UK Marine Industries Roadmap & Capability Study

Workshop A: Marine-related services & ICT, 20 Sept 2011

Report Issue 1.0

Technology Strategy Board
Driving Innovation

UK Marine Industries Alliance

Knowledge Transfer Networks

BIS Department for Business Innovation & Skills

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Executive Summary

This report results from a one-day workshop to assist the Technology Strategy Board, BIS, UK Marine Industries Alliance and the Transport KTN to develop a roadmap to identify future priority opportunities and capability needs for the UK Marine Industries. The workshop was the first of five "Deep Dive" explorations of the sector, focussing on Marine Services and ICT. The workshop took place at the Southampton University Technology on 20 September 2011, with input from over 20 experts drawn from across the Marine Industry, academia and other stakeholders. The workshop took a sub-set of the landscape roadmap, developed in June 2011, which was then developed further to identify priority trends & drivers and then to identify and characterise around 30 Market Opportunities in Marine Services & ICT.

Participants contributed before the workshop by providing their perspectives in a roadmap template – identifying priority Drivers, Opportunities, Capabilities and Enablers in the Short, Medium and Long timeframes. These were consolidated ahead of the workshop to provide a start point to which further issues were added and priorities identified. The most important market opportunities were then highlighted, where UK capability could deliver against major global market needs. These assessments were based on defined criteria for Value (global & UK market, competitive strength, added value and impact on societal and environmental challenges) and Capability (in the marine industry, academia, research organisations and from adjacent industries – see Appendix C for details.)

In prioritising relevant Trends & Drivers (see section 1), there was a strong emphasis on security and safety, the changing nature of military threat and consequent needs for marine surveillance; Climate change figured strongly in relation to adaption (eg to rising sea levels), mitigation (through renewables and greater efficiencies) and as a driver for the "Green Economy"; availability of new technologies for CAE, simulation and modelling, ICT, positioning and integrated transport were all identified as important components of a solution to these challenges, whilst changing demographics, consumer demands and the challenging cost environment were also important.

Executive Summary (continued)

Priority Opportunities (see section 4) were identified across a range of services and ICT areas, with a significant overlap emerging for knowledge-based services. The leading opportunities included: Maritime consulting; Ship management systems: I-ship; Training and education (including virtual training); In-service support of military and civilian vessels; Marine ICT & Information infrastructure; Decision Support Systems; Marine & Coastal environmental services; Design Services for "Green shipping" technologies; Emergency response systems (eg to natural disasters, terrorism, piracy); Recycling / Re-purposing / Decommissioning of ships, platforms, oil rigs etc.; Insurance; and Certification, Testing & Classification.

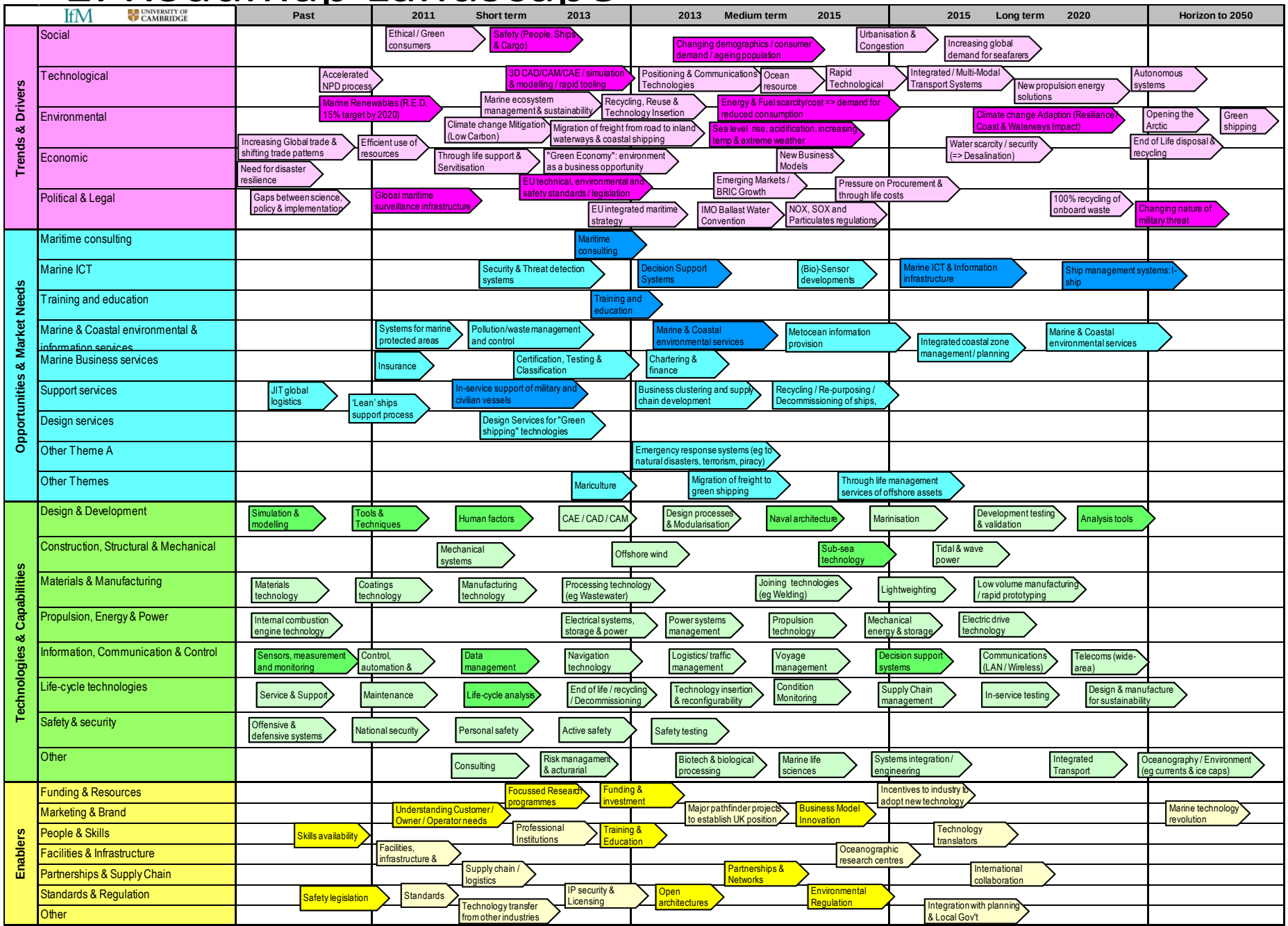
Of these, the first seven were explored in more detail – to characterise the market value and identify relevant sources of UK capability for delivery (and potential gaps that will need to be filled – see section 7)

In support of these opportunities, a wide range of capabilities were identified from within the Marine Industries but also in academia and research organisations. The most relevant areas of capability to support these market opportunities were in Design & Development; Information, Communication & Control; and Life-cycle technologies. Specifically important capabilities included: Simulation & modelling; Life-cycle analysis; Sub-sea technology; Naval architecture; Data management; Sensors, measurement and monitoring technology; Human factors; and Decision support systems.

The workshop also identified other key enablers for success, underpinning these capabilities as: Skills availability; Funding & investment; Understanding Customer / Owner / Operator needs; Open architectures; Safety legislation; Business Model Innovation; Environmental Regulation; and Training & Education

Contents

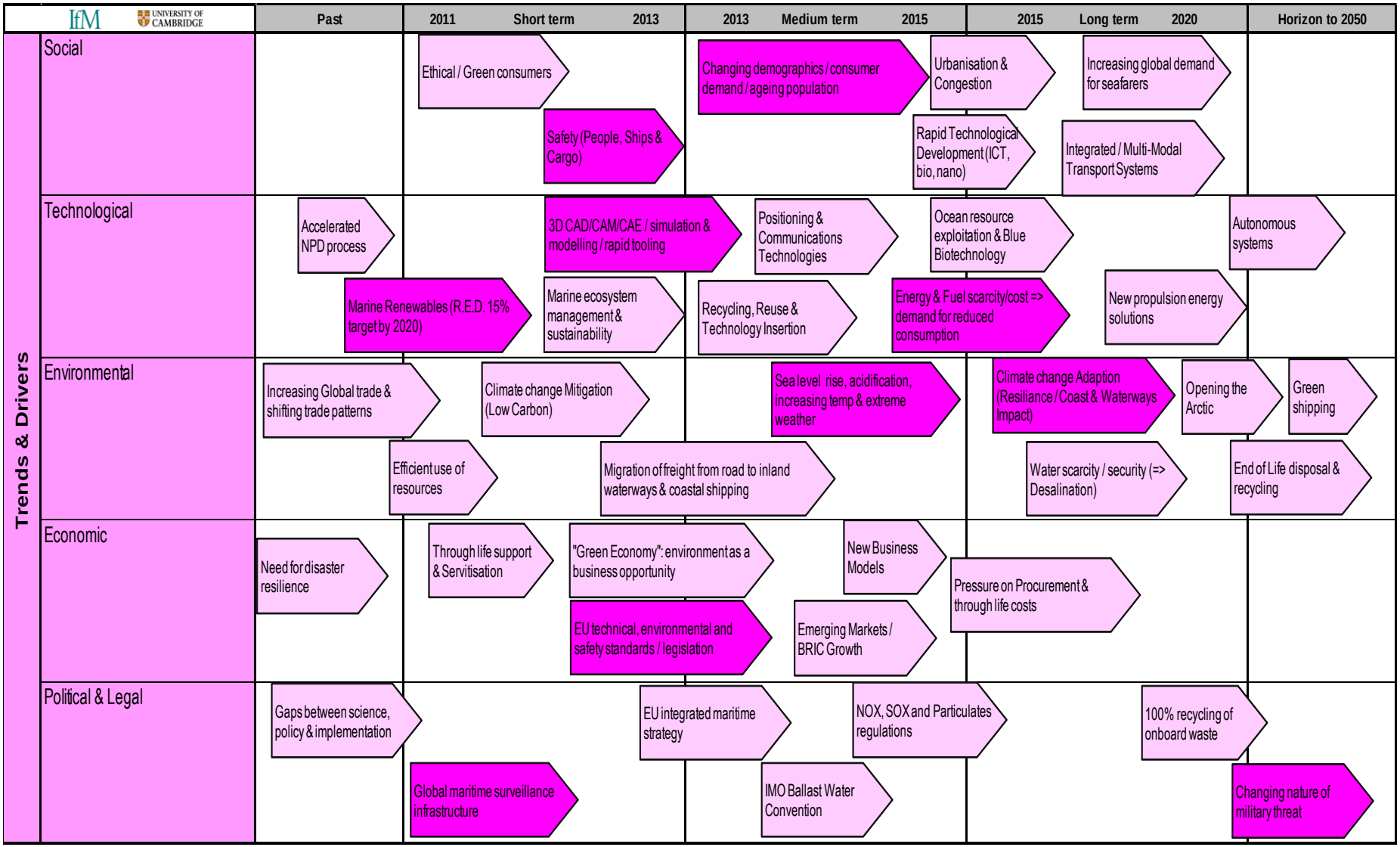
1. Roadmap Landscape



2. Landscape Linkages

Trends & Drivers														Market Opportunities			Capabilities																				Enablers												
Safety (People, Ships & Cargo)	Autonomous systems	EU technical, environmental and safety standards / legislation	Positioning & Communications Technologies	Global maritime surveillance infrastructure	New Business Models	Changing demographics / consumer demand / ageing population	Climate change Adaption (Resiliance / Coast & Waterways Impact)	Marine Renewables (R.E.D. 15% target by 2020)	Energy & Fuel scarcity/cost => demand for reduced consumption	Rapid Technological Development (ICT, bio, nano)	Recycling, Reuse & Technology Insertion						Simulation & modelling	Life-cycle analysis	Sub-sea technology	Naval architecture	Data management	Sensors, measurement and monitoring technology	Human factors	Decision support systems	Tools & Techniques	Analysis tools	Condition Monitoring	Systems integration / engineering	Design processes & Modularisation	Control, automation & autonomy	Maintenance	Risk managament & acturarial	CAE / CAD / CAM	Service & Support	Consulting	Communications (LAN / Wireless)	Skills availability	Funding & investment	Understanding Customer / Owner / Operator needs	Open architectures	Safety legislation	Business Model Innovation	Environmental Regulation	Training & Education	Partnerships & Networks	Focussed Research programmes	Standards	Oceanographic research centres	
1	2	3	4	5	6	7	8	9	10	11	12			**Market Opportunities**			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8	9	10	11	12	
1	1			1	1						1	A	Maritime Consulting (Submarine)	5	3	3	3	3		3																	1			1												17
1	1	1	1						1	1		B	Ship Management Systems - I-Ships	6	2				3		1	3	2	2	3	3	2	3								1	1	1	1	1	1	1	1										32
1	1					1						C	Training & Education incl. Virtual training	3	3	3	3	3	1	3	3											3	3				1	1	1		1	1		1	1	1	1	1					35
			1		1			1			1	D	In-service Support of Military & Civilian Assets	4	3	3	3	1	3	3	1	3	3	1	3		2	2	3	1	1	3		1	1		1	1		1	1				1								46
1	1		1	1	1	1				1		E	Marine ICT & Information Infrastructure	7	3	2			2		3	2	3	3	2	3	2	3	3			3	2	3	3	1	1	1	1	1		1	1	1	1	1								52
1		1		1			1	1	1			F	Decision Support Services	6	3	3			3		2	3	3	3	3	3	3	1	3	3			3	3	2		1	1	1	1	1									1				50
		1					1					G	Marine & Coastal Environmental Services	2	3		2		3	2	2	3	3	3	1	2	2	2	2		1	2	3	2	1	1					1	1	1	1		1						45
5	4	3	3	3	3	2	2	2	2	2	2						20	14	11	7	15	11	12	14	14	12	12	11	11	11	11	7	8	10	9	9	6	5	5	5	4	4	4	3	3	3	3	3	

3.1 Trends & Drivers



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3.2 Trends & Drivers (1 to 20)

Rank	Driver	%
1	Changing nature of military threat	7%
2	"Green Economy": environment as a business opportunity	7%
3	Marine Renewables (R.E.D. 15% target by 2020)	5%
4	EU technical, environmental and safety standards / legislation	5%
5	Global maritime surveillance infrastructure	5%
6	Sea level rise, acidification, increasing temp & extreme weather	4%
7	Safety (People, Ships & Cargo)	4%
8	Climate change Adaption (Resiliance / Coast & Waterways Impact)	4%
9	3D CAD/CAM/CAE / simulation & modelling / rapid tooling	4%
10	Energy & Fuel scarcity/cost => demand for reduced consumption	4%
11	Rapid Technological Development (ICT, bio, nano)	3%
12	Changing demographics / consumer demand / ageing population	3%
13	Pressure on Procurement & through life costs	3%
14	Positioning & Communications Technologies	3%
15	Integrated / Multi-Modal Transport Systems	3%
16	Ocean resource exploitation & Blue Biotechnology	3%
17	EU integrated maritime strategy	3%
18	Gaps between science, policy & implementation	3%
19	Climate change Mitigation (Low Carbon)	2%
20	Autonomous systems	2%

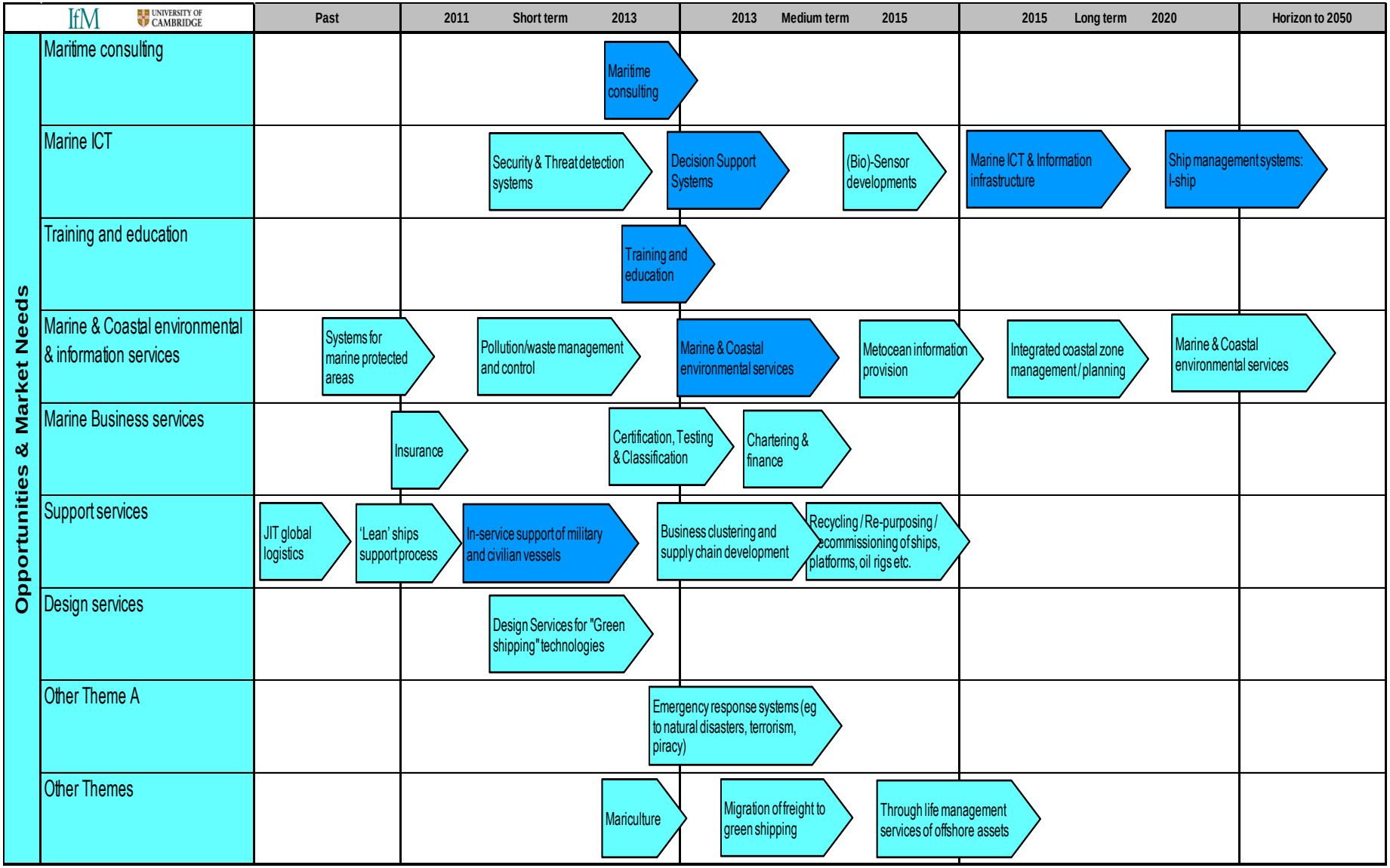
3.2 Trends & Drivers (cont)

Rank	Driver	%
21	NOX, SOX and Particulates regulations	2%
22	Marine ecosystem management & sustainability	2%
23	Efficient use of resources	1%
24	New propulsion energy solutions	1%
25	Recycling, Reuse & Technology Insertion	1%
26	Water scarcity / security (=> Desalination)	1%
27	New Business Models	1%
28	Emerging Markets / BRIC Growth	1%
29	End of Life disposal & recycling (& design for...)	1%
30	Increasing Global trade & shifting trade patterns	1%
31	Ethical / Green consumers	1%
32	Through life support & Servitisation	1%
33	100% recycling of onboard waste	1%
34	Need for disaster resilience	1%
35	Migration of freight from road to inland waterways & coastal shipping	1%
36	Increasing global demand for seafarers	1%
37	Openning the Arctic	1%
38	Green shipping	0%
39	Security (eg Piracy & Terrorism)	0%
40	Urbanisation & Congestion	0%

3.3 Trends & Drivers Linkages

			A	B	C	D	E	F	G	
Rank	ID	Driver	Maritime Consulting (Submarine)	Ship Management Systems - I-Ships	Training & Education incl. Virtual training	In-service Support of Military & Civilian Assets	Marine ICT & Information Infrastructure	Decision Support Services	Marine & Coastal Environmental Services	Total
1	D5	Safety (People, Ships & Cargo)	1	1	1		1	1		5
2	D8	Autonomous systems	1	1	1		1			4
3	D30	EU technical, environmental and safety standards / legislation		1				1	1	3
4	D15	Positioning & Communications Technologies		1		1	1			3
5	D39	Global maritime surveillance infrastructure	1				1	1		3
6	D21	New Business Models	1			1	1			3
7	D9	Changing demographics / consumer demand / ageing population			1		1			2
8	D10	Climate change Adaption (Resiliance / Coast & Waterways Impact)						1	1	2
9	D16	Marine Renewables (R.E.D. 15% target by 2020)				1		1		2
10	D26	Energy & Fuel scarcity/cost => demand for reduced consumption		1				1		2
11	D3	Rapid Technological Development (ICT, bio, nano)		1			1			2
12	D11	Recycling, Reuse & Technology Insertion	1			1				2
13	D14	Pressure on Procurement & through life costs	1			1				2
14	D28	Marine ecosystem management & sustainability		1				1		2
15	D38	EU integrated maritime strategy					1		1	2
16	D23	3D CAD/CAM/CAE / simulation & modelling / rapid tooling			1		1			2
17	D37	Changing nature of military threat	1				1			2
18	D2	Climate change Mitigation (Low Carbon)		1						1
19	D36	Sea level rise, acidification, increasing temp & extreme weather							1	1
20	D41	Ethical / Green consumers					1			1
21	D1	Green shipping					1			1
22	D7	New propulsion energy solutions		1						1
23	D25	Emerging Markets / BRIC Growth				1				1
24	D35	Increasing global demand for seafarers					1			1

4.1 Market Opportunities



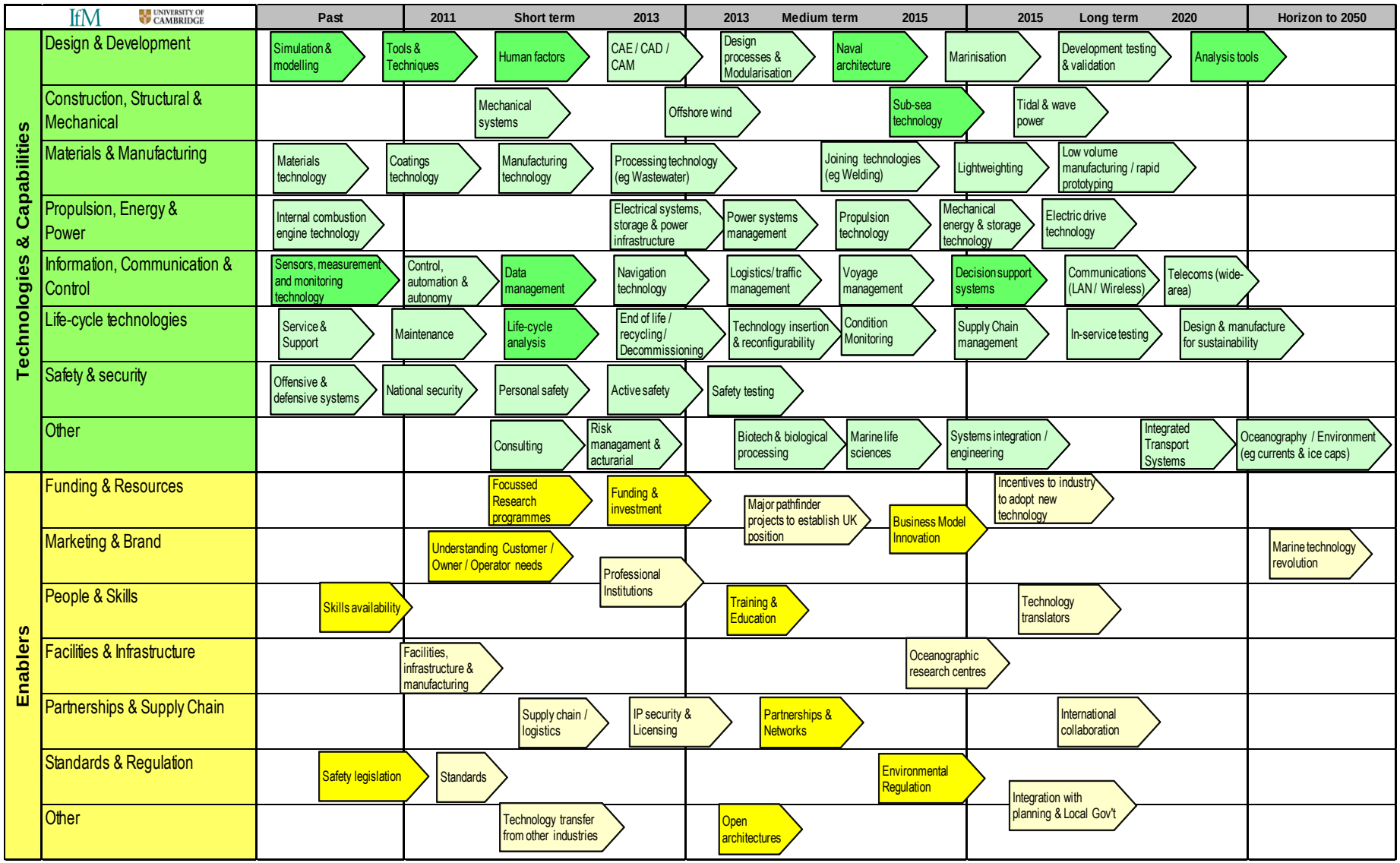
4.2 Market Opportunities (1 to 12)

ID	Opportunities	Market Attractiveness	Capability Fit	Total	
1	Maritime consulting				A
2	Ship management systems: I-ship				B
3	Training and education (including virtual training)				C
4	In-service support of military and civilian vessels				D
5	Marine ICT & Information infrastructure				E
6	Decision Support Systems				F
7	Marine & Coastal environmental services				G
8	Design Services for "Green shipping" technologies				inc in A & c/f to shipping
9	Emergency response systems (eg to natural disasters,				poss application of F
10	Recycling / Re-purposing / Decommissioning of ships,				c/f to shipping
11	Insurance				interesting but no skills in room
12	Certification, Testing & Classification				interesting but no skills in room

4.2 Market Opportunities (cont)

ID	Opportunities	Market Attractiveness	Capability Fit	Total	
13	Business clustering and supply chain development				enabler
14	Security & Threat detection systems				inc in F
15	Metocean information provision				inc in G
16	Integrated coastal zone management / planning				inc in G
17	Through life management services of offshore assets				inc in D
18	Systems for marine protected areas				inc in G
19	(Bio)-Sensor developments				
20	Mariculture				
21	Pollution/waste management and control				
22	Communications				inc in E
23	Chartering & finance				
24	JIT global logistics				

5.1 Capabilities & Enablers



5.2 Capabilities

		A	B	C	D	E	F	G	
		Marine Consulting (Submarine)	Ship Management Systems - I-ships	Training & Education incl. Virtual training	In-service Support of Military & Civilian Assets	Marine ICT & Information Infrastructure	Decision Support Services	Marine & Coastal Environmental Services	
A	**Design & Development**								0
A1	Simulation & modelling	**3**	2	**3**	**3**	**3**	**3**	**3**	
A2	Tools & Techniques	0	2	0	**3**	**3**	**3**	**3**	
A3	Human factors	0	1	**3**	1	**3**	2	2	
A4	CAE / CAD / CAM	0	0	**3**	1	**3**	0	1	
A5	Design processes & Modularisation	0	2	0	2	2	**3**	2	
A6	Naval architecture	**3**	0	**3**	1	0	0	0	
A7	Marinisation	0	0	0	0	2	0	**3**	
A8	Development testing & validation	0	2	0	0	**3**	0	2	
A9	Analysis tools	0	2	0	1	**3**	**3**	**3**	
A Total	**Design & Development**	6	**11**	**12**	**12**	**22**	**14**	**19**	
C	**Construction, Structural & Mechanical**								
C1	Mechanical systems	0	0	0	0.5	0	0	0	
C2	Offshore wind	0	0	0	**3**	0	0	0	
C3	Tidal & wave power	0	0	**3**	**3**	0	0	0	
C4	Sub-sea technology	**3**	0	**3**	**3**	0	0	2	
C5	Naval & Civilian platforms	0	0	0	**3**	0	0	0	
C Total	**Construction, Structural & Mechanical**	3	0	6	**12.5**	0	0	2	
M	**Materials & Manufacturing**								
M1	Materials technology	0	0	0	**3**	0	0	1	
M2	Coatings technology	0	0	0	**3**	0	0	0	
M3	Manufacturing technology	0	0	0	1	0	0	0	
M4	Processing technology (eg Wastewater)	0	0	0	0.5	0	0	0	
M5	Joining technologies (eg Welding)	0	0	0	2	0	0	0	
M6	Lightweighting	0	0	0	1	0	0	0	
M7	Low volume manufacturing / rapid prototyping	0	0	0	0	0	0	0	
M8	Command & Control	0	0	**3**	0	0	0	0	
M Total	**Materials & Manufacturing**	0	0	3	**10.5**	0	0	1	
P	**Propulsion, Energy & Power**								
P1	Internal combustion engine technology	0	0	0	0	0	0	0	
P2	Electric drive technology	0	0	0	1	0	0	0	
P3	Mechanical energy & storage technology	0	**3**	0	0	0	0	0	
P4	Electrical systems, storage & power infrastructure	0	**3**	0	1	**3**	0	0	
P5	Power systems management	0	0	0	**3**	**3**	0	1	
P6	Propulsion technology	0	0	0	0.5	0	0	0	
P Total	**Propulsion, Energy & Power**	0	6	0	5.5	6	0	1	

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5.2 Capabilities (cont)

		A	B	C	D	E	F	G	
		Marine Consulting (Submarine)	Ship Management Systems - I-ships	Training & Education incl. Virtual training	In-service Support of Military & Civilian Assets	Marine ICT & Information Infrastructure	Decision Support Services	Marine & Coastal Environmental Services	
I	**Information, Communication & Control**								
I1	Sensors, measurement and monitoring technology	0	**3**	0	**3**	**3**	**3**	**3**	
I2	Control, automation & autonomy	0	**3**	0	2	**3**	1	2	
I3	Data management	0	**3**	1	**3**	2	**3**	**3**	
I4	Navigation technology	0	1	0	0	2	1	0	
I5	Logistics/ traffic management	0	1	0	0	2	0	0	
I6	Voyage management	0	**3**	0	0	2	1	0	
I7	Decision support systems	0	**3**	0	**3**	2	**3**	**3**	
I8	Communications (LAN / Wireless)	0	1	0	1	**3**	2	2	
I9	Telecoms (wide-area)	0	1	0	0	**3**	2	2	
I Total	**Information, Communication & Control**	0	**19**	1	**12**	**22**	**16**	**15**	
L	**Life-cycle technologies**								
L1	Service & Support	0	0	0	**3**	2	**3**	2	
L2	Maintenance	0	0	0	**3**	**3**	**3**	2	
L3	Life-cycle analysis	**3**	0	**3**	**3**	2	**3**	0	
L4	End of life / recycling / Decommissioning	0	0	0	1	1	0	0	
L5	Technology insertion & reconfigurability	0	2	0	2	1	2	0	
L6	Condition Monitoring	0	**3**	0	**3**	2	**3**	1	
L7	Supply Chain management	0	0	**3**	0.6	2	0	0	
L8	In-service testing	0	0	0	2	2	0	0	
L9	Design & manufacture for sustainability	0	0	0	1	2	0	2	
L Total	**Life-cycle technologies**	3	5	6	**18.6**	**17**	**14**	**7**	
S	**Safety & security**								
S1	Offensive & defensive systems	0	0	0	1	0	0	0	
S2	National security	0	0	0	**3**	2	0	0	
S3	Personal safety	0	1	0	0	0	0	0	
S4	Active safety	0	2	0	0	0	0	0	
S5	Safety testing	0	0	0	**3**	**3**	0	0	
S Total	**Safety & security**	0	3	0	**7**	5	0	0	
O	**Other**								
O1	Biotech & biological processing	0	0	0	0	0	0	0	
O2	Marine life sciences	0	0	0	0	0	2	2	
O3	Consulting	0	0	0	0	**3**	**3**	**3**	
O4	Risk managament & acturarial	0	0	**3**	1	0	**3**	0	
O5	Integrated Transport Systems	0	0	0	0	0	0	0	
O6	Oceanography / Environment (eg currents & ice caps)	0	0	0	0	0	2	**3**	
O7	Systems integration / engineering	0	**3**	0	0	**3**	**3**	2	
O Total	**Other**	0	3	3	1	6	**13**	**10**	

5.3 Capability - Ranked

Capabilities	A	B	C	D	E	F	G	
	Marine Consulting (Submarine)	Ship Management Systems - I-ships	Training & Education ind. Virtual training	In-service Support of Military & Civilian Assets	Marine ICT & Information Infrastructure	Decision Support Services	Marine & Coastal Environmental Services	TOTAL Theme A Marine Services & ICT
Ranked capabilities (top-level grouping)								
A Total	Design & Development							
I Total	Information, Communication & Control							
L Total	Life-cycle technologies							
O Total	Other							
C Total	Construction, Structural & Mechanical							
P Total	Propulsion, Energy & Power							
M Total	Materials & Manufacturing							
S Total	Safety & security							
Ranked capabilities (detail)								
A1	Simulation & modelling	3	2	3	3	3	3	3	
L3	Life-cycle analysis	3	0	3	3	2	3	0	
C4	Sub-sea technology	3	0	3	3	0	0	2	
A6	Naval architecture	3	0	3	1	0	0	0	
I3	Data management	0	3	1	3	2	3	3	
I1	Sensors, measurement and monitoring technology	3	0	3	3	0	0	2	
A3	Human factors	0	1	3	1	3	2	2	
I7	Decision support systems	0	3	0	3	2	3	3	
A2	Tools & Techniques	0	2	0	3	3	3	3	
A9	Analysis tools	0	2	0	1	3	3	3	
L6	Condition Monitoring	0	3	0	3	2	3	1	
O7	Systems integration / engineering	0	3	0	0	3	3	2	
A5	Design processes & Modularisation	0	2	0	2	2	3	2	
I2	Control, automation & autonomy	0	3	0	2	3	1	2	
L2	Maintenance	0	0	0	3	3	3	2	
O4	Risk managament & acturarial	0	0	3	1	0	3	0	
A4	CAE / CAD / CAM	0	0	3	1	3	0	1	
L1	Service & Support	0	0	0	3	2	3	2	
O3	Consulting	0	0	0	0	3	3	3	
I8	Communications (LAN / Wireless)	0	1	0	1	3	2	2	

6.1 Enablers

		A	B	C	D	E	F	G	
Rank	Enablers	Maritime Consulting (Submarine)	Ship Management Systems - I-Ships	Training & Education incl. Virtual training	In-service Support of Military & Civilian Assets	Marine ICT & Information Infrastructure	Decision Support Services	Marine & Coastal Environmental Services	Total
1	Skills availability	1	1	1	1	1		1	6
2	Funding & investment		1	1		1	1	1	5
3	Understanding Customer / Owner / Operator needs		1	1	1	1	1		5
4	Open architectures	1	1		1	1	1		5
5	Safety legislation		1	1		1	1		4
6	Business Model Innovation		1	1	1		1		4
7	Environmental Regulation		1		1	1		1	4
8	Training & Education			1		1		1	3
9	Partnerships & Networks			1		1		1	3
10	Focussed Research programmes			1		1		1	3
11	Standards			1	1	1			3
12	Oceanographic research centres			1			1	1	3
13	Incentives to industry to adopt new technology			1		1		1	3
14	Technology transfer from other industries		1		1			1	3
15	Facilities, infrastructure & manufacturing capacity			1	1				2
16	International collaboration	1						1	2
17	Major pathfinder projects to establish UK position			1			1		2
18	Professional Institutions			1		1			2
19	Marine technology revolution					1			1
20	IP security & Licensing					1			1
21	Expert links assistance (UKTI etc)				1				1

7. Priority Market Opportunities (explored in breakout groups)

Rank	Opportunities	Opportunity grouping and allocation to other themes
1	**Maritime consulting**	**Opportunity A**
2	**Ship management systems: I-ship**	**Opportunity B**
3	**Training and education (including virtual training)**	**Opportunity C**
4	**In-service support of military and civilian Assets**	**Opportunity D**
5	**Marine ICT & Information infrastructure and Communications**	**Opportunity E**
6	**Decision Support Systems (& Services)**	**Opportunity F**
7	**Marine & Coastal environmental services**	**Opportunity G**
8	Design Services for "Green shipping" technologies	Included in Opportunity A and to be explored further in Theme D: Shipping
9	Emergency response systems (eg to natural disasters, terrorism, piracy)	Possible application of F
10	Recycling / Re-purposing / Decommissioning of ships, platforms, oil rigs e	To be explored in Theme D: Shipping
11	Insurance	To be explored outside of workshop as insufficient relevant expertise present
12	Certification, Testing & Classification	To be explored outside of workshop as insufficient relevant expertise present
13	Business clustering and supply chain development	Enabler
14	Security & Threat detection systems	Possible application of Opportunity F
15	Metocean information provision	Included in Opportunity G
16	Integrated coastal zone management / planning	Included in Opportunity G
17	Through life management services of offshore assets	Included in Opportunity D and to be explored further in Theme B: Renewables
18	Systems for marine protected areas	Included in Opportunity G
19	(Bio)-Sensor developments	Enabling capability
20	Mariculture	To be explored in Theme B: Renewables

See over for outputs from breakout group exploration of Priority Market Opportunities.

Key: **Black text – original team input**
Red text – carousel group comments

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7. Priority Market Opportunities (summary)

Opportunities	Market Attractiveness:					Triple bottom-line		Value	Fit with UK Capability						Fit	Total
Opportunity	Global Market Size	Home (UK) market size	Strength of competition	Added Value / Margin	Cross-sector opportunity	Planet / Environmental	People / Societal	Weighted Value	Marine Industry	University / Academic	RTO / Design Services	Other Industry	Other UK resources	Timeliness	Weighted Capability	Combined Value & Fit
Maritime consulting	4	2	1	4	1	1	3		3	2	2	1	1	1		
Ship Management Systems - I-Ships	4	2	2	1	1	2	2		3	2	1	3	1	2		
Training & Education incl. Virtual training	3	1	2	4	0	3	3		2	4	3	3	3	1		
In-service Support of Military & Civilian Assets	4	4	2	2	3	3	1		3	3	2	3	2	2		
Marine ICT & Information Infrastructure	4	2	1	2	1	1	3		3	4	3	4	2	3		
Decision Support Services	4	2	3	4	4	2	2		1	3	3	4	4	3		
Marine & Coastal Environmental Services Monitoring	3	2	1	2	2	3	2		2	3	3	3	1	3		

See over for outputs from breakout group exploration of Priority Market Opportunities.

Key: **Black text – original team input**
Red text – carousel group comments

Opportunity	A	Maritime Consulting (Submarine)	Team	AP, JD, UV
Maybe 5% to 10% of overall marine consulting sector - example only. Others: surface, environmental, propulsion, marine resource			Score	2.2
		Basis for Characterisation & Evidence	Score	This opportunity is attractive because:
Market Attractiveness:	Global Market Growth Opportunity	**V. Large > £5bn**	large percentage of emerging markets have/desire sub capability (Global market total) Submarine chosen as exemplar, others would have been warship, passenger ship, commercial ship, rigs, offshore structures, ports, environmental issues. Each of these would give a different set of results. Super yachts and leisure craft are other possibilities.	4.0	Large opportunity. UK respected Navy & eng. An emerging market. Existing UK capability. Time bound. High value added
	Home (UK) Market Growth Opportunity	Modest > £100m	Manpower Limited. (Potential UK market share of global)	2.0	
	Strength of competition (Global)	Dominant / Entrenched	France, Italy, Germany	1.0	
	Added Value in UK	**90%**	White collar work, engineering etc	4.0	
	Cross-sector opportunity	Small < £100m	small/incidental. Surely significant opps for technology crossover by multi-sectoral consultancies? SW	1.0	
Triple bottom-line	Planet / Environmental	None	Not a driver but associated benefits	1.0	Knowledge Gaps (in team): Submarine propulsion systems have potential for civil opportunities. Need to keep costs reasonable!
	People / Societal	Major	High skills, high value added	3.0	
Capability			Where is the capability	Score	UK has the capability to deliver...
Fit with UK Capability	Marine Industry	World-Leading OR significant scale	World leading but short on #'s of people. Potential rivals: Germany, French, Australia, HDW, DCN	3.0	Strategically important to retain knowledge base in UK. Shouldn't export secrets to rivals
	University / Academic	Moderate / Emerging / Dispersed	World leading but short on #'s of people & breadth of subjects	2.0	
	R&T Org. / Design	Moderate / Emerging / Dispersed	Moderate but could be world leading	2.0	
	Non-Marine / Other	None	Moderate	1.0	
	Other UK resources	None	Moderate but needs Gov support	1.0	Knowledge Gaps (in team): Conventional prop.
Timeliness	UK Capability matches market need	Already "missed the boat"	Lagging, but could recover	1.0	

Opportunity	B	Ship Management Systems - I-Ships	Team	PS, IH, RS
Open infrastructure backbone for ICT on vessel			Score	2.1

Value			Basis for Characterisation & Evidence	Score	This opportunity is attractive because:
Market Attractiveness:	Global Market Growth Opportunity	**V. Large > £5bn**	Military and commercial shipbuilding - biggest markets. Introduction - long term. Difficult business case at present	4.0	Integrates many existing technologies. Improved safety. Manpower reduction. Improves system efficiency. Higher vessel utilisation. Improved strategic planning. Must be virus/hacker-proof
	Home (UK) Market Growth Opportunity	Modest > £100m	Limited market for large shipbuilding in UK? Limited market for I ship. But what is the incentive for commercial owners to buy this? Iship would need legislation to drive it in commercial market	2.0	
	Strength of competition (Global)	Strong / Established	US & UK Global leaders. US largely military	2.0	
	Added Value in UK	10%	UK companies more likely to be system integrators than hardware manufacturers.	1.0	
	Cross-sector opportunity	Small < £100m	Technology likely to be imported from other sectors (auto & aerospace)	1.0	
Triple bottom-line	Planet / Environmental	Modest	Legislation, fuel economy . Weather avoidance systems	2.0	Knowledge Gaps (in team): Commercial market. IP model? Open architectures already in service in UK since last 5-10 years
	People / Societal	Modest	Different skill set. Lower manpower requirement. More training required Need to understand how humans interact with systems	2.0	

Capability			Where is the capability	Score	UK has the capability to deliver...
Fit with UK Capability	Marine Industry	World-Leading OR significant scale	Information, communication & control. Design & development Propulsion, energy & power	3.0	Open architecture system could be available now. Most of enabling technologies are existing. Companies protective of their own patch. Stops collaboration.
	University / Academic	Moderate / Emerging / Dispersed	Design & development	2.0	
	R&T Org. / Design	None		1.0	
	Non-Marine / Other	World-Leading OR significant scale	Synergy with auto & aero sectors	3.0	
	Other UK resources	None		1.0	Knowledge Gaps (in team):
Timeliness	UK Capability matches market need	Lagging but could recover	Market need not established	2.0	

Opportunity	C	Training & Education incl. Virtual training	Team	TD, SH, DH
			Score	2.5

Value			Basis for Characterisation & Evidence	Score	This opportunity is attractive because:
Market Attractiveness:	Global Market Growth Opportunity	Large > £2bn	CPD, oceanographers, marine engineers, ship's crew, legal, classification bodies	3.0	Inc CPD. It's life-long learning now. Potentially large foreign market - until they do it better/cheaper! E-learning huge growth. Strong existing infrastructure. Problem of institutional inertia. Advantage of English as home language
	Home (UK) Market Growth Opportunity	Small < £100m	UK home market mature - new areas incl. Marine spacial planners, geo-engineers etc. Aquaculture, biotech	1.0	
	Strength of competition (Global)	Strong / Established	Strong in Europe, US, Australasia - growing fast elsewhere	2.0	
	Added Value in UK	**90%**	Risk of 'training the competition' UK-owned qualifications add value & CPD/professional. Opportunity to set global standards > expert opps? Opportunity to meet global requirements	4.0	
	Cross-sector opportunity	Small < £100m	Disaster mitigation/resilience planning, new ideas. Showing best practice	0.0	
Triple bottom-line	Planet / Environmental	Major	Warming. Species shift, new diseases. Floods, rainfall. Change. Water supply, living space, war	3.0	Knowledge Gaps (in team): V.customer driven - once you lose students hard to get them back. Slow to adapt to change.
	People / Societal	Major	Food supply, shelter, impact of AI. Data management, data interpretation	3.0	

Capability			Where is the capability	Score	UK has the capability to deliver...
Fit with UK Capability	Marine Industry	Moderate / Emerging / Dispersed	Good training base but needs updating - esp. Shipping. V good in oil & gas sector & navy. Niche shipbuilding is world class. Are these linked?	2.0	TRG colleges. South Shields, Liverpool John Moores. Diver training: Universities including Newcastle, Strathclyde, Southampton, Plymouth, Bangor, UEA, Imperial etc. Plus law schools. You name it, UK can train it. E-learning needs more development to provide value
	University / Academic	**World-Leading & significant scale**	Oceanography, marine law Naval architecture, Engineering all world class. Problem of price for overseas students. Need better communication with industry needs	4.0	
	R&T Org. / Design	World-Leading OR significant scale	BMT, QinetiQ etc. Ship simulators for new harbour layouts well advanced in UK.	3.0	
	Non-Marine / Other	World-Leading OR significant scale	Good in aerospace; defence; insurance, law, composites, nuclear, civil engineering	3.0	
	Other UK resources	World-Leading OR significant scale	Professional bodies - IMAREST, RINA, IMECHE etc. Help tie standards to UK.	3.0	Knowledge Gaps (in team): Co-ordination & integration of resources a problem. Gap in simulation infrastructure. Can be easily lost as a sector!!
Timeliness	UK Capability matches market need	Already "missed the boat"	No UK 'brand' or co-ordinated recruitment of students. High costs losing students to Australia, Canada. Does academia focus enough on applicable tech? + EPSRC	1.0	

Opportunity	D	In-service Support of Military & Civilian Assets	Team	NM, SW, SP
Maintenance & refitting of Naval & civilian vessels & other marine assets			Score	2.6

Value			Basis for Characterisation & Evidence	Score	This opportunity is attractive because:
Market Attractiveness:	Global Market Growth Opportunity	**V. Large > £5bn**	Growing global market - growth in new markets: renewables (tidal, wind) Naval platforms (ships, subs), civilian. Emerging markets, growing demand - TLC decreasing. Increased global threats. Marine renewables are v important. Game changer.	4.0	Sensors overlap with other applications. ICT on-board management of ship/system functions. Wind farms will provide huge in country growth by 2020
	Home (UK) Market Growth Opportunity	**V. Large > £2bn**	New build Naval platforms wind farms > offshore renewables	4.0	
	Strength of competition (Global)	Strong / Established	Civ. Infrastructure - less strong. Mil-strong. Science & tech base - strong.	2.0	
	Added Value in UK	30%	Mil: CN/Ren/EN:	2.0	
	Cross-sector opportunity	Large > £1bn	In-service support - universal need	3.0	
Triple bottom-line	Planet / Environmental	Major	Critical for REN. En affordability	3.0	Knowledge Gaps (in team):
	People / Societal	None	Considered out of scope > 1 (if in scope - 3). Need to include support of the human element	1.0	

Capability			Where is the capability	Score	UK has the capability to deliver...
Fit with UK Capability	Marine Industry	World-Leading OR significant scale	Lloyds Reg, QinetiQ: capacity support services. Naval architecture/test facilities. (VT) Babcock, BAE Systems, Serco: Dockyard design & servicing. Thales contractor logistical support of naval vessels/systems (contracting for availability). Not sure renewables capability is as developed as Naval.	3.0	Planned & unplanned. Condition-based monitoring, repair & overhaul/& maintenance & operational. UKMAIB accident investigation. Incident support i.e.. Oil spill response Ltd. Analysis /Naval architecture & ship stability
	University / Academic	World-Leading OR significant scale	Aerospace/other - CBM, structural health. Marine: Strathclyde, UCL, Newcastle, Cranfield, Southampton. General Technology: Bristol, Bath, Sheffield. Service science: Nottingham, Bath, Cranfield, Cambridge, Strathclyde, Shrivenham (Cranfield)	3.0	
	R&T Org. / Design	Moderate / Emerging / Dispersed	QinetiQ - revalidation. CBM. Technology consultancies CBM	2.0	
	Non-Marine / Other	World-Leading OR significant scale	Aerospace expertise - structural health. Asset management 'power by the hour' (Rolls Royce) Rail sector asset management, IBM - software. Computing infrastructure - tech consultants/ PWC/KPMG/Detica/Accenture	3.0	
	Other UK resources	Moderate / Emerging / Dispersed	Marine renewables industry - structural health, maintenance planning etc. MoD DE&S - through-life management plans	2.0	Knowledge Gaps (in team): Market size opportunity definition to be firmed up!
Timeliness	UK Capability matches market need	Lagging but could recover		2.0	

Opportunity	E	Marine ICT & Information Infrastructure	Team	SM, NA
E - Incl. Comms & Sat Comm			Score	2.6

Value			Basis for Characterisation & Evidence	Score	This opportunity is attractive because:
Market Attractiveness:	Global Market Growth Opportunity	**V. Large > £5bn**	Airtime c. $16bn Satcom. 5-10% cost of warship comms/IT. What about land-based infrastructure for data transmission/provision? Marine surveillance - EE2. Exclusive economic zone	4.0	Operating cost reduction (significant). Aids crew reduction/retention. Is an enabling technology for 1 ship. Opportunity to create a maritime open ICT standard
	Home (UK) Market Growth Opportunity	Modest > £100m	Naval new build & retrofit programmes	2.0	
	Strength of competition (Global)	Dominant / Entrenched	Global defence contractors	1.0	
	Added Value in UK	30%	Known operating margins	2.0	
	Cross-sector opportunity	Small < £100m	Commercial shipping opportunities. Maritime security market	1.0	
Triple bottom-line	Planet / Environmental	None	Integration of systems could enhance voyage optimisation. Improved safety?	1.0	Knowledge Gaps (in team): Integration of previously unconnected systems i.e.. Combat & IPMS
	People / Societal	Major	Crew retention & passenger entertainment expectation. Needs major bandwidth increase for 'gaming' generation whether passenger or crew	3.0	

Capability			Where is the capability	Score	UK has the capability to deliver...
Fit with UK Capability	Marine Industry	World-Leading OR significant scale	Satcom service providers. Marine electronics suppliers. Defence contractors. Land-based data management & handling is big in UK	3.0	Novel. Innovative, Affordable. High-end solutions. Comprehensive marine environmental databases via MEDIN & MMO
	University / Academic	**World-Leading & significant scale**	Many high end electronics research organisations	4.0	
	R&T Org. / Design	World-Leading OR significant scale	Many marine/defence electronics & ICT companies	3.0	
	Non-Marine / Other	**World-Leading & significant scale**	BT. HP etc	4.0	
	Other UK resources	Moderate / Emerging / Dispersed	Private sector	2.0	Knowledge Gaps (in team): Integration. Good capability in UK
Timeliness	UK Capability matches market need	Pace setting	Involvement in master maritime programmes & research	3.0	

Opportunity	F	Decision Support Services	Team	JW, KM, NR
			Score	3.0

Value			Basis for Characterisation & Evidence	Score	This opportunity is attractive because:
Market Attractiveness:	Global Market Growth Opportunity	**V. Large > £5bn**	3 areas: design, construction, operation. Customers: capital intensive assets, high maintenance assets. Major liability. Many factors. Avoids liabilities - saves money	4.0	High value add: exploits UK capability, scalable, leverages data infrastructure. Market Lead, reduces risk: what if, empowers decision making
	Home (UK) Market Growth Opportunity	Modest > £100m	Shipping, oil & gas, MSP, renewables, fisheries. Could be larger	2.0	
	Strength of competition (Global)	Weak / Emerging	Process knowledge is established but not packaged as a DSS embedded within orgs	3.0	
	Added Value in UK	**90%**	Builds to UK strengths: expert in data/domain. Knowledge & value data assurance/service.. Data > inf > knowledge	4.0	
	Cross-sector opportunity	**V. Large > £2bn**	Defence, transport, agriculture	4.0	
Triple bottom-line	Planet / Environmental	Modest	Optimises resources ; avoidance of impacts	2.0	Knowledge Gaps (in team): Market segment. Demand & sales channels. Need to understand how humans deal with risk/making decisions. Risk is one value-add a DSS could make. 'Risk DSS
	People / Societal	Modest	Not 'mainstream' societal benefit. Automatic decision technologies will have dramatic impact in future societies. True but we don't envisage direct use by citizens	2.0	
Capability			Where is the capability	Score	UK has the capability to deliver...
Fit with UK Capability	Marine Industry	None		1.0	Full end-end service (design, build, operate). Market diversification: sensor supplies, 'app' developers. Protect it's small market. Yes, bt this is part of the value proposition. Liabilities an issue.
	University / Academic	World-Leading OR significant scale	World leading in components but not DSS > sensors, data management, maths, gaming, computing	3.0	
	R&T Org. / Design	World-Leading OR significant scale		3.0	
	Non-Marine / Other	**World-Leading & significant scale**	Retail, finance, insurance, utilities. Man consultancies	4.0	
	Other UK resources	**World-Leading & significant scale**	Key infrastructure (data supply): Modelling, HRW etc, Met office, marine data man, EADS. NoC. Nottingham: digital test bed	4.0	Knowledge Gaps (in team): Cost effective DSS architecture. Links to EU decision support system? FP7 project EESS trans environmental support system. Case in point: (FP) EV has probably funded at least 100 projects developing DSS so why is it not widely established?
Timeliness	UK Capability matches market need	Pace setting	Market is unsatisfied - UK is at top table. Could do better!	3.0	

Opportunity G		Marine & Coastal Environmental Services Monitoring	Team	EM, RN, DB
Huge and diverse market opportunity - this review focusses on Monitoring aspects ONLY			Score	2.4
Value		Basis for Characterisation & Evidence	Score	This opportunity is attractive because:
Market Attractiveness: Global Market Growth Opportunity	Large > £2bn	Very dependant on impacts of climate change. Highly dependant on oil & gas market. Covering MCA, MMG, monitoring for GES, MSPet. Huge markets v.large > global. Large > UK. Increased aquacultures driver - need info on coastal water quality > Currently major gap in sensor technology	3.0	Export knowledge. Consulting expertise, standards. Low import/production cost for high value return
Market Attractiveness: Home (UK) Market Growth Opportunity	Modest > £100m	Coastal zone monitoring. Government agencies	2.0	
Market Attractiveness: Strength of competition (Global)	Dominant / Entrenched	In UK all monitoring is completely tendered	1.0	
Market Attractiveness: Added Value in UK	30%	Buy in infrastructure to sell on with UK added supportive infrastructure. * Large market but need to combine knowledge with the infrastructure	2.0	
Market Attractiveness: Cross-sector opportunity	Modest > £100m	MSP - Marine spacial planning. Integrated coastal zone management. Marine planning strategies	2.0	
Triple bottom-line: Planet / Environmental	Major	Linked to GEnS > good environmental status	3.0	Knowledge Gaps (in team): MSP UK leading - rest of world keen to learn from our success/failure. Need to raise awareness of UK expertise - links to education & training. What do we need to do to enhance UK market share?
Triple bottom-line: People / Societal	Modest	Providing data link to the general public	2.0	
Capability		Where is the capability	Score	UK has the capability to deliver...
Fit with UK Capability: Marine Industry	Moderate / Emerging / Dispersed	O&G has a strong env. Monitoring reputation, shipping is emergent, fishing is limited.	2.0	Very high quality consultancy/monitoring services. Opportunity to engage in high value knowledge transfer. Is there a real global market here? Yes! Assessments & market compare well with DSS team's assessment.
Fit with UK Capability: University / Academic	World-Leading OR significant scale	NOC - Southampton & Liverpool. Bangor, Plymouth, Aberdeen, St Andrews, Herriot Watt	3.0	
Fit with UK Capability: R&T Org. / Design	World-Leading OR significant scale	A lot of significant commercial research. Modelling - Met Office, HR Wallingford	3.0	
Fit with UK Capability: Non-Marine / Other	World-Leading OR significant scale	Strong environment monitoring of impacts. Private sector orgs/HR Wallingford, Gardline, Fuegro etc, EMU	3.0	
Fit with UK Capability: Other UK resources	None	Transferring terrestrial technologies (e.g. decision making tools) to marine	1.0	Knowledge Gaps (in team): Cross sector synergies for marine env.monitoring services
Timeliness: UK Capability matches market need	Pace setting	Consultancy based expertise. Coastal monitoring: we are world leading	3.0	