Roadmapping for strategy and innovation

Rob Phaal & Dominic Oughton

21 May 2013

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Topics

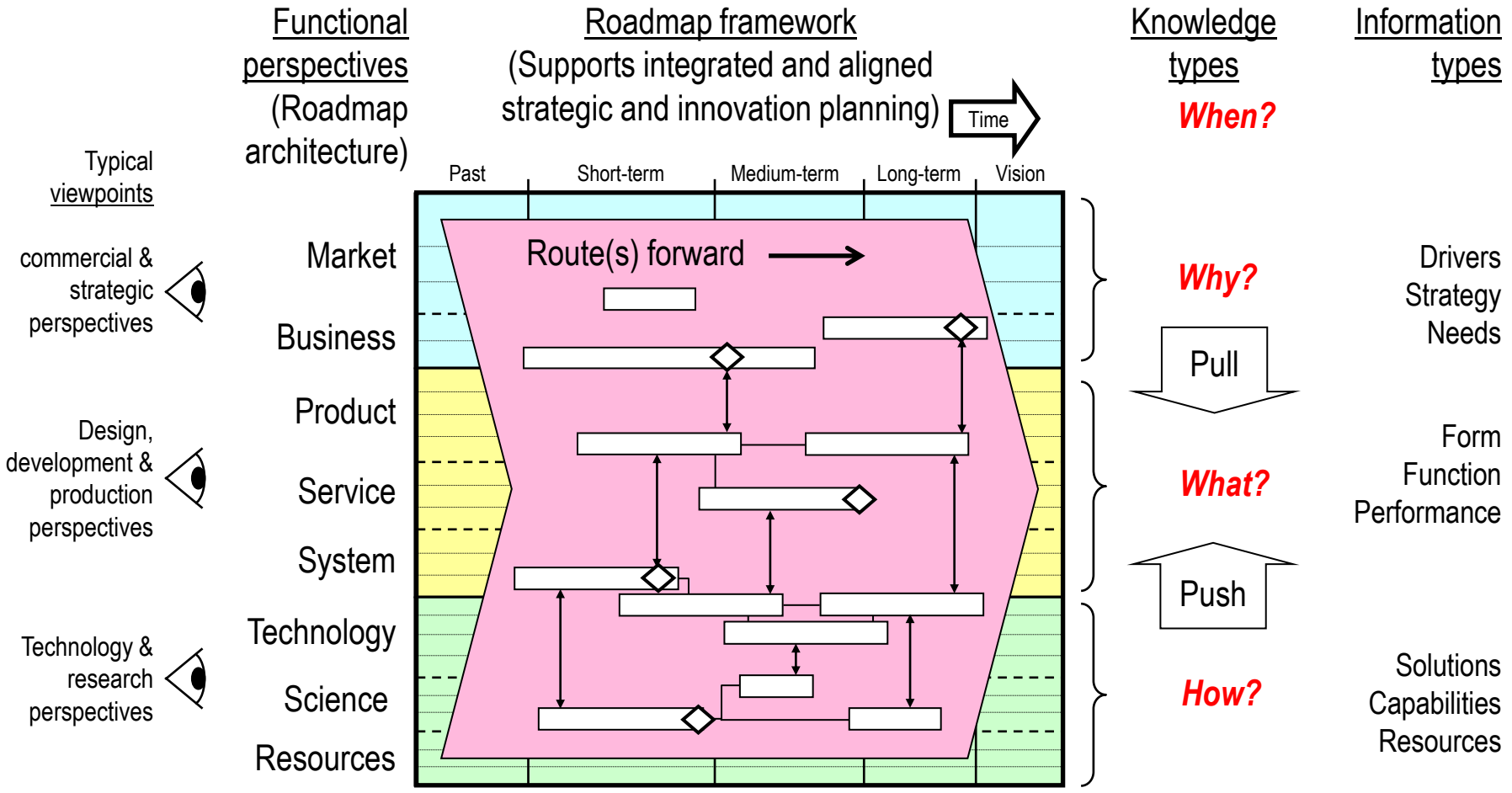
- **Introduction to roadmapping**
- **Roadmapping case studies**

Motorola Roadmap Matrix (1980s)

Year	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Tuning	Push button		Push button - Synthesizers			Touch pad - Synthesizers			Voice actuated	
Selectivity	Ceramic resonators			SAWs			Digital signal processors			
Subcarrier function	Stereo			Paging			Data		Maps	
IC technology	Linear	5u CMOS			3u CMOS			1u CMOS		
Display	LEDs		Liquid crystal				Fluorescence			
Vehicular LAN						Single wire			Glass fibre	
Digital modulation									500 kHz bandwidth	
PRODUCTS	RECEIVER 1 Stereo		RECEIVER 2 Plus: Scan Seek		RECEIVER 3 Plus: Personal paging		NEXT GENERATION Plus: Stock market Road information Remote amplifiers Remote controls		FUTURE GENERATION A NEW SERVICE Super Hi Fi Local maps	

Source: Willyard & McClees, 1987

Structured visualisation of strategy supports communication and alignment



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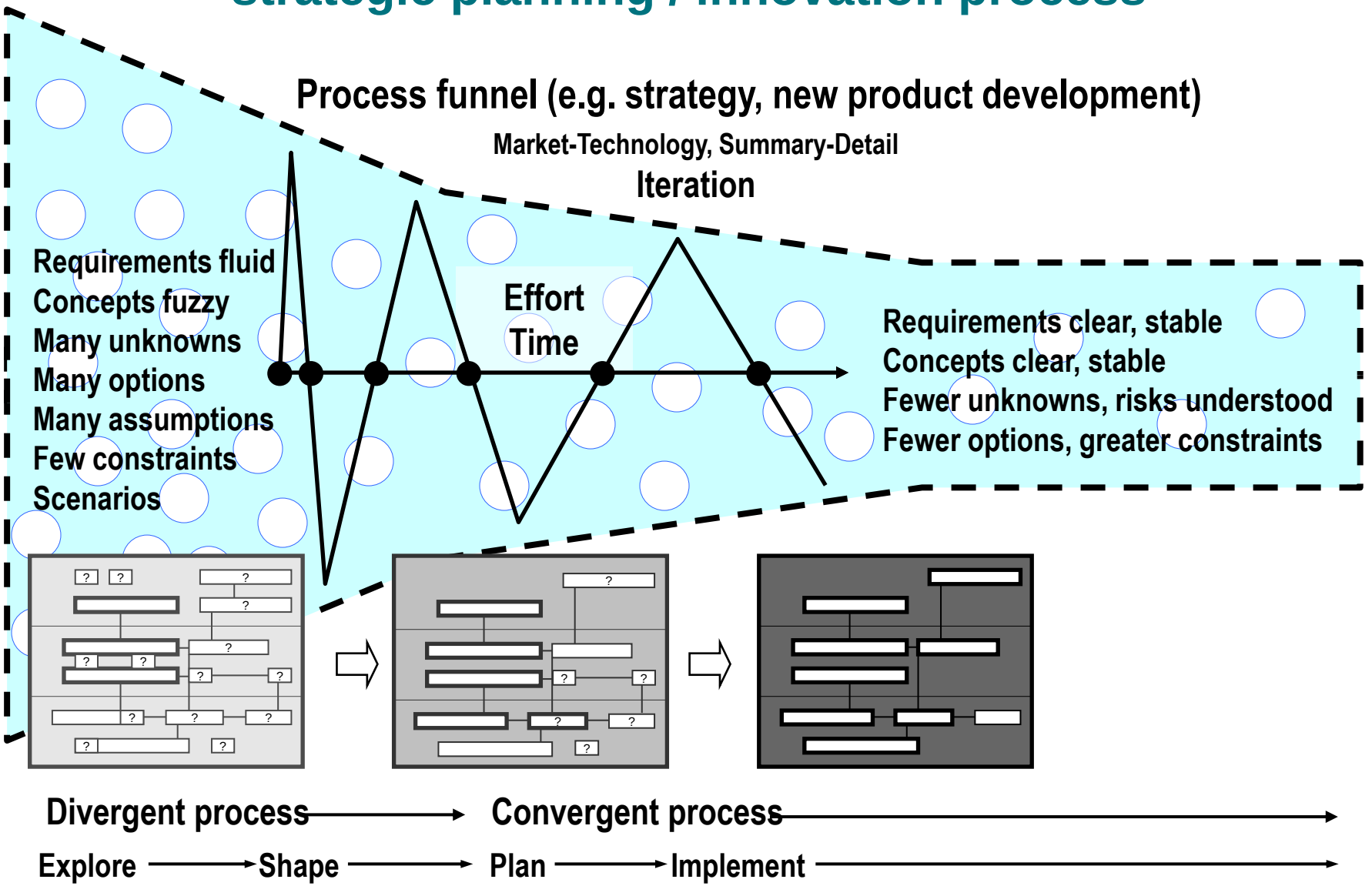
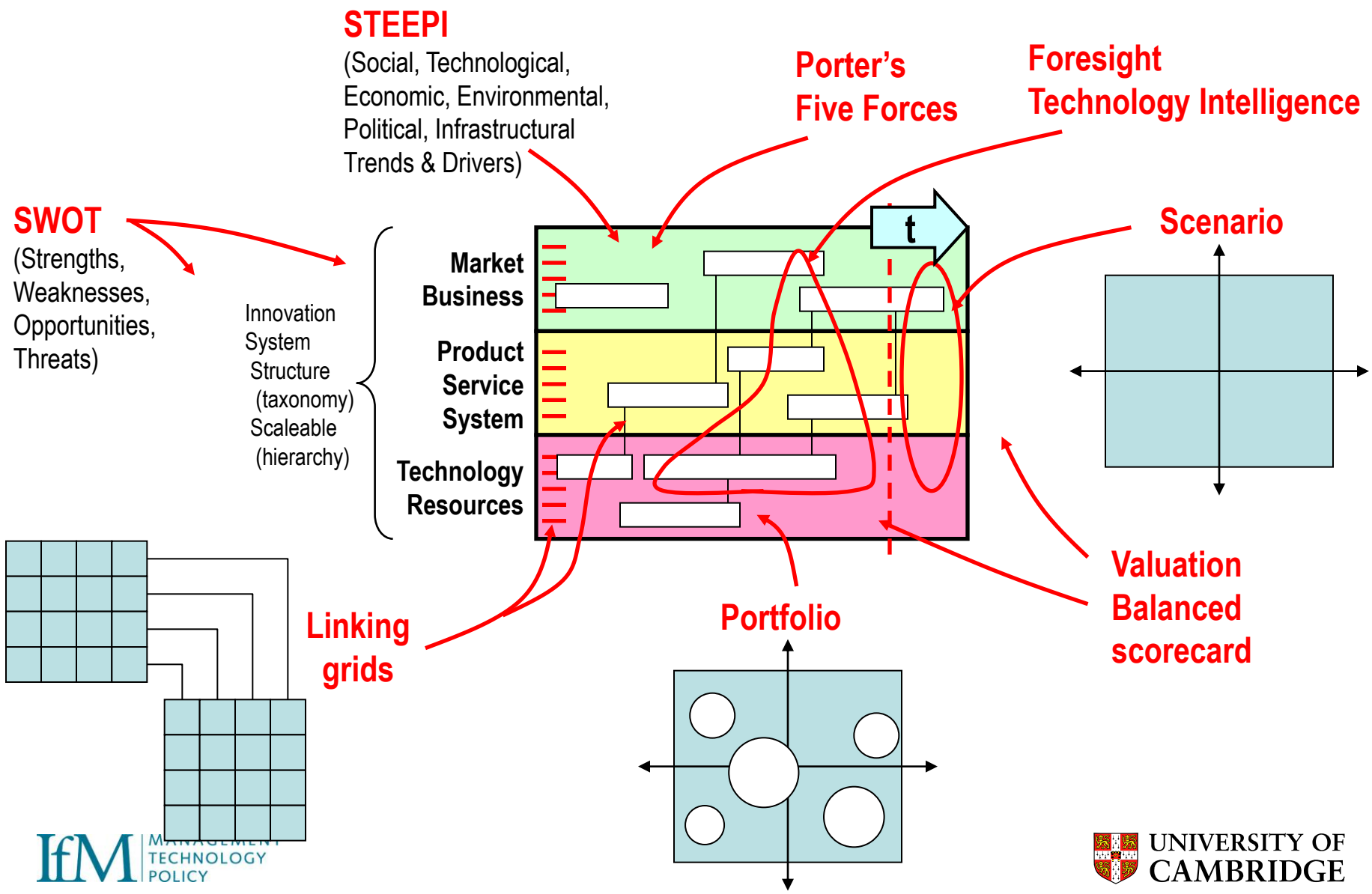
Roadmaps provide a consistent framework throughout the strategic planning / innovation process



A platform for integrated strategy toolkits



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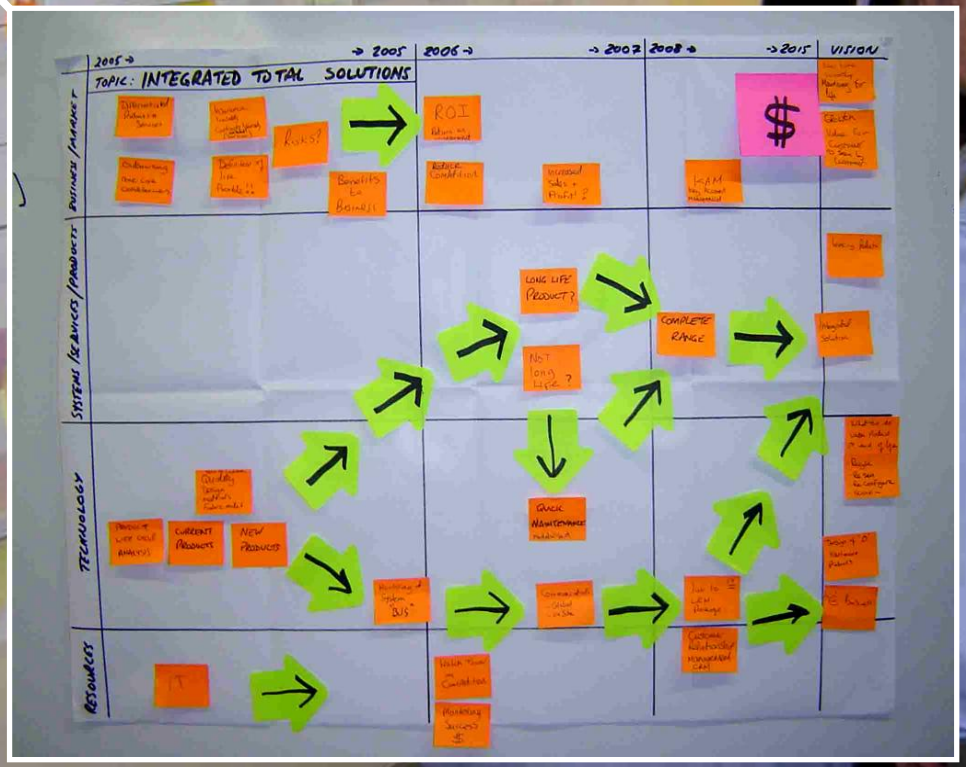
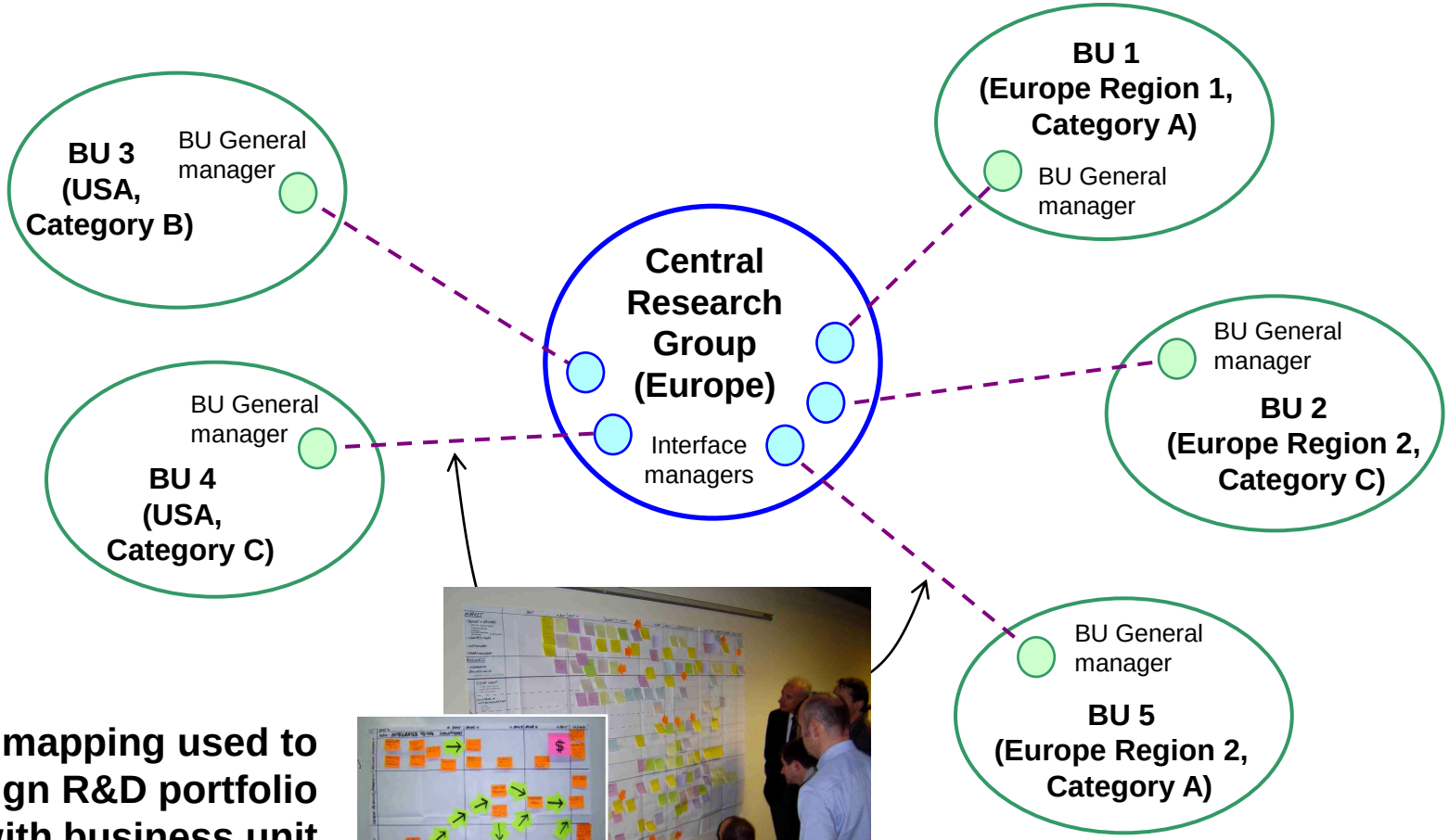
Typical roadmapping workshop activities (Breadth & Depth)



Example - Aligning central R&D with business innovation in global packaging firm



Roadmapping used to align R&D portfolio with business unit innovation strategy

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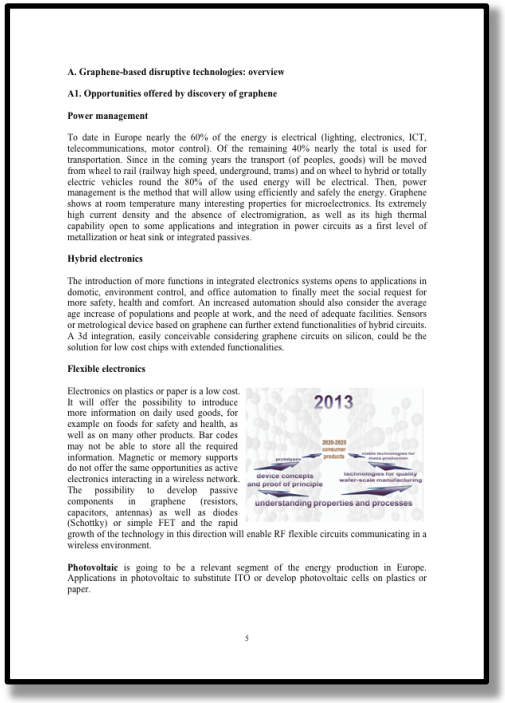
Communication roadmap design process



A. Graphene-based disruptive technologies: overview

A1. Opportunities offered by discovery of graphene

Power management

To date in Europe nearly the 60% of the energy is electrical (lighting, electronics, ICT, telecommunications, motor control). Of the remaining 40% nearly the total is used for transportation. Since in the coming years the transport (of peoples, goods) will be moved from wheel to rail (railway high speed, underground, trams) and on wheel to hybrid or totally electric vehicles round the 80% of the used energy will be electrical. Then, power management is the method that will allow using efficiently and safely the energy. Graphene shows at room temperature many interesting properties for microelectronics. Its extremely high current density and the absence of electromigration, as well as its high thermal capability open to some applications and integration in power circuits as a first level of metallization or heat sink or integrated passives.

Hybrid electronics

The introduction of more functions in integrated electronics systems opens to applications in domotic, environment control, and office automation to finally meet the social request for more safety, health and comfort. An increased automation should also consider the average age increase of populations and people at work, and the need of adequate facilities. Sensors or metrological device based on graphene can further extend functionalities of hybrid circuits. A 3d integration, easily conceivable considering graphene circuits on silicon, could be the solution for low cost chips with extended functionalities.

Flexible electronics

Electronics on plastics or paper is a low cost. It will offer the possibility to introduce more information on daily used goods, for example on foods for safety and health, as well as on many other products. Bar codes may not be able to store all the required information. Magnetic or memory supports do not offer the same opportunities as active electronics interacting in a wireless network. The possibility to develop passive components in graphene (resistors, capacitors, antennas) as well as diodes (Schottky) or simple FET and the rapid growth of the technology in this direction will enable RF flexible circuits communicating in a wireless environment.

Photovoltaic is going to be a relevant segment of the energy production in Europe. Applications in photovoltaic to substitute ITO or develop photovoltaic cells on plastics or paper.

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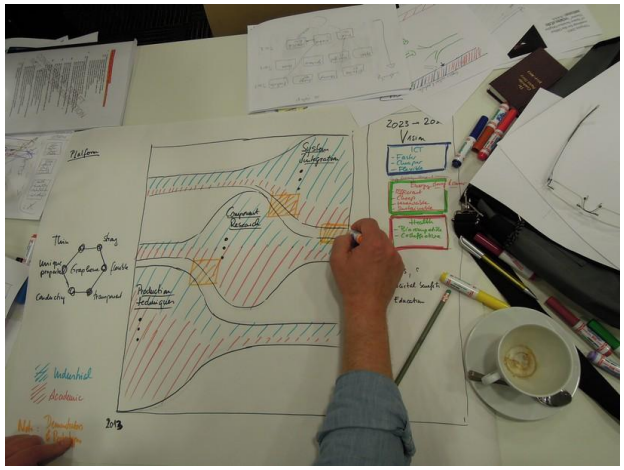
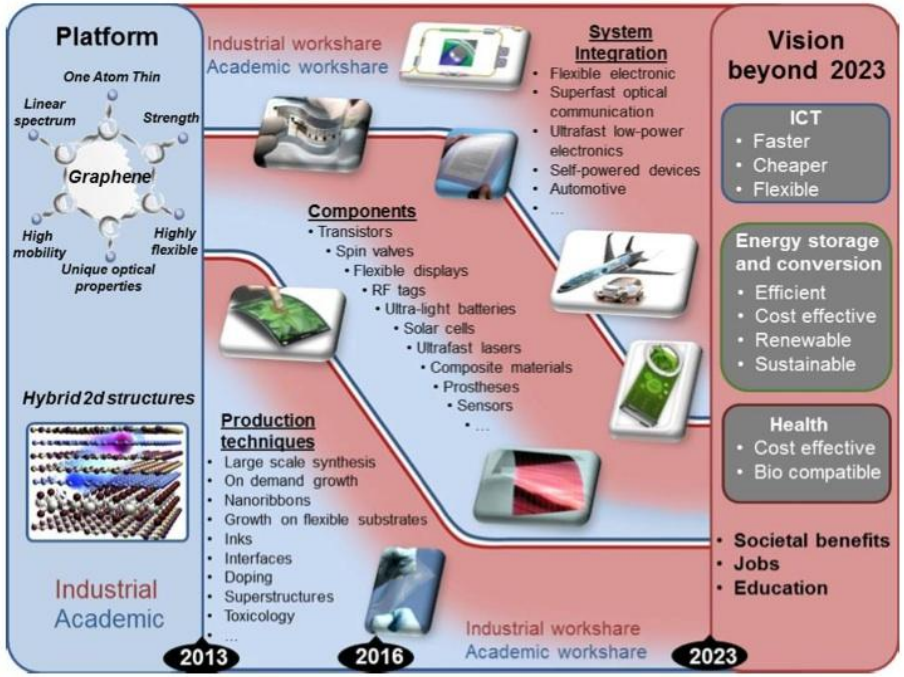
120 page roadmap document & detailed graphics



Design workshop

Communication roadmap



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EU Graphene Flagship
Bonaccorso et. al., 2012

Roadmapping for strategy and innovation – Case studies

Dominic Oughton, Principal Industrial Fellow

21 May 2013

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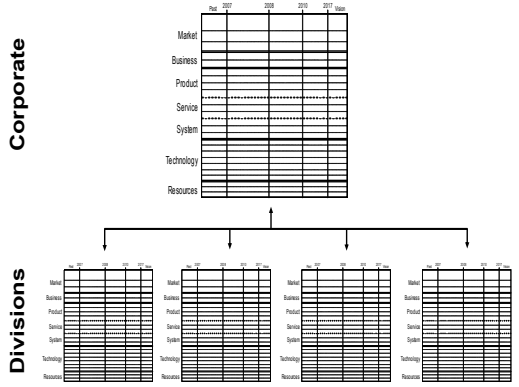
Finding a strategic direction for technology at GKN

- GKN is a tier 1 supplier of engineered products to OEMs in (largely) the automotive and aerospace sectors, employing 40,000 employees, with manufacturing operations in around 30 countries, and an annual turnover of around £4 billion (2008)
- Dedicated R&D centres embedded in each of the main businesses (Driveline, Aerospace, Off-Highway and Powder Metallurgy)
- How to develop a sustainable longer term strategy for technology, and to co-ordinate technology development across the business?

→

- Two-day multi-Divisional roadmapping workshop involving more than 60 participants, linked to GKN technology conference, to develop Divisional and Corporate roadmaps, focusing on innovation opportunities, feeding into business strategy process
- Follow on ‘white space’ workshop focussing on radical innovation



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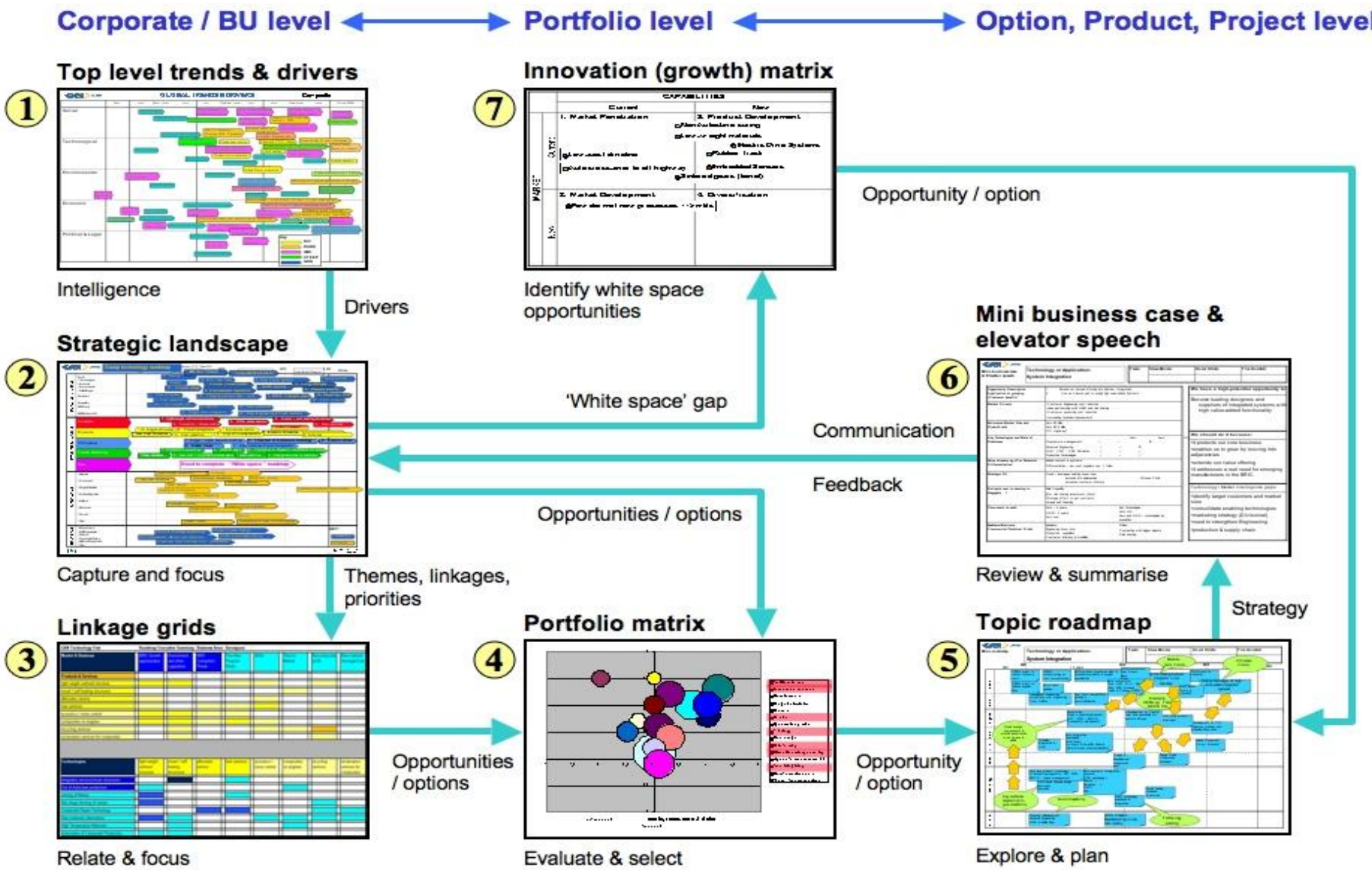
Roadmapping process - integrated toolset



What did GKN say afterwards?

"While roadmapping has proven itself to be a powerful and flexible technique for strategic planning and innovation, a **principle benefit is the communication that is engendered**, both during the development of the roadmap and afterwards."

"The **"hands-on" nature of the workshop-based process is a key feature**, where the group is responsible for building a common visual representation of their strategic context, issues, goals and plans."

"Roadmaps can be used as a **common reference point and language** to support the ongoing dialogue that is essential for effective innovation and strategy development and implementation."

Technology Strategy for a sector

Technical Strategy Advisory Group **TSAG**

- Routemap to support the 30 year Rail Technical Strategy

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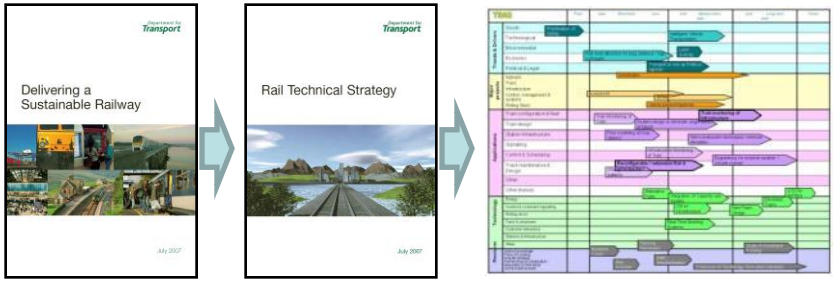
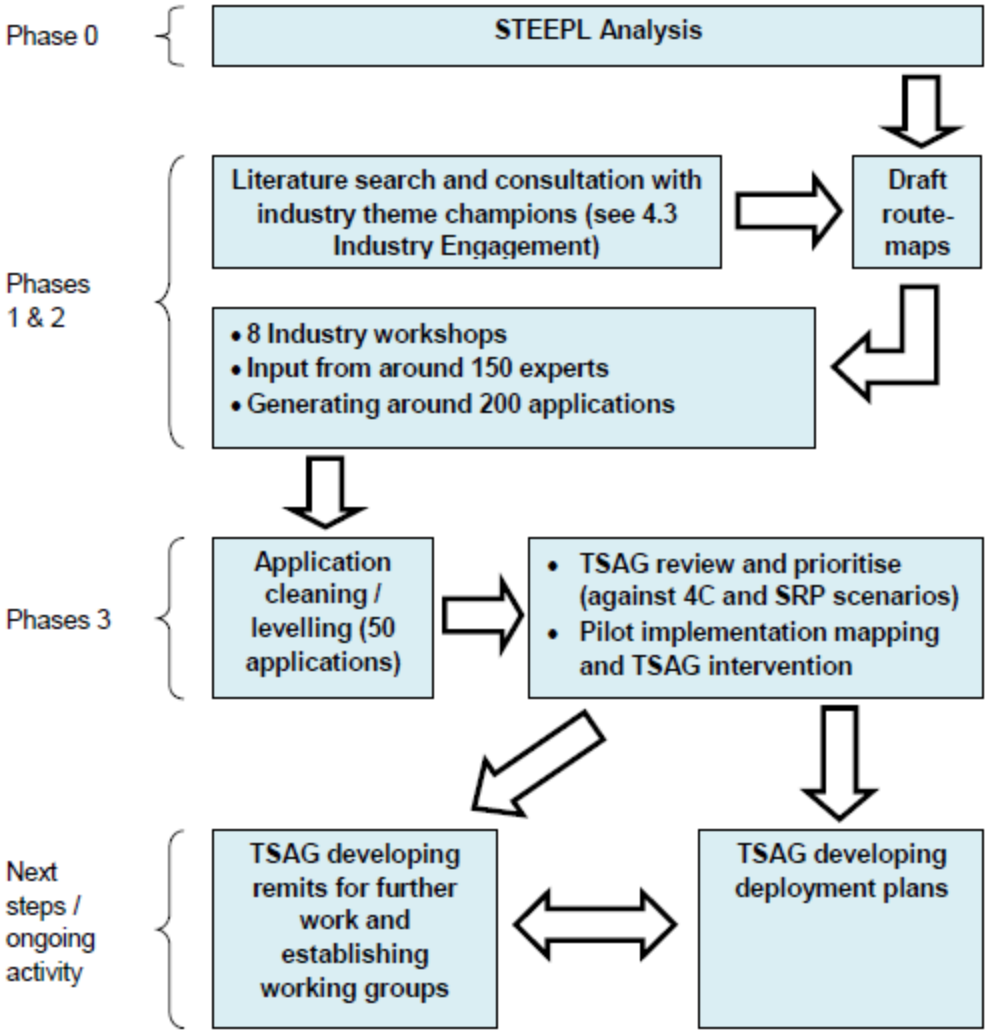
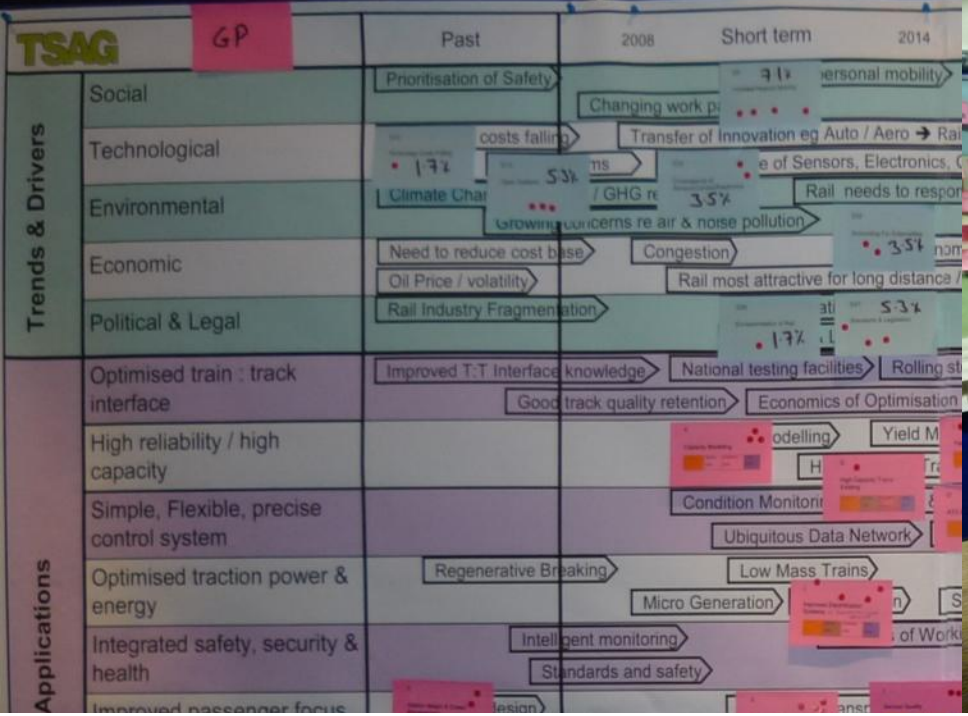
Routemap to support the 30 year Rail Technical Strategy



30 year aspirational 'stretch targets':

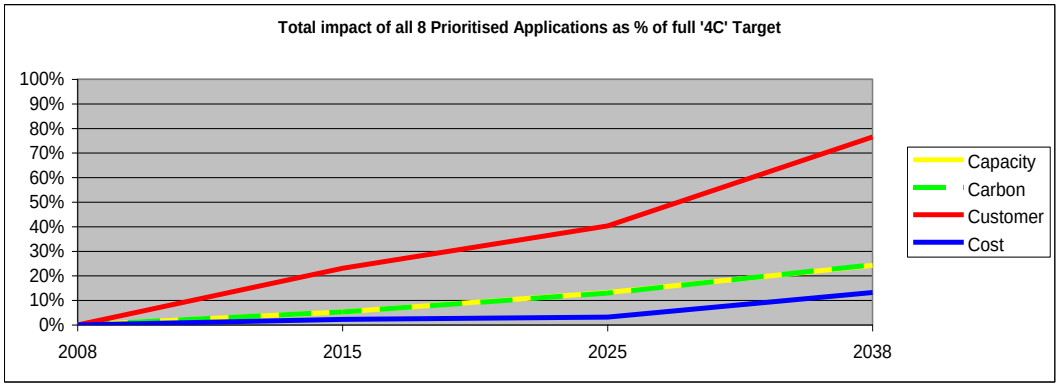
- **Customer** – reduction in dissatisfaction by 90%
- **Cost** – halving the cost of running the railway
- **Capacity** – doubling the capacity where required
- **Carbon** – reducing carbon in line with Government policy (50% by 2050)

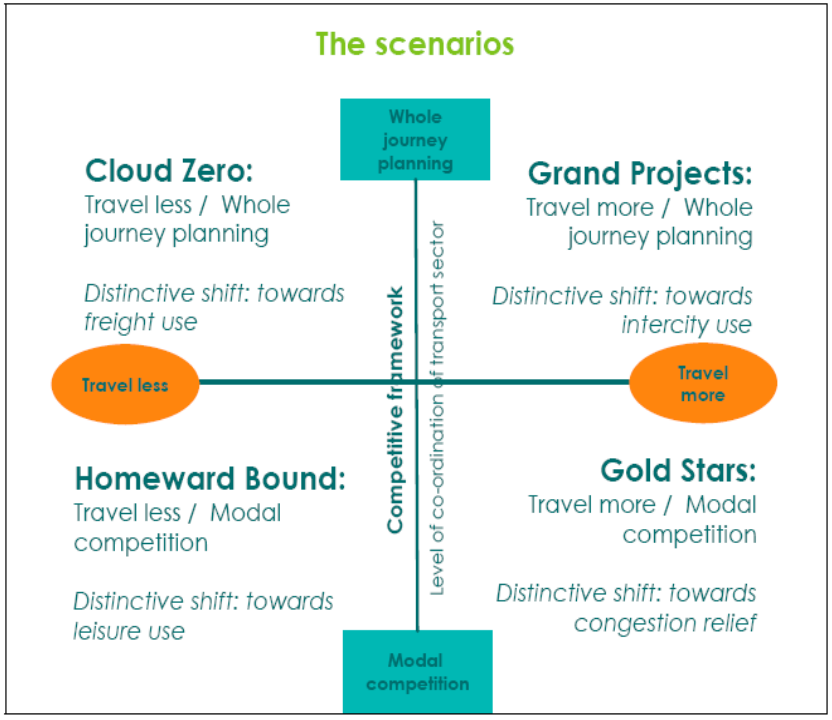




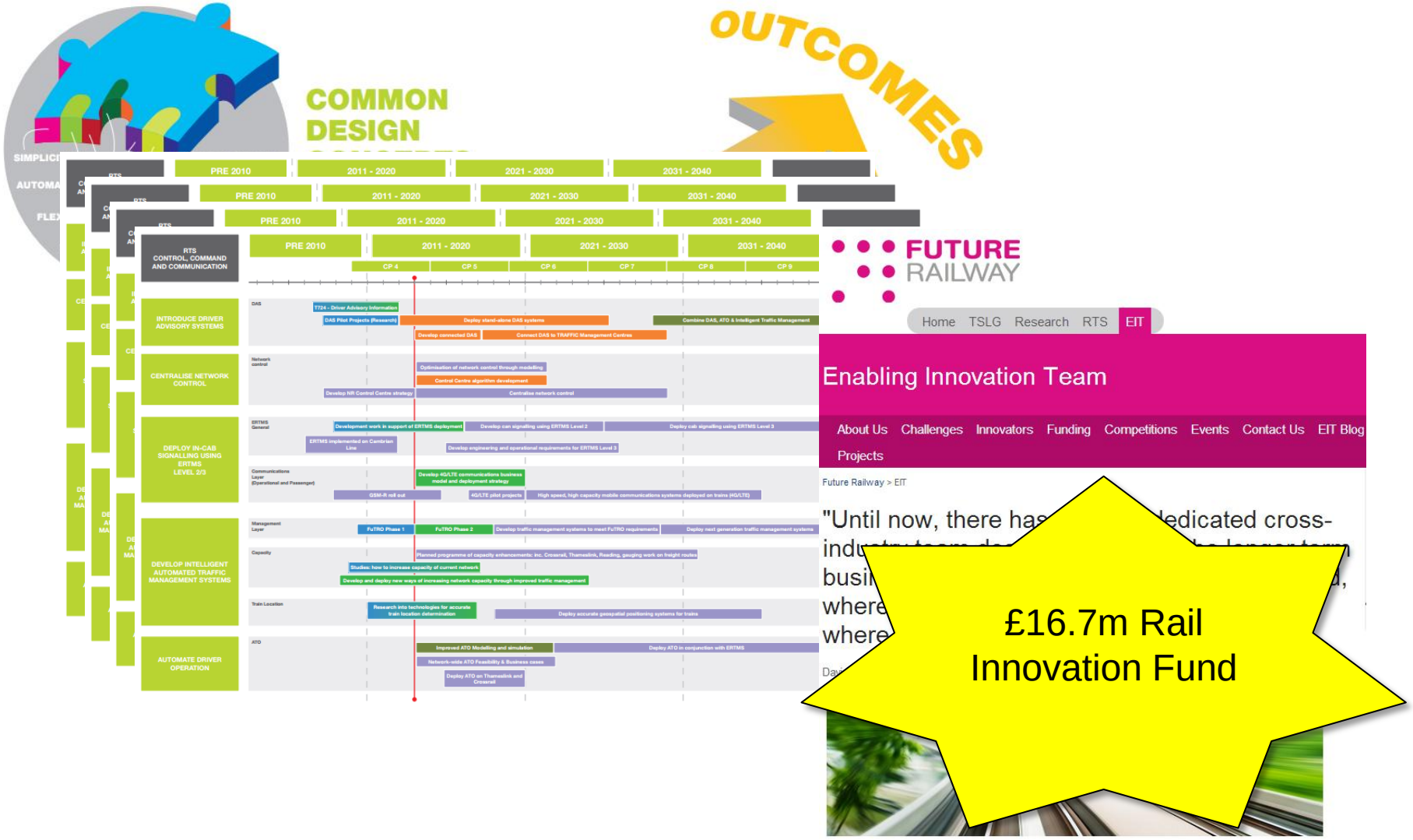
Example of an application impact summary

Application	TRL / Deployment				4C Impact			
	Current 2008	Short term 2015	Medium term 2025	Long term 2038	Capacity	Carbon	Customer	Cost
2.1 Robust Rail Network - Eliminate S.P. of F.	TRL 1	TRL 9	20%	100%	7.00%	3.50%	2.00%	5.00%
2.2 Traffic Management Layer	TRL 6	33%	50%	75%	4.00%	5.00%	1.00%	2.00%
2.3 High Capacity Trains	TRL 9	10%	33%	50%	20.00%	10.00%	0.00%	-10.00%
2.4 System Modelling (Capacity)	TRL 6	33%	50%	75%	10.00%	0.00%	2.00%	3.50%
2.5 Adapting to Extreme Weather due to Climate Change	TRL 2	TRL 9	33%	100%	1.00%	0.00%	0.40%	2.00%
2.6 24 / 7 Railway	TRL 8	33%	50%	50%	4.00%	-3.50%	2.00%	1.00%
2.7 Yield Management	TRL 6	5%	10%	20%	7.00%	0.00%	1.00%	0.00%
2.8 Condition Monitoring	TRL 7	33%	50%	75%	1.00%	0.00%	4.00%	3.50%





What happened next in UK Rail?



Industrial Strategy for an Industry sector

- AA2020 Australian Automotive Roadmap

Prime Minister of Australia

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Media Release

JOINT MEDIA RELEASE WITH
MINISTER FOR INNOVATION, INDUSTRY, SCIENCE AND RESEARCH, KIM CARR
A NEW CAR PLAN FOR A GREENER FUTURE

10 November 2008

Prime Minist… …otive industry more economically and environmentally sustai…

The Gr… …n will provide Australian car companies with the opportunity to re… …endly cars.

$1.3 billion Green Car Innovation Fund

Urgent need for Roadmap

Identification of Partners

AA2020 Programme

AutoCRC

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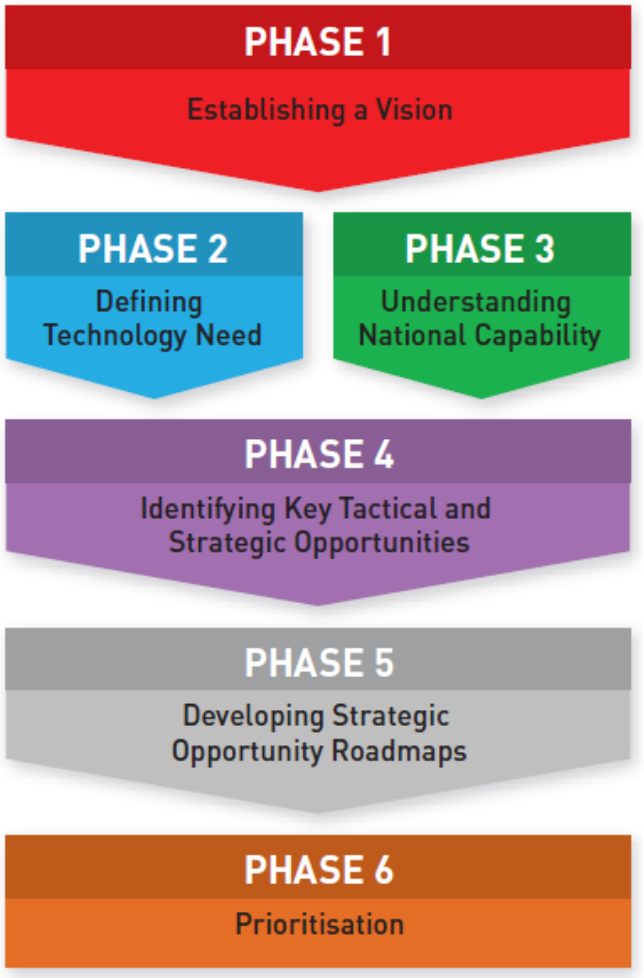
Process, Participation & Outputs



220 Participants from 160 organisations included:

- **vehicle producers,**
- **automotive suppliers,**
- **research organisations,**
- **relevant non-automotive companies,**
- **government officials**
- **and other stakeholder groups.**

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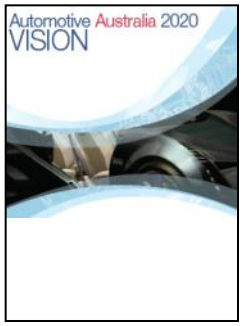
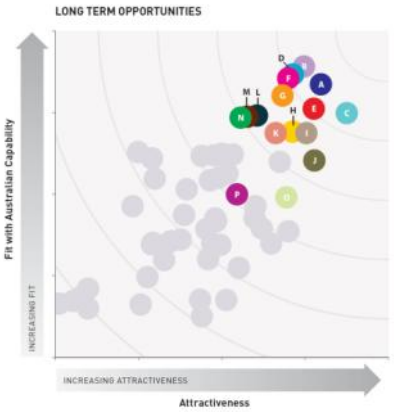
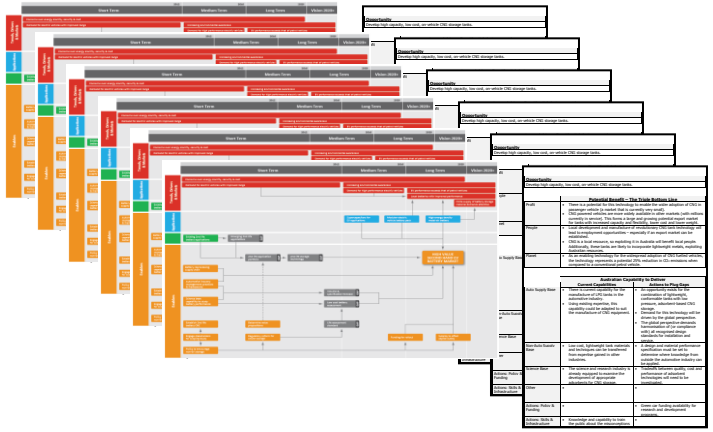
AA2020 – Process

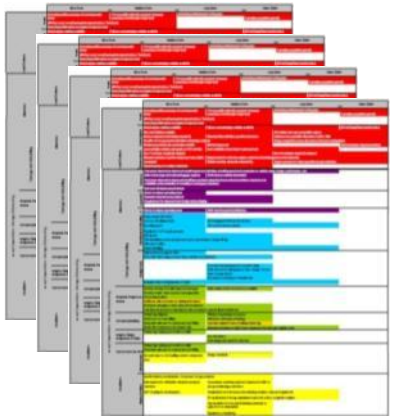




- Gaseous Fuel Driveline:
  - LPG & CNG Engines, and
  - On-vehicle storage of gaseous fuels.
- Materials and Processes for Lightweighting:
  - Design for reduced vehicle weight,
  - Reduced weight vehicle bodies,
  - Materials and Processes for light-weight composites and plastics, and
  - Materials and Processes for light-weight metals.
- Advanced Data and Communications Systems:
  - V2V and V2I Wireless Communications,
  - Driver information Systems, and
  - High-speed in-vehicle data-buses.
- Vehicle Electrification:
  - Electric Motors,
  - EV Driveline Systems,
  - Advanced Batteries,
  - Supercapacitors, and
  - Vehicle Recharging.



38 Applications



4 Themes

Priorities & Recommendations

Application	
Benefits:	Profit People Planet
Likelihood of Success	
Cost	

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Industry

Opportunity Areas

Applications

TRENDS AND DRIVERS

OPPORTUNITY AREAS

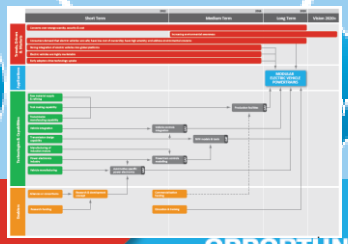
TECHNOLOGIES AND CAPABILITIES

ENABLERS

Vehicle Electrification

Lightweighting

Data & Communication Systems



Storage and Charging

Architecture and Platform Development

Natural Gas Technology

Platform and Architecture Development

Lightweighting of Specific Components

Novel Materials and Processes

Provision of Data through V2I Communication

Driver HMI and Information Systems

TRENDS AND DRIVERS

Short Term

2010-2012

In the short term, increasing oil prices and perceived changes in the environment are driving increased public awareness in both areas. A trend toward smaller, lighter vehicles is already apparent as is a trend toward global automotive platforms. With expanding availability of wireless communications, data is becoming increasingly accessible. Australia has a number of existing strengths that can be leveraged, including a large natural resource endowment and an automotive industry capable of taking a car from concept to release. With significant emerging competition and markets, in countries such as China and Korea, there is a current need for the industry to remain competitive.

Medium Term

2012-2016

Beyond 2012, impacts from a changing economic climate are expected to result in some consolidation and restructuring of firms in the Australian industry. Public awareness will drive a coordinated focus on emissions reduction through regulation and policy, with the continuing prevalence of global automotive platforms allowing harmonisation of legislation. Environmental credentials will make electric vehicles highly marketable to early adopters. Safety, however, is a key influence for consumer buying decisions and will remain the primary driver in the mass market through all timeframes. This is particularly relevant to an aging population.

Long Term

2016-2020

Competition from low cost countries like Brazil, India, Thailand and Russia with large local markets and developing economies will continue to put pressure on the local industry. Advances in information and computer technology will allow smaller, less expensive, more capable, better integrated electronics. Alternative fuels and electricity generated by less carbon intensive means will see increasing availability making them viable alternatives to conventional fuels. As the economics of vehicle purchases become driven by energy efficiency, alternative vehicles with mass market appeal (featuring low cost of ownership and high amenity) will be demanded.

Vision 2020+

2020+

Beyond 2020, many trends and drivers relating to environmental and safety concerns will continue to have relevance. New economic concepts may monetise the value of energy storage and distributed energy generation. In addition, there are further goals that will only be achievable given sufficient time. A transportation system with zero net emissions and zero road fatalities are two examples. These goals will require novel technologies, like intelligent roads and vehicles. By addressing these trends and drivers, a sustainable, competitive Australian automotive industry can be achieved.

OPPORTUNITY AREAS

2012-2020+

Vehicle Electrification

The progressive shift from internal combustion to electric technologies is considered a major theme in the future of automotive technology. Driven by a desire to reduce emissions from transportation, future applications were highlighted in three areas: specific technologies, design services and underlying needs. Services included expertise in design, integration and platforming, and deployment of charging infrastructure. Some specific technologies were electric motors, batteries, modular battery packs, power electronics, driver interface, drive modules and supercapacitors. Finally, a need was highlighted for finance models to encourage adoption, applications for end-of-life batteries, and deployment of electrified fleets.

2012-2016

Gaseous Fuels

Transition from diesel and petrol to LPG or natural gas is influenced by three factors: economics, energy security and the environment. The relative price of liquid fuels is on the rise with an additional benefit that vehicles powered by natural gas and LPG emit substantially lower quantities of CO_2. In Australia, local reserves of gaseous fuels improve the security of fuel supply. There are opportunities for specific technology development in areas such as direct injected LPS systems, natural gas drivetrains and gas storage tanks. Perception issues relating to the safety and convenience of gaseous fuels, can be addressed through expansion of infrastructure, improving the refuelling experience, improving the standard of aftermarket installations, and public education.

2010-2020+

Lightweighting

The lightweighting application area aims to address energy scarcity and environmental drivers by reducing vehicle fuel consumption and the resource consumption. It leverages Australian strengths in two ways: by taking advantage of abundant mineral resources, and by developing applications for these resources through research and development. Two themes, of underlying technology and specific applications, emerged from the lightweighting workshop. Underlying technology applications included: recyclable materials, foam and adhesives, structural design processes, and modular platform design. Specific parts identified for lightweighting were: wheels, door and body panels, seats, and other steel components.

2010-2020+

Data & Communication Systems

Developments in data and communications systems will find application in all timeframes. Currently, the majority of new developments in passenger vehicles are dependant on electrical and electronic technology and this trend is expected to continue. Applications identified for data and communications can be grouped into two broad categories: provision of information, and specific technology development. Information suitable for integration into driver information systems is needed for dynamically updating speed limits, congestion information, and traffic incident warning. Opportunities for technology development were highlighted in driver information and HMI systems, and next generation vehicle navigation systems with improved resolution.

TECHNOLOGIES AND CAPABILITIES

2010-2020+

Automotive

In the short term, only capability currently existing in the automotive sector can be used to realise the opportunities that have been identified. This reflects the leadtimes to mass production associated with developing or adapting technology for manufacture. The Australian automotive industry is highly capable, with the ability to develop a vehicle from concept to release. Even future applications, of sufficient relevance to the Australian industry to be presented here, will build on existing capability in the manufacturing and supply base. For this reason, automotive capability remains relevant as it develops across all timeframes.

2012-2020+

Non-Automotive

There are complimentary technologies and capabilities that are fully production proven, but have not yet been transferred for application in the automotive industry. Because the technology development and commercialisation work has already been completed, the transfer process is much simpler than for ground up development of new technology. One example is the use of lightweight materials in the defence and aerospace industries, while the trucking industry has experience in gaseous fuel technology and complimentary capability in the development and implementation of fleet monitoring and communications systems. By leveraging these technologies and capabilities, lead times for automotive technology development can be substantially reduced.

2016-2020+

Science and Research

There are many examples where a future need can be identified, but underlying technology has not reached the level needed to realise the opportunity presented. In these cases, new technology will need to be developed and related applications will have the longest lead times. Development can take place in industry directly, but often requires collaboration with organisations such as CSIRO, universities, cooperative research centres (CRCs) and centres of excellence. By identifying technology gaps now, development programs can realise commercial capabilities in the long-term and vision timeframes.

ENABLERS

Feasibility and Planning

An immediate need was identified in all areas for targeted feasibility studies and business planning. The level of detail proposed varies by application: from establishing a business case for the development of lightweight road wheels, through the production of a roadmap specifically targeting an Australian electric vehicle industry.

Industry Collaboration

A coordinated approach from all stakeholders was another recurring theme. Proposed mechanisms for collaboration included the formation of cooperative research centres (CRCs), the re-targeting of existing CRCs, and development of joint-venture partnerships to ensure broad industry engagement. Regardless of the suggested method, it is clear that a collaborative approach and aligned objectives can be considered a very important factor.

Education and Training

Focussed education programs can be used to facilitate the development and uptake of identified applications. Poor public perception of gaseous fuel technology is based in large part on misinformation and this can be addressed through an education campaign. Beyond public education, training and certification of aftermarket installers can improve real and perceived public safety of gaseous fuels. In other application areas, a need for graduates and professionals with expertise in emerging technologies was identified.

Government Support

Required action by government was identified in three broad support areas: financial, infrastructure, and standards. While the predominant method of financial support mentioned was the existing Green Car Innovation Fund (GCF), other mechanisms proposed include incentive programs and the purchase of locally produced electric vehicles for government fleets. Infrastructure is required for some applications in the gaseous fuels, electrification and communications areas, while adjustment of Australian Design Rules (ADRs) and other standards will facilitate the development and uptake in all application areas.

Science and Research

Beyond the few short term opportunities identified, collaboration with the science and research sector to support technology development will be required by applications in all areas. Particular need for research programs was noted in areas requiring world-leading technology development, like the development of novel battery technology or the design of a lightweight modular vehicle platform. It is critical that research programs be aligned with programs in industry to ensure a coordinated approach.

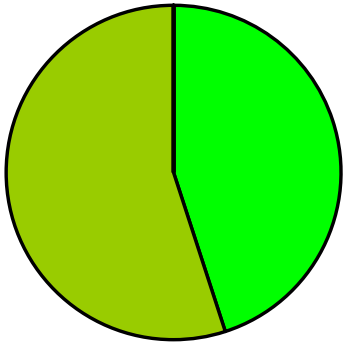
What did Stakeholders say afterwards?

*"The AA2020 Roadmap has **changed the way we perceive** the Australian automotive industry. It has provided a **vital context in which to understand and pursue opportunities** for our technology in the automotive market."* **Anthony Kongats – CEO, CAP-XX**

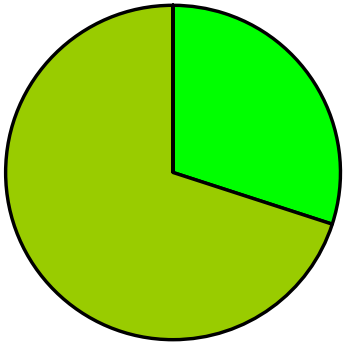
*"The Automotive Australia 2020 Roadmap charts the industry's **capabilities, needs, commercial potential, and opportunities** for expansion over the next decade and beyond. Over 220 people from 160 organisations contributed to creating the roadmap, **delivering strong industry support** for the directions suggested by the roadmap, and an **eagerness to be involved** in its implementation - to build competitive advantage wherever we can."* **Senator Kim Carr - Minister for Innovation, Industry, Science and Research**

Common themes

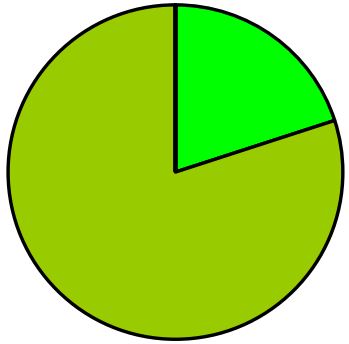
I found the workshop stimulating



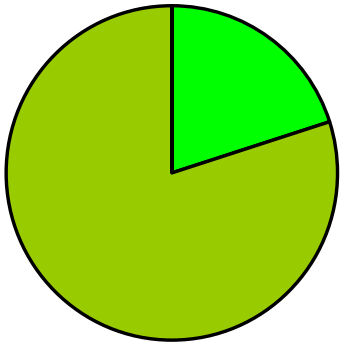
I enjoyed the workshop



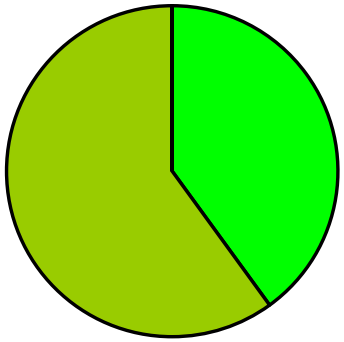
I found my participation worthwhile

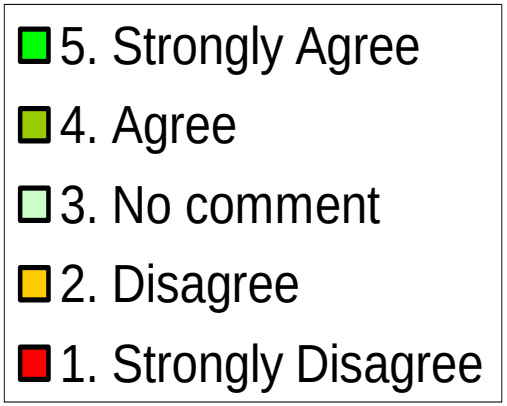


I feel I have contributed to the workshop



The workshop provides useful insights





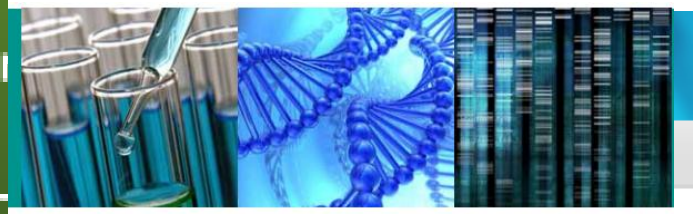
BBSRC
bioscience for the future

E·S·R·C
ECONOMIC & SOCIAL RESEARCH COUNCIL

EPSRC
Pioneering research and skills

Living With Envi

Technology Strategy Board
Driving Innovation



Stratified Medicine
in the UK
Vision and Roadmap

By: Michele Stanley | May 13, 2013 8:59 AM

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Mike Cowling, the
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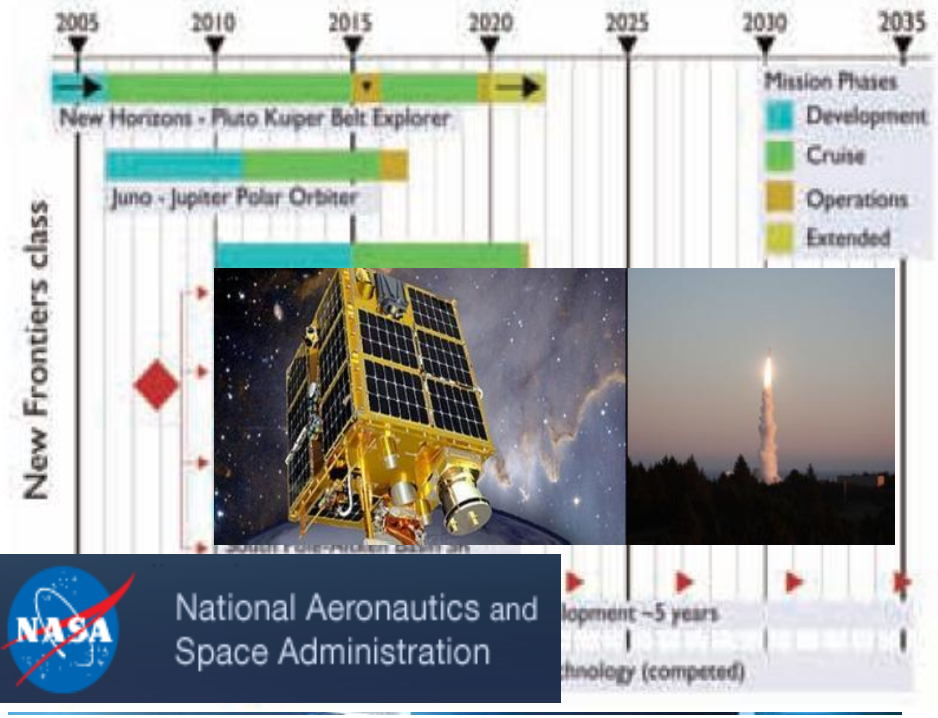
Dr Beatrix Schlarb-Ridley and Dr Brenda Parker from Adapt.



NASA
National Aeronautics and Space Administration

BIS
Department for Business Innovation & Skills

Technology Strategy Board
Driving Innovation

Knowledge Transfer Network
Transport

UK Marine Industries Roadmap

IfM Education and Consultancy Services

UK Marine Industries Alliance

IfM MANAGEMENT TECHNOLOGY POLICY

UNIVERSITY OF CAMBRIDGE

Further information

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