 Design requirements	•Standardisation (Design for manufacturing; Design for assembly; Simultaneous Engineering)		

Solution 1: Accuracy Control
Agenda

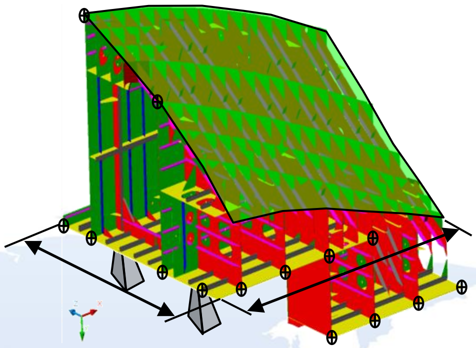
Solution 1

Parts of accuracy control

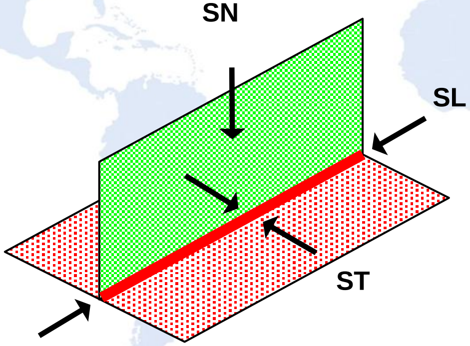


Quality control

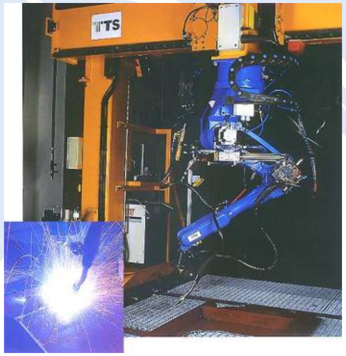
Measurement systems



Statistic Process Control



Shrinkage management

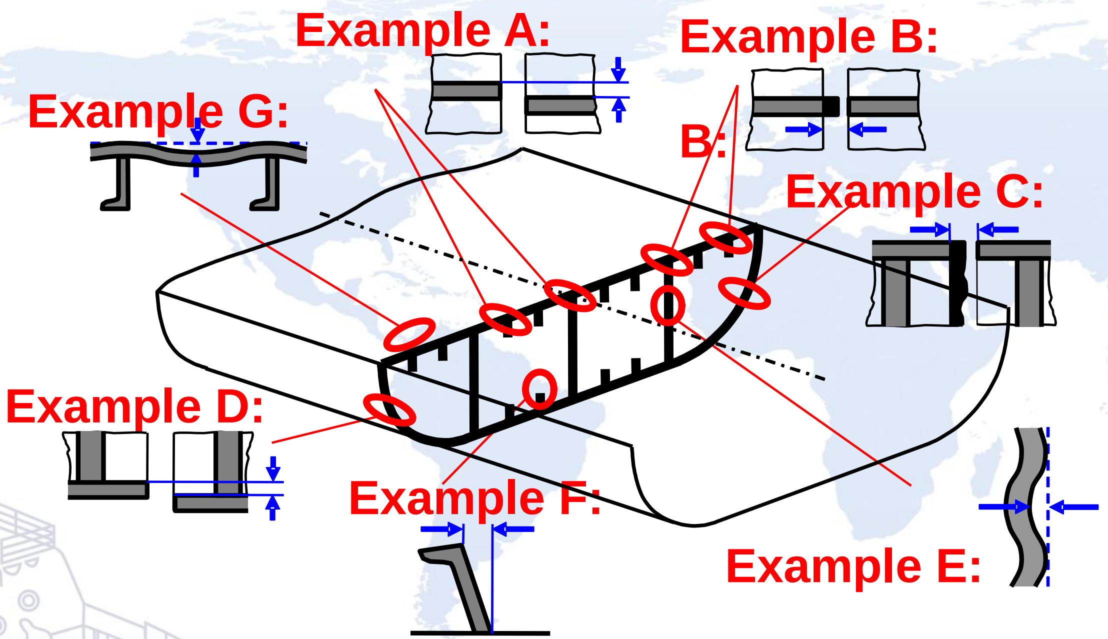


Mechanized welding

Solution 1

Quality control: Necessity of a quality control group – types of rework

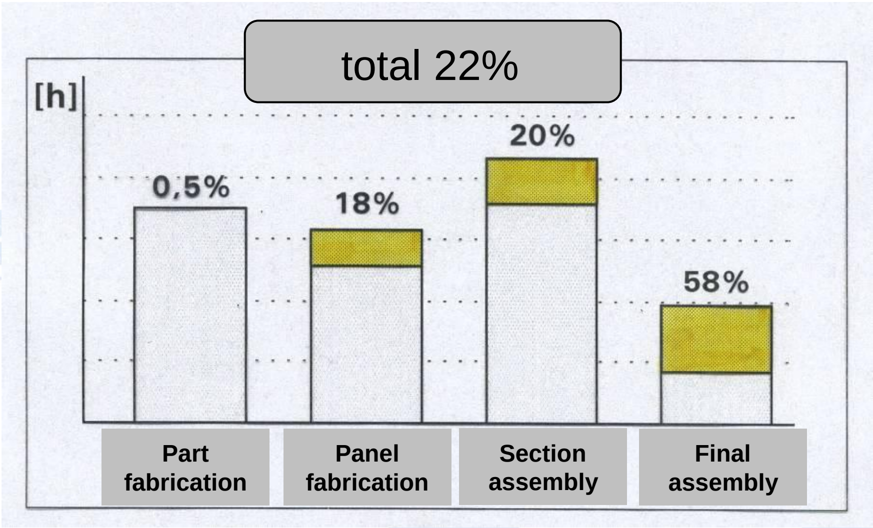
A plenty of reworks happens in the shipbuilding manufacturing process. The largest part of them can be reduced or canceled through the implementation of accuracy control.



Example A:	Unfixing welding beam and displacing
Example B:	Cutting of material or edge deposit welding
Example C:	Material cutting / deposit; difficult in curved areas
Example D:	Alignment and rework
Example E:	Warming up
Example F:	Mechanical force alignment
Example G:	Thermal straightening

Solution 1

Quality control: Necessity of a quality control group – costs of rework



Rate of reworks:

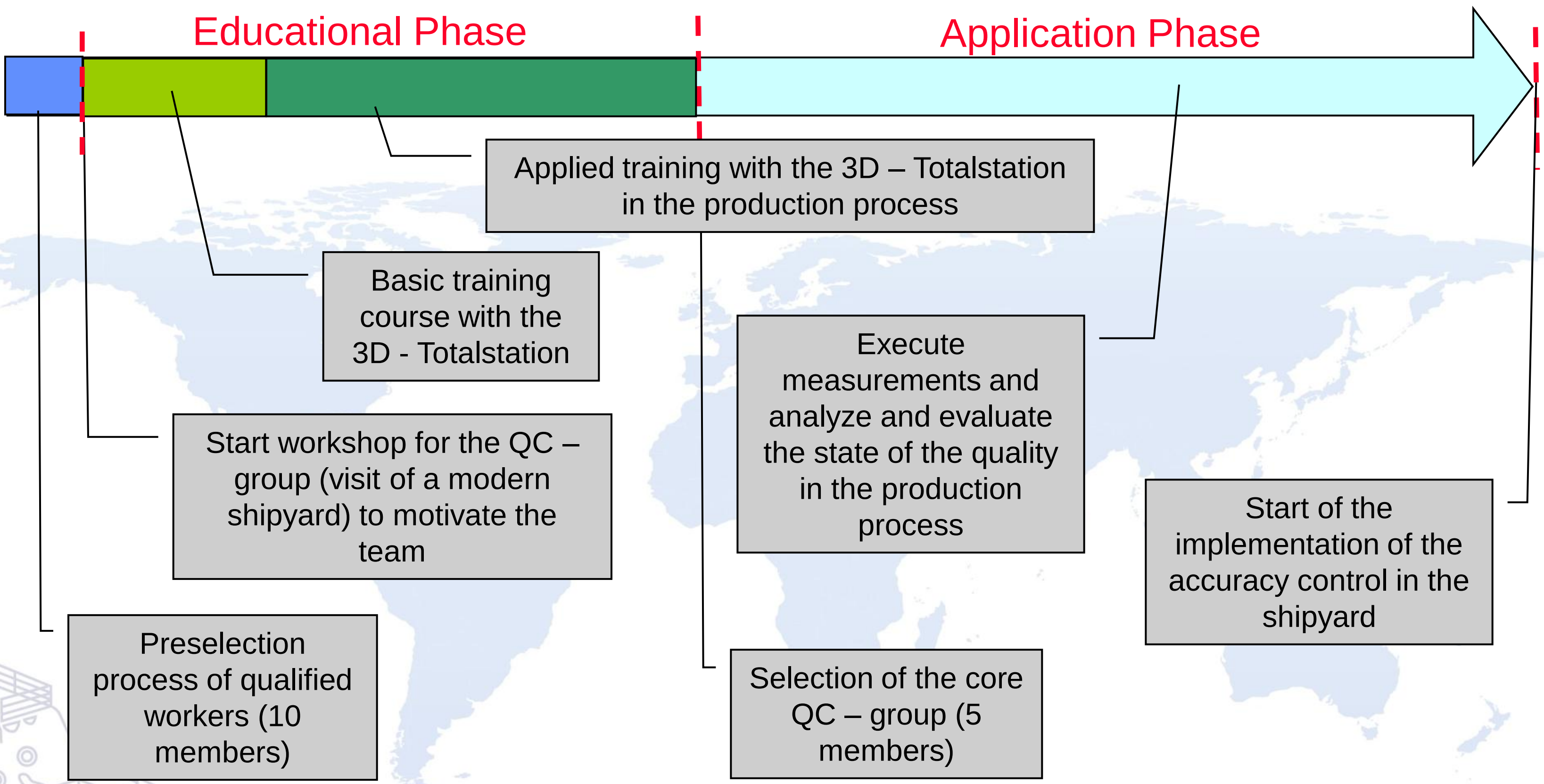
- Straight works at the mounting joint
- Straight works outside the mounting joint
- Reworks of dimensional corrections
- Reworks of joint-fit cutting

In **modern** shipyards **the implementation of accuracy control** saves up to 22% of the production costs by reducing the necessary reworks.

→ **The achievable results could be higher for the shipyard**

Solution 1

Quality control: Road map of implementation



Solution 2 + 3: Part and panel fabrication
Agenda

- Project requirements
- Analysis of functional and spatial structures
- **Results of the concept phase**
  - Solution 1: Accuracy Control
  - **Solution 2: Part fabrication**
  - **Solution 3: Panel fabrication**
  - Solution 4: Outfitting
  - Solution 5: Section assembly
  - Solution 6: Ring and final assembly
  - Solution 7: Organisation
  - Solution 8: Design requirements
- Final layout
- Roadmap of implementation
- Productivity analysis

Solution 2 + 3
New concept

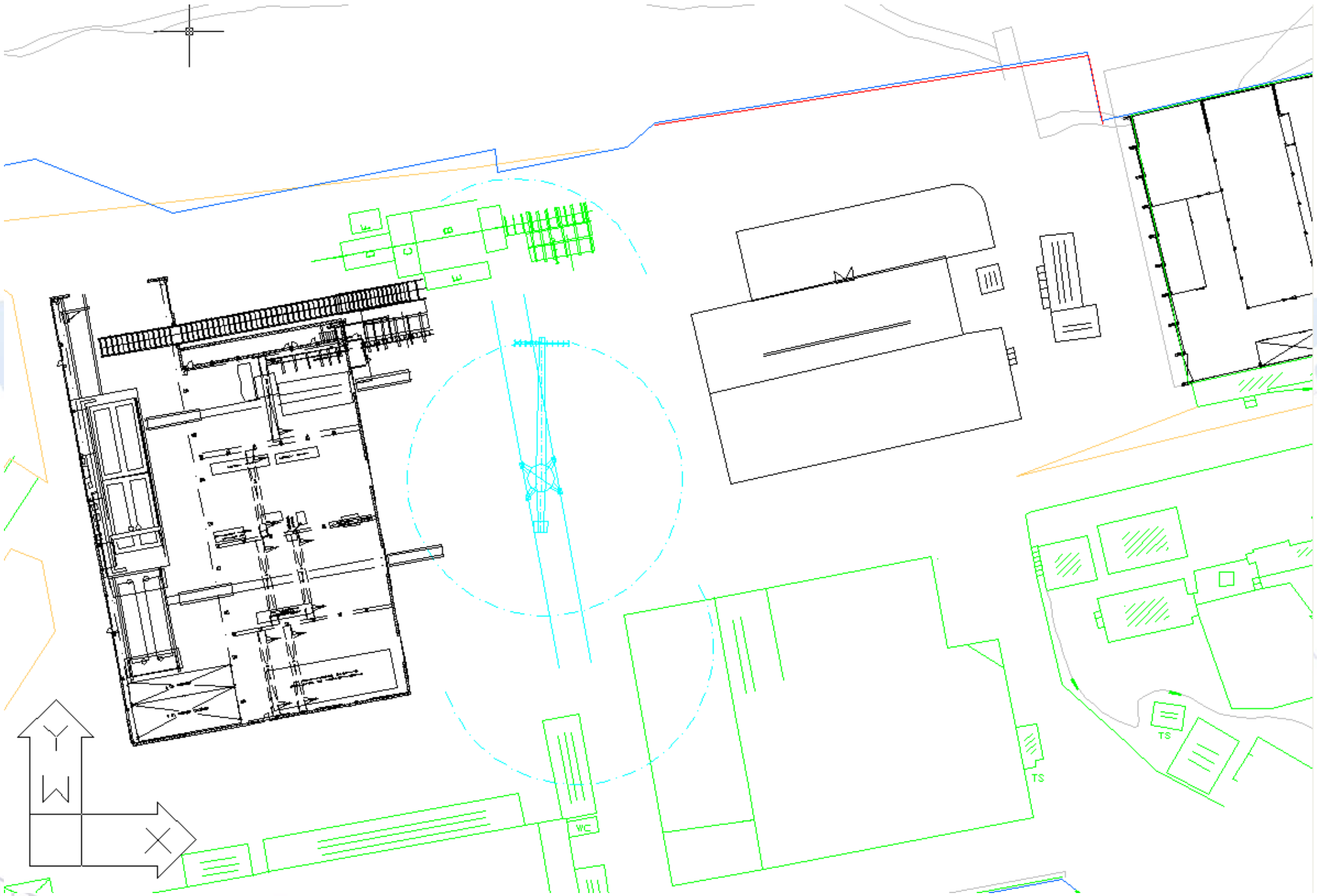
•Relocation of the part fabrication
- Warehouse
- Cutting workshop
- Bending workshop

•Relocation of the panel fabrication
- Micro panel fabrication
- Flat panel fabrication
- Closed section assembly

→ **Building a new part and panel fabrication building under the following requirements:**
- **Ongoing production**
- **Minimal investments**
- **Optimised material flow**
- **Future orientation for further increase beyond the proposed scheme**

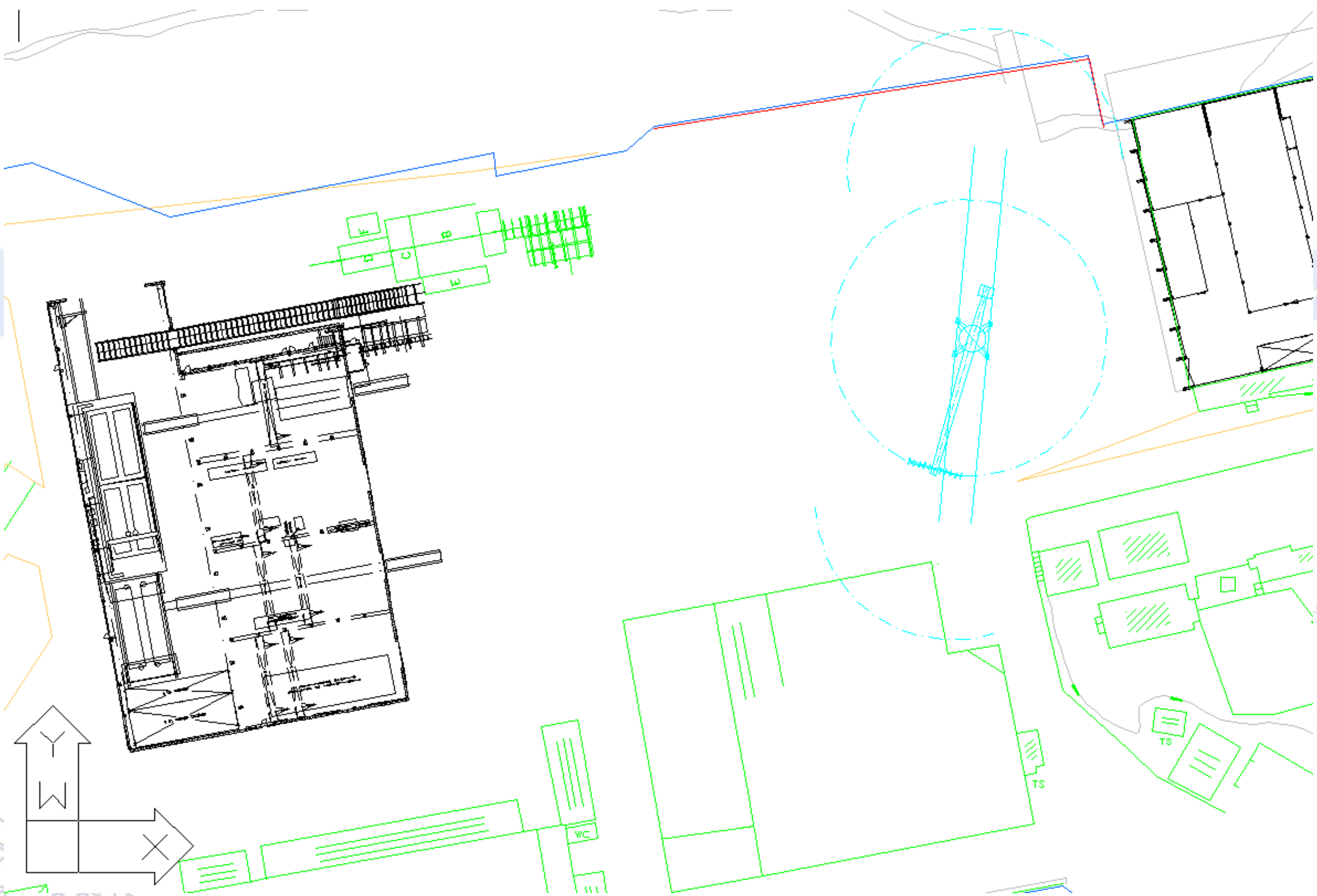
Solution 2 + 3

New concept: Procedure 1



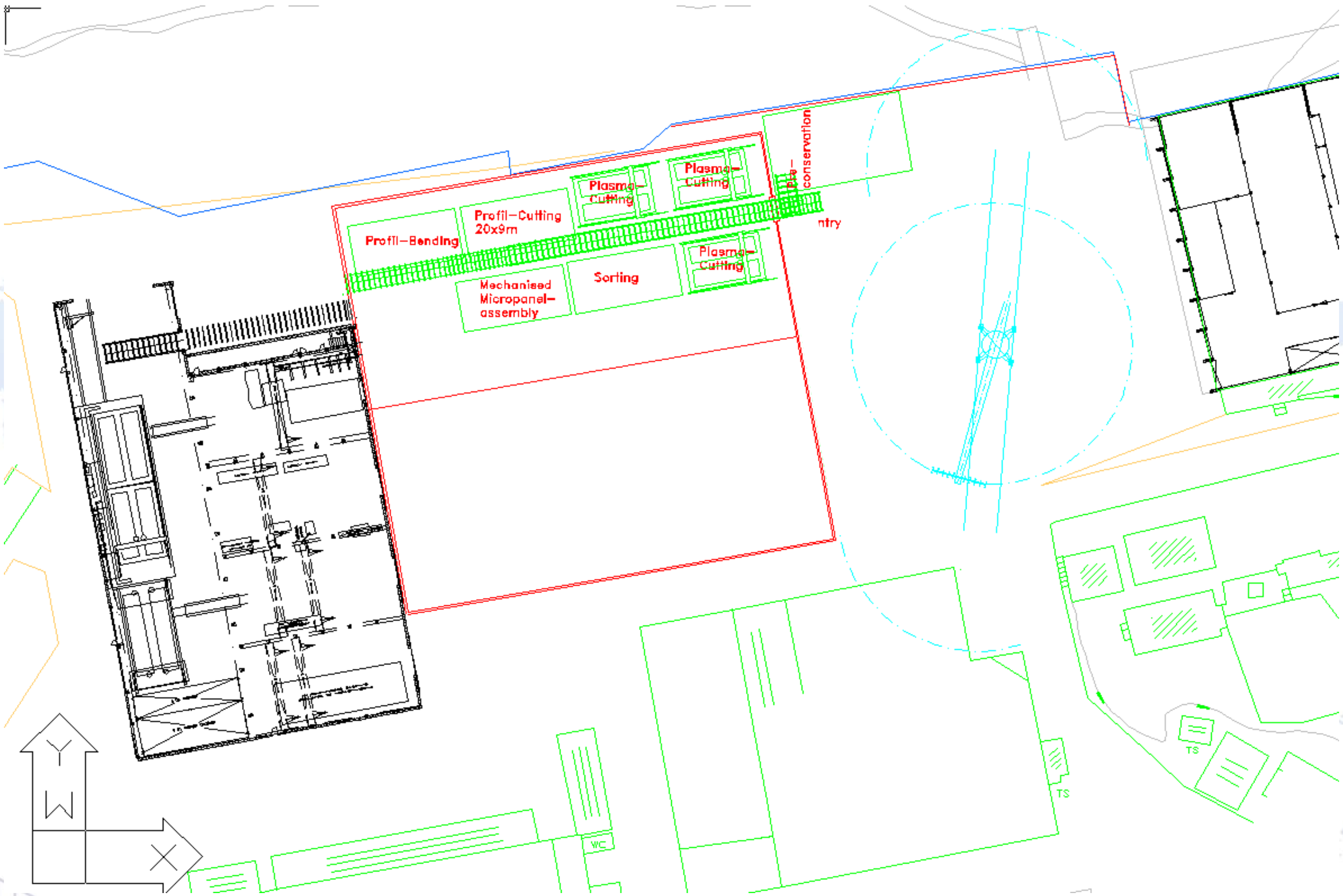
Solution 2 + 3

New concept: Procedure 2



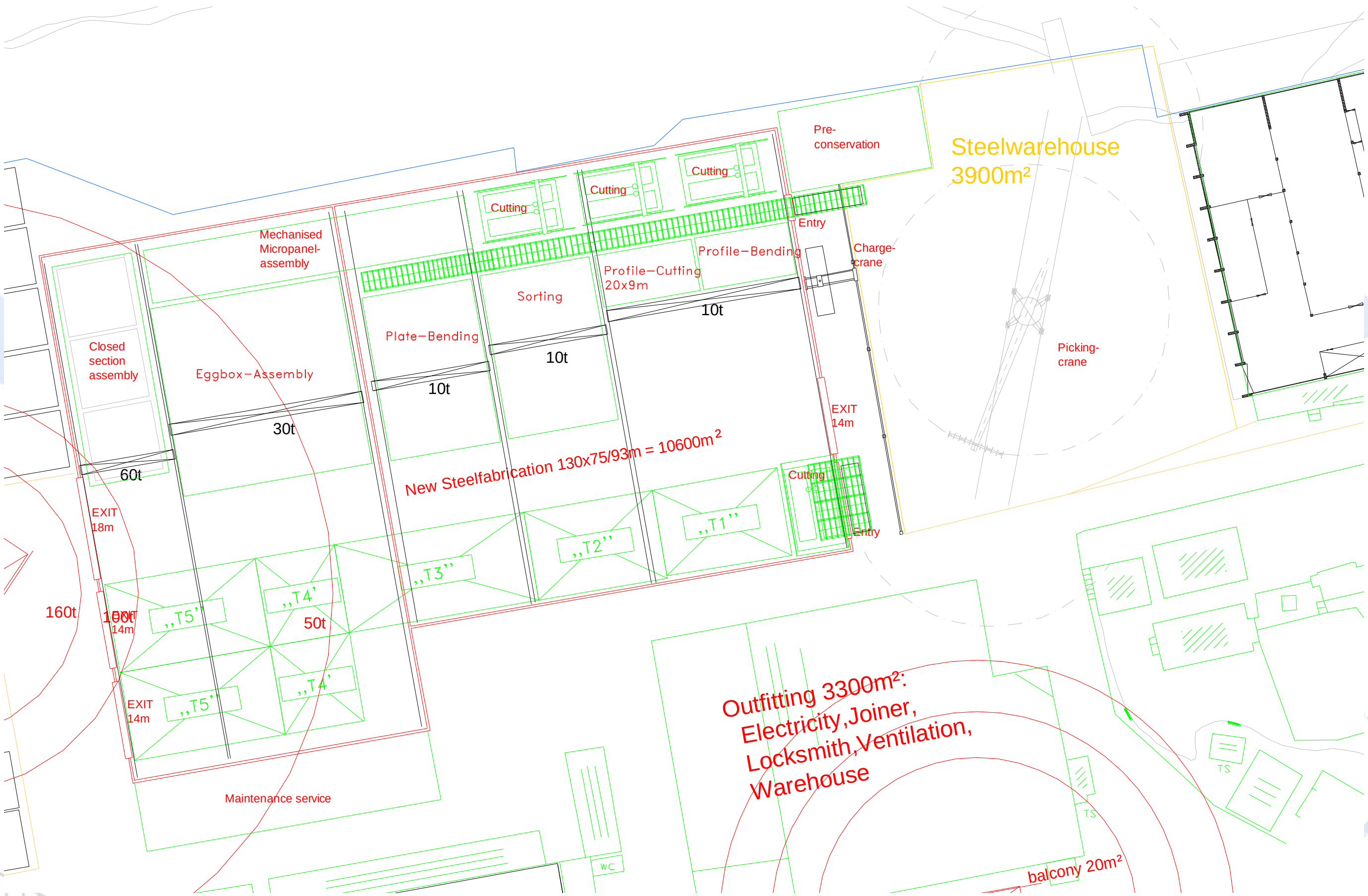
Solution 2 + 3

New concept: Procedure3



Solution 2 + 3

New concept: Procedure 4



Solution 2 + 3
Roadmap of implementation

1. Relocate the steel stock
   a. Pull down the old warehouse
   b. Level the ground
   c. Relocate the crane to the new steel stock
   d. Relocate the steel warehouse steel to its new place
2. Relocate the pre-conservation
   a. Construct a new building for the pre-conservation
   b. Move the pre-conservation
   c. Demolition of old pre-conservation-building
3. Build part 1 of the new steel fabrication building
4. Move plasma-cutting, profile-cutting and profile-bending
5. Build part 2 of the new steel fabrication building
6. Relocate the panel line
7. Integrate the micro panel line
8. Upgrade the panel line for the 4th and 5th workplace

Solution 4: Outfitting
Agenda

- Project requirements
- Analysis of functional and spatial structures
- **Results of the concept phase**
  - Solution 1: Accuracy Control
  - Solution 2: Part fabrication
  - Solution 3: Panel fabrication
  - **Solution 4: Outfitting**
  - Solution 5: Section assembly
  - Solution 6: Ring and final assembly
  - Solution 7: Organisation
  - Solution 8: Design requirements
- Final layout
- Roadmap of implementation
- Productivity analysis

Solution 4
Sub-contracting pipe fabrication

- The core competence of the shipyard is the development and installation of pipe systems
- The preparation of pipes can be done more efficiently by special pipe manufactures
    - Cutting, bending and flanging the pipes by subcontractors
- Therefore the preparation of pipes should be outsourced to reduce costs as a middle term solution
- The free workers will be relocated to the pre-outfitting of sections and rings to decrease the duration time of pre-outfitting
- Warehouse for the pipes on 600m²
    - Buffering the pipes on stackable pallets
    - Delivering the pipes JIT (small stock)

→ **the shipyard is responsible for the assembly of the pipe traces and the preparation of adjusting pipes**

Solution 4
Relocation and elimination of outfitting processes

- Along with the concentration on the core competencies the number of outfitting workshops has to be reduced

  → The halls and buildings are no longer necessary for the outfitting

- Corresponding to the strategic plan of the shipyard to install a new ship repair division, these buildings and the workers should be a part of the new repair division

  → This will decrease the numbers of workers and areas for the shipbuilding division and decrease the productivity

  → Foreman's of the shipyard could found a company with the help of the shipyard to decrease the outfitting processes at the shipyard

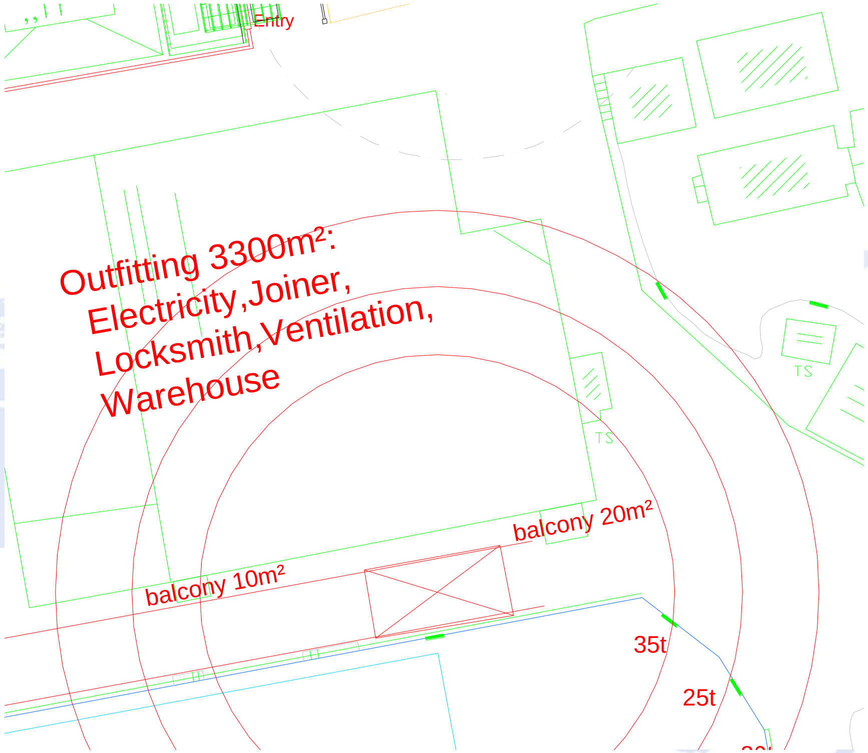
- A Benchmark has shown that a comparable shipyard will require approx. 6000 m² for all outfitting workshops including warehouse

Solution 4

Area allocation for outfitting 2

•For all other workshops 3300m² of the warehouse are allocated

- 2300m² as warehouse (with balconies to transport the outfitting components directly from the warehouse to the ship)
- Approx. 1000m² for preparation



→ **The available area for outfitting at the shipyard exceeds the benchmarked shipyard**

Solution 5: Section assembly

Agenda

Solution 5

Calculation of section assembly areas - Current state of the art

Present Brodo Trogir					
area	length [m]	width [m]	floorspace [m²]	working hours [h/d]	weighted floorspace
C	47	15	705	10	294
D	56	24	1344	10	560
D	13	10	130	10	54
F	155	15	2325	10	969
F1	41	19	779	10	325
P	186	26	4836	10	2015
PH	120	16	1920	10	800
total					**5016** m²
steel throughput					45000 t/a
					8,97 t/a*m²

Benchmark					
floorspace	400	62	24800	24	**24800** m²
steel throughput					100000 t/a
					4,03 t/a*m²

factor	**222** %

→the shipyard could assemble sections for 2,5 - 3 ships maximum in reference to the current production (1 shift)

→The section assembly area is a bottleneck in the middle term solution

Solution 5

Calculation of section assembly areas-Future scenario with closed assembly

Future state of Brodotrogir						
Area	**length [m]**	**width [m]**	**floorspace [m²]**	**workinghours [h/d]**	**weighted floorspace**	
Closed section building	40	13	520	24	520	
Section assembly hall	155	33	5115	24	5115	
Modul assembly hall	56	32	1792	24	1792	
Berth	160	32	5120	10	2133	
Total floorspace					**9560**	m²
Steel throughput					45000	t/a
					4,71	t/a*m²

Benchmark						
Total floorspace	400	62	24800	24	24800	m²
Steel throughput					100000	t/a
					4,03	t/a*m²

factor **117 %**

→the shipyard can produce sections for > 5 ships/year in consideration of the closed section assembly area (3 shifts) plus the berth in one shift

→Erection of an additional building for section / module assembly is necessary as a long term solution

Solution 5
Layout

Solution 6: Ring and final assembly
Agenda

- Project requirements
- Analysis of functional and spatial structures
- **Results of the concept phase**
  - Solution 1: Accuracy Control
  - Solution 2: Part fabrication
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  - Solution 8: Design requirements
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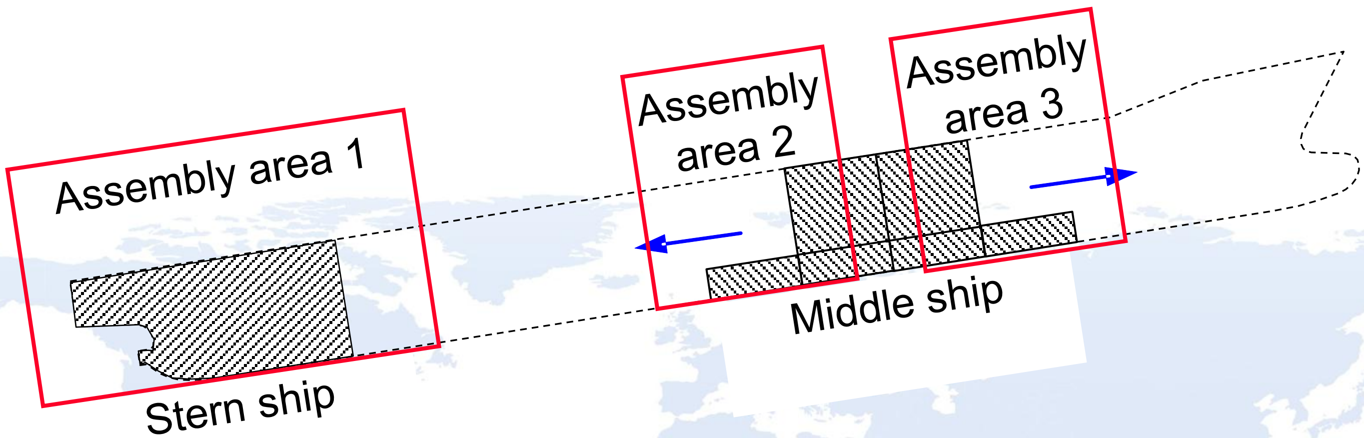
- Roadmap of implementation
- Productivity analysis

Solution 6
Production during the launching berth enlargement 2

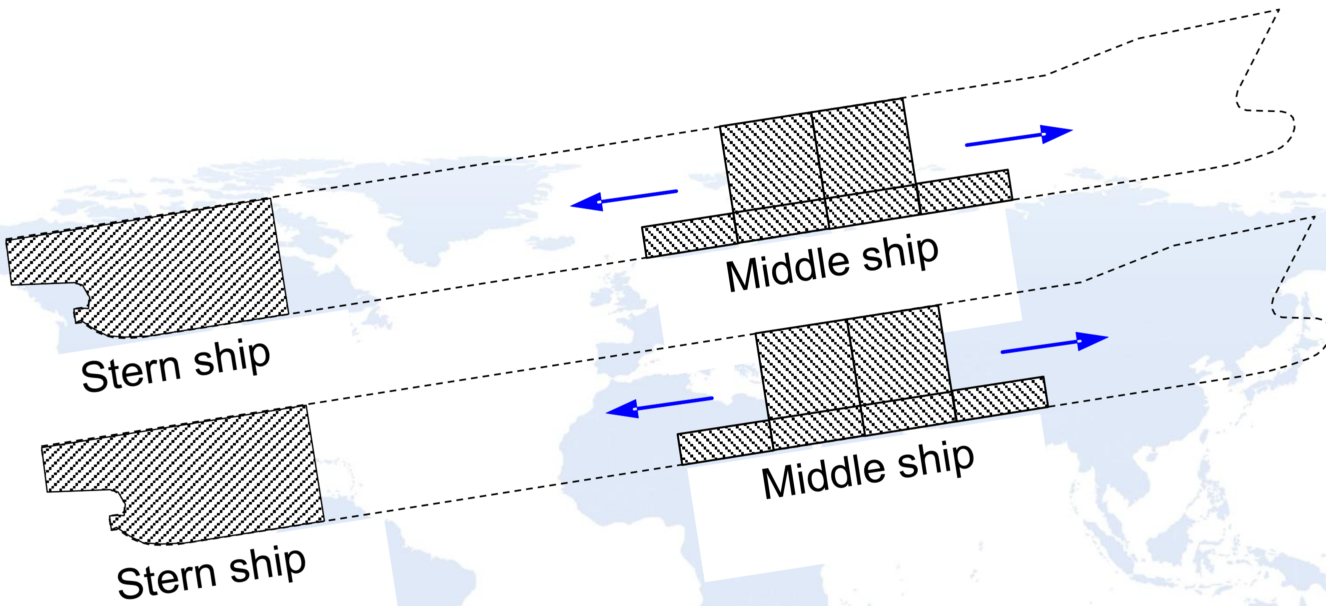


Variant : pyramid assembly
- Stern ship assembly
- Parallel pyramidal erection
  - Identification of the starting point of assembly (erection level, distance,..) could easily be measured
- Advantages: parallel erection of three areas of the ship and decrease of the duration time

→ **Using the tandem assembly method**

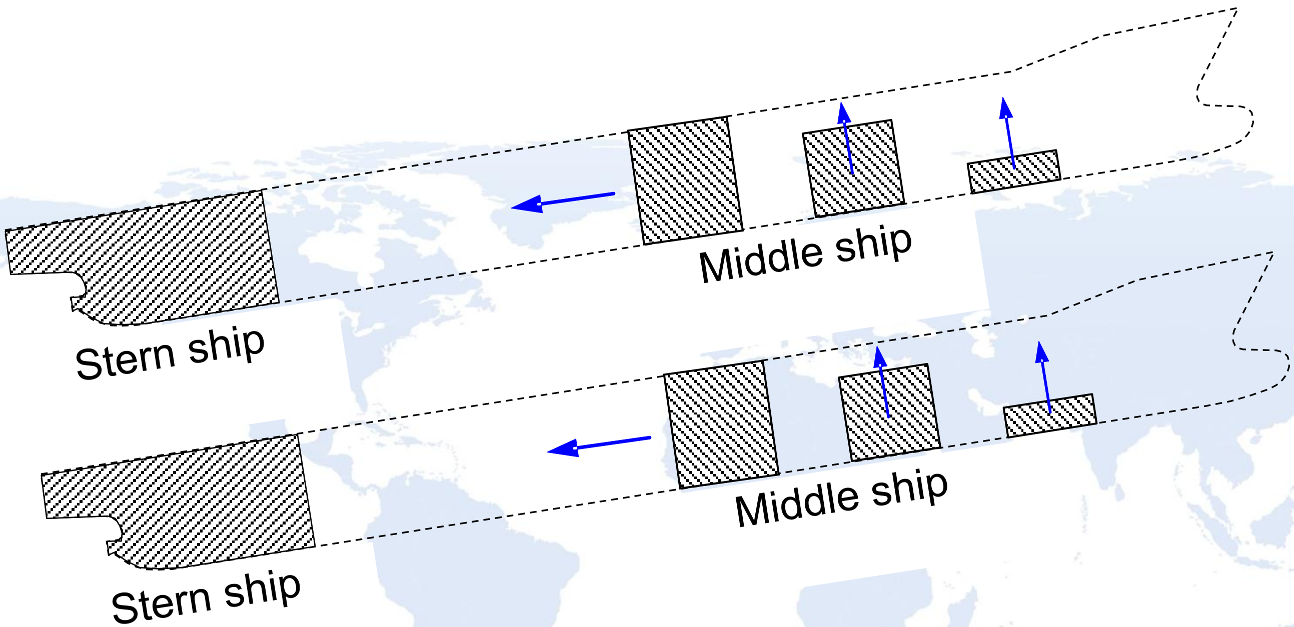
Solution 6

Variant 1: Assembly of two ships parallel 1



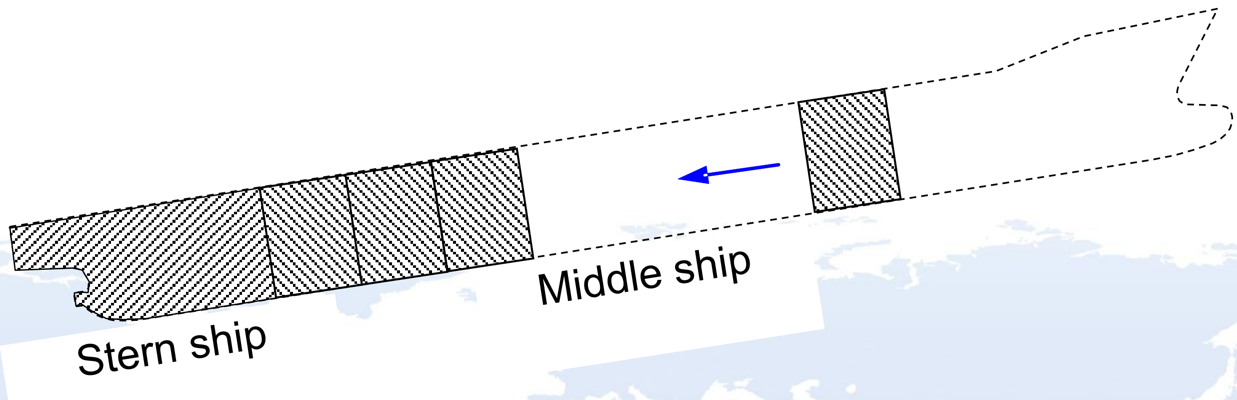
Solution 6

Variant 1a: Assembly of two ships parallel with ring assembly 1



Solution 6

Variant 2: Ring assembly procedure



- The stern ship will be produced on the ring assembly areas (launching berth 2) and after the finished production the stern ship will be transported immediately to the final assembly area (launching berth 1)

- The rings will be produced by a sequenced production on the ring assembly areas (launching berth 2) due to the assembly sequence on the final assembly area (launching berth 1). Afterwards they will be assembled in a defined order to the stern ship on the final assembly area (launching berth 1)

Solution 6
Variant 2: Ring assembly

•The launching berth 1 is the final assembly area

•The launching berth 2 is ring section assembly area

•The launching berth 2 consist of:

- 4 middle ship ring assembly workplaces
- 1 stern ship workplace

•The tanker of the shipyard consist of 6 middle ship rings plus 1 stern ship plus 1 bow ship

•The transport from the ring assembly area (launching berth 2) to the final assembly area (launching berth 1) is possible via 5 switches

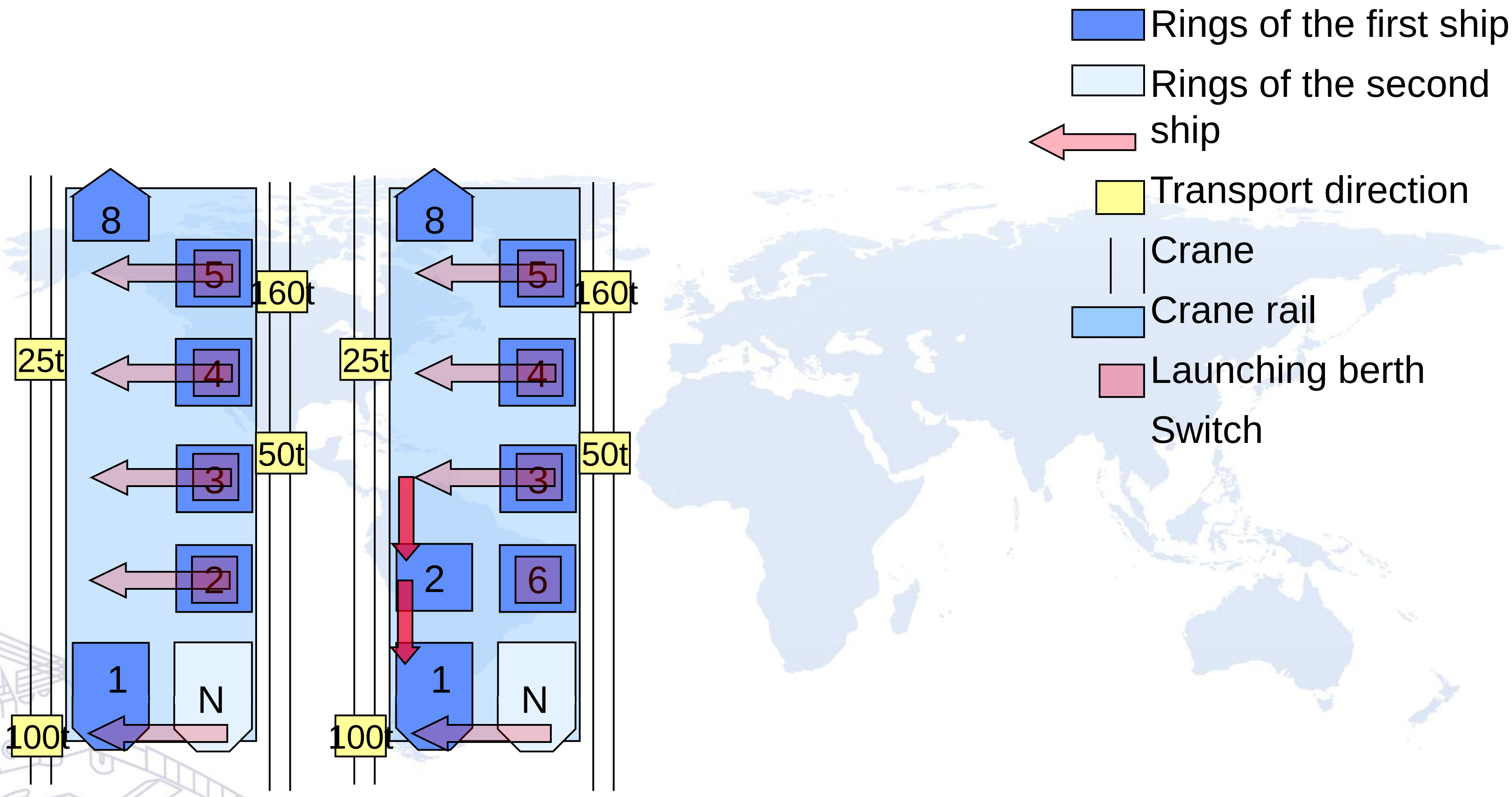
- 1 switch is allocated for the stern ship
- 4 switch are allocated for the middle ship rings

•The transport and the positioning of the rings on the final assembly area (launching berth 1) is done by a transport and positioning system

- Setting the stern ship
- Positioning the rings to the stern ship

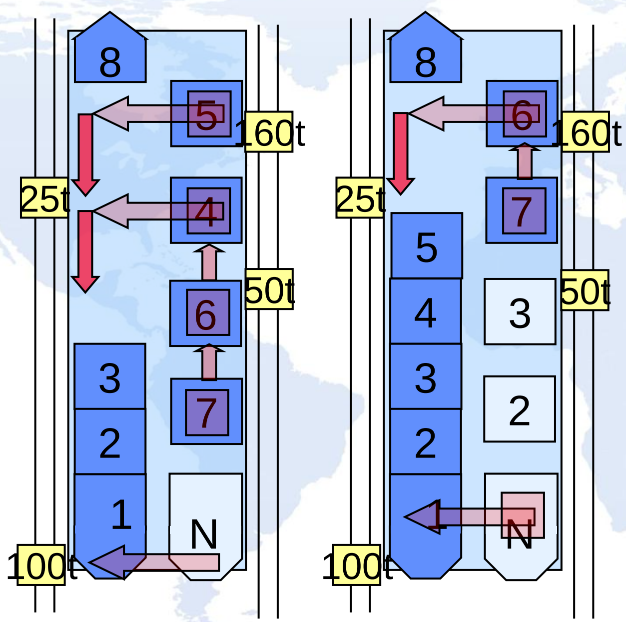
Solution 6

Variant 2: Transport procedure 1



Solution 6

Variant 2: Transport procedure 2



Rings of the first ship

Rings of the second ship

Transport direction

Crane

Crane rail

Launching berth

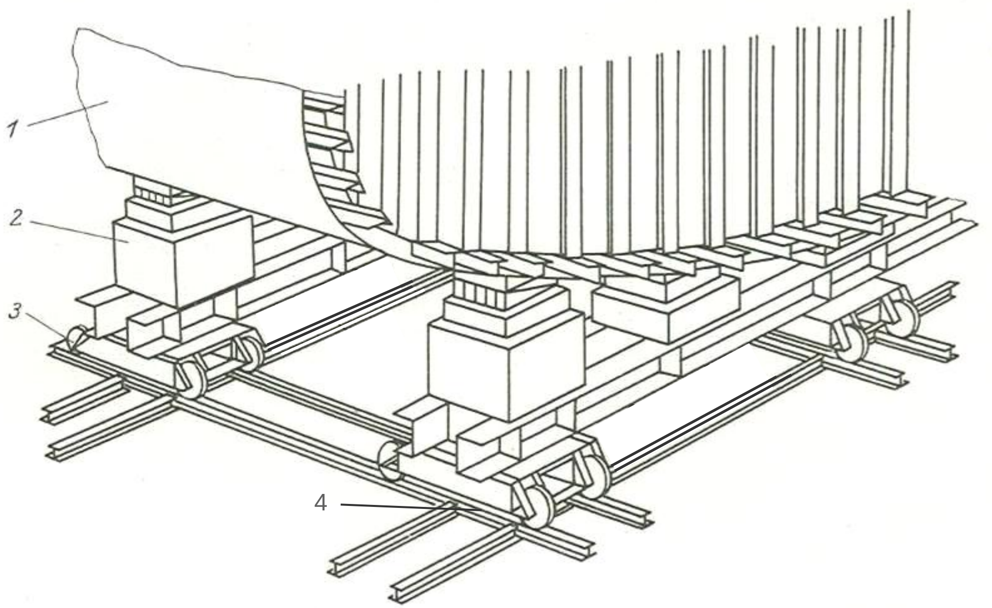
Switch

Solution 6
Variant 2: Estimation of the required duration and execution time 3

- The figures base on the know-how of Fraunhofer, literature and research projects of shipbuilding industry
- The closed manufacturing on the shipyard leads to a productivity growth of 20% in case of a climate independent fabrication.
- The implementation of mechanized welding leads to a longer working time of the welding torches
  - productivity growth up to 25% is possible
- Using a mechanized process the amount of required workers will be reduced.
  - The free workers will be replaced in a second and a third shift.
  - The new shifts leads to a productivity growth of 60% for the second shift and 40% for the third shift

Solution 6

Transport and positioning system 1



The keel block pillar could changes his moving direction.

The external wheels are pivoted moveable and can be lifted and lowered.

A integrated cylinder can lift the keel block pillar for the new positioning of the wheels → 90° rotation of the wheels on point

map …: keel block pillar
1 module; 2 external stamps; 3 wheel sets for ride along and across; 4 cross

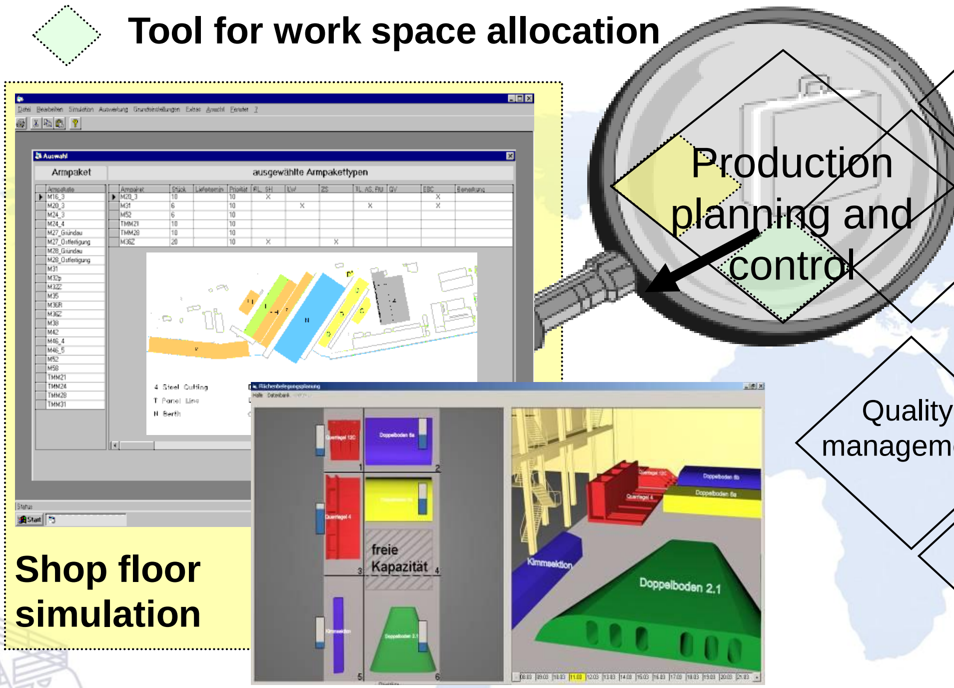
Solution 7: Organisation

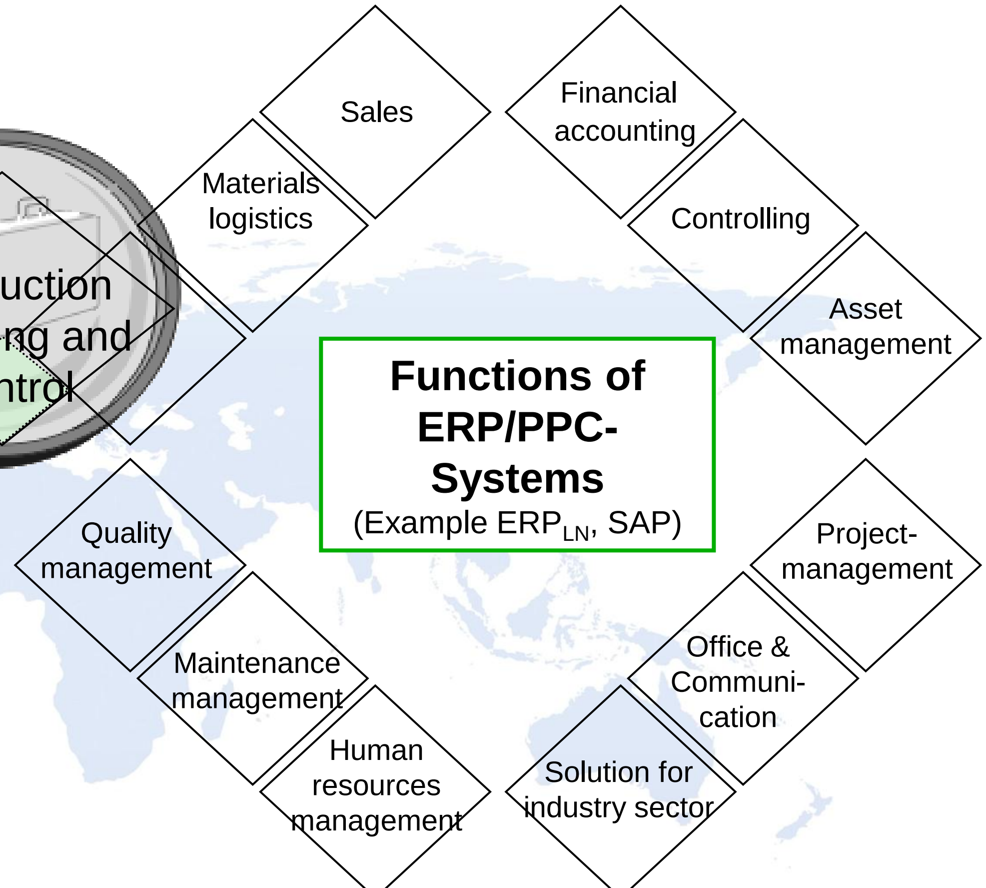
Agenda

Solution 7

Implementation of shop floor simulation: PPC vs. Simulation

- **Tool for shop floor simulation**
- **Tool for work space allocation**





Solution 7

Implementation of shop floor simulation: Future scenario

Backend-database-management system
(Oracle, Informix, SQL-Server, …)

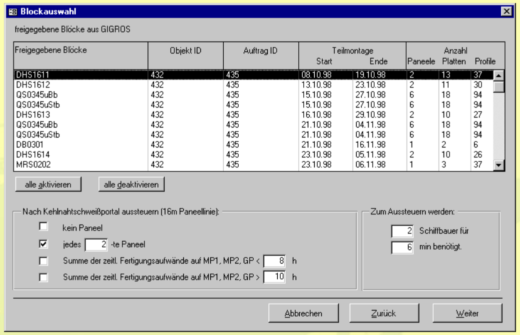
- production order
- task schedule, workflow, part list
- value of production resources
- availability of production resources
- requirement of space, weight, manpower
- ...

CAD-System

PPC-System

Project Management System

Shop floor planning tool



Blockauswahl

freigegebene Blöcke aus GIGROS

Freigegebene Blöcke	Objekt ID	Auftrag ID	Teilmontage Start	Teilmontage Ende	Anzahl Paneele	Anzahl Platten	Anzahl Profile
DHS1611	432	435	08.10.98	19.10.98	2	13	37
DHS1612	432	435	13.10.98	23.10.98	2	11	30
QS0345uBb	432	435	15.10.98	27.10.98	6	18	94
QS0345uStb	432	435	15.10.98	27.10.98	6	18	94
DHS1613	432	435	16.10.98	29.10.98	2	10	27
QS0345uBb	432	435	21.10.98	04.11.98	6	18	94
QS0345uStb	432	435	21.10.98	04.11.98	6	18	94
DB0301	432	435	21.10.98	16.11.98	1	2	6
DHS1614	432	435	23.10.98	05.11.98	2	10	26
MRS0202	432	435	23.10.98	06.11.98	1	3	37

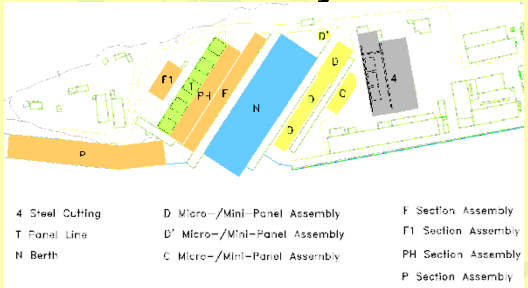
alle aktivieren | alle deaktivieren

Nach Kehlnahtschweißportal aussteuern (16m Paneellinie):
- [ ] kein Paneel
- [x] jedes 2 -te Paneel
- [ ] Summe der zeitl. Fertigungsaufwände auf MP1, MP2, GP < 8 h
- [ ] Summe der zeitl. Fertigungsaufwände auf MP1, MP2, GP > 10 h

Zum Aussteuern werden:
2 Schiffbauer für
6 min benötigt.

Abbrechen | Zurück | Weiter

Simulation system



Solution 8: Design requirements

Agenda

- Project requirements
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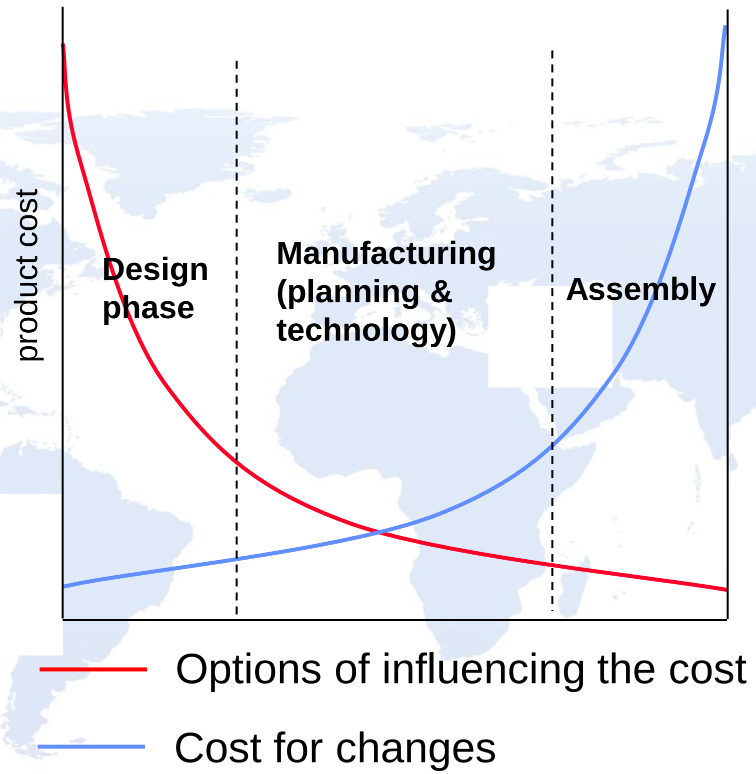
Solution 8

Design requirements

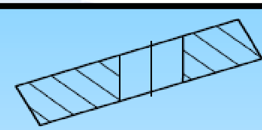
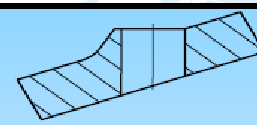
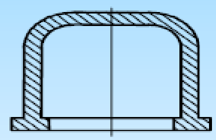
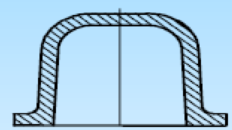
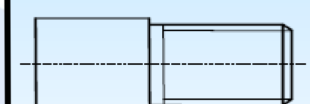
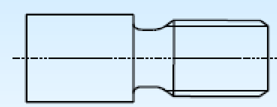
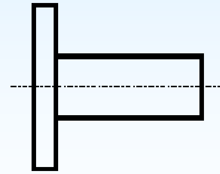
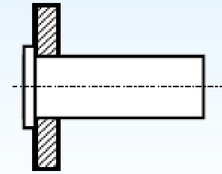
The main part of costs for manufacturing and assembly is committed during the design phase!



Solution 8

Standardisation - Design for manufacturing

- Several style guides are the result of the different manufacturing processes
- During the design process of parts these style guides must be allowed
- Examples:

Aim	Wrong	Right
Suitable for drilling		
Suitable for cast parts		
Escape for tools		
Avoidance of to much chipping		

Final layout
Agenda

- Project requirements
- Analysis of functional and spatial structures
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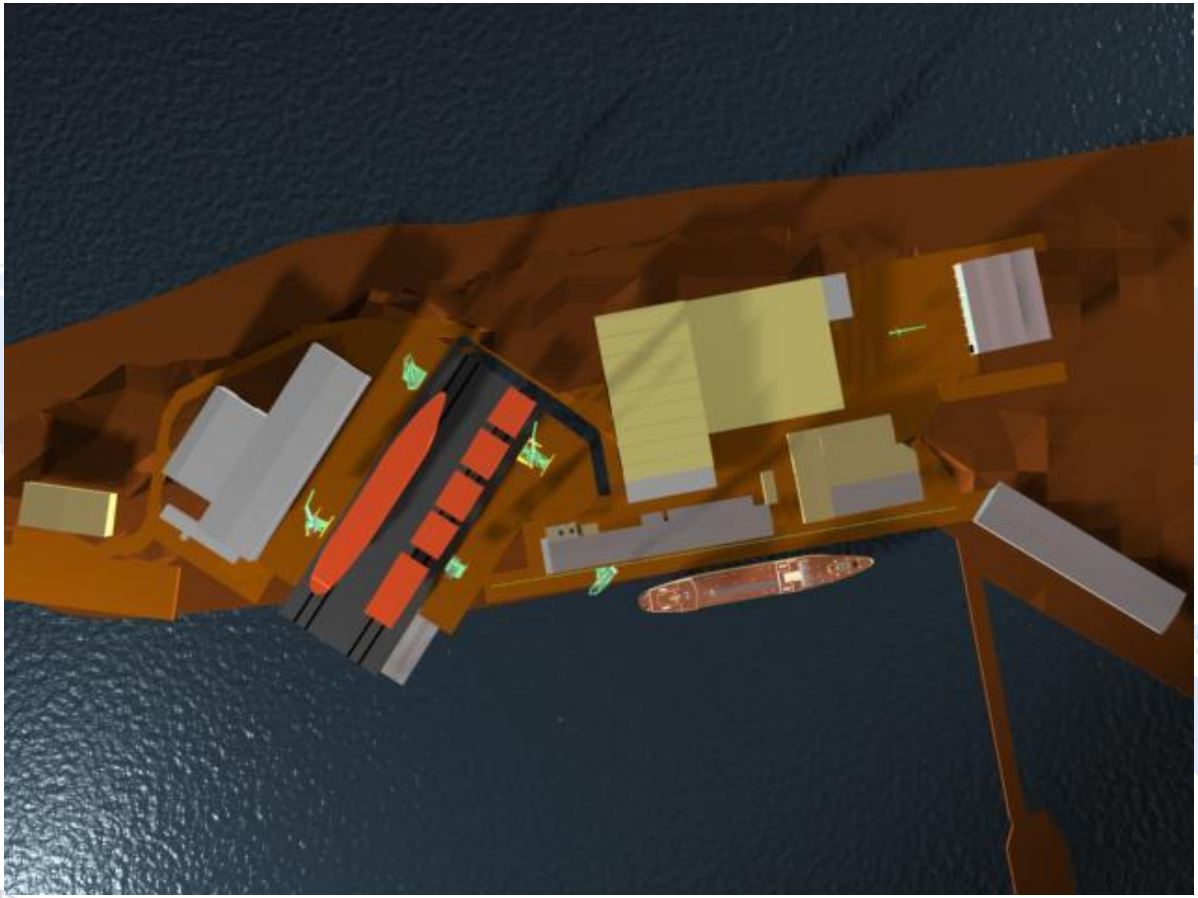
  - Solution 8: Design requirements
- **Final layout**
- Productivity analysis

Final layout

Overview



Productivity analysis

Agenda

Productivity analysis
Additional notes

•The investments in the micro panel line and in the upgrade of the panel line are required due to the limited capacities of the panel and section assembly area
→ without the investment the shipyard will require a large area for micro panel assembly and open section assembly because of

- Production in shifts is not possible
- Outside welding depends on the climate conditions
- Mechanised welding will achieve a productivity growth of approx . 25%
- Increased output to 5 ships

•The total output can be increased to 6 ships in consideration of having the full process under control

- Section can be produced outside → additional area is required
- Rings can be erected with a higher input of workers → organised production planning is required
- Duration for fitting the rings can be reduced with a higher input of workers → organised production planning is required

→ The targeted aim of the shipyard to produce 4 ships is realisable