Michael Sánchez

7th EMship cycle: October 2016 – February 2018

Master Thesis

Study for implementation of Advanced Outfitting concept in COTECMAR

Supervisor: Professor Zbigniew Sekulski, West Pomeranian University of Technology, Szczecin, Poland
Internship tutor: Eng. Kornel Kwiatkowski, Project Manager CRIST Shipyard, Gdynia - Poland

Szczecin, January 2018

COTECMAR

Shipyard: Mamonal plant

Source: Google.maps.

Source: COTECMAR

COTECMAR

Shipyard: Mamonal plant

Source: COTECMAR

Source: Google.maps

CRIST shipyard S.A.

Source: CRIST S.A.

Colombia Ministry of Defense

Military Force - General Command

Army

Navy

Air Force

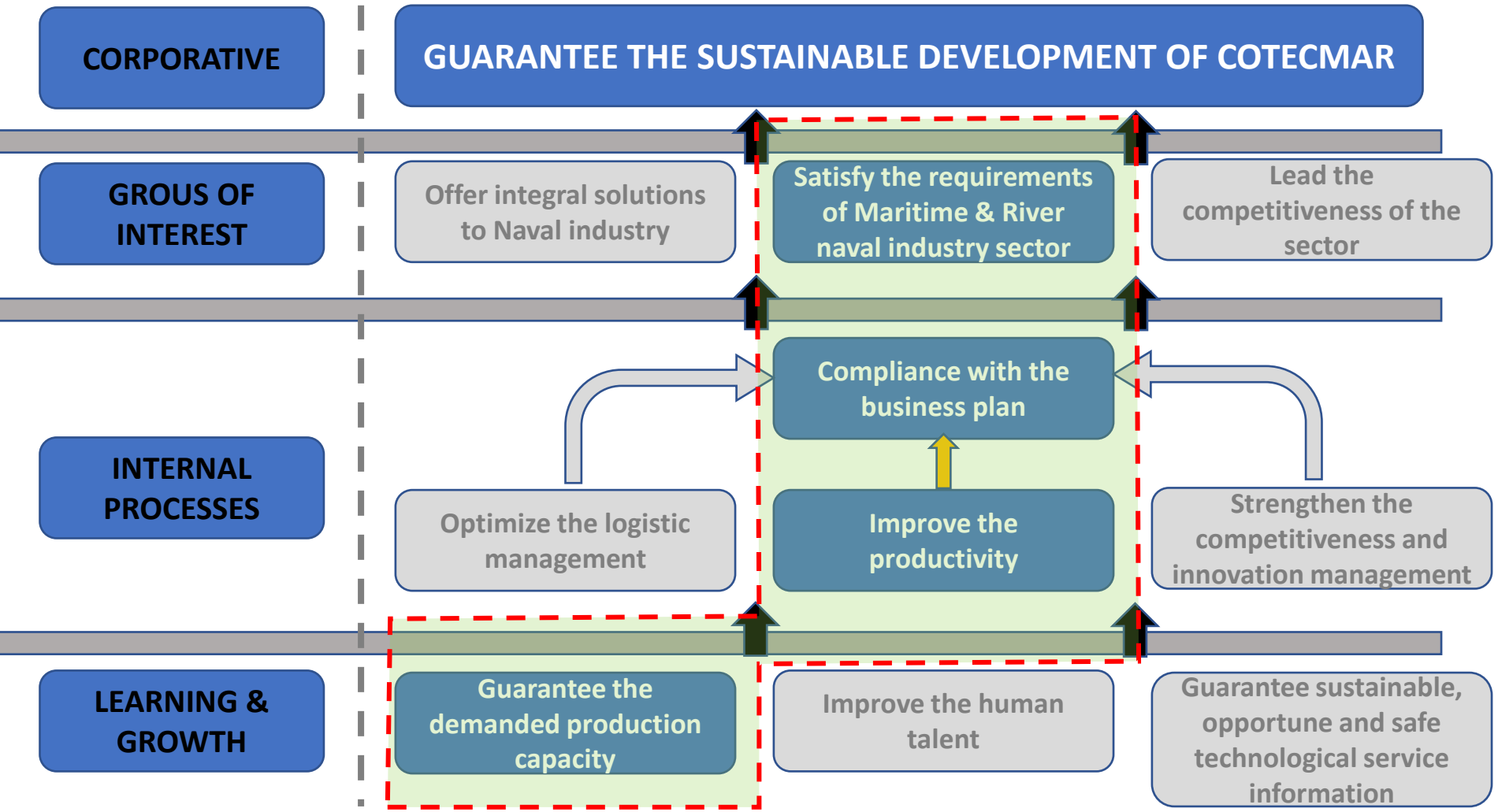
Police

Colombian Navy

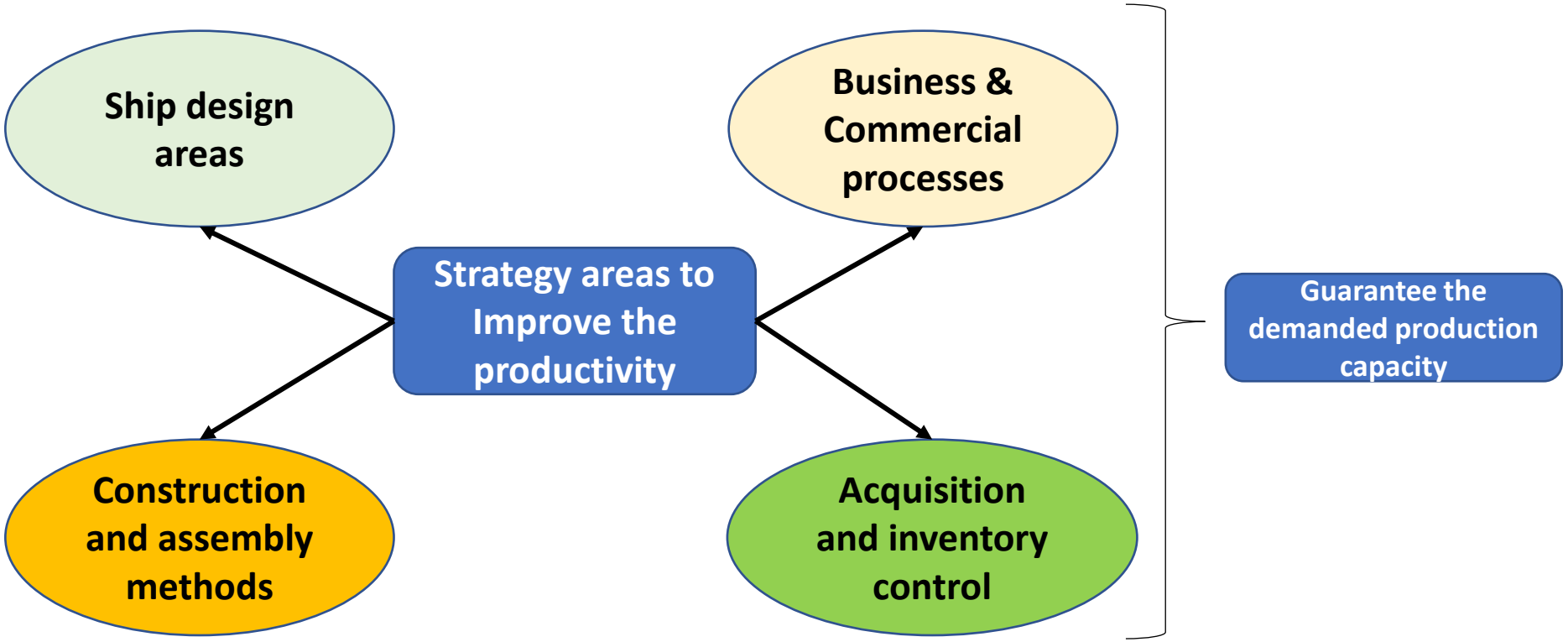
OPERATED BY:

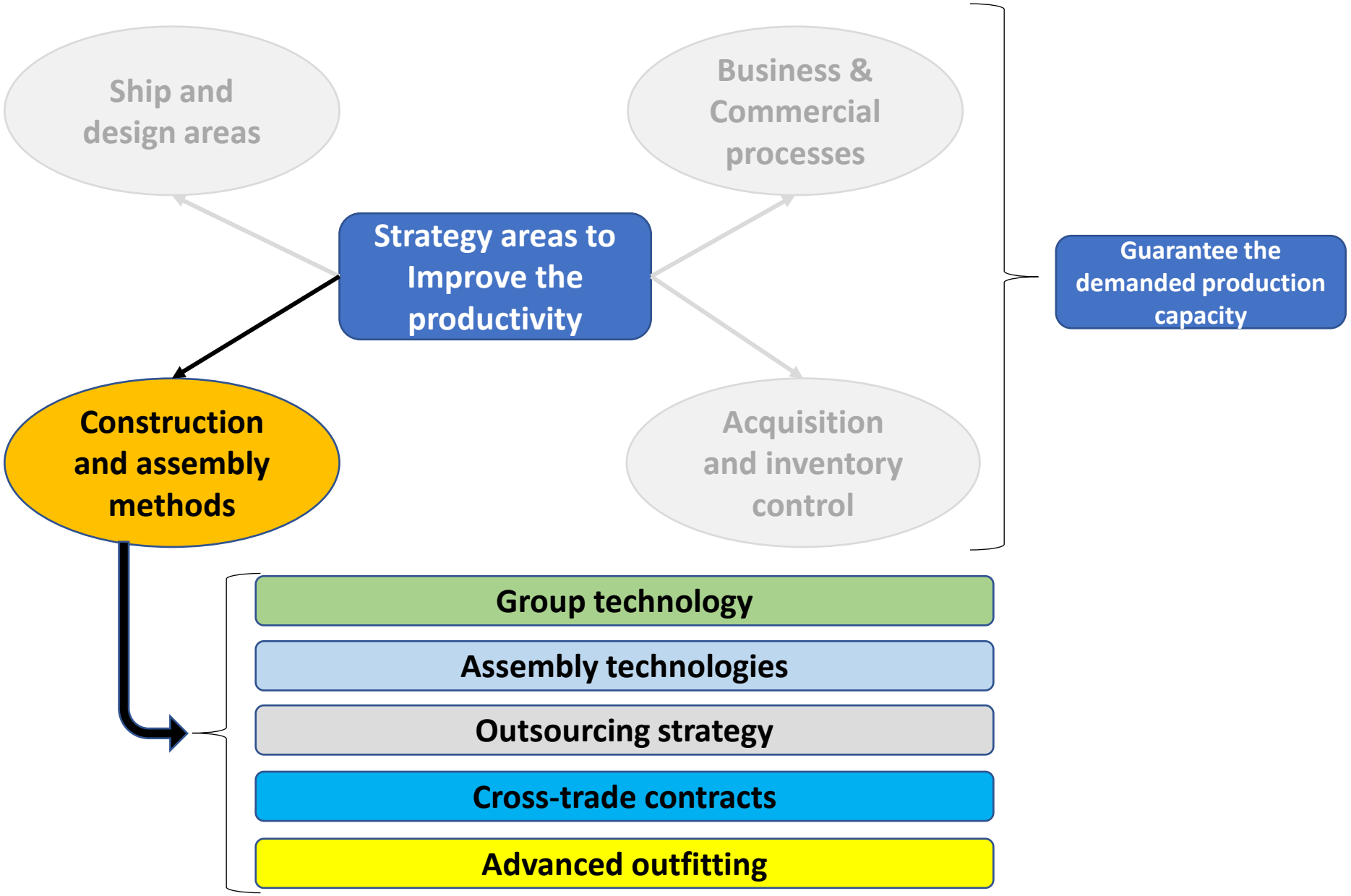
The Science and Technology Corporation for the Development of Maritime and River Naval Industry

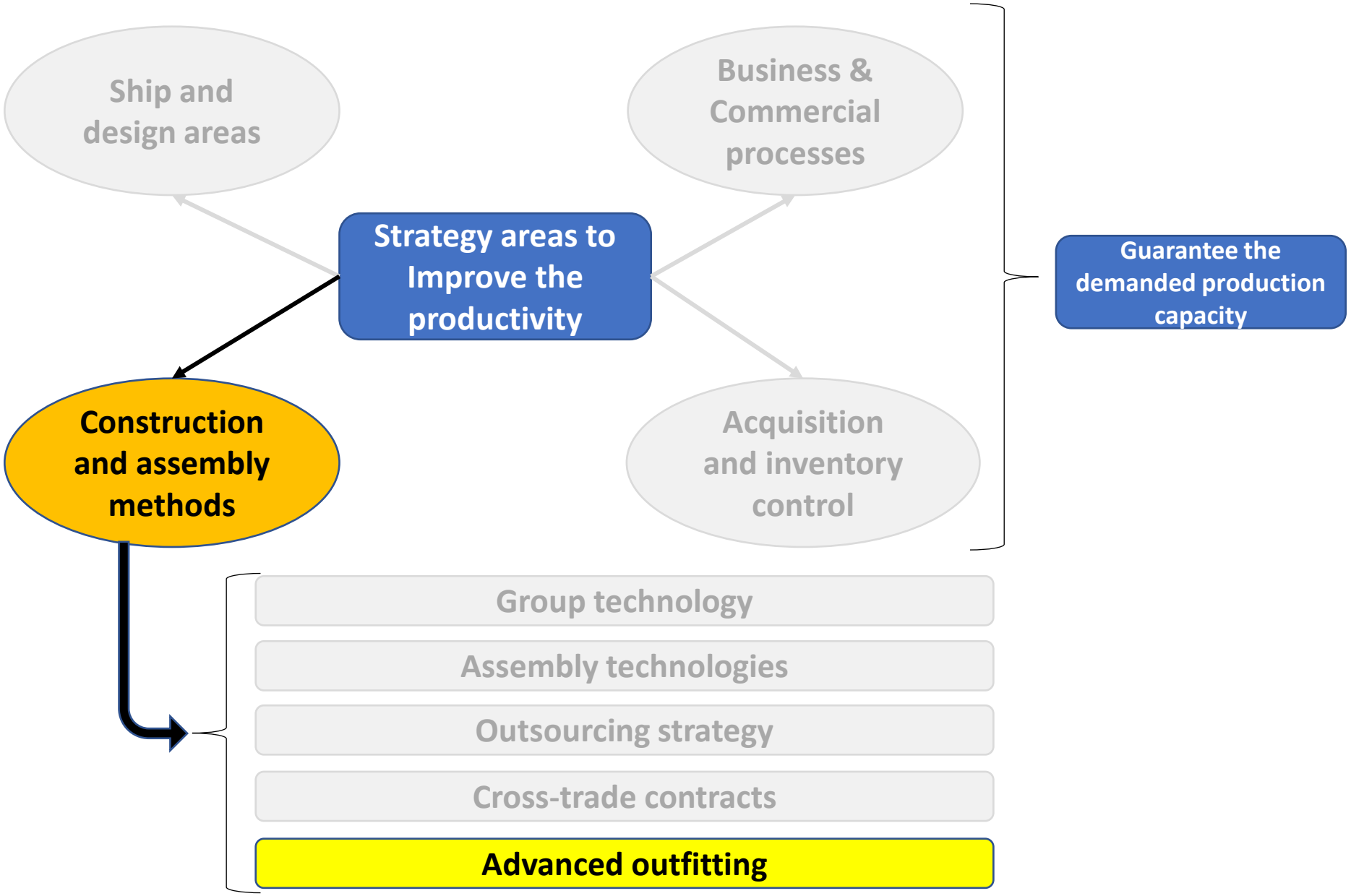
BALANCED SCORECARD OF COTECMAR



Strategy areas to Improve the productivity


Ship design areas
Business & Commercial processes
Strategy areas to Improve the productivity
Guarantee the demanded production capacity
Construction and assembly methods
Acquisition and inventory control


Ship and design areas
Business & Commercial processes
Strategy areas to Improve the productivity
Guarantee the demanded production capacity
Construction and assembly methods
Acquisition and inventory control
Group technology
Assembly technologies
Outsourcing strategy
Cross-trade contracts
Advanced outfitting


Ship and design areas
Business & Commercial processes
Strategy areas to Improve the productivity
Guarantee the demanded production capacity
Construction and assembly methods
Acquisition and inventory control
Group technology
Assembly technologies
Outsourcing strategy
Cross-trade contracts
Advanced outfitting

Strategy areas to Improve the productivity

→ **Guarantee the demanded production capacity**

Construction and assembly methods

***Hypothesis for this research*: "It is possible to increase the productivity of shipbuilding cycle in COTECMAR based on the implementation of advanced outfitting concept"**

Advanced outfitting

Strategy currently used by the most modern shipyards in the world and allows the installation of the largest amount of equipment (machinery, pipelines, cables, etc.) in the earliest stages of construction, especially during pre-assembly and assembly of each block that compose the hull.

Strategy areas to Improve the productivity

Construction and assembly methods

Advanced outfitting

How to implement it?

***Scope of the research**: "to establish and describe the general aspects that must be considered to implement advanced outfitting concept in COTECMAR"*

ZOFM
Zone Outfitting Method

Advanced outfitting

On-unit outfitting

On-block outfitting

On-board outfitting

Strategy areas to Improve the productivity

Construction and assembly methods

***Initial assessment*: What it the current level of outfitting processes in COTECMAR?**

Scope of the research: "to establish and describe the general aspects that must be considered to implement "advanced outfitting" in COTECMAR"

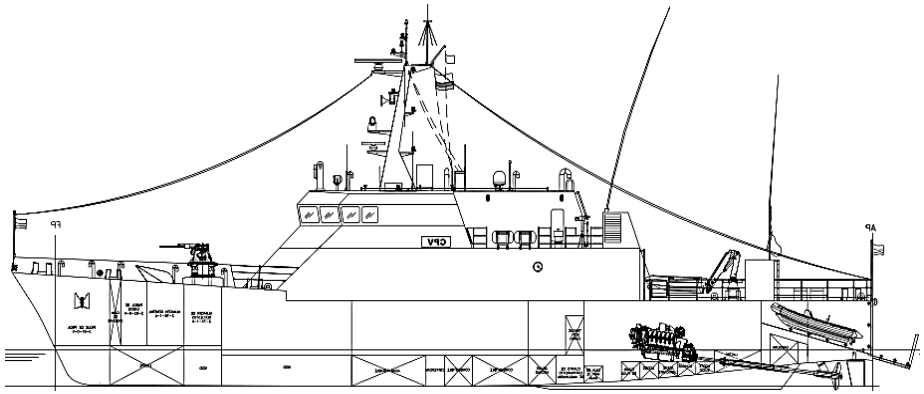
How to implement it?

Advanced outfitting

***Initial assessment*: What is the current level of outfitting processes in COTECMAR?**

Case of study: CPV coastal patrol vessel built by COTECMAR

Source: COTECMAR

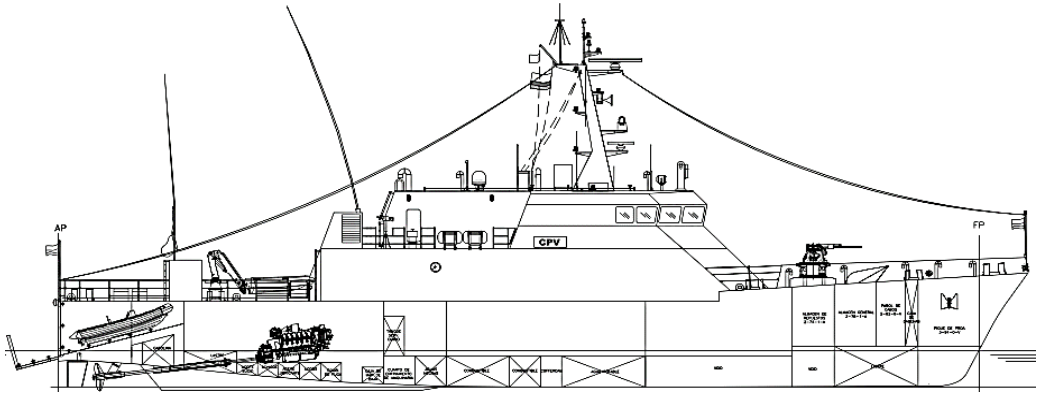


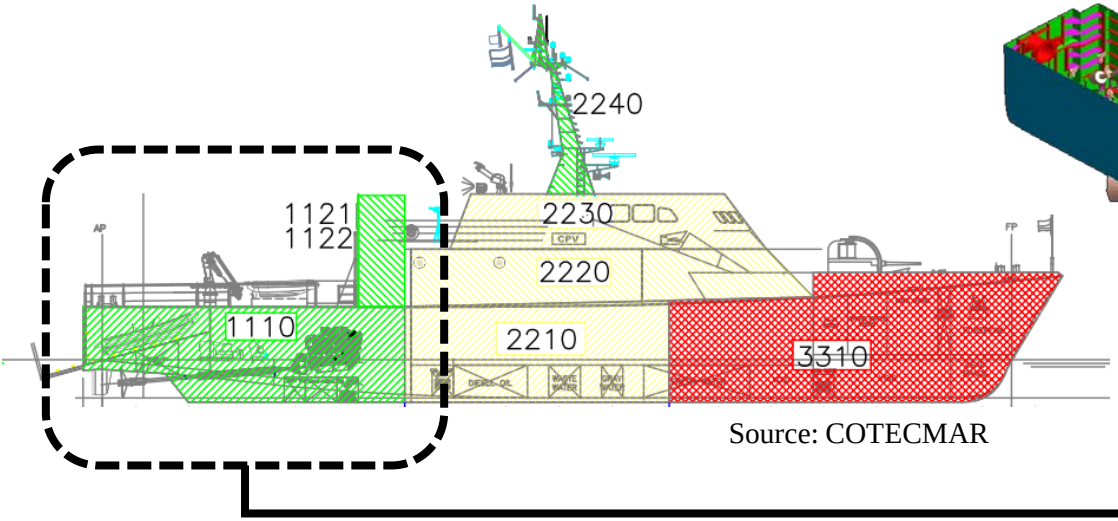
Source: COTECMAR

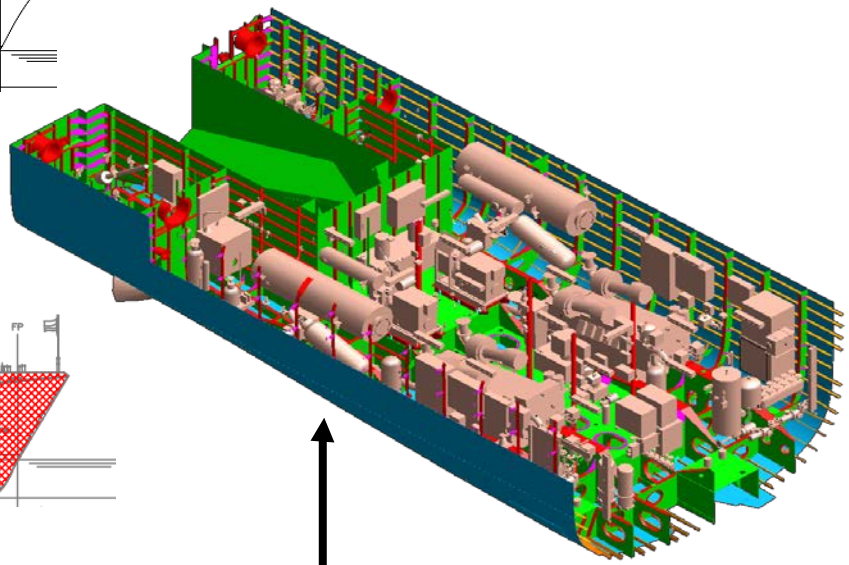
DIMENSIONS	
Length overall:	46,25 m
Waterline length	43,88 m
Moulded breadth:	7,09 m
Depth:	4,30 m
Design draft:	1,84 m
Operational draft:	2,00 m
PERFORMANCE	
Displacement:	286,27 MT
Max. speed:	20 knots
Operational range:	17 days
	2000 nautical miles @ 12 knots
Crew capacity:	18 people
Electrical plant	02 electrical groups 99 kW (123kVA)
Propulsion plant	MTU series 12V 4000 M70 1680kW @2000 rpm

***Initial assessment*: What is the current level of outfitting processes in COTECMAR?**

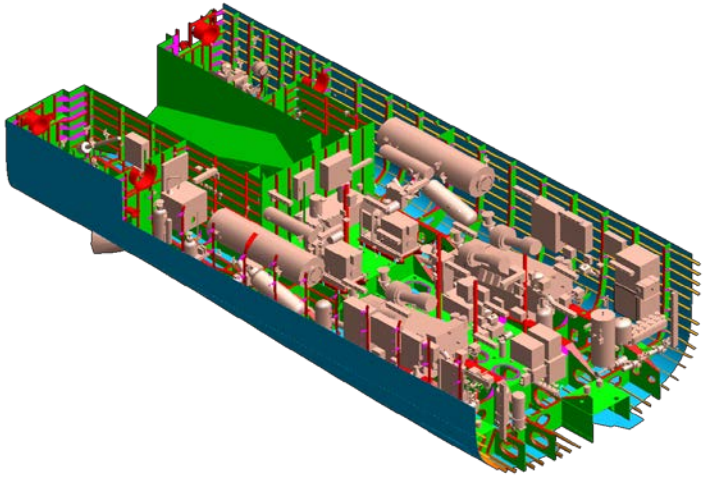
Case of study: CPV coastal patrol vessel built by COTECMAR







Source: COTECMAR

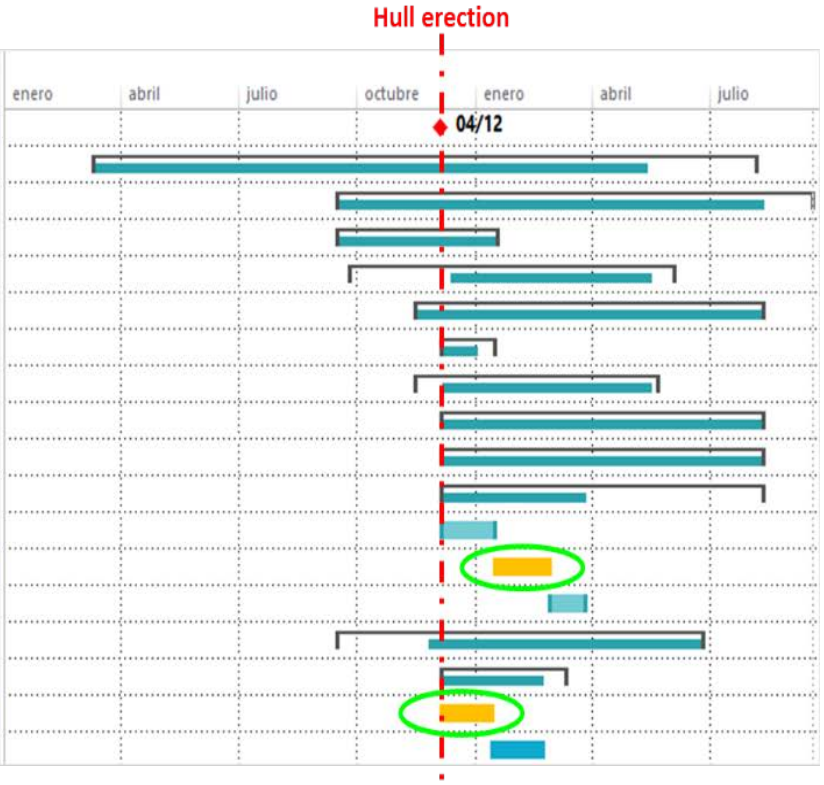


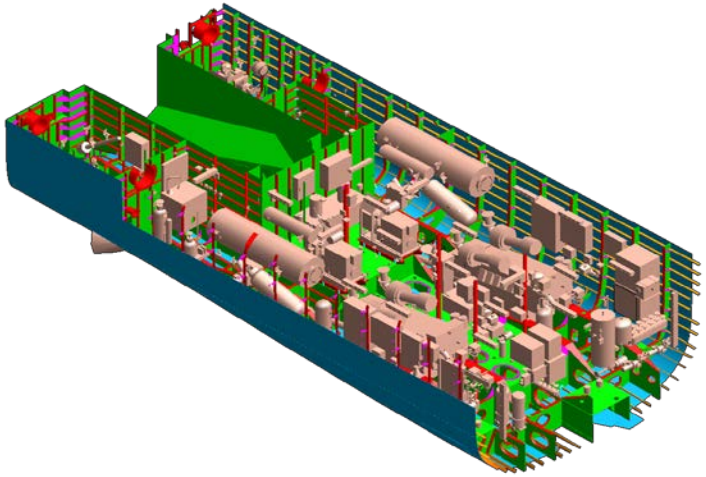
***Initial assessment*: What is the current level of outfitting processes in COTECMAR?**

Case of study: CPV coastal patrol vessel built by COTECMAR

Excerpt of CPV project schedule

Nombre de tarea	Duración	Comienzo	Fin
Hull erection	0 días	mié 04/12/13	mié 04/12/13
ACQUISITION PLAN	368 días?	lun 11/03/13	mié 06/08/14
CONSTRUCTION	264 días	lun 16/09/13	jue 18/09/14
100. Hull & Superstructure	90 días	lun 16/09/13	vie 17/01/14
200. Propulsion plant	180 días	mié 25/09/13	mar 03/06/14
300. Electrical plant	192 días	vie 15/11/13	lun 11/08/14
302. Electrical motors	30 días	jue 05/12/13	mié 15/01/14
310. Electrical generation	134 días	vie 15/11/13	mié 21/05/14
320. Electrical distribution system	178 días	jue 05/12/13	lun 11/08/14
324. Distribución Distribución de energía	178 días	jue 05/12/13	lun 11/08/14
Power distribution	178 días	jue 05/12/13	lun 11/08/14
Cable trays fabrication	30 días	jue 05/12/13	mié 15/01/14
Cable trays installation	30 días	jue 16/01/14	mié 26/02/14
Cable installation	20 días	jue 27/02/14	mié 26/03/14
500 Auxiliary systems	203 días	lun 16/09/13	mié 25/06/14
635. Insulation (hull)	69 días	jue 05/12/13	mar 11/03/14
Insulation pins intallation	28 días	jue 05/12/13	lun 13/01/14
Insulation panels installation	29 días	mar 14/01/14	vie 21/02/14



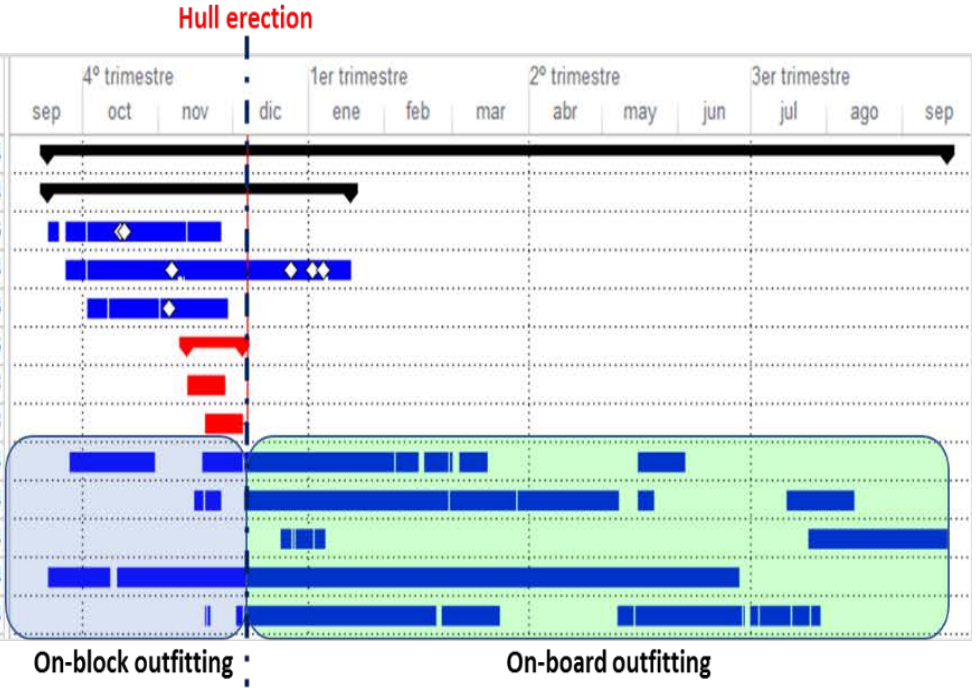


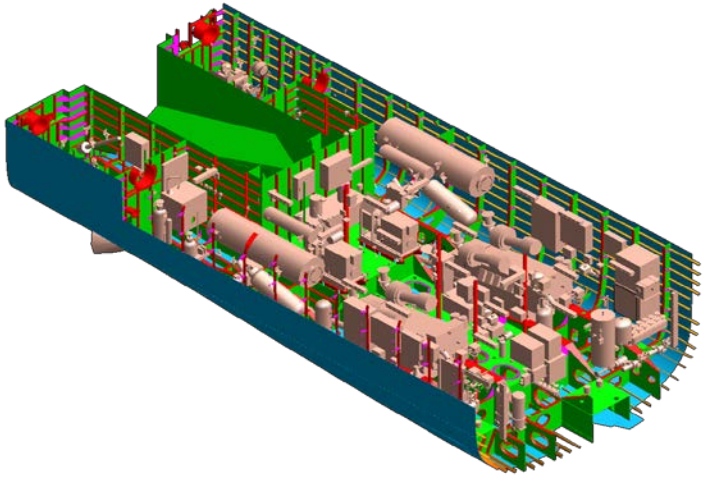
***Initial assessment*: What is the current level of outfitting processes in COTECMAR?**

Case of study: CPV coastal patrol vessel built by COTECMAR

Excerpt of CPV project schedule

Nombre de tarea	Duración	Comienzo	Fin
CONSTRUCTION	264 días	lun 16/09/13	jue 18/09/14
100. Hull & Superstructure	90 días	lun 16/09/13	vie 17/01/14
Zone 1	51 días	lun 16/09/13	lun 25/11/13
Zona 2	85 días	lun 23/09/13	vie 17/01/14
Zona 3	42 días	mié 02/10/13	jue 28/11/13
Hull erection	17 días	mar 12/11/13	mié 04/12/13
Zone 1 & 2	12 días	mar 12/11/13	mié 27/11/13
Zone 2 & 3	12 días	mar 19/11/13	mié 04/12/13
200. Propulsion plant	180 días	mié 25/09/13	mar 03/06/14
300. Electrical plant	192 días	vie 15/11/13	lun 11/08/14
400. Command & Surveillance	195 días	vie 20/12/13	jue 18/09/14
500 Auxiliary systems	203 días	lun 16/09/13	mié 25/06/14
600. Outfit & Furnishings	180 días	mar 19/11/13	lun 28/07/14





***Initial assessment*: What is the current level of outfitting processes in COTECMAR?**

Case of study: CPV coastal patrol vessel built by COTECMAR

Excerpt of CPV project schedule

Source: COTECMAR

First Marine International

a company of

Royal HaskoningDHV
Enhancing Society Together

***Initial assessment*: What is the current level of outfitting processes in COTECMAR?**

Case of study: CPV coastal patrol vessel built by COTECMAR

Shipyards Classification

- First Generation
- **Second Generation** → **A limited amount of outfitting was installed prior to launch. Steel and outfit facilities remained separated with outfitting shops generally located adjacent to an outfitting quay.**
- **Third Generation** → **The level of outfitting prior to launch increased and there was some pre-outfitting of blocks.**
- Fourth Generation
- Fifth Generation

***Initial assessment*: What it the current level of *Advanced outfitting* processes in COTECMAR?**

Evaluation of advanced outfitting level in COTECMAR, with reference on SWBS in CPV project.

SWBS Code - U.S. Navy
000. General Guidance and Administration
100. Hull Structure
200. Propulsion Plant
300. Electric Plant
400. Command and Surveillance
500. Auxiliary Systems
600. Outfit and Furnishings
700. Armament
800. Integration/Engineering
900. Ship Assembly and Support Service

SURVEY ABOUT ADVANCED OUTFITTING LEVELS IN COTECMAR CORPORATION'S SHIPYARD CASE: Coastal Patrol Vessel	
Present level of advanced outfitting: percentage of advanced outfitting (on-block and on-unit) in relation with all planned outfitting activities	
WORK BREAKDOWN STRUCTURE	**%**
Sea water system	
Fresh water system	
Fuel oil system	
Lubrication system	
Ballast system	
Bilge system	
Firefighting system	
Sanitary system	
Hydraulic system	
Exhaust system	
Propulsion system (including engines)	
Steering gear system	
Gen-sets	
Ventilation (ducts and blowers)	
Air-condition (ducts and equipment)	
Cable trays	
Cables	
Electrics distribution panels	
Electronics (navigation and communication)	
Foundations	
Furniture	
Accommodation	
Combat and weapons system	

CONFINDENTIAL RESULTS

***Initial assessment*: What it the current level of *Advanced outfitting* processes in COTECMAR?**

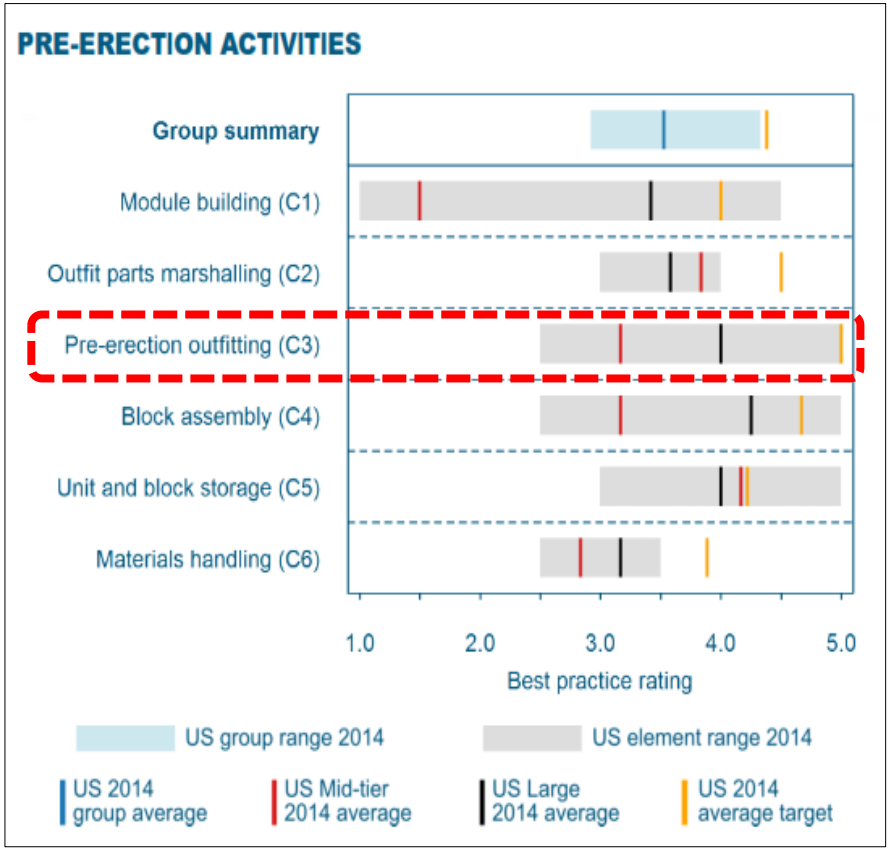
Evaluation of advanced outfitting level in COTECMAR, with reference on outfitting groups in CPV project.

Outfitting group	% Current advanced outfitting in COTECMAR	% Possible advanced outfitting	GAP	Relative GAP based on max. Advanced outfitting	Advanced outfitting ratio in COTECMAR
Electrical Power Distribution (local)	CONFINDENTIAL RESULTS	80%	CONFINDENTIAL RESULTS	CONFINDENTIAL RESULTS	CONFINDENTIAL RESULTS
Heating, Ventilation, and Air Conditioning (HVAC)		85%			
Pipelines		85%			
Habitability and working spaces		85%			
Painting		50%			
Structural outfitting		90%			
Main machinery		80%			
Auxiliary machinery		85%			
				Average	
				Relative average (1 to 10)	
				Relative average (1 to 5)	

***Initial assessment*: What it the current level of *Advanced outfitting* processes in COTECMAR?**

The report presents the findings of the 2014 US Naval Shipbuilding and Repair Industry Benchmarking study carried out by First Marine International (FMI)

Group	Description
A	Steelwork production
B	Outfit manufacturing and storage
C	Pre-erection activities
D	Ship construction and outfitting
E	Yard layout and environment
F	Design, engineering and production engineering
G	Organization and operating systems
H	Human resources
I	Purchasing and supply chain
K	Performance improvement



Source: 2014 US Naval Shipbuilding and Repair - Industry Benchmarking. London, United Kingdom: First Marine International Co.

Strategy areas to Improve the productivity

Construction and assembly methods

***Solution of the problem:* What are the most important aspects necessary to implement "Advanced outfitting" concept in COTECMAR?**

Initial assessment:* What it the current level of Advanced **outfitting processes in COTECMAR?
Answer: CONDIFENTIAL

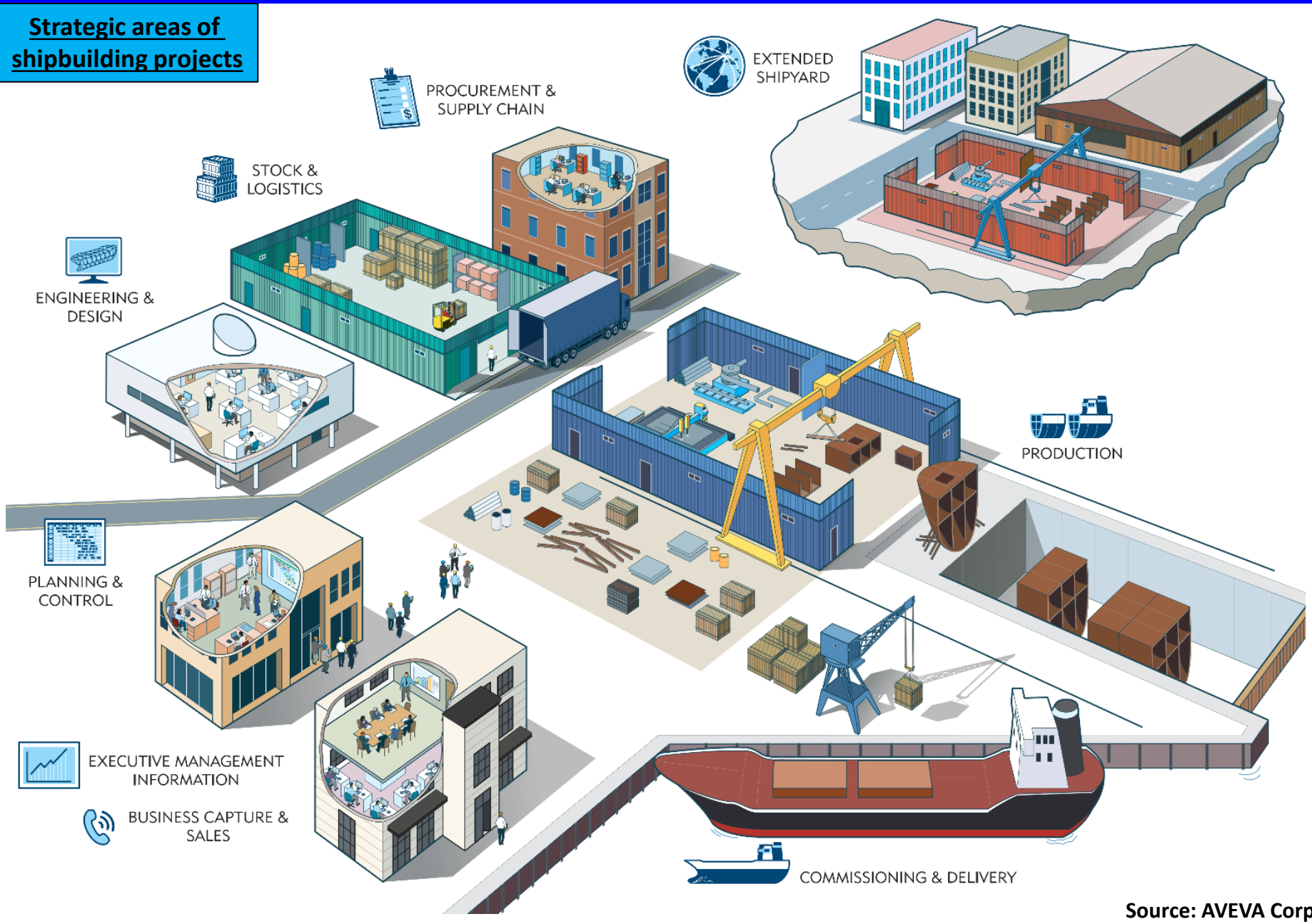
Initial assessment: What it the current level of outfitting processes in COTECMAR?.
Answer: CONFIDENTIAL

Scope of the research: "to establish and describe the general aspects that must be considered to implement "advanced outfitting" in COTECMAR"

How to implement it?

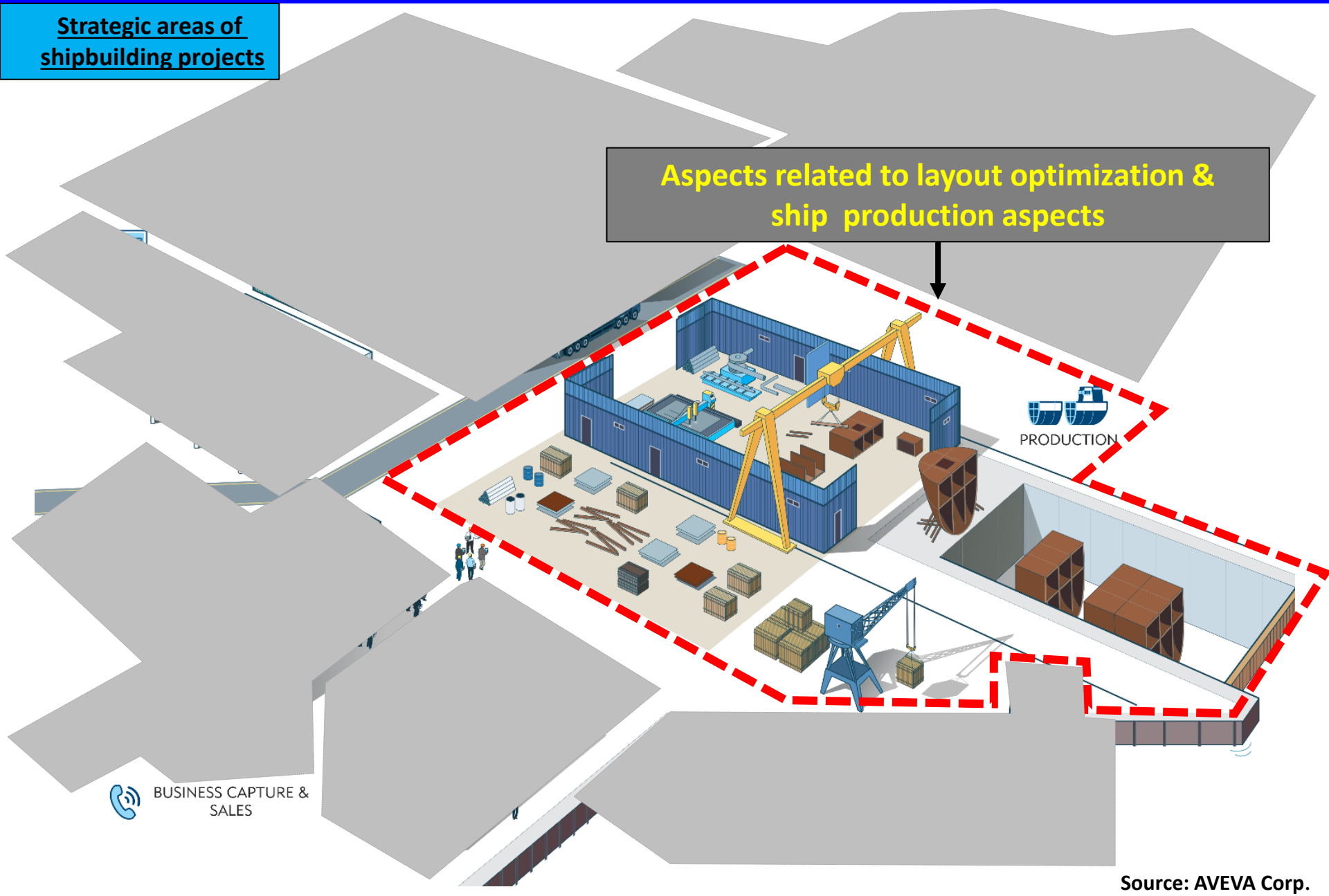
Advanced outfitting

Strategic areas of shipbuilding projects



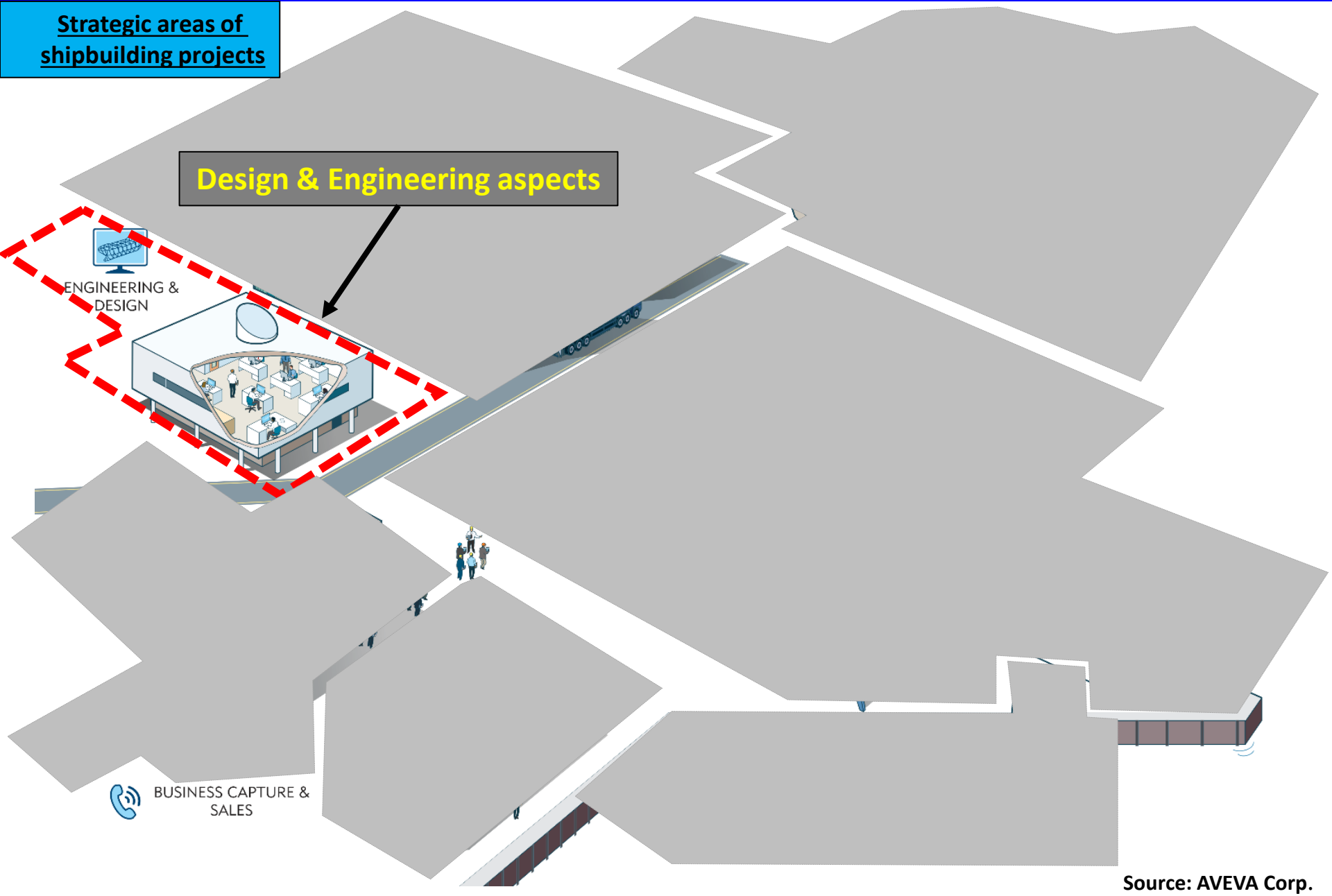
Source: AVEVA Corp.

Strategic areas of shipbuilding projects



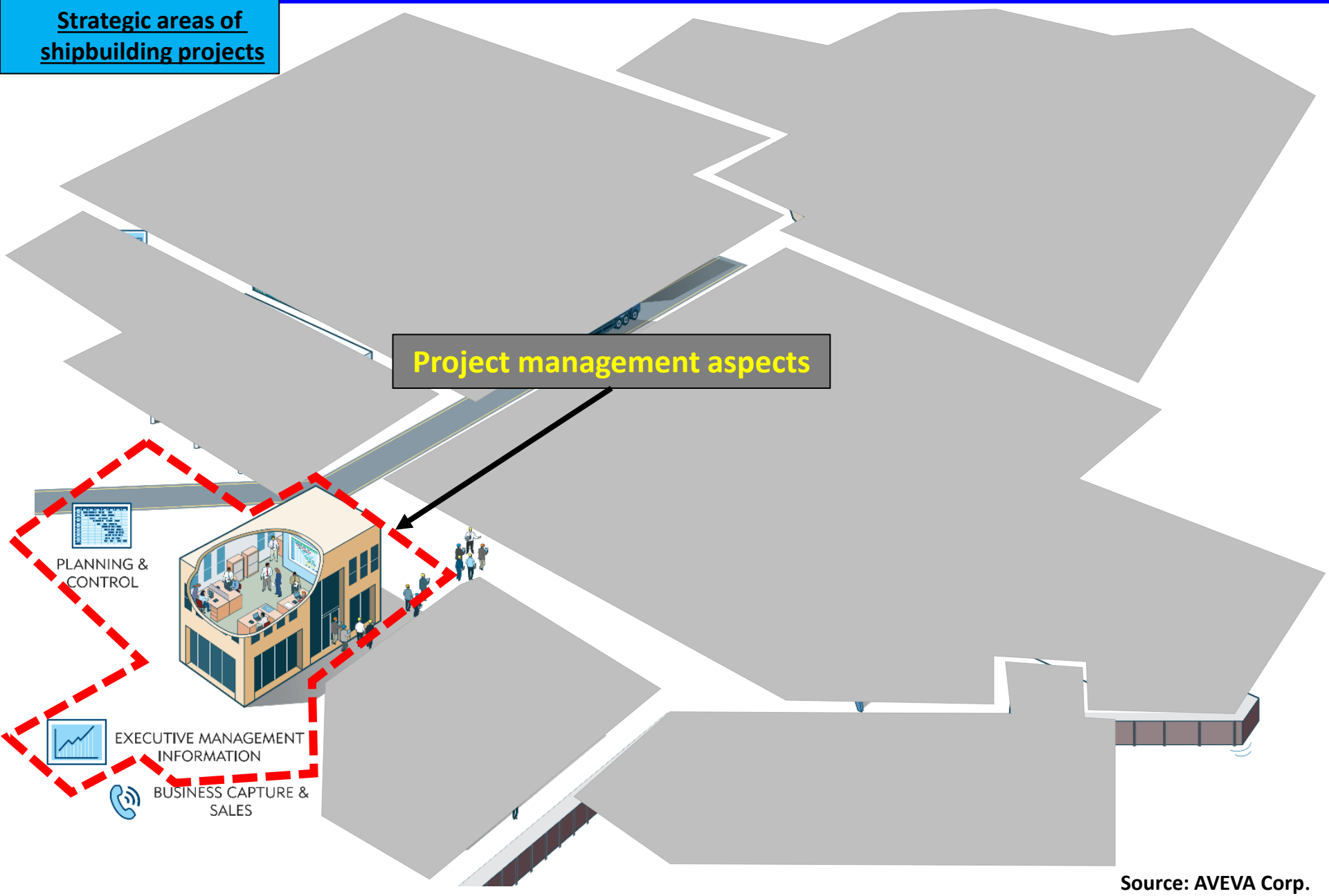
Source: AVEVA Corp.

Strategic areas of shipbuilding projects

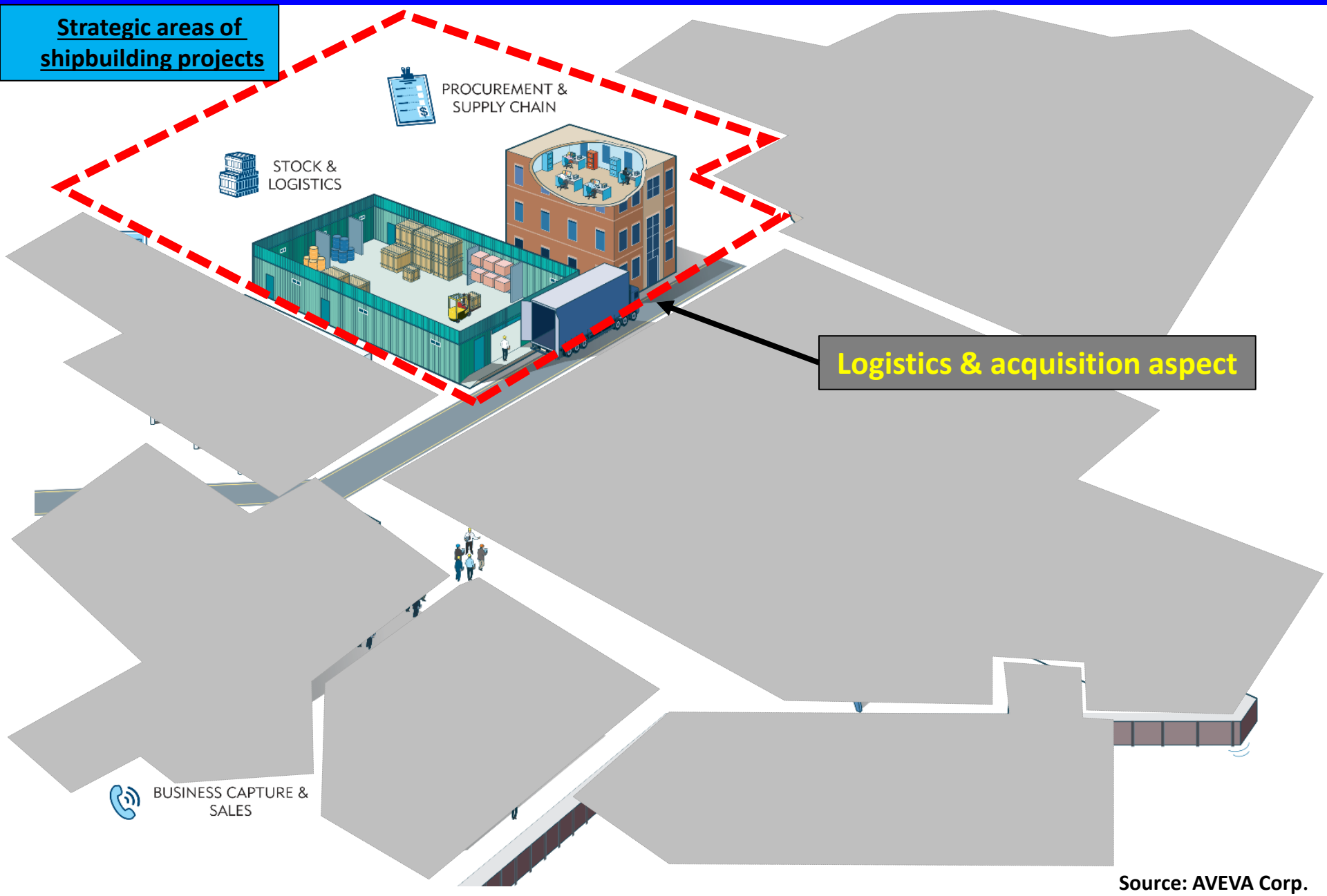


Source: AVEVA Corp.

Strategic areas of shipbuilding projects



Source: AVEVA Corp.

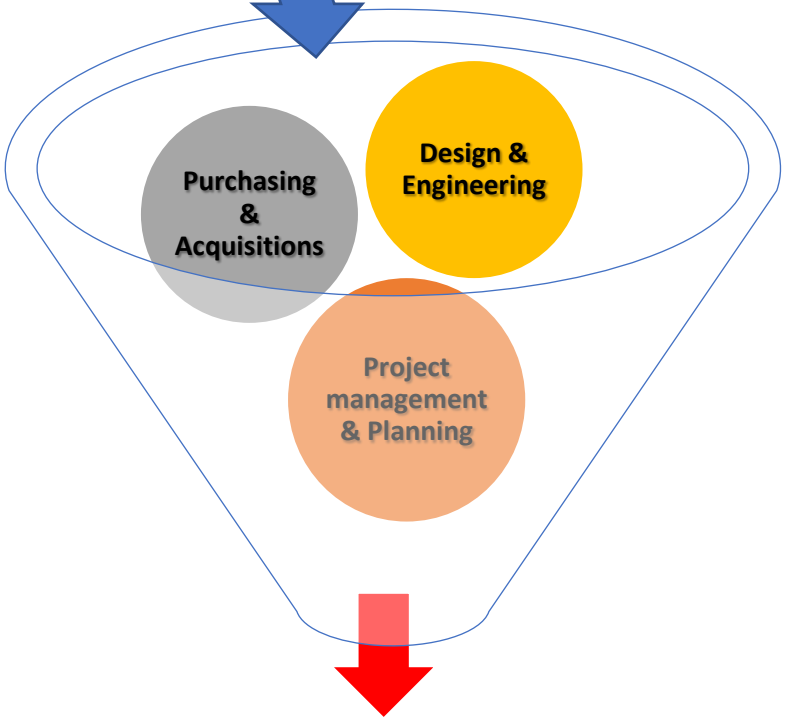


Source: AVEVA Corp.

Strategic areas of shipbuilding projects

- Layout optimization.
- Design and Engineering
- Project management
- Ship production
- Logistics and acquisition

Solution of the problem: ***What are the most important aspects necessary to implement "Advanced outfitting" concept in COTECMAR?***

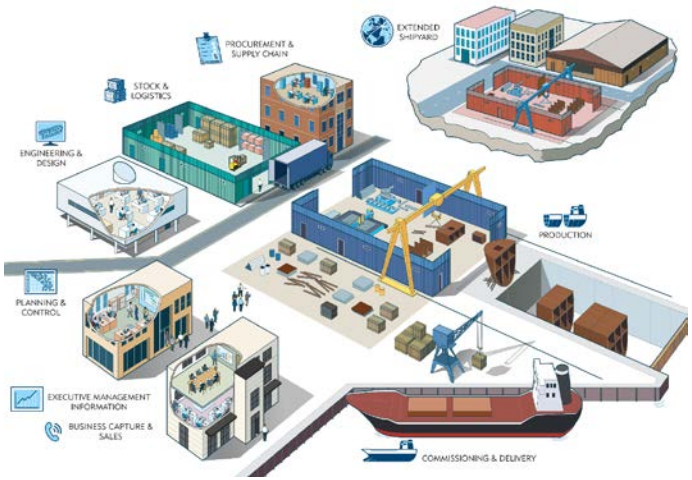


Strategic areas of shipbuilding projects

- **Layout optimization.**
- Design and Engineering
- Project management
- Ship production
- Logistics and acquisition

***Solution of the problem:* What are the most important aspects necessary to implement "Advanced outfitting" concept in COTECMAR?**

- **Warehouses**
- **Workshops**
- **Outfitting assembly areas**
- **Lifting capacity**

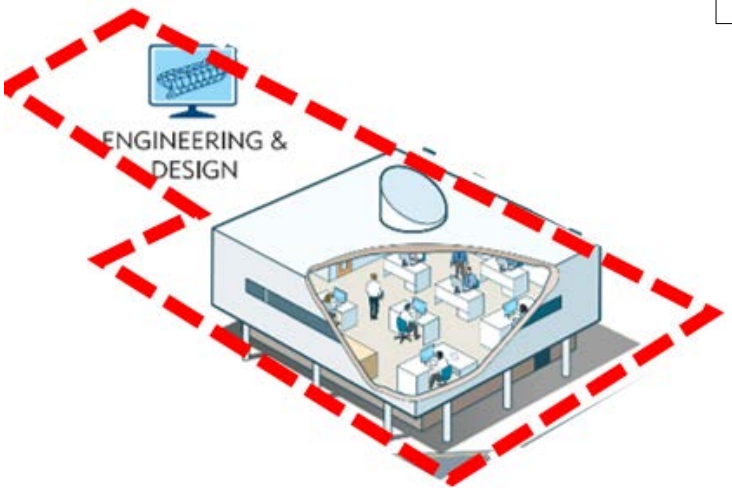


Strategic areas of shipbuilding projects

- Layout optimization.
- **Design and Engineering**
- Project management
- Ship production
- Logistics and acquisition

Solution of the problem: ***What are the most important aspects necessary to implement "Advanced outfitting" concept in COTECMAR?***

- **Higher level of technical and design information flow.**
- **Shipyard facilities limits (cooperation with production areas)**
- **Machinery and piping modules.**
- **Pre-fabricated modules**



Strategic areas of shipbuilding projects

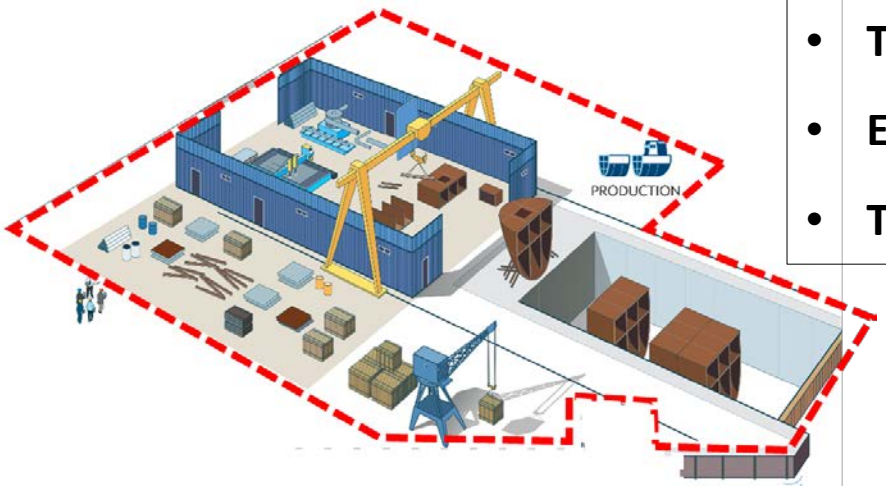
- Layout optimization.
- Design and Engineering
- **Project management**
- Ship production
- Logistics and acquisition

Solution of the problem: ***What are the most important aspects necessary to implement "Advanced outfitting" concept in COTECMAR?***

- **Integration: hull construction & outfitting activities.**
- **Schedule and planning.**
- **New shipbuilding strategy**
- **Outfitting planning**

Strategic areas of shipbuilding projects

- Layout optimization.
- Design and Engineering
- Project management
- **Ship production**
- Logistics and acquisition



***Solution of the problem:* What are the most important aspects necessary to implement "Advanced outfitting" concept in COTECMAR?**

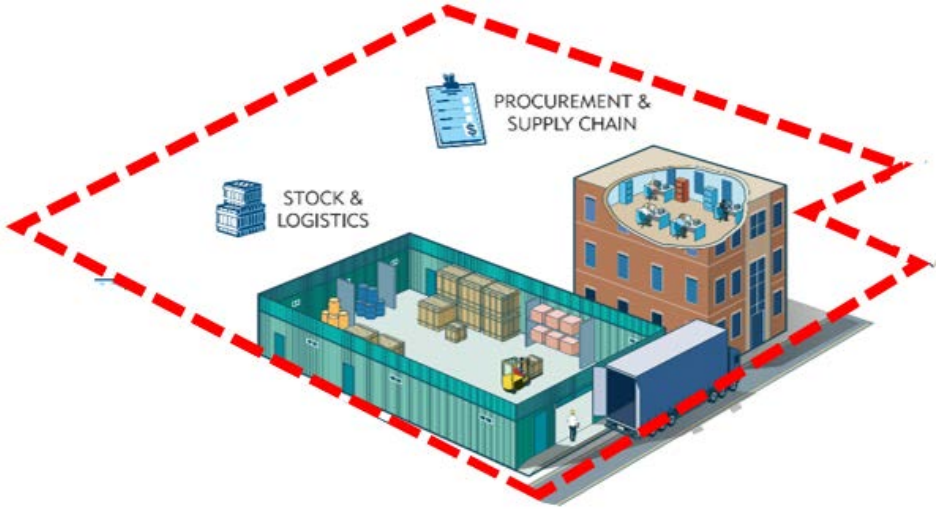
- **Working conditions.**
- **Assembly technics.**
- **Sequences: Pipes, cable trays, ducting for HVAC.**
- **Protection of equipment or components**
- **Scaffoldings system**
- **Training (improve skills)**
- **Effective dimensional control.**
- **Testing processes.**

Strategic areas of shipbuilding projects

- Layout optimization.
- Design and Engineering
- Project management
- Ship production
- **Logistics and acquisition**

Solution of the problem: ***What are the most important aspects necessary to implement "Advanced outfitting" concept in COTECMAR?***

- **High level of purchase and acquisition system.**
- **Shipbuilding procurement processes and purchase orders.**
- **Integration with shipbuilding & design department.**



Strategy areas to Improve the productivity

Construction and assembly methods

How to implement it?

Advanced outfitting

Final assessment: ***What is the impact of implementing Advanced Outfitting Concept in COTECMAR?***

Solution of the problem: What are the most important aspects necessary to implement "Advanced outfitting" concept in COTECMAR?
Answer: Strategic areas of shipbuilding projects aspects

Initial assessment: What it the current level of Advanced **outfitting processes in COTECMAR?*
Answer: CONFIDENTIAL

Initial assessment: What it the current level of outfitting processes in COTECMAR?.
Answer: CONFIDENTIAL

Scope of the research: "to establish and describe the general aspects that must be considered to implement "advanced outfitting" in COTECMAR"

***Final assessment:* What is the impact of implementing Advanced Outfitting Concept in COTECMAR?**

COST-BENEFIT ANALYSIS BASED ON CPV PROJECT

Outfitting cateogries: labour load factors (Rule of thumb)	*On board*	*On Block*	*On Unit*
Electrical Power Distribution (local)	1	0,7	0,4
Heating, Ventilation, and Air Conditioning (HVAC)	1	0,6	0,4
Pipelines	1	0,5	0,3
Habitability and working spaces	1	0,5	0,3
Painting	1	0,6	0,4
Structural outfitting	1	0,6	0,3
Main machinery	1	0,6	0
Auxiliary machinery	1	0,7	0,3

Outfitting group	% Current advanced outfitting in COTECMAR	% Possible advanced outfitting
Electrical Power Distribution (local)	CONFINDENTIAL RESULTS	80%
Heating, Ventilation, and Air Conditioning (HVAC)		85%
Pipelines		85%
Habitability and working spaces		85%
Painting		50%
Structural outfitting		90%
Main machinery		80%
Auxiliary machinery		85%

A	Percentage of current level of advanced outfitting in COTECMAR with reference on total outfitting work done during previous shipbuilding projects.
B	Maximum percentage of outfitting work that could be done as advanced outfitting with reference on total outfitting work done during previous shipbuilding projects.
C	Proportion of outfitting that can improved as advanced outfitting.
D	Number of man-hour required to complete all the outfitting activities in on-board stage for each outfitting group.
E	Labour cost per man per hour.
OH_f	On-board labour load factor
OB_f	On-block labour load factor
OU_f	On-unit labour load factor

$$\%\ outfitting\ taks\ that\ can\ be\ optimized\ as\ advanced\ outfitting = C = \frac{(B-A)}{100}$$

$$On.block\ outfitting\ cost\ savings = C * (OH_f - OB_f) * D * E$$

$$On.unit\ outfitting\ cost\ savings = C * (OH_f - OU_f) * D * E$$

Strategy areas to Improve the productivity

Construction and assembly methods

How to implement it?

Advanced outfitting

Scope of the research: "to establish and describe the general aspects that must be considered to implement "advanced outfitting" in COTECMAR"

Initial assessment: What it the current level of outfitting processes in COTECMAR?.
Answer: CONDIFENTIAL

Initial assessment: What it the current level of Advanced **outfitting processes in COTECMAR?*
Answer: CONFIDENTIAL

Solution of the problem: What are the most important aspects necessary to implement "Advanced outfitting" concept in COTECMAR?
Answer: Strategic areas of shipbuilding projects aspects

Final assessment: What is the impact of implementing Advanced Outfitting Concept in COTECMAR?
Answer: Positive impact

Strategy areas to Improve the productivity

Construction and assembly methods

OPTIMIZATION OF PRODUCTIVITY IN COTECMAR

BETTER SHIP LIFE CYCLE COST

REDUCTION OF COSTS

IMPROVE THE QUALITY OF FINAL PRODUCTS

BETTER PRODUCTION ENVIRONMENT

REDUCTION OF CONSTRUCTION TIME

Implementation

Advanced outfitting


thank you.
ANY QUESTIONS?