# 10

# ROADMAPPING

## 10.1 Introduction

Roadmapping is extensively used in industry and government to support strategy, innovation and policy. Motorola is widely credited with the development of the roadmapping approach in the 1970s to support integrated product/technology strategic planning (Willyard and McClees, 1987). Since then, the method has been adopted by many organizations in a wide range of sectors and for many purposes.

Bob Galvin (1998), who was CEO of Motorola during the period when roadmapping was established, provides the following definition:

> 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.

At the heart of the method is the use of simple graphical charts that provide an overview of strategy, in particular how various aspects of strategy are aligned. This concept is illustrated in Figure 10.1 (Phaal et al., 2004b), which is adapted from the approach developed by Philips in the 1990s (EIRMA, 1997; Groenveld, 1997).

The roadmap provides an integrating framework that summarizes at a high level (on one page) the various strategic elements that must be aligned to achieve the overall organizational goals. The roadmap provides a structure (a common visual language) that enables key stakeholders to articulate their perspectives and identify the key relationships and points of alignment. A major benefit of roadmapping is the communication associated with the development and dissemination of roadmaps.

## 10.2 Where and why it is used

Although early applications of roadmapping were in large technology-intensive organizations in the electronics, aerospace and defence sectors, the approach is flexible and has been adapted for many different purposes such as planning and strategy in many different sectors. The major issues that roadmapping can address include:

- Identification.
- Exploitation.
- Learning.

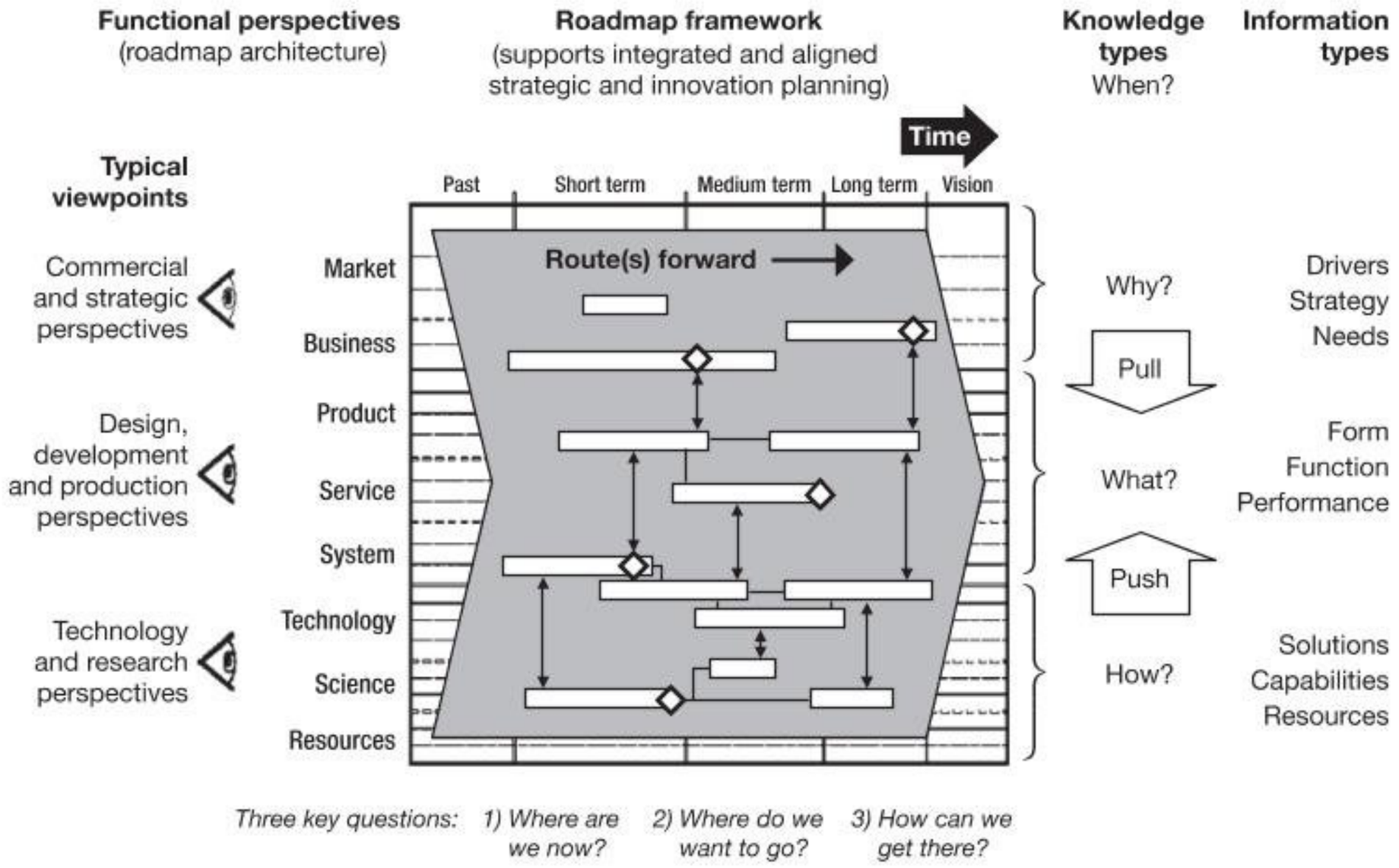


**Figure 10.1** Schematic roadmap

The innovation process is often represented as a funnel, as shown in Figure 10.2, and a similar model can be applied to the strategy process. At the start (the 'fuzzy front end'), the process is divergent and exploratory, with the aim of identifying as many potential opportunities as possible and then assessing and filtering these down to those that show the most promise. The process is iterative, typically managed by a series of review points or stage-gates (see details in Chapter 12). The approach on the right-hand side of the funnel is very different – the focus is more on the implementation of innovations and strategic plans, where a tightly controlled, efficient process is appropriate.

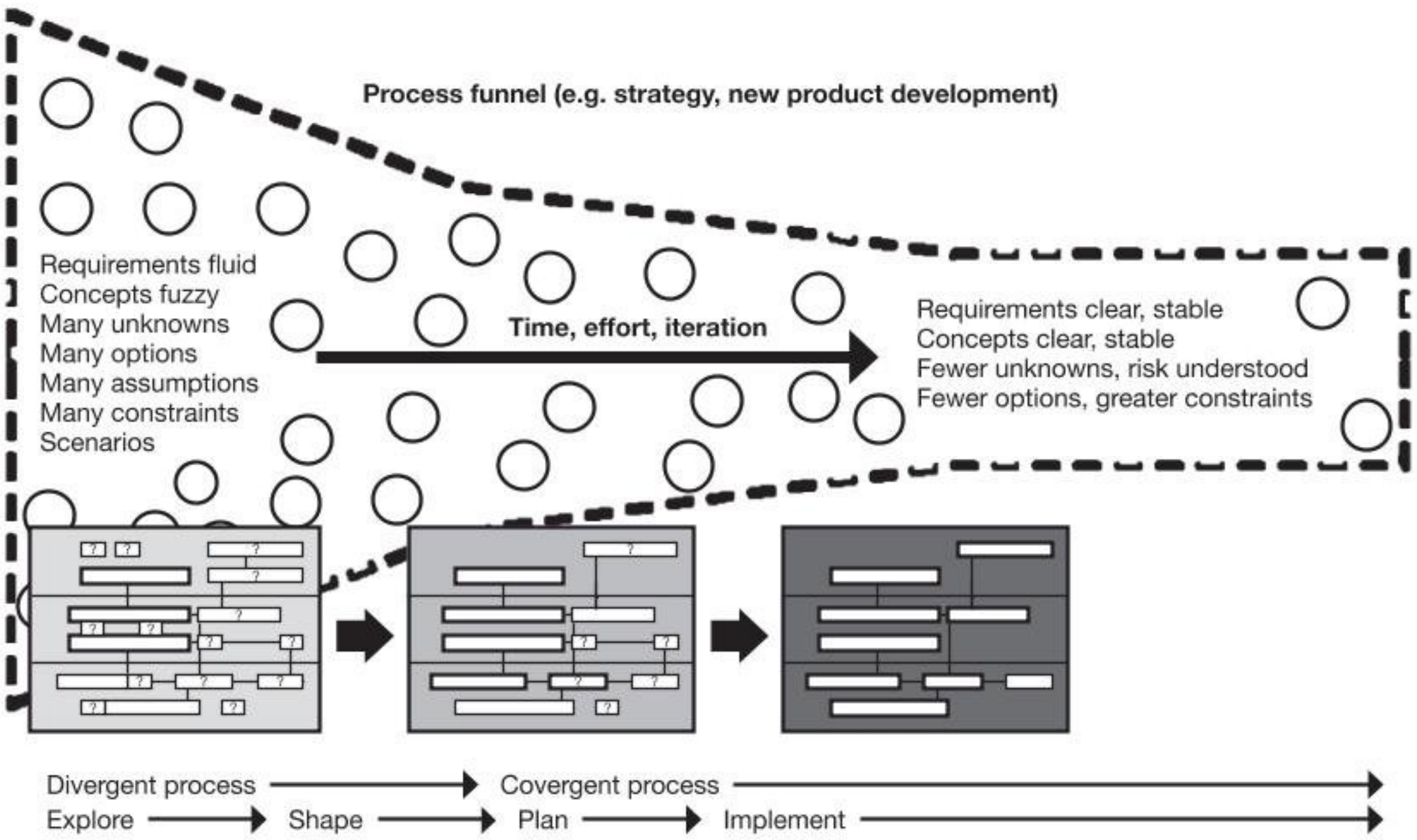


**Figure 10.2** The roadmapping process as a funnel

Roadmapping can be applied throughout the funnel. At the front end, the method can be used to structure, capture and explore strategic issues, focusing and agreeing key actions to move forward. Later on, roadmapping has some similarities to project management such as Gantt charts, providing a high-level 'programme' view of a project, ensuring that the various activities are aligned.

The format of roadmaps, and the process for developing them, is different at the front and back ends of the process funnel. Workshop-based methods feature strongly at the start, while software often becomes necessary to manage the data associated with the roadmaps later on.

## 10.3 Process

Roadmapping as a process should not be divorced from the business processes (strategy, innovation, new product development and so on) that are supported by the development and deployment of roadmaps. The roadmapping process itself should be thought of as a simple systems-based organizing framework for enabling the capture, exploration, analysis, synthesis and reporting of strategic issues associated with the business process.

Garcia and Bray (1997) provide a description of the technology roadmapping process developed by Sandia National Laboratories in the USA, which is divided into three broad phases:

1. Preliminary activity.
2. Development of the technology roadmap.
3. Follow-up activity.

The preliminary activity consists of three separate steps:

1. Success factors should be considered at the start of the process, including the perceived need for roadmapping and collaborative development, and the input and participation of all relevant groups, for example functions, customers, suppliers, partners, government agencies and universities.
2. Committed leadership/sponsorship is needed from key decision makers and those involved in implementing the roadmap because of the effort required to develop a roadmap.
3. The context of the roadmap needs to be understood, including a definition of the vision for the organization, the aims of the roadmapping initiative, scope and boundaries, level of required detail and time frames.

The development of the technology roadmap phase has seven tasks/steps:

1. The product needs and focus should be agreed if buy-in is to be achieved and sustained. Garcia and Bray (1997) recommend the use of scenario planning if there is major uncertainty about the project needs.
2. Critical system requirements need to be defined, including time-based targets. These requirements relate to the functions and performance required from the product or system.

3 The major technology areas that can contribute to the critical product or system requirements need to be specified.
4 The product or system requirements and targets need to be translated into technology drivers and targets for the major technology areas. These are criteria that can be used to evaluate the benefits of the technology as a basis for differentiating the various options for selection purposes.
5 Technology alternatives need to be identified, which have the potential to respond to the technology drivers and achieve the targets.
6 The most attractive technologies need to be selected, which have the potential to achieve the desired targets. Various tools and techniques may be helpful during this step to support analysis and decision making, although expert judgement is often a key factor, benefiting from a collaborative process. The output from this step is the graphical representation that is the focal point of the roadmap document or report.
7 The information generated from the first six steps needs to be pulled together into an integrated report, including the graphical roadmap, description of each technology and its current status, critical risks and barriers, gaps and technical and implementation recommendations.

The follow-up activities include three steps:

1 The validation of the roadmap is needed. Development of the first (draft) version of the roadmap usually involves a relatively small group of key participants. Broader consultation is beneficial for validation purposes, to address key gaps identified and to build broader buy-in from those involved in or who influence its implementation.
2 The development of an implementation plan requires activities and projects to be planned, resourced, coordinated and managed.
3 The review and update step keeps the roadmap up to date in order to reflect changing circumstances and learning (Chapter 5). Typically, this will be linked to business processes such as strategy and new product development or as future events require.

Companies are different, in terms of sector, size, markets, products, technology, organizational structure, business, processes, culture, history and characteristics of individual people. Although there are similarities at a high level, including some well-established and widespread practices, there is great variety in terms of the specific way that business processes are deployed and the particular circumstances that companies find themselves in at any given point in time.

There are many textbooks and journal papers that provide guidance on innovation and strategic management. These sources can provide useful guidance and support when implementing roadmapping, which generally needs to be customized to fit the particular organizational context.

One example is shown in Figure 10.3, which shows a fairly generic strategic innovation process (EIRMA, 1997), combining both market pull and technology push aspects. In this example, the roadmapping creation is a single stage in the overall process. However, as highlighted in Figure 10.2, roadmapping can be used throughout the process, but applied in a different way at the 'front end' compared to the later stages.

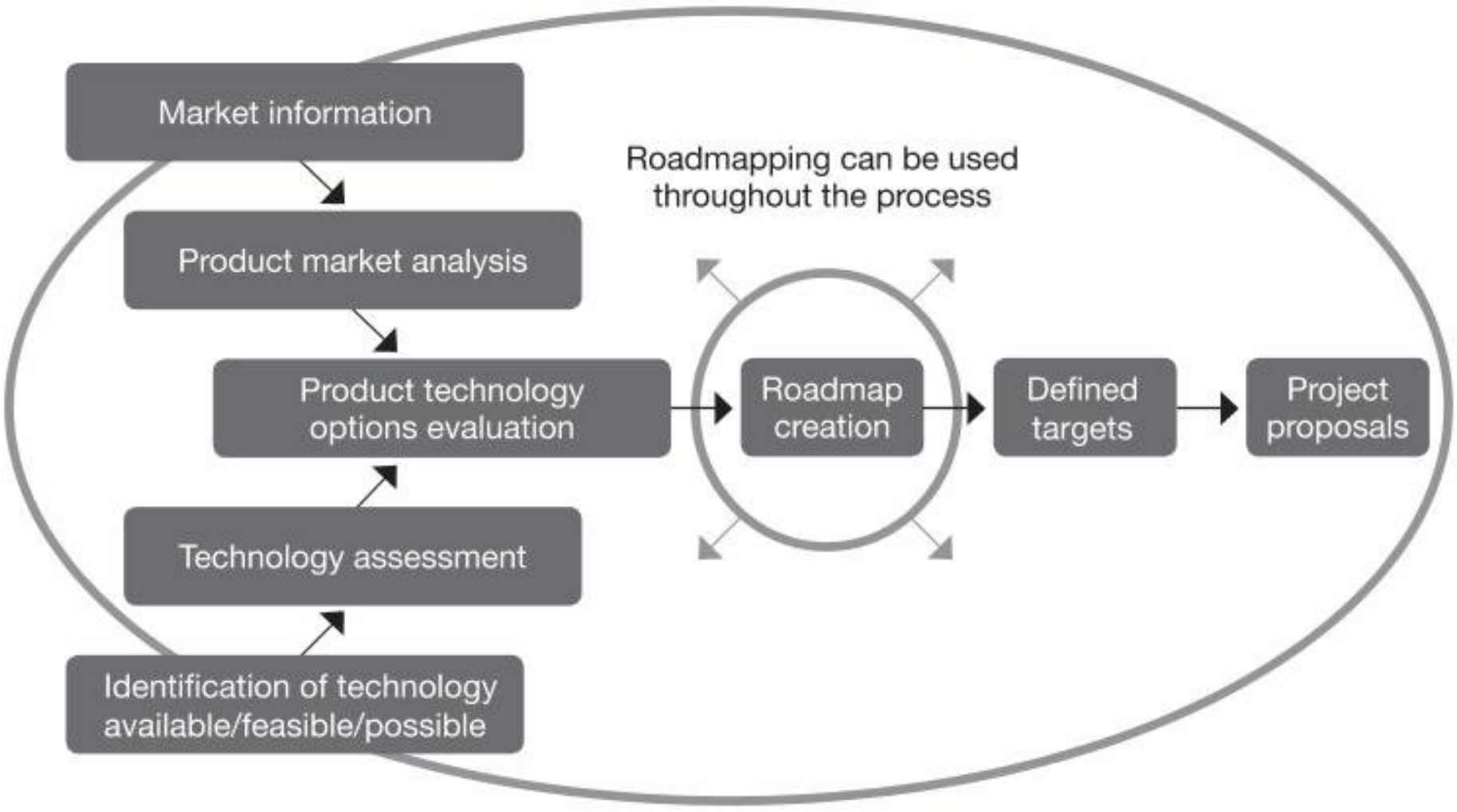


**Figure 10.3** A sample strategic innovation process

*Source*: Based on EIRMA (1997).

Roadmapping is an inherently flexible technique, in terms of:

- The wide range of aims to which it can contribute.
- The time frame covered by the roadmap – past and future.
- The structure of the roadmap – layers and sublayers, which can be adapted to fit the particular application.
- The process that is followed to develop and maintain the roadmap(s).
- The graphical format that is selected to present information and communicate the roadmap.

However, this flexibility is subject to certain constraints, including the level of resources available and the need to integrate roadmapping with other systems, processes and management tools within the firm, for example the use of portfolio methods, balanced scorecard and stage-gates in the new product development process.

The key areas to consider when planning a roadmapping activity are:

- *Context*: the nature of the issue that triggered the interest in roadmapping needs to be explored, together with any constraints that will affect the approach adopted. Careful consideration should be given to establishing a clear business need and ownership, defining aims and scope, and identifying key people across the organization who should be involved.
- *Architecture*: the layout of the roadmap needs to be designed (see Figure 10.1), considering both time frame and structure, comprising layers and sublayers. The roadmap can be considered a 'dynamic systems framework', providing a structure within which the evolution of the system of interest can be mapped. Generally, this system relates to innovation, at the firm or sector level, where there is a need to align markets (know-why) with applications and processes (know-what) and technology and resources (know-how), over time (know-when). The roadmap framework provides a 'common language',

which supports communication between different communities, such as functions, technical disciplines or organizations.
- *Process*: this comprises the staged set of activities needed to build the roadmap content, make decisions, identify and agree actions and maintain the roadmap that is developed. Typically, the process will involve one or more workshops, for which the agenda needs to be designed to incorporate a logical set of facilitated activities, which can be combined in a flexible way to address the issues of interest.

Workshops are often a key element of a roadmapping process, particularly at the front end, bringing the various stakeholders together to share their knowledge and experience. Some typical workshop activities are shown in Figure 10.4, which emphasize how the use of simple structures and activities can enable strategic dialogue. The roadmap structure provides a framework to capture and organize knowledge, typically following a logic such as that expressed in Figure 10.3, drawing on experience from workshop participants, other key stakeholders and other available information sources. The process can start at various points on the roadmap (often trends and drivers, business strategy or vision), and then progressively populating the rest of the roadmap.

Roadmapping can be challenging because of the broad scope and complexity of the issues being addressed, uncertainties associated with the future and gaps in available knowledge. There are also a number of organizational challenges to address when implementing roadmapping activities, which are often high-profile initiatives. Key hurdles to consider as the process is implemented include:

- Initiating the process (taking the first step) – developing 'roadmap version 1.0', which is 'fit for purpose', for example clarifying the business context, pointing the way forward and enabling key decisions to be made.
- Ongoing maintenance of the first roadmap; if required, roadmapping can be used as a one-off problem-solving/decision-making tool.
- Rolling out the roadmapping process within an organization, either in an 'organic' fashion (community of practice) or, more formally, linked to key business process review points, such as budgeting or product development stage-gates.

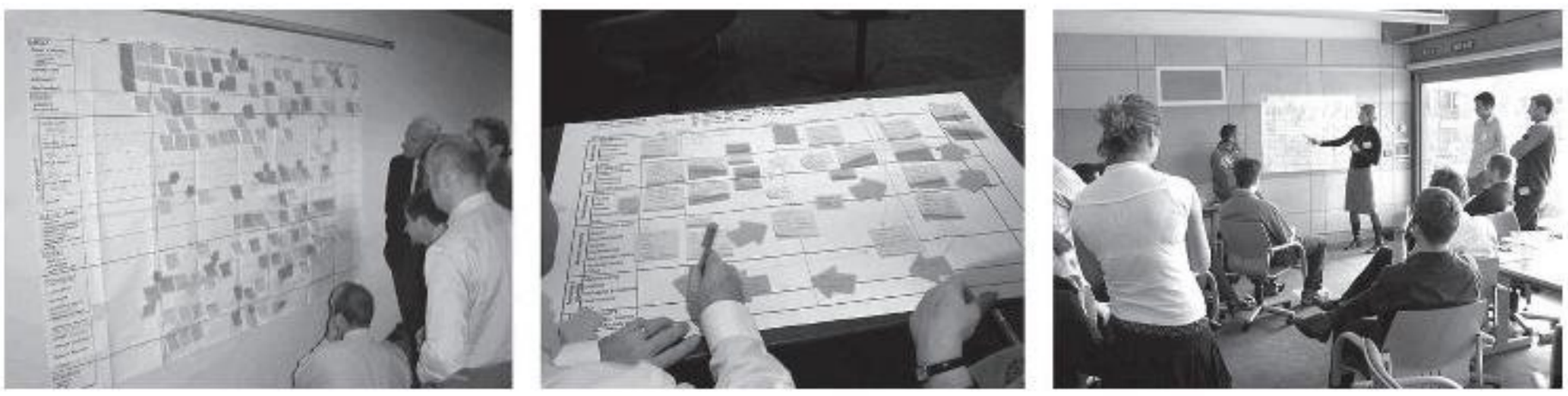

**Figure 10.4** Typical roadmapping workshop activities

The following success factors should be considered when embarking on a roadmapping initiative:

- Establish a clear business need.
- Ensure commitment from senior management.

- Plan carefully and customize the approach to suit your circumstances.
- Phase the process to ensure that benefits are delivered early.
- Ensure that the right people and functions are involved.
- Link the roadmapping activity to other business processes and tools.
- Provide adequate support and resources.
- Keep it simple.
- Iterate and learn from experience.

## 10.4 Roadmapping emerging technologies

The early stage of a technology development project is difficult to handle because of ingenious problems of exploring the value proposition and improving the design of the technology development project while reducing the risk. The approach called value roadmapping seems to offer a framework for supporting technology evaluation and valuation for emerging technologies (Dissel et al., 2009). In principle, the approach can also be used to support the business case for technology investment decisions, qualitatively and quantitatively (in financial terms), when the technology reaches a higher maturity level (assessed in terms of technology readiness level). Thus, the value roadmapping concept provides a consistent framework that can be used to link technological and commercial perspectives throughout the technology lifecycle.

The process is typically conducted as a workshop or a set of workshops with both technical and commercial people involved. The approach is based on eight process stages:

### Define strategic framework, vision and scenario

In the first step, it is important to define the strategic framework/vision/scenario that governs the technology exploitation, including any overall assumptions, boundaries and constraints that apply. Step 1 is typically done in the preparation phase, before the value roadmap workshop takes place.

### Map technology development and investment milestones

Participants at the workshop are asked to map the technology development project milestones and investment (current and future/potential), in terms of the technical capabilities that will be achieved at key milestones, together with any knowledge of competing and complementary technologies. The results are captured in the technology research and technology programs layer of the value roadmapping architecture.

### Define value streams

The technology developments and opportunities identified in step 2 are used to put into the context (strategic framework, market pull and technology push) so that the potential value that may result from the technology investment can be explored (and potentially

calculated). The goal is to identify specific sources of potential future revenue and value, articulated as clearly as possible. Participants are encouraged to forecast or estimate revenue/value for each opportunity. For estimating value, traditional methods (such as NPV) or some rough estimates might be used.

If opportunities are prioritized and value is estimated, the decision tree/options methods can be used to aggregate the various value contributions, including dependencies and estimates of likelihoods, to give a single financial measure of value. The goal is to identify as many value-generating opportunities as possible, after which it is necessary to cluster.

## Map market and business trends and drivers

The participants are requested to map the market, the business trends and drivers that influence the prioritized value opportunities. These are typically social, economic, environmental, technological and political drivers, knowledge about potential customer needs and competitors as well as the milestones and goals of the technology. The results are mapped in the appropriate layer of the value roadmapping architecture.

## Map barriers and enablers

This step maps the technical and non-technical barriers and enablers associated with developing and exploiting the technology. The map also includes the associated and complementary assets and actions that must be in place to achieve the aim of the roadmap.

## Review project plan and value roadmapping

The technology development project plan is reviewed against the results of the roadmapping. The review typically focuses on the key strategic business drivers (e.g., using ROI or SWOT Strengths-Weaknesses-Opportunities-Threats analysis) of the respective firm. It is important to have these drivers defined by the decision makers. In some cases this is a technology council who makes the final investment decision. In other cases this can be the business unit director or board. By doing so, the key linkages between the elements of the value roadmapping are further enhanced and a common picture is created. The review can either be carried out as a part of the workshop or afterwards by the process owner and the responsible technology project managers supported by the facilitator. The outcome can, for example, be a (revised) business case or an 'elevator pitch'.

## Present visualization

Complex projects' value roadmaps might be dense and fragmented, with gaps and data of varying quality. For those types of project, additional effort will be required to tidy up the roadmap. This detailed roadmap can be considered as a database, containing relevant information at a fairly high level of granularity and is unlikely to be very helpful

in communicating key messages about the project and its value. Thus, communication roadmaps that might be in a presentable format need to be developed. For example, elevator pitch roadmaps or templates were found to be useful in condensing the roadmap information. The value roadmapping can also provide a useful resource for 'what if' and sensitivity analyses and to assess the impact of events and new information on the plan as a whole.

## Maintain value roadmapping as a process

The resulting roadmap and associated documentation should be maintained on an ongoing basis as part of a core business process (e.g. project management, new product development, research management and strategic planning/budgeting).

### Case studies

Roadmapping is a generic technique to be used for any TM activity. The case of Lucent Technologies, a large telecommunications firm, shows the use of roadmapping for new products at Lucent and how links are established with the company-level strategy and building selection capabilities (Chapter 7).

#### Lucent Technologies

Lucent has a complicated new product development process that is managed by roadmapping.

Figure 10.5 shows the overall roadmapping process, where a series of structured templates guide the team through the process, ensuring that the key required information

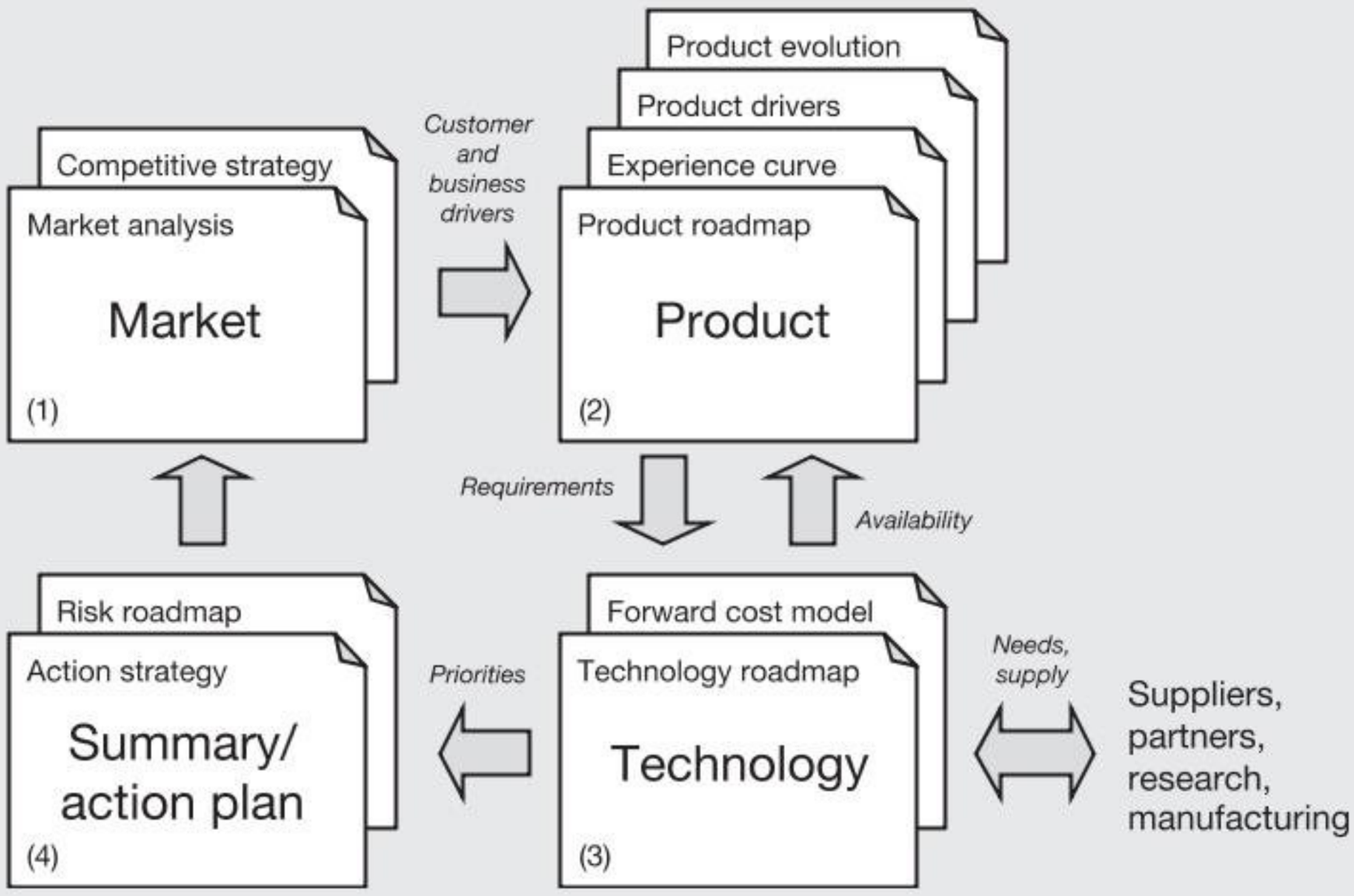


**Figure 10.5** Lucent Technologies roadmapping process

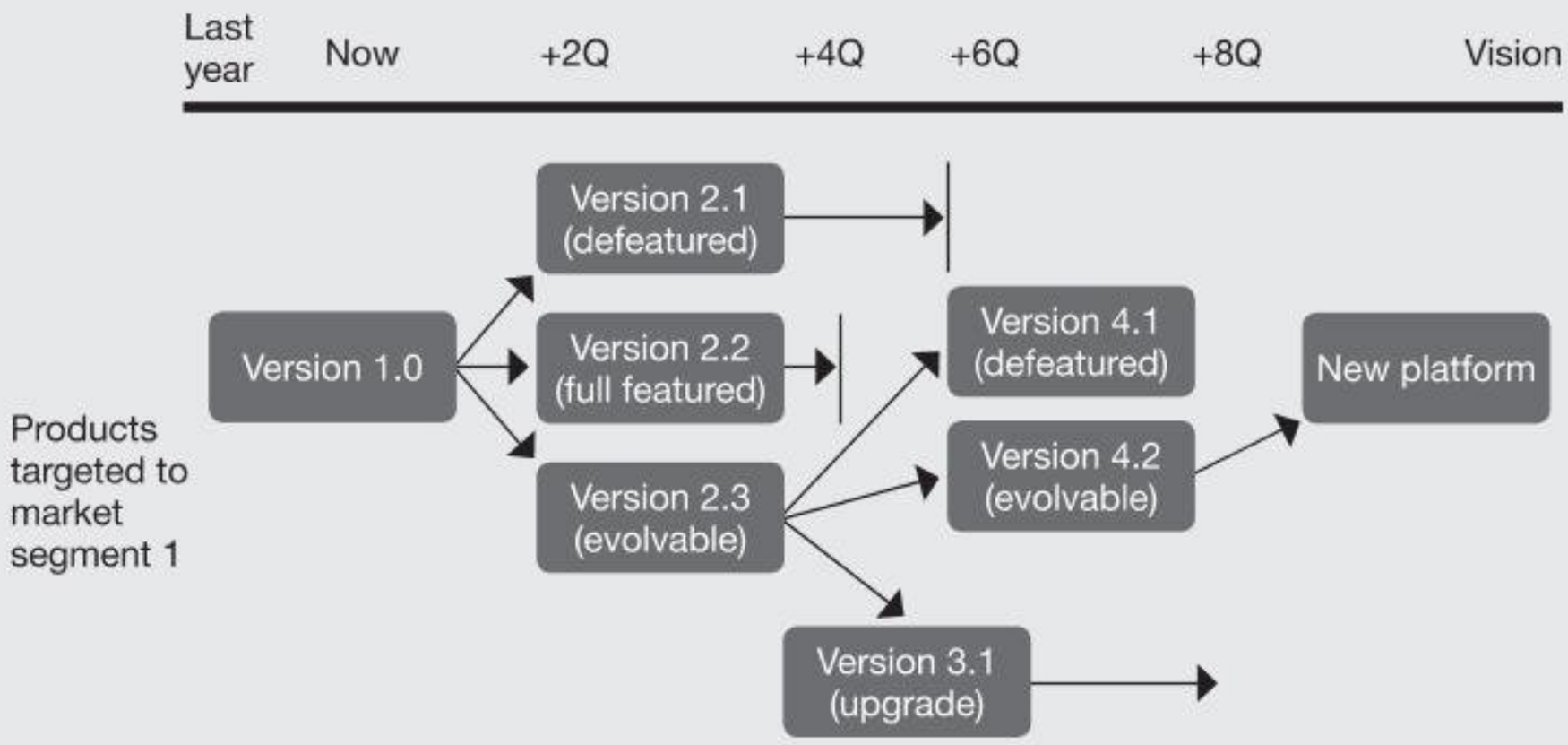


**Figure 10.6** Lucent Technologies product roadmap

*Source*: Albright, R. E. and Kappel, T. A. (2003) 'Roadmapping in the Corporation', *Research-Technology Management*, **42**(2), 31–40.

is captured and summarized. The process starts with the market, considering both customers and competitors. This information, combined with inputs from the business strategy, drives the next step, which focuses on the product, including customer needs (requirements) and forecasts of product performance, leading to a product roadmap that sets out the key development phases (see Figure 10.6). Technology development must be considered in parallel, since product functionality and performance are closely linked to technological capability. Technology strategy is summarized in a technology roadmap (Figure 10.7), together with the associated costs, actions and risks.

The experience of Lucent Technologies highlights five key benefits from the process, focusing the team's thinking on the most important priorities at each step:

1. Linking strategy to product or technology plans, which are typically developed by different functional groups within the business.
2. Enabling corporate-level technology plans through the aggregation of product-level roadmaps.
3. Focusing on longer term planning by extending the planning horizon beyond strategy time frames.
4. Improving communication and ownership of plans through the joint development of integrated and aligned roadmaps.
5. Focusing planning on the highest priority topics by the use of structured visual representations of the various components of strategic planning.

## Key Questions

1. What is roadmapping?
2. What are the advantages and disadvantages of roadmapping?
3. What is the process of roadmapping?

## Exercises

### 1. Bicycle company: Biko

Figure 10.7 below shows a roadmap developed by Biko, a traditional, but well-regarded, bicycle manufacturer with a strong brand and global manufacturing and distribution networks. Biko has just been acquired and its new owner has requested this technology roadmap to communicate Biko's business vision and strategic plan, as a basis for investment decisions.

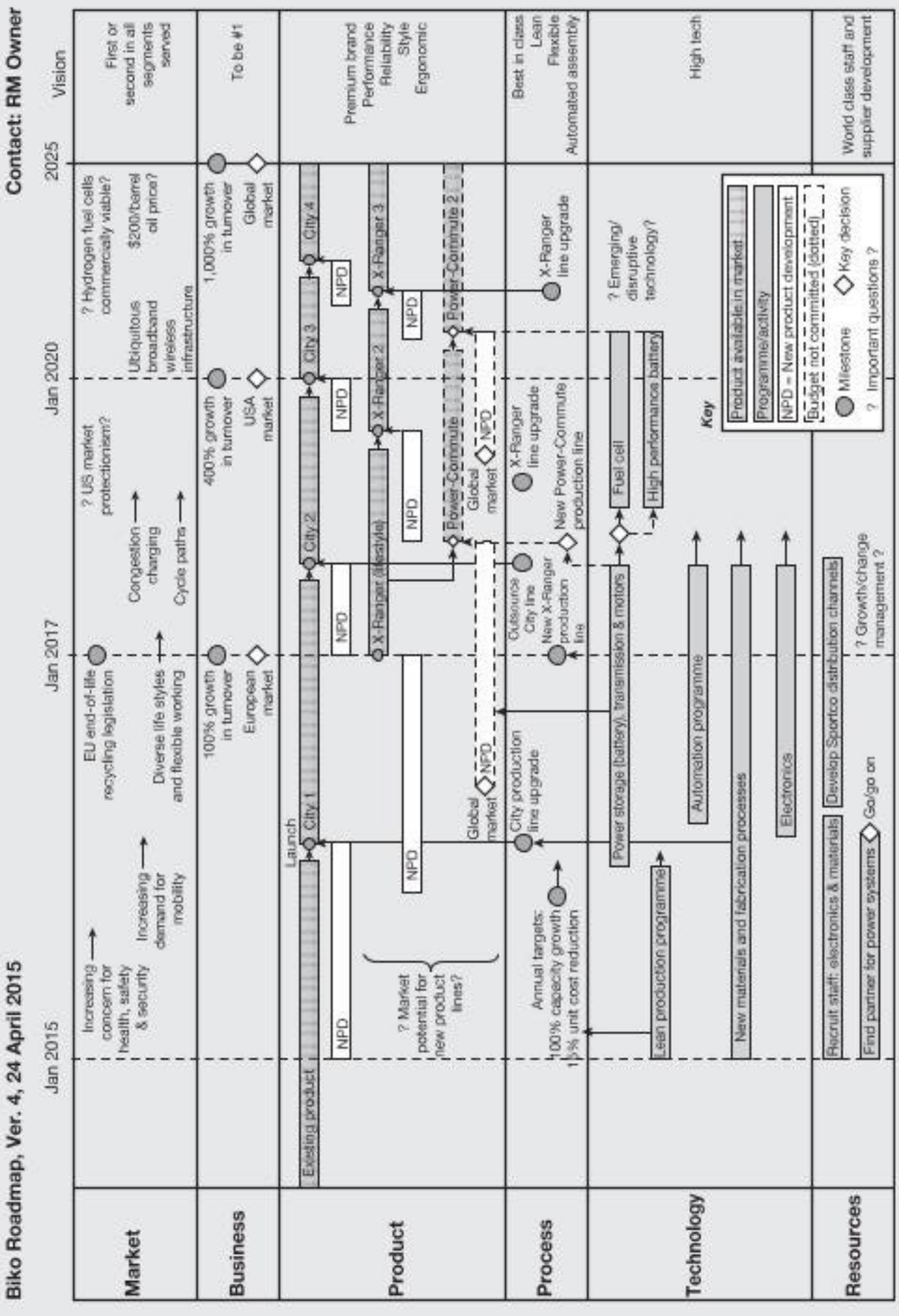


**Figure 10.7** Biko's roadmap

Two key opportunities for product innovation have been identified: power-assisted bikes, typically for commuting; and high-performance 'lifestyle' bikes, such as mountain bikes. Roadmaps were produced for each of these options to explore how the existing product could be upgraded (in two years' time); the form a radical new product could take (in five years' time); and what a next generation product might look like (in ten years' time) – a product vision.

These product-level roadmaps were combined to create a business-level 'portfolio' roadmap (see Figure 10.7), showing how the existing product can provide a platform from which three distinct new product variants can be developed to serve different market segments: the robust 'City' bicycle range for general urban use, based directly on the current product; the 'X-Ranger' high-performance leisure bicycle, aimed at the affluent young professional; and the 'Power-Commute' power-assisted bicycle aimed at the growing professional urban commuting market.

With reference to the above roadmap, discuss:

**a** The meaning of each layer (market, business, etc.) of the roadmap.
**b** The critical links between layers, giving examples.
**c** Where the key strategic decision points are in the roadmap.
**d** What further information will be needed before investment decisions can be made with confidence.
**e** Discuss the relationship between roadmapping and innovation and business strategy processes in the firm and how roadmapping can support these.

*Source*: Center for Technology Management, University of Cambridge.

## 2. The Intelligent Transportation (ITS) Roadmap

Based on the information given below, try to build a technology roadmap for the Canadian government to build its ITS and discuss a strategy to follow.

The Vision: Canada becomes a key player in wireless backhaul systems for ITS by 2026. A 5% share of the world market is a reasonable goal. ITS should not be limited to highway systems – for example, Canada has a huge pipeline transportation system.
The Strategy: Development of an integrated human resources response to exploit the product, technology and market drivers.

### Product drivers

Passive Sensors – 2016–2019.
Risk Capital – 2019–2022.
Flexible Networks – 2019–2022.
Intelligent Sensors – 2018–2024.
Human Implant Sensors – 2018–2026.
Smart Cards – 2016–2019.

### Market drivers

Personal Safety – 2016–2019.
Security of Information – 2016–2023.
Need for Real-Time Information – 2017–2024.
Aging Population – 2018–2026.
IP Compatibility – 2016–2019.

(*Continued*)

### Technology drivers

Sensor Data Fusion – 2016–2024.
5G – 2019–2026.
Standards Know-How – 2018–2022.
Improved Battery Life – 2018–2023.
Nanotechnology (nano generators) – 2019–2025.
Encryption – 2018–2020.
Spectrum Limitations – 2021–2026.
Software Expertise – 2016–2023.

### Response to drivers

- Encourage the formation of Canadian multinational enterprises in response to globalization. This will require improvements in our financing infrastructure, particularly in the availability of pools of Canadian buyout capital.
- Encourage collaboration between industry groups.
- Address software engineering. This is a global issue but Canadian policy makers should be aware of it.

### Human resources issues

- Government monitors skills requirements and alerts industry and academia about impending shortages.
- A greater emphasis on soft skills development is recommended to deal with complex management systems which are in turn related to globalization.
- A greater emphasis on co-op programmes to accommodate the shift in corporate infrastructures brought about by globalization (for example large companies are not the training grounds they used to be).
- The processes involved in career selection should be better understood. Guidance counsellors play a critical role.

### Key external factors

- Transfer of R&D and Manufacturing offshore.
- Globalization complicates the management of software development.

*Source*: http://www.ic.gc.ca/eic/site/trm-crt.nsf/eng/rm00259.html#return72 (Dates are fictitious)

## Further reading

Dissel, M., Phaal, R., Farrukh, C. J. and Probert, D. R. (2009) 'Value Roadmapping', *Research-Technology Management*, **52**(6), 45–55.
Phaal, R., Farrukh, C. J. and Probert, D. R. (2004) 'Customizing Roadmapping', *Research-Technology Management*, **47**(2), 26–37.