UK Marine Industries Roadmap & Capability Study

Workshop C: Marine Leisure & Equipment, 9 November

Technology Strategy Board
Driving Innovation

UK Marine Industries Alliance

Knowledge Transfer Networks
Transport

BIS Department for Business Innovation & Skills

Dominic Oughton do251@cam.ac.uk IfM

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 third of five "Deep Dive" explorations of the sector, focussing on Marine Leisure & Equipment. The workshop took place at the University of Warwick on 9 November 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 40 Market Opportunities in Marine Leisure and Equipment.

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 changing demographics and consumer demand (from the needs of an ageing population, challenges of introducing new people to boating and opportunities from emerging Markets / BRIC Growth) resulting in a more "clean hands - no sweat" boat operation; as well as the challenges of reversing the increasing cost of boating at a time of economic downturn. The role of standards will be significant, especially from EU and relating to technical, environmental (NOX, SOX, particulates, waste & CO_2) and safety; as will new technologies including more environmentally-friendly propulsion energy solutions; simulation & modelling and Accelerated NPD processes. Through-life support will be vital in delivering lower cost of ownership, with the need to consider recycling, retrofit and upgrade, as well as end of life disposal & recycling .

Dominic Oughton do251@cam.ac.uk IfM

Executive Summary (continued)

Priority Opportunities (see section 4) were identified across a range of areas, though largely focussed on marine leisure rather than equipment. The leading opportunities included: Easy to use leisure navigation system & integrated communications / data; Alternative fuels / Electrification & Hybrids & efficient propulsion / re-powering ;New leisure marine products for developing markets (and tailoring for specific market needs); Volume produced smaller leisure craft types for affordable participation eg for first-time owners / 3rd age; Lower-cost construction methods and Hull design, vessel design & aesthetics . Opportunities for equipment and component technologies were highlighted, including sustainable composites & smart materials; Coatings (eg for low friction); Safety systems & equipment ; Technologies for (Semi-)autonomous control & navigation (eg Intuitive IT based controls) and Exhaust after treatment systems however these were not highly prioritised as the necessary expertise were under-represented in the workshop participants.

Of these opportunities, the first six 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)

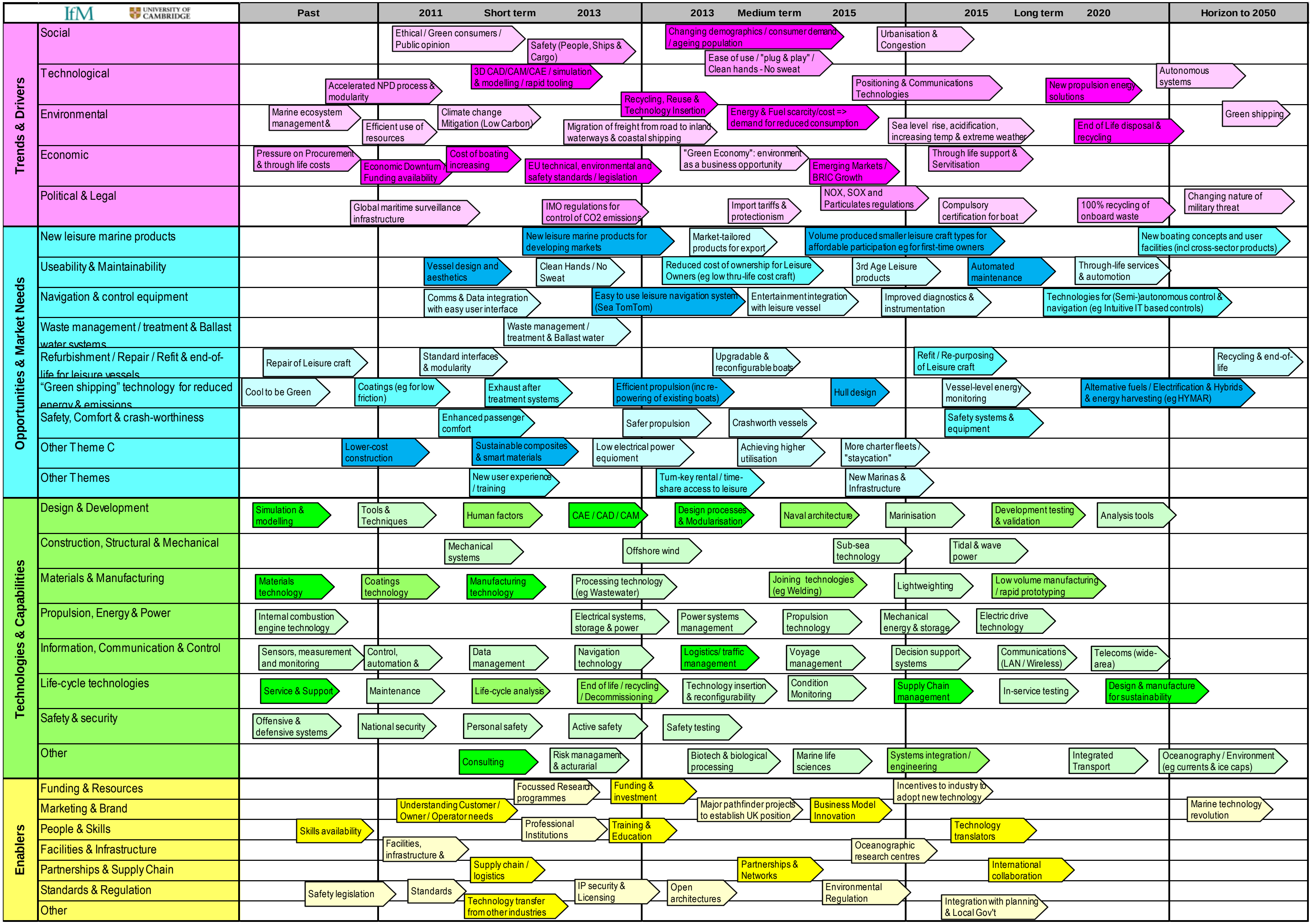
In support of these opportunities, a wide range of capabilities were identified from within the Marine Industries but also in academia and research organisations. The most relevant areas of capability to support these market opportunities were: Supply Chain management; Service & Support; Simulation & modelling; CAE / CAD / CAM; Design processes & Modularisation; Materials technology; Manufacturing technology; Design & manufacture for sustainability.

The workshop also identified other key enablers for success, underpinning these capabilities as: Understanding Customer / Owner / Operator needs; Technology transfer from other industries; Skills availability; Training & Education; Funding & investment; Partnerships & Networks; International collaboration; Supply chain / logistics; Business Model Innovation and Technology translators.

It was particularly notable that the role of technology transfer from other areas of Marine and the wider industrial base (and supporting enablers to deliver this) was strongly prevalent in the delivery of all the priority opportunities.

Contents

1. Roadmap Landscape



2. Landscape Linkages

Trends & Drivers

	Market Opportunities		1 Changing demographics / consumer demand / ageing population	2 Emerging Markets / BRIC Growth	3 Energy & Fuel scarcity/cost => demand for reduced consumption	4 New Business Models	5 Cost of boating increasing	6 Ethical / Green consumers	7 Green shipping	8 Efficient use of resources	9 New propulsion energy solutions	10 NOX, SOX and Particulates regulations	11 Pressure on Procurement & through life costs	12 EU technical, environmental and safety standards / legislation
A	Easy to use Leisure Navigation System & Integrated Comms/Data	4	1			1			1	1				
B	Alternative fuels: Electrification, Hybrids etc	5			1			1			1	1		1
C	New Leisure Marine Products for Developing Markets	11	1	1	1	1	1	1	1		1	1	1	1
D	Volume/Smaller Craft (New users/3rd Age)	7	1	1	1	1	1	1		1				
E	Lower cost construction	3		1			1						1	
F	Hull Design, Vessel Design & Aesthetics	3	1	1	1									
			4	4	4	3	3	3	2	2	2	2	2	2

Capabilities

	1 Supply Chain management	2 Service & Support	3 Simulation & modelling	4 CAE / CAD / CAM	5 Design processes & Modularisation	6 Materials technology	7 Manufacturing technology	8 Design & manufacture for sustainability	9 Consulting	10 Logistics/ traffic management	11 Coatings technology	12 Command & Control	13 Development testing & validation	14 Low volume manufacturing / rapid prototyping	15 Naval architecture	16 Human factors	17 End of life / recycling / Decommissioning	18 Joining technologies (eg Welding)	19 Systems integration / engineering	20 Life-cycle analysis
A	2	3	3	3	3	1	1	3	3	3	1		3	2		3	3	1	3	2
B			2	2		2	3	2	2				3	2					3	
C	3	3			3					3	2	3								
D	3	3	2	3		3	3	3			2		2	3	3	2	3	1		3
E	3		3	2	2	3	3	2	3		2		2	3	2		2	2	2	2
F			3	3		3	2	2	3						3	3	1	3		1
	11	9	13	13	8	12	12	12	11	6	7	3	10	10	8	8	9	7	8	8

Enablers

	1 Understanding Customer / Owner / Operator needs	2 Technology transfer from other industries	3 Skills availability	4 Training & Education	5 Funding & investment	6 Partnerships & Networks	7 International collaboration	8 Supply chain / logistics	9 Business Model Innovation	10 Technology translators	11 Incentives to industry to adopt new technology	12 Focussed Research programmes	
A	1	1		1			1	1	1	1	1	1	52
B		1				1				1	1	1	26
C	1		1	1	1	1	1	1	1		1		26
D	1	1	1	1	1	1	1	1	1				48
E	1	1	1		1	1				1		1	45
F	1	1	1	1	1		1						33
	5	5	4	4	4	4	4	3	3	3	3	3	

Dominic Oughton do251@cam.ac.uk IfM

3.1 Trends & Drivers

Trends & Drivers

	Past	2011 Short term 2013	2013 Medium term 2015	2015 Long term 2020	Horizon to 2050
Social		Ethical / Green consumers / Public opinion; Safety (People, Ships & Cargo)	Changing demographics / consumer demand / ageing population; Ease of use / "plug & play" / Clean hands - No sweat; Urbanisation & Congestion		
Technological	Accelerated NPD process & modularity	3D CAD/CAM/CAE / simulation & modelling / rapid tooling; Recycling, Reuse & Technology Insertion	Positioning & Communications Technologies	New propulsion energy solutions; Autonomous systems	
Environmental	Marine ecosystem management &	Climate change Mitigation (Low Carbon); Efficient use of resources; Migration of freight from road to inland waterways & coastal shipping	Energy & Fuel scarcity/cost => demand for reduced consumption; Sea level rise, acidification, increasing temp & extreme weather	End of Life disposal & recycling	Green shipping
Economic		Cost of boating increasing; "Green Economy": environment as a business opportunity; Economic Downturn / Funding; EU technical, environmental and safety standards / legislation	Through life support & Servitisation; Emerging Markets / BRIC Growth	Pressure on Procurement & through life costs	
Political & Legal	Global maritime surveillance infrastructure	IMO regulations for control of CO2 emissions	NOX, SOX and Particulates regulations; Import tariffs & protectionism	Compulsory certification for boat users; 100% recycling of onboard waste	Changing nature of military threat

Technology Strategy Board Driving Innovation

UK Marine Industries Alliance

BIS Department for Business Innovation & Skills

Dominic Oughton do251@cam.ac.uk IfM

3.2 Trends & Drivers (1 to 20)

Rank	Driver	%
1	Changing demographics / consumer demand / ageing population	11%
2	Cost of boating increasing	10%
3	Emerging Markets / BRIC Growth	8%
4	Economic Downturn / Funding availability	5%
5	EU technical, environmental and safety standards / legislation	5%
6	New propulsion energy solutions	5%
7	Recycling, Reuse & Technology Insertion	5%
8	3D CAD/CAM/CAE / simulation & modelling / rapid tooling	4%
9	End of Life disposal & recycling	4%
10	Energy & Fuel scarcity/cost => demand for reduced consumption	4%
11	NOX, SOX and Particulates regulations	4%
12	Positioning & Communications Technologies	4%
13	Pressure on Procurement & through life costs	4%
14	IMO regulations for control of CO2 emissions	3%
15	Safety (People, Ships & Cargo)	3%
16	Through life support & Servitisation	3%
17	100% recycling of onboard waste	2%
18	Accelerated NPD process & modularity	2%
19	Clean hands - no sweat	2%
20	Compulsory certification for boat users	2%

3.2 Trends & Drivers (cont)

Rank	Driver	%
21	Marine ecosystem management & sustainability	2%
22	"Green Economy": environment as a business opportunity	1%
23	Autonomous systems	1%
24	Changing nature of military threat	1%
25	Climate change Mitigation (Low Carbon)	1%
26	Efficient use of resources	1%
27	Gaps between science, policy & implementation	1%
28	Global maritime surveillance infrastructure	1%
29	Green shipping	1%
30	Migration of freight from road to inland waterways & coastal shipping	1%
31	Sea level rise, acidification, increasing temp & extreme weather	1%
32	Urbanisation & Congestion	1%
33	Fuel systems effects of low-sulphur & bio diesel	1%

3.3 Trends & Drivers Linkages

		A	B	C	D	E	F	
Rank	**Driver**	**Easy to use Leisure Navigation System & Integrated Comms/Data**	**Alternative fuels: Electrification, Hybrids etc**	**New Leisure Marine Products for Developing Markets**	**Volume/Smaller Craft (New users/3rd Age)**	**Lower cost construction**	**Hull Design, Vessel Design & Aesthetics**	**Total**
1	Changing demographics / consumer demand / ageing population	1		1	1		1	4
2	Emerging Markets / BRIC Growth			1	1	1	1	4
3	Energy & Fuel scarcity/cost => demand for reduced consumption		1	1	1		1	4
4	New Business Models	1		1	1			3
5	Cost of boating increasing			1	1	1		3
6	Ethical / Green consumers		1	1	1			3
7	Green shipping	1		1				2
8	Efficient use of resources	1			1			2
9	New propulsion energy solutions		1	1				2
10	NOX, SOX and Particulates regulations		1	1				2
11	Pressure on Procurement & through life costs			1		1		2
12	EU technical, environmental and safety standards / legislation		1	1				2
13	Increasing Global trade & shifting trade patterns	1		1				2
14	Climate change Mitigation (Low Carbon)		1					1
15	Autonomous systems	1						1
16	Recycling, Reuse & Technology Insertion				1			1
17	Positioning & Communications Technologies	1						1
18	Marine Renewables (R.E.D. 15% target by 2020)			1				1
19	3D CAD/CAM/CAE / simulation & modelling / rapid tooling					1		1
20	Accelerated NPD process					1		1
21	End of Life disposal & recycling				1			1
22	Migration of freight from road to inland waterways & coastal shipping	1						1
23	Changing nature of military threat	1						1
24	Global maritime surveillance infrastructure	1						1

4.1 Market Opportunities

Opportunities & Market Needs

	Past	2011 Short term 2013	2013 Medium term 2015	2015 Long term 2020	Horizon to 2050
New leisure marine products		New leisure marine products for developing markets	Market-tailored products for export (BRIC); Volume produced smaller leisure craft types for affordable participation eg for first-time owners		New boating concepts and user facilities (incl cross-sector products)
Useability & Maintainability		Vessel design and aesthetics; Clean Hands / No Sweat	Reduced cost of ownership for Leisure Owners (eg low thru-life cost craft); 3rd Age Leisure products	Automated maintenance; Through-life services & automotion	
Navigation & control equipment		Comms & Data integration with easy user interface; Easy to use leisure navigation system (Sea TomTom)	Entertainment integration with leisure vessel; Improved diagnostics & instrumentation	Technologies for (Semi-)autonomous control & navigation (eg Intuitive IT based controls)	
Waste management / treatment & Ballast water systems		Waste management / treatment & Ballast water systems			
Refurbishment / Repair / Refit & end-of-life for leisure vessels	Repair of Leisure craft	Standard interfaces & modularity	Upgradable & reconfigurable boats	Refit / Re-purposing of Leisure craft	Recycling & end-of-life
"Green shipping" technology for reduced energy & emissions	Cool to be Green	Coatings (eg for low friction); Exhaust after treatment systems; Efficient propulsion (inc re-powering of existing boats)	Hull design	Vessel-level energy monitoring; Alternative fuels / Electrification & Hybrids & energy harvesting (eg HYMAR)	
Safety, Comfort & crash-worthiness		Enhanced passenger comfort; Safer propulsion	Crashworth vessels	Safety systems & equipment	
Other Theme C		Lower-cost construction; Sustainable composites & smart materials; Low electrical power equiopment	Achieving higher utilisation; More charter fleets / "staycation"		
Other Themes		New user experience / training	Turn-key rental / time-share access to leisure marine; New Marinas & Infrastructure		

4.2 Market Opportunities (1 to 20)

Rank	Opportunities	Market Attractiveness	Capability Fit	Total
1	Easy to use leisure navigation system (Sea TomTom)			
2	Alternative fuels / Electrification & Hybrids & energy harvesting (eg HYMAR)			
3	New leisure marine products for developing markets			
4	Volume produced smaller craft types for affordable participation eg for first-time owners			
5	Lower-cost construction			
6	Hull design			
7	Efficient propulsion (inc re-powering of existing boats)			
8	Vessel design and aesthetics			
9	Automated maintenance			
10	Sustainable composites & smart materials			
11	Coatings (eg for low friction)			
12	Reduced cost of ownership for Leisure Owners (eg low thru-life cost craft)			
13	Refit / Re-purposing of Leisure craft			
14	Safety systems & equipment			
15	New user experience / training			
16	Turn-key rental / time-share access to leisure marine			
17	Technologies for (Semi-)autonomous control & navigation (eg Intuitive IT based controls)			
18	Enhanced passenger comfort			
19	New boating concepts and user facilities (incl cross-sector products)			
20	Exhaust after treatment systems			

4.2 Market Opportunities (cont)

Rank	Opportunities	Market Attractiveness	Capability Fit	Total
21	Upgradable & reconfigurable boats			
22	Improved diagnostics & instrumentation			
23	Vessel-level energy monitoring			
24	Low electrical power equioment			
25	Clean Hands / No Sweat			
26	Standard interfaces & modularity			
27	Recycling & end-of-life			
28	Waste management / treatment & Ballast water systems			
29	3rd Age Leisure products			
30	Comms & Data integration with easy user interface			
31	Achieving higher utilisation			
32	Cool to be Green			
33	Higher utilisation of existing vessels			
34	Safer propulsion			
35	Entertainment integration with leisure vessel			
36	Repair of Leisure craft			
37	Crashworth vessels			
38	More charter fleets / "staycation"			
39	Market-tailored products for export (BRIC)			
40	Through-life services & automotion			
41	New Marines & Infrastructure			

5.1 Capabilities & Enablers

		Past	2011 Short term 2013	2013 Medium term 2015	2015 Long term 2020	Horizon to 2050
Technologies & Capabilities	Design & Development	Simulation & modelling; Tools & Techniques	Human factors; CAE / CAD / CAM	Design processes &; Naval architecture; Marinisation	Development testing & validation; Analysis tools	
	Construction, Structural & Mechanical		Mechanical systems; Offshore wind	Sub-sea technology	Tidal & wave power	
	Materials & Manufacturing	Materials technology; Coatings technology	Manufacturing technology; Processing technology (eg Wastewater)	Joining technologies (eg Welding); Lightweighting	Low volume manufacturing / rapid prototyping	
	Propulsion, Energy & Power	Internal combustion engine technology	Electrical systems, storage & power infrastructure	Power systems management; Propulsion technology; Mechanical energy & storage	Electric drive technology	
	Information, Communication & Control	Sensors, measurement and; Control, automation &	Data management; Navigation technology	Logistics/ traffic; Voyage management; Decision support systems	Communications (LAN/ Wireless); Telecoms (wide-area)	
	Life-cycle technologies	Service & Support; Maintenance	Life-cycle analysis; End of life / recycling / Decommissioning	Technology insertion & reconfigurability; Condition Monitoring; Supply Chain management	In-service testing; Design & manufacture for sustainability	
	Safety & security	Offensive & defensive systems; National security	Personal safety; Active safety	Safety testing		
	Other		Consulting; Risk managament &	Biotech & biological; Marine life sciences; Systems integration / engineering	Integrated Transport; Oceanography / Environment (eg currents & ice caps)	
Enablers	Funding & Resources		Focussed Research; Funding & investment	Incentives to industry to adopt	Marine technology	
	Marketing & Brand		Understanding Customer / Owner /	Major pathfinder projects to establish; Business Model Innovation		
	People & Skills	Skills availability	Professional Institutions; Training & Education		Technology translators	
	Facilities & Infrastructure		Facilities, infrastructure & manufacturing	Oceanographic research centres		
	Partnerships & Supply Chain		Supply chain / logistics; IP security & Licensing	Partnerships & Networks	International collaboration	
	Standards & Regulation	Safety legislation	Standards	Open architectures; Environmental Regulation		
	Other		Technology transfer from other industries		Integration with planning & Local Gov't	

Dominic Oughton do251@cam.ac.uk IfM

5.2 Capabilities

		A	B	C	D	E	F	
		Easy to use Leisure Navigation System & Integrated Comms/Data	Alternative fuels: Electrification, Hybrids etc	New Leisure Marine Products for Developing Markets	Volume/Smaller Craft (New users/3rd Age)	Lower cost construction	Hull Design, Vessel Design & Aesthetics	
A	**Design & Development**							0
A1	Simulation & modelling	3	2	0	2	3	3	
A2	Tools & Techniques	3	0	0	0	2	0	
A3	Human factors	3	0	0	2	0	3	
A4	CAE / CAD / CAM	3	2	0	3	2	3	
A5	Design processes & Modularisation	3	0	3	0	2	0	
A6	Naval architecture	0	0	0	3	2	3	
A7	Marinisation	3	0	0	1	0	0	
A8	Development testing & validation	3	3	0	2	2	0	
A9	Analysis tools	3	0	0	2	2	0	
A Total	**Design & Development**	**24**	7	3	**15**	**15**	**12**	
C	**Construction, Structural & Mechanical**							
C1	Mechanical systems	3	0	0	1	2	0	
C2	Offshore wind	3	0	0	0	0	0	
C3	Tidal & wave power	1	0	0	0	0	0	
C4	Sub-sea technology	2	0	0	0	0	0	
C5	Naval & Civilian platforms	0	0	0	0	0	0	
C Total	**Construction, Structural & Mechanical**	**9**	0	0	1	2	0	
M	**Materials & Manufacturing**							
M1	Materials technology	1	2	0	3	3	3	
M2	Coatings technology	1	0	2	2	2	0	
M3	Manufacturing technology	1	3	0	3	3	2	
M4	Processing technology (eg Wastewater)	1	0	0	2	0	0	
M5	Joining technologies (eg Welding)	1	0	0	1	2	3	
M6	Lightweighting	1	0	0	2	2	0	
M7	Low volume manufacturing / rapid prototyping	2	2	0	3	3	0	
M8	Command & Control	0	0	3	0	0	0	
M Total	**Materials & Manufacturing**	**8**	**7**	**8**	**16**	**15**	**8**	
P	**Propulsion, Energy & Power**							
P1	Internal combustion engine technology	0	3	0	2	0	0	
P2	Electric drive technology	0	3	0	3	0	0	
P3	Mechanical energy & storage technology	2	0	0	1	0	0	
P4	Electrical systems, storage & power infrastructure	0	3	0	3	0	0	
P5	Power systems management	0	0	0	1	0	0	
P6	Propulsion technology	0	0	0	3	0	0	
P Total	**Propulsion, Energy & Power**	2	**9**	0	**13**	0	0	

5.2 Capabilities (cont)

		A	B	C	D	E	F	
		Easy to use Leisure Navigation System & Integrated Comms/Data	Alternative fuels: Electrification, Hybrids etc	New Leisure Marine Products for Developing Markets	Volume/Smaller Craft (New users/3rd Age)	Lower cost construction	Hull Design, Vessel Design & Aesthetics	
I	**Information, Communication & Control**							
I1	Sensors, measurement and monitoring technology	3	2	0	0	0	0	
I2	Control, automation & autonomy	3	3	0	0	0	0	
I3	Data management	3	0	0	0	0	0	
I4	Navigation technology	3	0	0	1	0	0	
I5	Logistics/ traffic management	3	0	3	0	0	0	
I6	Voyage management	3	0	0	0	0	0	
I7	Decision support systems	3	2	0	0	0	0	
I8	Communications (LAN / Wireless)	3	0	0	2	0	0	
I9	Telecoms (wide-area)	3	0	0	1	0	0	
I Total	**Information, Communication & Control**	27	7	3	4	0	0	
L	**Life-cycle technologies**							
L1	Service & Support	3	0	3	3	0	0	
L2	Maintenance	2	0	0	3	0	0	
L3	Life-cycle analysis	2	0	0	3	2	1	
L4	End of life / recycling / Decommissioning	3	0	0	3	2	1	
L5	Technology insertion & reconfigurability	3	3	0	1	0	0	
L6	Condition Monitoring	3	2	0	2	1	0	
L7	Supply Chain management	2	0	3	3	3	0	
L8	In-service testing	1	0	0	0	0	0	
L9	Design & manufacture for sustainability	3	2	0	3	2	2	
L Total	**Life-cycle technologies**	22	7	6	21	10	4	
S	**Safety & security**							
S1	Offensive & defensive systems	3	0	0	0	0	0	
S2	National security	3	0	0	0	0	0	
S3	Personal safety	3	0	0	2	0	0	
S4	Active safety	3	0	0	3	0	0	
S5	Safety testing	3	0	0	3	0	0	
S Total	**Safety & security**	15	0	0	8	0	0	
O	**Other**							
O1	Biotech & biological processing	0	0	0	0	0	0	
O2	Marine life sciences	1	0	0	0	0	0	
O3	Consulting	3	2	0	0	3	3	
O4	Risk managament & acturarial	0	0	0	0	0	0	
O5	Integrated Transport Systems	0	0	0	1	0	0	
O6	Oceanography / Environment (eg currents & ice caps)	3	0	0	0	0	0	
O7	Systems integration / engineering	3	3	0	0	2	0	
O Total	**Other**	10	5	0	1	5	3	

5.3 Capability - Ranked

Capabilities		A Easy to use Leisure Navigation System & Integrated Comms/Data	B Alternative fuels: Electrification, Hybrids etc	C New Leisure Marine Products for Developing Markets	D Volume/Smaller Craft (New users/3rd Age)	E Lower cost construction	F Hull Design, Vessel Design & Aesthetics	
Ranked capabilities (top-level grouping)								
M Total	Materials & Manufacturing							
A Total	Design & Development							
L Total	Life-cycle technologies							
I Total	Information, Communication & Control							
P Total	Propulsion, Energy & Power							
O Total	Other							
S Total	Safety & security							
C Total	Construction, Structural & Mechanical							
Ranked capabilities (detail)								
L7	Supply Chain management	2	0	3	3	3	0	
L1	Service & Support	3	0	3	3	0	0	
A1	Simulation & modelling	3	2	0	2	3	3	
A4	CAE / CAD / CAM	3	2	0	3	2	3	
A5	Design processes & Modularisation	3	0	3	0	2	0	
M1	Materials technology	1	2	0	3	3	3	
M3	Manufacturing technology	1	3	0	3	3	2	
L9	Design & manufacture for sustainability	3	2	0	3	2	2	
O3	Consulting	3	2	0	0	3	3	
I5	Logistics/ traffic management	3	0	3	0	0	0	
M2	Coatings technology	1	0	2	2	2	0	
M8	Command & Control	0	0	3	0	0	0	
A8	Development testing & validation	3	3	0	2	2	0	
M7	Low volume manufacturing / rapid prototyping	2	2	0	3	3	0	
A6	Naval architecture	0	0	0	3	2	3	
A3	Human factors	3	0	0	2	0	3	
L4	End of life / recycling / Decommissioning	3	0	0	3	2	1	
M5	Joining technologies (eg Welding)	1	0	0	1	2	3	
O7	Systems integration / engineering	3	3	0	0	2	0	
L3	Life-cycle analysis	2	0	0	3	2	1	

6.1 Enablers

Rank	Enablers	A Easy to use Leisure Navigation System & Integrated Comms/Data	B Alternative fuels: Electrification, Hybrids etc	C New Leisure Marine Products for Developing Markets	D Volume/Smaller Craft (New users/3rd Age)	E Lower cost construction	F Hull Design, Vessel Design & Aesthetics	Total
1	Understanding Customer / Owner / Operator needs	1		1	1	1	1	5
2	Technology transfer from other industries	1	1		1	1	1	5
3	Skills availability			1	1	1	1	4
4	Training & Education	1		1	1		1	4
5	Funding & investment			1	1	1	1	4
6	Partnerships & Networks		1	1	1	1		4
7	International collaboration	1		1	1		1	4
8	Supply chain / logistics	1		1	1			3
9	Business Model Innovation	1		1	1			3
10	Technology translators	1	1			1		3
11	Incentives to industry to adopt new technology	1	1	1				3
12	Focussed Research programmes	1	1			1		3
13	Safety legislation	1			1			2
14	IP security & Licensing			1			1	2
15	Environmental Regulation		1		1			2
16	Marine technology revolution	1			1			2
17	Open architectures	1						1
18	Professional Institutions				1			1
19	Facilities, infrastructure & manufacturing capacity				1			1
20	Major pathfinder projects to establish UK position				1			1

7. Priority Market Opportunities (explored in breakout groups)

Rank	Opportunities	Breakout Group
1	Easy to use leisure navigation system & integrated comms / data	**A**
2	Alternative fuels / Electrification & Hybrids & energy harvesting (eg	**B**
3	New leisure marine products for developing markets (inc tailoring for	**C**
4	Volume produced smaller leisure craft types for affordable participation eg	**D**
5	Lower-cost construction	**E**
6	Hull design, vessel design & aesthetics	**F**
7	Efficient propulsion (inc re-powering of existing boats)	inc in B
8	Vessel design and aesthetics	inc in F
9	Automated maintenance	
10	Sustainable composites & smart materials	Technology capability
11	Coatings (eg for low friction)	Technology capability
12	Reduced cost of ownership for Leisure Owners (eg low thru-life cost craft)	
13	Refit / Re-purposing of Leisure craft	
14	Safety systems & equipment	
15	New user experience / training	
16	Turn-key rental / time-share access to leisure marine	
17	Technologies for (Semi-)autonomous control & navigation (eg Intuitive IT	related to A
18	Enhanced passenger comfort	
19	New boating concepts and user facilities (incl cross-sector products)	inc in D
20	Exhaust after treatment systems	

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

Key: **Black text – original team input**

Red text – carousel group comments

7. Priority Market Opportunities (summary)

Opportunities		Market Attractiveness:					Triple bottom-line		Value	Fit with UK Capability						Fit	Total
Topic	**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
A	Easy to use Leisure Navigation System & Integrated Comms/Data	3	1	1	2	3	4	2		4	3	3	3	3	3		
B	Alternative fuels: Electrification, Hybrids etc	1	0	1.5	1	2	1	1		1.5	3	3	3	2	1		
C	New Leisure Marine Products for Developing Markets	4	2	2	2	0	1	2		4	4	3	3	1	2		
D	Volume/Smaller Craft (New users/3rd Age)	3	1	2	2	0	1	2		3	4	4	2	2	3		
E	Lower cost construction	2	1	1.5	2	2	2	1		1	2	3	2.5	0	1		
F	Hull Design, Vessel Design & Aesthetics	1	0	2	1	1	1	0		4	4	1	4	3	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	Easy to use Leisure Navigation System & Integrated Comms/Data	Team	SH, Jo, SP
			Score	2.7

Value			Basis for Characterisation & Evidence	Score	This opportunity is attractive because:
Market Attractiveness:	Global Market Growth Opportunity	Large > £2bn	25m leisure craft globally. Auto pilot etc suit of applications. AIS advanced. Comms at sea. Legislation changes. Safety for 'man overboard' etc	3.0	Large global market - product. Service penetration. Growth in marine leisure - aftermarket & OEM. Greater safety at sea. Cross service opportunities. Develop new markets - emerging industries. Emerging global markets - international & China
	Home (UK) Market Growth	Small < £100m	550, 000 leisure boats in UK. Integrated technology. Retrofit & after-market.	1.0	
	Strength of competition (Global)	Dominant / Entrenched	Current technology base strong. Developing technology emerging	1.0	
	Added Value in UK	30%	Growth of industry by making boating easier. Additional service opportunity. Platform architecture. Education & training. IP generation - value not manufacturing	2.0	
	Cross-sector opportunity	Large > £1bn	e.g. Logistics (Asset management & security) Navigational aids for wind turbines etc. Fishing vessels. Environment monitoring. Maintenance alert	3.0	
Triple bottom-line	Planet / Environmental	**Game-Changing**	Track boat globally re movement > efficient > scheduling	4.0	Knowledge Gaps (in team): Comms & systems integration. HMI - end user operation. Maritime language!
	People / Societal	Modest	Develops better leisure experience	2.0	

Capability			Where is the capability?	What are the Gaps?	Score	UK has the capability to deliver...
Fit with UK Capability	Marine Industry	**World-Leading & significant scale**	Simulation & modelling - Raymarine. Navigation & sensors. Maritime, marinisation. Innovation & technology	Integration. Global market exploit opportunity. Global market export opportunity. R&D funding commercialisation	4.0	Technology yes
	University / Academic	World-Leading OR significant scale	Design & simulation. Analysis tools. Marine & mechanical systems. Sensors. Southampton Controls bag!	Human interface. Mapping & charting	3.0	
	R&T Org. / Design	World-Leading OR significant scale	Development design. Security of safety. Marine		3.0	
	Non-Marine / Other	World-Leading OR significant scale	Asset management. Auto sat nav. Telematics	Integration of mapping services. Information services. Military navigation systems. QinetiQ, BAE?	3.0	
	Other UK resources	World-Leading OR significant scale	Coastline freight. See NSS slides, write to/contact www.C4FF.org		3.0	Knowledge Gaps (in team): Exploitation
Timeliness	UK Capability matches market need	Pace setting	See AIS. Www.EGMDSS.com. MCA support reg/certification		3.0	

Opportunity	B	Alternative fuels: Electrification, Hybrids etc	Team	RS, PG, RZ
ironing'			Score	1.6

Value			Basis for Characterisation & Evidence	Score	This opportunity is attractive because:
Market Attractiveness:	Global Market Growth Opportunity	Small <£200m	Oil price rise. Emissions legislation. Green badge of honour - leave nothing but wake	1.0	Not sure this is a major opportunity. Overall market is small? Opportunity i for technology transfer from other markets. Which is the bigger market - new tonnage or refitting to existing tonnage? How much demand is there for reduced fuel cons in leisure marine products? How much will customer pay? Little driver for this without legislation. Major opp - just a question of time. Potential for improved fuel cons. to open market to new consumer types. System management technologies. Energy harvesting from ship/boat motions in a huge opportunity
	Home (UK) Market Growth	Small < £100m		1.0	
	Strength of competition (Global)	Strong / Established	Strong competition in other sectors - Auto. Energy, commercial marine. Techy transfer into leisure is req'd	1.5	
	Added Value in UK	10%		1.0	
	Cross-sector opportunity	Modest > £100m	Nb. Technologies are already being developed in other sectors - energy, auto, commercial marine	2.0	
Triple bottom-line	Planet / Environmental	None	Small impact on a small market - leisure marine. Existing techy has more major effect in other sectors	1.0	Knowledge Gaps (in team): Leisure marine industry
	People / Societal	None	Ditto	1.0	

Capability			Where is the capability?	What are the Gaps?	Score	UK has the capability to deliver...
Fit with UK Capability	Marine Industry	Moderate / Emerging / Dispersed	Other sectors - auto, energy, commercial marine. RR	Leisure marine application	1.5	
	University / Academic	World-Leading OR significant scale	Warwick - hybrids, energy management. Bath - bio fuel engine test (both Auto) Southampton - Marine electrical prop	ditto	3.0	
	R&T Org. / Design	World-Leading OR significant scale	Ricardo - Bio fuel, gas recips (De Montfort - Bio fuel engine) Coventry - Diesel engine. Caff - hybrid design/clean diesel	ditto	3.0	
	Non-Marine / Other	World-Leading OR significant scale	Automotive industry _ bio fuel, hybrids	ditto	3.0	
	Other UK resources	Moderate / Emerging / Dispersed	Maredu - R&D. Lloyds - safety certification	ditto	2.0	Knowledge Gaps (in team):
Timeliness	UK Capability matches market need	Already "missed the boat"	Developed/developing in other sectors but needs techy transfer	ditto	1.0	

Opportunity	C	New Leisure Marine Products for Developing Markets	Team	OW, BS, SW
			Score	2.5

Value			Basis for Characterisation & Evidence	Score	This opportunity is attractive because:
Market Attractiveness:	Global Market Growth Opportunity	**V. Large > £5bn**	Local product design & manufacture poor - good product from UK suppliers. V Large growth market potential: large population & wealth untapped market. Only if price & quality is right	4.0	we are already doing it > limited by rate of growth of marine infrastructure
	Home (UK) Market Growth	Modest > £100m	British - branded products attractive. Limited by scalability within UK boat building arena	2.0	
	Strength of competition (Global)	Strong / Established	Luxury products: UK & Italy dominate. Mainstream products: France & Germany. Local suppliers operating in different market segments	2.0	
	Added Value in UK	30%	1. Export. 2. Local build (wholly owned by UK company). Or licensed build to fund UK based development & growth of new products	2.0	
	Cross-sector opportunity	Small < £100m	N/A in this case	0.0	
Triple bottom-line	Planet / Environmental	None	Local build - Reduced embedded CO2	1.0	Knowledge Gaps (in team):
	People / Societal	Modest	Developing local skill base & economy. Fair trade mark!	2.0	

Capability			Where is the capability?	What are the Gaps?	Score	UK has the capability to deliver...
Fit with UK Capability	Marine Industry	**World-Leading & significant scale**	UK already very experienced in global export > business as usual	Lack of knowledge about measurements in emerging markets. Capacity limited in UK	4.0	As above
	University / Academic	**World-Leading & significant scale**	World leading academic capability	lack of practical application. Lack of commercial network	4.0	
	R&T Org. / Design	World-Leading OR significant scale	World leading design	Funding for comprehensive R&D. Technically weak. R&D is wrong end of TRL scale?	3.0	
	Non-Marine / Other	World-Leading OR significant scale	Knowledge transfer from more mature industry e.g. Auto		3.0	
	Other UK resources	None		Poor awareness of marine industry as economy contributor	1.0	Knowledge Gaps (in team):
Timeliness	UK Capability matches market need	Lagging but could recover	Readiness for export, depending on readiness of marine infrastructure		2.0	

Opportunity	D	Volume/Smaller Craft (New users/3rd Age)	Team	JG, AW, AP
			Score	2.3

Value			Basis for Characterisation & Evidence	Score	This opportunity is attractive because:
Market Attractiveness:	Global Market Growth Opportunity	Large > £2bn	Family boating - trailable. 15'-30' LOA. Size of emerging markets. Manageability/cost for increasing size of older generation. Accessibility. LCA of a trailable boat 'Bentley's Bike' scheme.EU/TSB funding for cooperative projects - learning from others, funding support	3.0	The size of the potential market is huge - new users & growing economies. Current product lifecycles mature. Generation of new market with growth potential. Because UK has knowledge/capability to exploit. Manufacturers not clubs taking responsibility for getting people to try boating. Do you want your companies future dependant on the volunteer @ a club?
	Home (UK) Market Growth	Small < £100m	Capped by size of established market. New to tap into post baby boom generation. Review small car design production practices	1.0	
	Strength of competition (Global)	Strong / Established	Most manufacturers have built larger boats when small boat market slowed - leaving a void	2.0	
	Added Value in UK	30%	IP licensing - Equipment/sales/services/tourism/repair/jobs	2.0	
	Cross-sector opportunity	Small < £100m	Materials & composites. Systems. Components - servicing	0.0	
Triple bottom-line	Planet / Environmental	None	Depends on material & tech used. For e.g. renewable/recycle	1.0	Knowledge Gaps (in team):
	People / Societal	Modest	Increasing environmental awareness (new users). Fishing/holiday/tourism	2.0	

Capability			Where is the capability?	What are the Gaps?	Score	UK has the capability to deliver...
Fit with UK Capability	Marine Industry	World-Leading OR significant scale	Design & Naval architecture	Engine/propulsion. Raw materials (Imports)	3.0	Do we know how to access & thrive in emerging markets
	University / Academic	**World-Leading & significant scale**	Several leading universities. Apprentice schemes	Not enough UK students (irrelevant subjects). UK funding	4.0	
	R&T Org. / Design	**World-Leading & significant scale**	QinetiQ - advanced manufacture. Ricardo. Military/Naval. TWI, AMRC, NCC, RINA, IMECHE etc	Test tank & lab facilities	4.0	
	Non-Marine / Other	Moderate / Emerging / Dispersed	BPF (composites). Scott Barder. ACG - International paints	Market knowledge exploit	2.0	
	Other UK resources	Moderate / Emerging / Dispersed	TSB. Professional institutions	FUNDING. Willingness to invest in UK plc	2.0	Knowledge Gaps (in team):
Timeliness	UK Capability matches market need	Pace setting	Knowledge/understanding. Transport KTN. Materials KTN. Trade associations	Ability to collaborate. Scalable knowledge transfer in mass production	3.0	

Opportunity	E	Lower cost construction		Team	PC, SA
				Score	1.7

Value			Basis for Characterisation & Evidence	Score	This opportunity is attractive because:
Market Attractiveness:	Global Market Growth Opportunity	Modest > £200m	Aim to double market by addressing global market & reducing price	2.0	Bigger margin x sales. Existing competition is strong but will similar conservatism. Emerging competition weak? Focus on quality dimensions. Review KSF when reducing cost. Application of novel strategy (like Hoshing Kanri) for reducing cost
	Home (UK) Market Growth	Small < £100m	Aim to retain market against overseas competition	1.0	
	Strength of competition (Global)	Strong / Established	Developed: US strong but we wish to leapfrog technology. Developing market weak	1.5	
	Added Value in UK	30%	Halve cost of UK production. Any ideas how? Lean manufacture, design for "". Lower energy cost, reduced production cost, reduced time for production, to market. Material substitution. Agree! Design for production as well as, rather than materials cost reduction.	2.0	
	Cross-sector opportunity	Modest > £100m	? Wish to benefit from Aero/Auto. Through skills knowledge transfer. Learning from Auto sector lean practices (Lean optimals)	2.0	
Triple bottom-line	Planet / Environmental	Modest	V significant reduction in materials & energy per boat. (keep fleet impact consistent with growth)	2.0	Knowledge Gaps (in team): Global market size
	People / Societal	None	Better access for more people to leisure	1.0	

Capability			Where is the capability?	What are the Gaps?	Score	UK has the capability to deliver...
Fit with UK Capability	Marine Industry	None	Dispersed between. Very dispersed sector	Integrate OEM knowhow & access to technology. Agility £	1.0	New manufacturing tech and lower cost of materials by adapting existing solutions from other sectors. Aero & Auto manufacturing processes may still be too costly > scope for process R&T for marine
	University / Academic	Moderate / Emerging / Dispersed	AMRC> Advanced manufacturing Research Centres & TIC (Aero)	Technology sporadically applied to marine sector	2.0	
	R&T Org. / Design	World-Leading OR significant scale	TWI, PIRA. Lso professional Institutions e.g. RINA etc	Transfer to aero & automotive, but....	3.0	
	Non-Marine / Other	Strong but below critical mass	Volume manufacturing aero, auto	Scale down to marine vol. £. Adapt to marine environment	2.5	
	Other UK resources	None			0.0	Knowledge Gaps (in team):
Timeliness	UK Capability matches market need	Already "missed the boat"		De-risk to the level where a conservative industry will adopt	1.0	

Opportunity	F	Hull Design, Vessel Design & Aesthetics		Team	SB, SC, TD
				Score	1.7
Value		Basis for Characterisation & Evidence		Score	This opportunity is attractive because:
Market Attractiveness: Global Market Growth Opportunity	Small <£200m	Design here, license overseas (and built). Sell & market capabilities & IP abroad if we manufacture overseas too, it a diff model/revenue. Growing markets in BRICs		1.0	We have the skill sets for design & ergonomics. Can sell to export AND use for home market . Opportunity is ripe. Licensing & how to manage
Market Attractiveness: Home (UK) Market Growth	Small < £100m	Grow market into entry-level boats & increase production at home market		0.0	
Market Attractiveness: Strength of competition (Global)	Strong / Established	BRICs weak to established markets stronger		2.0	
Market Attractiveness: Added Value in UK	10%	(added value in UK branding)		1.0	
Market Attractiveness: Cross-sector opportunity	Small < £100m	More value in bringing expertise /capabilities IN from other sectors		1.0	
Triple bottom-line: Planet / Environmental	None	More efficient: green (credentials). Hull design/shape has less environmental impact on environmental e.g. Reduced bow-wave/wash		1.0	Knowledge Gaps (in team): 1 academic, 1 knowledge manager = not enough sector knowledge (finger in air)
Triple bottom-line: People / Societal	None			0.0	
Capability		Where is the capability?	What are the Gaps?	Score	UK has the capability to deliver...
Fit with UK Capability: Marine Industry	**World-Leading & significant scale**	Design & ergonomics - we are world leaders. Trade e.g. Oyster Fairline etc. Also Naval consultancies	Not looking at X-sector potential	4.0	Lots of UK design offices design for overseas clients. Leaver this relationship for benefit of UK supplier
Fit with UK Capability: University / Academic	**World-Leading & significant scale**	Southampton. Coventry. Newcastle. Imperial. Strathclyde etc. We rock!! Coventry Uni/C4FF EBDIG. Www.ebdig.eu www.c4ff.org	Translating/exploitation of research - make it accessible/affordable. Also RINA for worldwide Naval architects	4.0	
Fit with UK Capability: R&T Org. / Design	None	Cross sector knowledge	Exploitation into trade. Affordable/accessible. Model test facilities declining in UK?	1.0	
Fit with UK Capability: Non-Marine / Other	**World-Leading & significant scale**	Cross sector: automotive, aero, motorsport. World leading design & validation skills in UK companies & universities	collaborating x-sector influx of tech & expertise to marine	4.0	
Fit with UK Capability: Other UK resources	World-Leading OR significant scale	Naval hull design & human factors	Hydrodynamic testing for hull design	3.0	Knowledge Gaps (in team):
Timeliness: UK Capability matches market need	Pace setting	Builders, designers, Rates to UK market	Routes to global market. Global market knowledge - cultural , legislation	3.0	

Appendices

A. Participants
B. Workshop Feedback
C. Workshop Process
D. Market Opportunities Detail
E. Participant pre-work

Appendix A: Workshop Participants

Name	Surname	Organisation
Steve	Austen	RNLI
Steve	Boyd	Southampton University
Sam	Clarke	Transport iNet
Peter	Cowley	Lewmar
Tessa	Darley	Transport KTN
Jane	Gentry	Association of Brokers & Yacht Agents
Paul	Greaves	Rolls Royce
Stephen	Hart	Technology Strategy Baord
John	Oliver	PJB Systems
Sarah	Pearson	ANU
Andrew	Pope	Fairline Boats
Richard	Seager	WMG
Bob	Stevens	Lewmar
Adrian	Waddams	British Marine Federation
Oliver	Winbolt	Fairline Boats
David	Wooller	PJB Systems and Technology Ltd
Simon	Wrigley	Ricardo
Reza	Ziarati	Centre for Factories of the Future
Dominic	Oughton	IfM
Jonathan	Hughes	IfM