Lecture in course contents

- Production planning
- Introduction
- Shipbuilding process and shipyard productivity
- Outfitting
- Design process and materials management
- Hull production
Objectives, contents and literature

• Learning objective:
  – Understand the contents of hull production stages and their relationships
  – Know the shipyard’s support services and their importance for the hull production

• Contents:
  – Support services

• Literature
  – Ship production, Storch et al., SNAME, 1995
Production stages – Part 1

- Steel storage
  - Pre-processing
- Part fabrication
- Part assembly
- Sub-block assembly in panel line
Steel storage

- Plates
- Profiles
- Transportation by rail, ship or truck
- In Finland, delivery time is 2-3 weeks for plates and 2-3 months for profiles
- Plate material handling by magnet crane
- Storing according to the size and quality or block number
- Delivery from storage to production based on block number
- Storage should be kept small
Pre-processing

- **Acceptance inspection of steel material**
- Intermediate storing
- Transfer to the straightening along conveyor roll
- **Roll-straightening (optional)**
- Transfer to the cleaning along conveyor roll
- **Washing or flame treatment and the heating**
- Transfer to blasting plan along conveyor roll
- **Blast cleaning**
- Transfer to the painting along conveyor roll
- **Painting (1.15 µm), drying with hot air**
- Transfer to the inspection along conveyor roll
- **Inspection and measurement of the paint thickness**
- Transfer to the intermediate storage along conveyor roll
- Storing according to the next production stage

Pre-processing is done by shipyard or material supplier.
Part fabrication

- Manufacturing of bending models
- Plate marking and cutting
- Profile marking and cutting
- Forming of plates
- Forming of profiles
- Sorting and intermediate storing

About 15% of the block workload
Part assembly

• Preliminary assembly related part fabrication
  – Brackets
  – Floors and keel plates
  – Bulkheads (internal, external, side)
  – T-beams
• Fixed or mobile platform
• Adjustable or fixed jig
• Product-specific production line
Sub-block assembly in panel line

- Milling of a long parallel plate edges
- One side submerged arc welding of plate’s butt joint using backing rod
- Shot blasting and marking of stiffener lines, cutting of opening, and plate edge beveling
- Stiffener installation and submerged arc welding
- Installation and flux cored arc welding of stiffeners, bulkheads and steel outfit features
Sub-block assembly in panel line
Example of production line

- Production line for shaped parts
- Part assembly line for panels
- Production line for bulkheads
- Automated production line for blocks with curved-surfaced
- Robot applications in
  - Tractor on the floor
  - Portal
  - Telescopic
Examples

Production line for shaped parts
Examples

Part assembly line for panels
Examples

Production line for bulkheads
Examples

Automated production line for blocks with curved-surfaced
Examples

Assembly of VLCC's double bottom block in a Japanese shipyard
Robot applications
Production stages – Part 2

• Block assembly
• Painting
• Hull erection
• Support services
Products of block assembly

- Products of block assembly stage (before hull erections stage) are:
  - Blocks, grand blocks and section blocks

- Blocks
  - Double bottom
  - Side structure
  - Deck and bulkhead below of it
  - Fore peak
  - Bilge
  - Bulkhead in cargo area
Products of block assembly

• **Grand block**
  – Ship part composed of the shell structure, bilge/wing tank
  – Multilayer part of superstructure
  – Larger part of ship’s stern or bow

• **Section block**
  – Slice of ship including the whole cross-section
  – Requires usually special transmission equipment
 Assembly of block with curved-shapes

• Decks and panels from panel production line or main
  – Assembly in the production line is alternative
• Assembly of curved block parts in jig
• Web frames and T-bar from their production line
  – Part production next to production line is alternative
• Assembly of block and welding
• Installation, welding, protection of outfit parts

• Labor-intensive with long lead-time
Painting

• Pre-treatment of steel materials
• Painting of block
• Painting of ship before launching
• Painting of ship after launching (outfit pier)
Hull erection

Hull erection can be done in

• Inclined construction ramp i.e. slipway
  – Longitudinal
  – Transverse

• Building dock with floodgate
  – Possible (partially) covered
  – Tandem allowing flexible erection; midterm log floating

• Hall on land
  – Requires the special transfer track and launching "lift"
Hull erection - Slipway
Hull erection - Building dock
Hull erection – Building dock
Hull erection - Hall on land
Support services

- Lifting and transportation
- Stands, openings, lifting platforms
- Operation network
  - Electricity
  - Oxygen, acetylene, shielding gas
  - Compressed air
  - Ventilation, heating
  - Water for fire safety
- Pressure testing
Lifting examples
Example of support services

<table>
<thead>
<tr>
<th>City, country, shipyard</th>
<th>Maximum lift capacity (MN)</th>
<th>Lifting height from top of rail (m)</th>
<th>Span (m)</th>
<th>Total height (m)</th>
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Example of support services
Example of support services
Welding and inspection services

- Welding instructions, welding procedure specification WPS
- Welder qualification
- Filler materials handling
- Non-destructive inspection (NDT)
  - Liquid penetrant testing
  - Magnetic particle inspection
  - Radiography scanning
  - Ultrasonic testing
- Visual inspection
Welding and inspection services

- Dimensional accuracy
  - Measuring tape
  - Leveling (vaaituskone), theodolite, total station (takymetri), calculators
  - Margin for shrinkage, oversize
  - Margin for fabrication

- Quality Systems, ISO9000, etc.

- Ship-specific quality instruction (“Laatuluotain”)

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**TERÄSTYÖN MITTATARKKUUS**

- **Toleranssijaattelu**
  - Esim. $\pm 3$

- **Osaalvaimistus**
  - Toleranssi: $\pm 2$

- **Osalohkoalvaimistus**

- **Lohkoalvaimistus**
  - Toleranssit: $\pm 2$

- **Suurlohkoalvaimistus**
  - Toleranssit: $\pm 3$

- **Runkovalvaimistus**
  - Kansivaikutus $\pm 10\text{mm}$
  - $\pm 5\text{mm}$
  - Päämitat $1\%$

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Aalto University
School of Engineering
Ship-specific quality instruction

1. Kielletyt alueet

Ei reikä polvien, palkkisteykseen, pilarin tms. lahelsyteen
Huom! H-mitan ollessa ≤ 300 ei saa tehdä aukkoja

2. Aukkojen sijoitus

3. Aukkojen koot
A. Vahvistamattomat aukot

B ≤ 0,4 x h
A ≤ 2 x B

80
80

700-850
700-850

KANSI
KANSI

185
185

185
185

KORR. 65/400
KORR. 65/400

200
200

100
100

130
130

185
185

185
185

KORR. 65/400
KORR. 65/400

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200

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KORR. 65/400
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