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Roadmapping for strategy and innovation

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Summary

Roadmapping approaches are now widely used at company, sector and national levels to align research and other investments with goals and strategy. This paper provides an overview of the technique, focusing on how roadmapping can support innovation and business strategy, building consensus on priorities and actions required to move forward, illustrated with a case study.

1. Introduction

Technology roadmapping was originally developed by Motorola in the 1970s to support improved alignment between technology and product development, providing a structured visual depiction of strategy, as illustrated in Fig. 1[1]. Since then the approach has been adopted widely by many organisations in different sectors around the world, at company, sector and national levels. The underlying concept is very flexible, and roadmapping methods have been adapted to suit many different goals, supporting innovation, strategy and policy development and deployment[2].

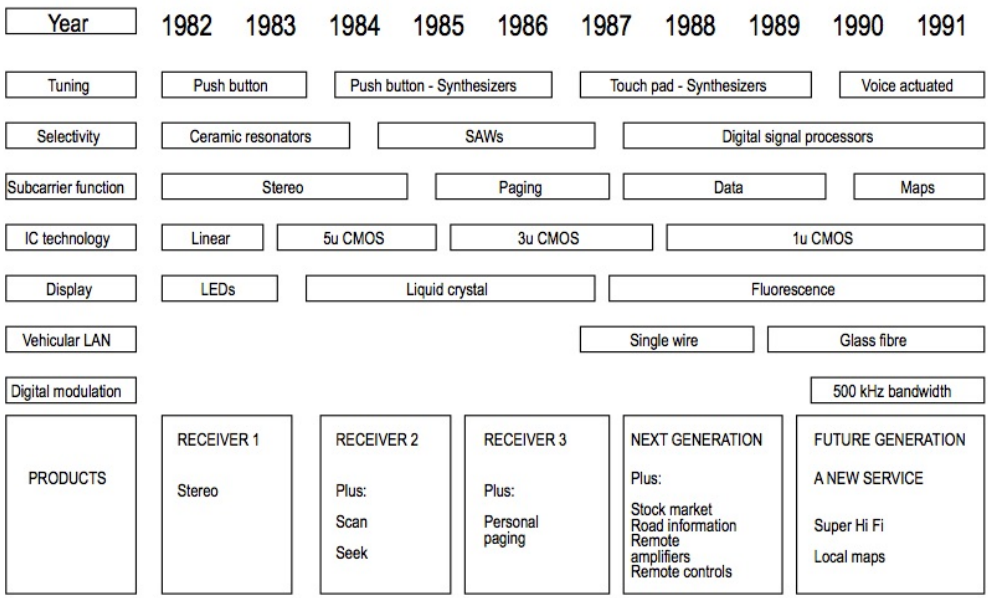

Fig. 1 – First published Motorola technology roadmap, for car radios[1], linking technology investment to product strategy, looking forward 10 years

[1] Willyard, C.H. and McClees, C.W. (1987), "Motorola's technology roadmap process", *Research Management,* Sept.-Oct., pp. 13-19.
[2] Phaal, R., Farrukh, C.J.P. and Probert, D.R. (2004), "Customizing roadmapping", *Research Technology Management,* 47 (2), pp. 26-37.

The most frequently cited benefit of the roadmapping approach is communication across functional and organisational boundaries. The process of roadmap development brings together the various key stakeholders and perspectives, building consensus. Once a roadmap has been developed it can be more widely disseminated, acting as reference point for ongoing dialogue and action.

Bob Galvin, who was CEO of Motorola during the period when roadmapping was established, provides the following definition[3]: "A 'roadmap' is an extended look at the future of a chosen field of inquiry composed from the collective knowledge and imagination of the brightest drivers of change in that field". This definition emphasises the importance that knowledge and expertise plays in the process, the forward-looking nature of the approach, and its flexibility.

Many different approaches to roadmapping have been developed, and roadmaps can take many forms, although generally the focus is a graphical representation that provides a high-strategic view of the topic of interest. The most flexible and powerful framework for the creation of roadmaps is illustrated schematically in Fig. 2, comprising a multi-layered time-based chart, bringing together various perspectives into a single visual diagram. This type of roadmap enables both 'demand' and 'supply' side views to be represented, balancing 'market pull' and 'technology push'.

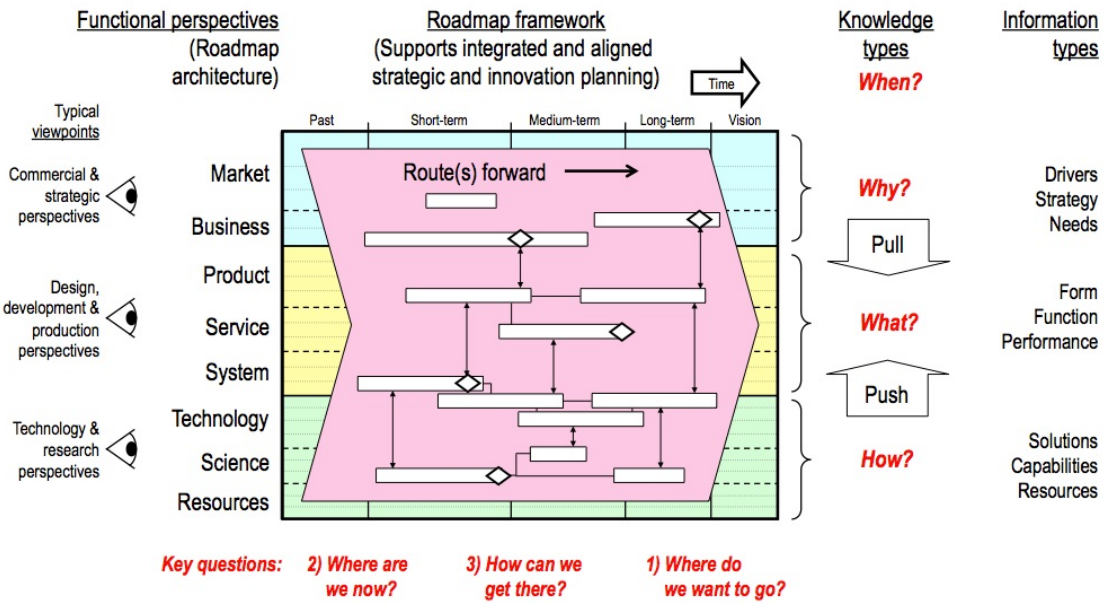

Fig. 2 – Schematic multi-layered roadmap, aligning multiple perspectives, highlighting fundamental generic strategic questions in red

This holistic roadmap framework shown in Fig. 2 links directly to fundamental questions that apply in any strategic context:

1. Where do we want to go? Where are we now? How can we get there?
2. Why do we need to act? What should we do? How should we do it? By when?

[3] Galvin, R. (1998), 'Science roadmaps', *Science,* 280 (5365), pp. 803.

The generic form of roadmap illustrated above highlights the flexibility of the approach, which can be readily adapted to suit a wide range of goals and contexts. In essence, roadmaps are simple, adaptable 'strategic lenses' through which the evolution of complex systems can be viewed, supporting dialogue, alignment and consensus. The systematic multi-layered format is helpful for developing strategy, but may not always be the best way to communicate strategy, depending on context, purpose and audience. Alternative formats may be helpful for communicating key strategic messages to particular stakeholder groups – for example senior management or investors. An example is shown in Fig. 3, where a bespoke communication roadmap was developed for a large European collaborative research program on the development and application of graphene.

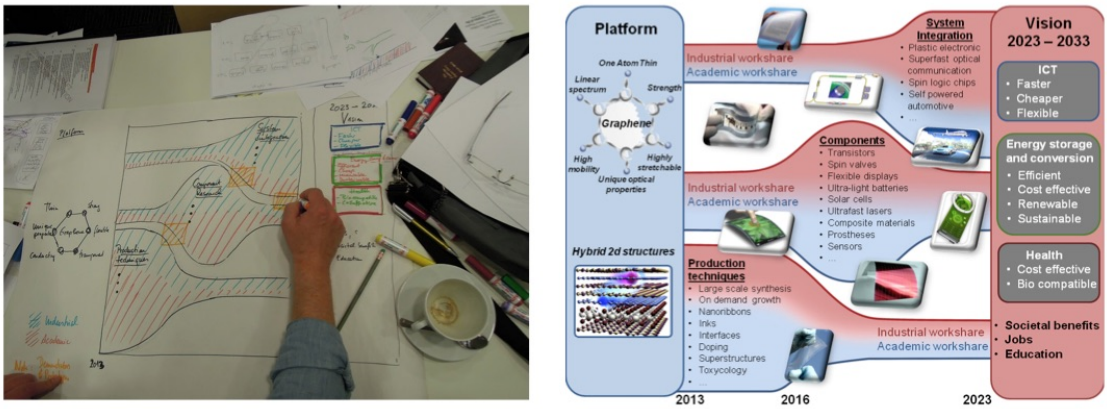

Fig. 3 – Developing a communication roadmap for EU Graphene Flagship (courtesy of Kerr & Bonaccorso, 2012)

From its origins in the consumer electronics sector in the 1970s, roadmapping techniques spread initially to organisations in other technology-intensive sectors – aerospace and defence in particular. A key milestone in the evolution of the method was its adoption by the semiconductor industry, where in 1992 the first sector-level roadmap was published. This has been very influential, defining the collective vision of the industry and establishing a benchmark for technology development, accelerating innovation in the semiconductor sector[4]. Unlike company roadmaps, which are usually confidential, the International Technology Roadmap for Semiconductors is in the public domain[5], leading to a much wider awareness of the approach.

The application of roadmapping at the sector level was further promoted by the US Department of Energy, which funded a series of roadmaps in different industries[6]. The concept and term 'roadmap' was further popularised by the publication and promotion of the 'Roadmap for peace in the Middle East'[7], although this has led to a proliferation of so-called 'roadmaps' that do not build on the intellectual origins of the approach. A survey[8] of public-domain roadmaps has identified more than 2,000 examples from a wide range of sectors, including energy, transport, materials, aerospace, electronics,

[4] Schaller, R.R. (2004), *Technological innovation in the semiconductor industry: a case study of the International Technology Roadmap for Semiconductors (ITRS),* PhD thesis, George Mason University.
[5] www.itrs.net
[6] www.eere.energy.gov
[7] United Nations (2001), A performance-based roadmap to a permanent two-State solution to the Israeli-Palestinian conflict.
[8] www.ifm.eng.cam.ac.uk/uploads/Research/CTM/Roadmapping/public_domain_roadmaps.pdf

ICT, manufacturing, construction, healthcare, defence, and pure science. Companies participate in such programs to ensure their priorities are considered, and published roadmaps provide a useful source of information for firm level strategy.

2. *Roadmapping in practice*

It is often claimed that the process of developing roadmaps is more important than the roadmaps themselves, due to the associated communication and consensus-building benefits (although a healthy strategy process should also challenge this consensus, as Motorola did with a requirement to include a 'minority report' with their consensus-based roadmap[1]). The process needs to be customised to suit the context, along with the structure and format of the roadmap. Consideration should be given to how the first roadmap is developed and then also to how the roadmap can be maintained, and how to deploy the approach more widely in the organisation.

While particular roadmapping approaches can vary considerably, the use of workshops as a key ingredient is a common feature, owing to the associated communication and social benefits, building consensus about what the key issues of interest and concern are, and the actions that are needed to move forward. Figure 4 shows how the roadmap framework is deployed in a workshop, using the 'S-Plan' approach[9], providing a coherent structure and common language to guide discussion and capture views, in an active, creative hands-on process. Two activities are illustrated:

1. A large roadmap wall chart (main photograph in Fig. 4) is used to share perspectives across the full scope of the topic of interest, to create a 'strategic landscape', providing context within which specific opportunities or issues of concern can be identified ('landmarks' in the landscape).
2. Small groups then explore the specific topics in more detail, using a common template, to develop roadmaps for review and discussion, to agree priorities, the way forward and actions (inset photograph in Fig. 4).
3. Further work is typically required before, between and after workshops to collect data, analyse results, develop roadmap representations and associated reports.

Roadmapping can be applied throughout the innovation and new product development process, aligned to key milestones and review points. At the early stages (the front end of innovation), exploratory approaches are appropriate. As innovations progress and mature, the roadmap needs to be developed further – for example the Motorola roadmap shown in Fig. 1. Multifunctional workshop approaches are helpful here too – for example the 'T-Plan' method[10], which incorporates additional structure and analytical tools within the process, as illustrated in Fig. 5.

All management tools have strengths and weaknesses, and typically several are needed to create a robust toolkit, as illustrated in Fig. 5, where linkage grids are used to support roadmapping, and Fig. 6, with competing strategic options prioritised in terms of both the scale of the opportunity and feasibility of attainment (OxF). "Think big, act small" is good advice heard from an experienced technical manager, encouraging quick

[9] Phaal, R., Farrukh, C.J.P. and Probert, D.R. (2007), 'Strategic roadmapping: a workshop-based approach for identifying and exploring innovation issues and opportunities', *Engineering Management Journal,* 19 (1), pp. 16-24.
[10] Phaal, R., Farrukh, C.J.P. and Probert, D.R. (2001), *T-Plan: the fast-start to technology roadmapping - planning your route to success*, ISBN 978-1-902546-09-4, Institute for Manufacturing, University of Cambridge.

exploratory iterative applications of tools, scaling up as confidence in the methods grows, as illustrated in Fig. 7 for LEGO.

Fig. 4 – Typical 'S-Plan' roadmapping workshop (corporate innovation strategy here), showing how the roadmap template provides a structured framework for guiding discussion and capturing views

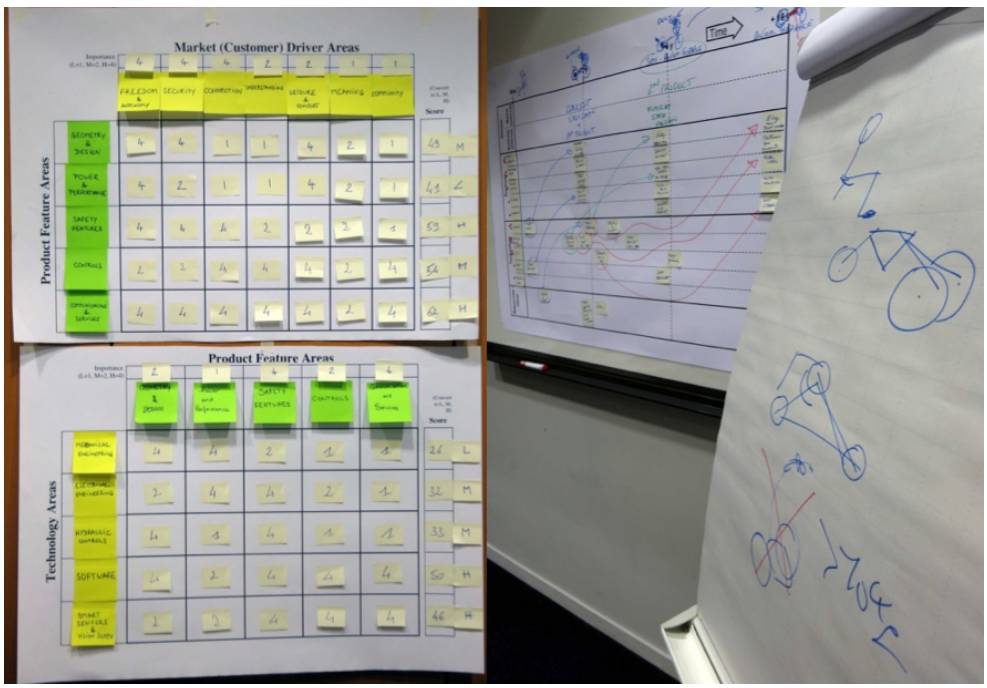

Fig. 5 – 'T-Plan' workshop approach for product-technology roadmapping, showing how 'linkage grids' are used to link and prioritise product and technology areas in terms of their impact on customer needs (left), supporting product vision and roadmap development (right)

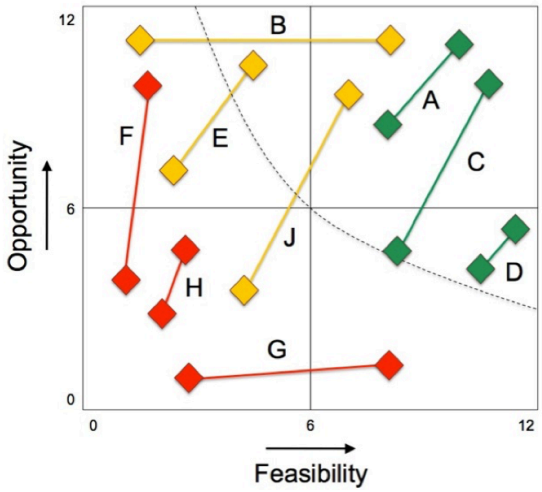

Fig. 6 – Opportunity x Feasibility portfolio selection matrix, based on scoring of factors, including consideration of uncertainties

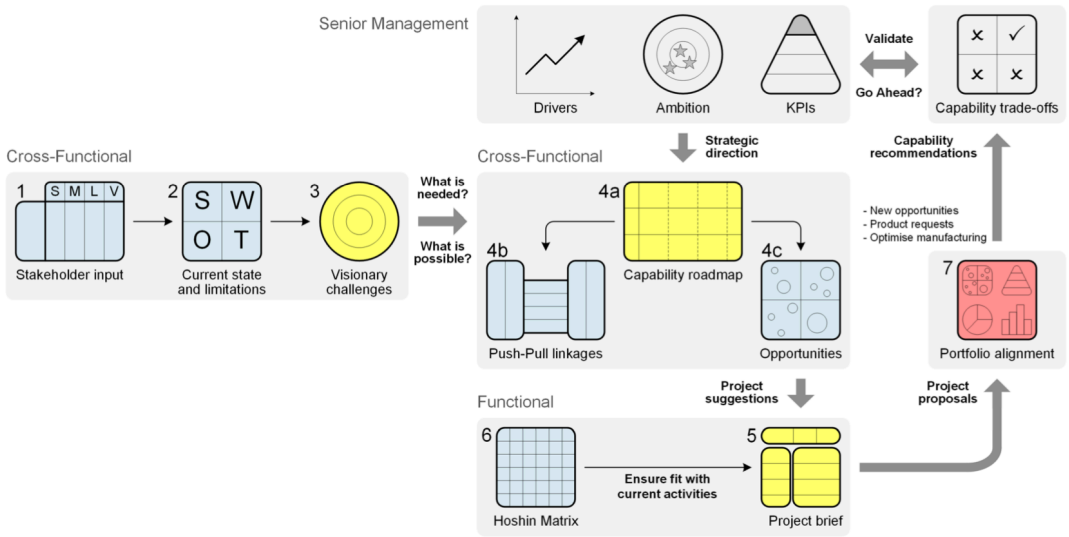

Fig. 7 – Prototyped toolkit for the LEGO 'Operations' side of the organisation (Kerr & Phaal, 2017)[11]

3. *Implementation success factors*

In 2003 the Dutch Ministry of Economic Affairs sponsored a study of the effectiveness of 'supra-company' (sector level) roadmapping initiatives around the world[12], with the aim of assessing how roadmapping can support national innovation policy and systems. The study reviewed a total of 78 roadmapping initiatives, mainly in Europe, USA, Canada and Japan, from which the following 'good practices and lessons' were identified, most of which also apply to firm level roadmapping.

[11] Kerr, C.I.V. and Phaal, R. (2017), 'Roadmapping as a platform for developing management toolkits: a collaborative design approach with the LEGO Group', *PICMET Conference: Technology Management for Interconnected World,* 9-13 July, Portland OR.
[12] De Laat, B. and McKibbin, S. (2003), *The effectiveness of technology road mapping – building a strategic vision,* Dutch Ministry of Economic Affairs. [www.ez.nl]

Planning:

- The roadmapping initiative should be clearly linked to broader strategy initiatives (for example, national innovation priorities).
- It is much easier to launch a roadmapping activity within an existing 'social infrastructure' (for example, a industry association).
- In order to mobilise participants there must be a sense of 'urgency'.
- Creating high-level commitment from the start is critical, involving decision makers within companies (and government) throughout the process.
- Visioning and goal setting is important, as a focus for developing consensus within the community.
- Industry oriented roadmapping activities should be owned by industry from the outset to encourage take-up.
- A clear link to decision-makers is important if roadmapping is to have impact.

Implementation:

- No single format is suitable for all situations – the approach generally has to be customised.
- It is important that momentum is sustained, to keep participants interested and involved.
- Roadmapping is inherently exploratory in nature, and so the plan should be flexible to accommodate learning as the process advances.
- A spirit of openness is important, to encourage new participants and thinking throughout the process.
- The financial aspects need to be clear – generally the costs of such initiatives are shared between the administrating and participating organisations.

Follow-up:

- Roadmapping is typically an iterative process, benefiting from review after the first roadmap is produced.
- Outcomes should be monitored, including uptake and impact.

4. Case study – Corporate research strategy

The case study below demonstrates how roadmapping can support alignment of technology strategy across a large global organisation. Similar approaches have been applied to sector, regional and national level strategy and foresight[13].

This case focuses on a global packaging company, with a central European corporate R&D facility and business units distributed around the world, organised in terms of geography and product lines. The company had grown through a series of acquisitions, with the corporate R&D Centre a legacy from one of the original companies. The central research laboratory provided troubleshooting and development support, funded directly by business units on a project basis. In addition, a 'tax' was levied on the business units to fund longer-term research, focusing on new materials, products and processes.

[13] www.ifm.eng.cam.ac.uk/roadmapping/case-studies

A key challenge for the company was a lack of alignment between business unit goals, which tend to focus on the short- and medium-term, with investment in longer term R&D in the research laboratory. There was a history of interesting technology developments that were not deployed in the business units, leading to a concern that corporate research budgets would be cut substantially, and the central research laboratory potentially closed.

The S-Plan process was used in a series of workshops, each focusing on particular business units, bringing together staff from both organisations, with the commercial perspective provide by the business unit and the technological perspective by the corporate R&D centre (see Fig. 8). The process was piloted first in one business unit, and then applied across other key business areas.

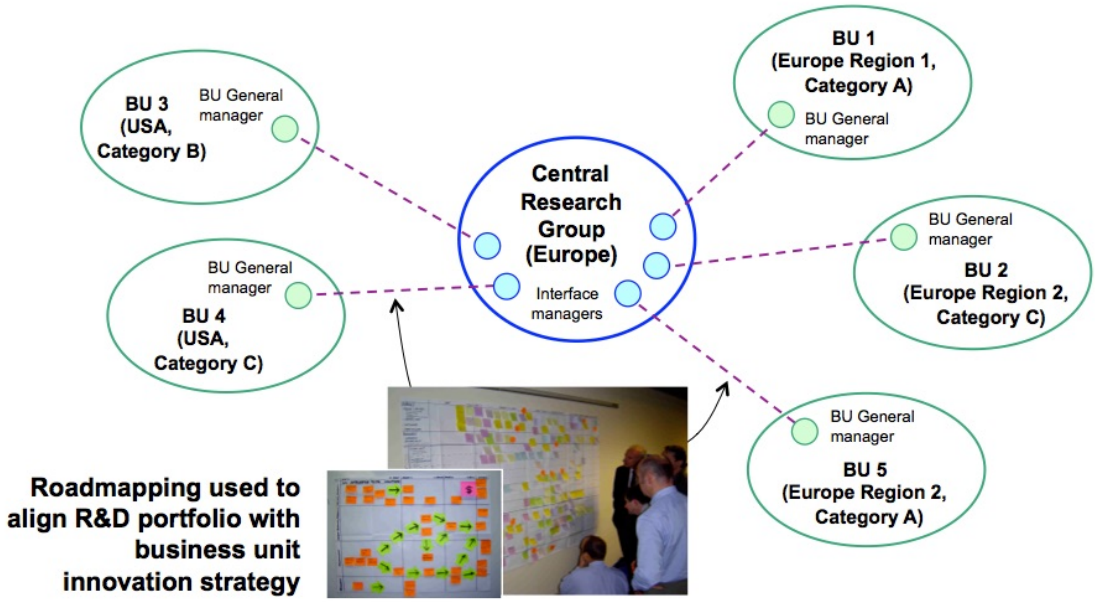

Fig. 8 – Coordination of research strategy in global packaging company

In each case, three key people worked together to plan and run the workshop, and ensure that the outputs were taken forward, both within the business unit and the research laboratory:

1. Senior manager within the central research laboratory, responsible for the interface with the business unit. This person tended to instigate the process, liaised with the business unit to ensure their commitment, made sure that appropriate technical experts participated in the workshop, and ensured that the outputs were implemented within the laboratory

2. General Manager of the business unit, who ultimately 'owned' the resulting roadmaps that were generated in each workshop, which focused on innovation opportunities and strategic options for the business unit. This person ensured that the business objectives were clearly understood, made sure that appropriate commercial, development and managerial staff participated in the workshop, and ensured that the outputs were implemented within the business.

3. Facilitator, an expert in roadmapping techniques, who helped to design and coordinate the process, and facilitated the workshops. This role was initially undertaken by an external consultant, but one of the aims was to ensure that the learning was transferred to the company. After the first three workshops staff in the research laboratory took on this role.

The main outputs from each workshop were a prioritised set of innovation opportunities and strategic options for the business units, and agreed plans to take these forward, combined with an understanding of the technologies needed to support these plans. This included short-, medium- and long-term technical priorities, aligned with the troubleshooting, development and research activities in the laboratory. The priorities established during the roadmapping process were compared to the existing R&D portfolio. Where existing programs were identified that matched the business unit priorities these were strengthened, and where gaps were identified budgets were reallocated.

The overall benefits of the process were:

- Reinvigorated innovation strategy in the business units, with new opportunities identified and pursued.
- A realigned corporate research budget, linked to the future business needs of the company.