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Strategic roadmapping: identifying and exploring innovation opportunities

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Abstract

Roadmapping has become one of the most widely used approaches for supporting innovation and strategy, at both firm and sector levels. A key benefit is the communication associated with the development and dissemination of roadmaps, particularly for aligning technology and commercial perspectives. This paper presents a workshop-based method for supporting the identification and exploration of strategic innovation opportunities, as part of a 'fast-start' approach for the rapid initiation of roadmapping. The approach has been tested in 17 applications, covering a broad range of organizational contexts, at both the firm and sector levels. Details of the workshop approach and facilitation techniques are described.

1. Introduction

Since the initial development of the technology roadmapping approach in the late 1970s by Motorola (Willyard & McClees, 1987) to support the linkage of strategic product and technology plans, the method has been adopted (and adapted) by many different organizations in different domains, at the firm, sector and national levels, to support a range of different strategic goals.

Although roadmaps are used for a range of purposes and can take various forms (Phaal *et al.*, 2004a), they generally aim to capture a high level, synthesized and integrated view of strategic plan/s, in a simple graphical or tabular format, as the focal point of a strategic planning document or business case. In addition, they seek to answer three simple questions (simple to pose, but not to answer), considering a range of perspectives, including markets, products and technology: 1) where are we going? 2) where are we now? and 3) how can we get there?

Exhibit 1 illustrates perhaps the most useful and powerful format that roadmaps can take, comprising a multi-layered time-based chart, showing how various functional strategies align.

<< INSERT Exhibit 1 – Multi-layer roadmap structure supports alignment of strategic plans (adapted from EIRMA, 1997) >>

Early adopters of the roadmapping approach included firms in the consumer electronics sector, such as Philips (Groenveld, 1997) and Lucent Technologies (Albright & Kappel, 2003), and also organizations in other technology intensive sectors – primarily aerospace and defense. A key landmark in the evolution of the approach was the development of the sector-level semiconductor roadmap, initially in the USA and then internationally (Kostoff & Schaller, 2001), where competitors collaborate to ensure that the whole sector benefits through common standards and infrastructure, and to ensure appropriate government funding and support. Whilst company-level roadmaps are generally highly confidential, sector-level roadmaps tend to be actively promoted and disseminated, resulting over time in the proliferation of the approach in other sectors and by governments and trade associations (for example, US Department of Energy and Industry Canada – see de Laat & McKibbin, 2003).

The range of roadmapping applications and approaches adopted is broad and increasing, leading to significant confusion in industry about how to implement the approach. As a contribution to addressing this challenge, this paper describes a workshop-based roadmapping process for supporting the identification and exploration of strategic and innovation opportunities. The process represents a development of the T-Plan process (Phaal *et al.*, 2001), which is aimed at the rapid initiation and customization of the roadmapping approach, summarized in Section 2, below. The work described forms part of a wider ongoing research project investigating methods for appraising the business potential of technology.

2. T-Plan ‘fast-start’ roadmapping approach

One of the reasons why organizations struggle with the application of roadmapping is that the approach generally has to be tailored to the specific needs of the firm, and its business context (Phaal *et al.*, 2004b). This need for customization has resulted in published guidance to support the implementation of roadmapping being limited, and so organizations have to re-invent, develop and adapt the process. The development of an effective roadmapping process within a business is reliant on significant vision and commitment for what is an iterative, and initially exploratory, process.

To address this industrial need, a ‘fast-start’ process (‘T-Plan’) was developed to support the initiation of technology roadmapping in organizations, leading to the publication of a facilitation guide (Phaal *et al.*, 2001). The T-Plan process aims to:

- Support the efficient start-up of organization-specific roadmapping processes.
- Establish key linkages between technology resources and business drivers.
- Identify important gaps in market, product and technology intelligence.

- Develop a ‘first-cut’ technology roadmap.
- Support technology strategy and planning initiatives in the organization.
- Support communication between technical and commercial functions.

The T-Plan process is workshop-based, bringing together key stakeholders and experts to capture, share and structure knowledge about the issue being addressed, to identify strategic issues and to plan the way forward. An important principle is that the roadmapping process must be ‘completed’, even if issues identified need to be captured for future consideration, and assumptions made when there are gaps in knowledge. In this way a ‘first-cut’ roadmap can be produced, delivering direct benefits, but equally importantly the participants learn how roadmapping can be applied in their particular context.

The T-Plan approach is illustrated in Exhibit 2, which comprises the following three broad phases:

1. *Planning*: this is crucial, in order to ensure that both the process and roadmap architecture are appropriate for the intended purpose.
2. *Roadmapping*: development of the first roadmap, based on multifunctional workshops. Two options are available here: the ‘standard’ process for integrated product-technology planning, and the ‘customized’ process for other applications.
3. *Roll-out*: the aim of the T-Plan approach is to develop a ‘first-cut’ roadmap as economically and quickly as possible. This provides an opportunity for the organization to assess how best to take the approach forward, prior to committing significant resources and effort.

<< INSERT Exhibit 2 – T-Plan ‘fast-start’ roadmapping process (Phaal *et al.*, 2001) >>

The T-Plan approach is intended as the first step of a longer-term roadmapping process. The challenges associated with rolling out and embedding roadmapping within an organization should not be underestimated, and companies that have succeeded in this typically report that it can take many iterations over a number of years before the full benefits of the approach are realized. Kappel (2001) identifies three iterative levels of maturity for roadmapping, which can be characterized by the degree of benefit in terms of ‘sharing’ (Level 1), ‘persuading’ (Level 2) and ‘synchronizing’ (Level 3).

The ‘standard’ T-Plan process focuses on integrated product-technology planning, based on a series of four half-day workshops, which draw on a range of knowledge and experience from within the business. The first three workshops address each layer of the roadmap successively (market and business drivers; products and services; technology and resources). The final workshop integrates the outputs of the first three and results in a ‘first-cut’ roadmap.

Technology roadmapping is an inherently flexible technique, in terms of:

- The wide range of aims that roadmapping can contribute towards.
- The timeframe covered by the roadmap (past and future).
- The structure of the roadmap, in terms of layers and sub-layers, 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.

The ‘customized’ T-Plan approach focuses on the principles of context, architecture and process, described below. These factors are considered during the planning stage, providing a checklist for supporting design of the roadmap architecture and process:

- *Context* – the nature of the issue that triggered interest in roadmapping needs to be explored and articulated, together with any constraints that will affect the approach adopted, including the following considerations:
 - *Ownership of the business problem*: the roadmapping will not be successful unless a clear business purpose and business problem owner is established.
 - *Scope*: defining the boundaries of the domain of interest (i.e. what is being considered, and what is not).
 - *Focus*: the focal issue that is driving the need to roadmap.

- *Aims*: the set of goals and objectives that it is hoped to achieve with roadmapping, in the long- and short-term. As well as the overt business aims, organizational goals are also typically included, such as the desire to improve communication and to understand how the roadmapping approach can be used to support ongoing strategic activities in the firm.
 - *Resources*: the level of resource that the organization is willing to contribute, in terms of people, effort and money.
 - *Participants*: typically a multi-functional team is required, representing both commercial and technical perspectives and with the knowledge and expertise necessary to develop a well-founded and credible roadmap.
 - *Integration*: it is important that the roadmapping activity is aligned with other business processes and systems, and takes account of the best available information.
- *Architecture* – the structure of the roadmap, in terms of (see Exhibit 3):
 - *Timeframe*: the chronological aspects of the roadmap (horizontal axis), in terms of the planning horizon and key milestones, and also whether past events and activities should be included.
 - *Layers*: the structure of the vertical axis of the roadmap, in terms of broad layers and sub-layers, which is closely related to how the business is structured and viewed (physically and conceptually). The roadmap can be considered as a ‘dynamic systems framework’ (Phaal *et al.*, 2005), providing a structure within which the evolution of a system can be mapped. Generally, the system that is of interest relates to innovation, at the firm or sector level, where there is a need to align markets (‘know-why’) with applications (‘know-what’) and resources (‘know-how’). The roadmap architecture provides a ‘common language’, which supports communication between different communities (e.g. functions, technical disciplines or organizations).
 - *Process* – the staged set of activities needed to build roadmap content, make decisions, identify and agree actions and maintain the roadmap in the future. The process includes a ‘macro’ level, in terms of the broad steps needed in the short-, medium- and long-term, as well as a ‘micro’ level, associated with the short-term and in particular the agenda that will guide the workshop/s.

<< INSERT Exhibit 3 – Generalized roadmap form, showing example layer titles on left, and general form on right >>

3. Approach for opportunity identification and exploration

Since the publication of T-Plan in 2001, research has continued to explore further the generalization and customization of the roadmapping approach (e.g. Phaál *et al.*, 2004a, 2004b, 2004c, 2004d, Wells *et al.*, 2004). A stable process has emerged, which is the focus of this paper. This will in due course be incorporated into the second edition of T-Plan, and is designed to support the identification and exploration of new strategic, innovation and business opportunities. The method is particularly suited to the ‘front-end’ of strategy and innovation processes (see Exhibit 4), and will be positioned as a precursor to the current ‘standard’ T-Plan method (i.e. if after exploring an opportunity it still looks promising, then the standard process can be applied to develop a more detailed plan).

<< INSERT Exhibit 4 – Roadmaps can provide a unifying structure and focus through strategic planning and innovation processes >>

In addition to the primary aims (identification and exploration of opportunities), there are often secondary aims, typically relating to organizational benefits such as improving communication and consensus-based decisions, team building and network development, support for development of business processes (strategy and innovation), learning about (and customizing) roadmapping, strengthening the interface between corporate research and business units and investment prioritization.

The overall process comprises six broad steps (see Exhibit 5), focused around a multi-functional workshop:

1. *Planning*: the issues relating to customization described in Section 2 are used as a checklist to support the planning activity, which is a collaborative design process involving the business and process ‘owners’. The focus, scope and aims are considered, together with roadmap architecture, process (workshop agenda), participants; logistics (schedule, venue, etc.) and required preparation.
2. *Workshop stage (a)*: development of ‘strategic landscape’, based on presentations and brainstorming activity, using roadmap template. The aim is to share and capture as many perspectives as possible across the full scope of the area of interest, together with identification of key issues.
3. *Workshop stage (b)*: identification and prioritization of strategic opportunities, using strategic landscape as a resource and to provide context.
4. *Workshop stage (c)*: explore priority opportunities in more depth, using roadmap template as a common structure. Small groups work in parallel, followed by a session where ‘first-cut’ roadmaps are presented for discussion.
5. *Workshop stage (d)*: review opportunities and agree way forward and actions, together with identifying key learning points (about the organization and roadmapping process).
6. *Review*: progress is reviewed after the workshop, at a suitable time, to ensure that the actions and learning points are taken forward.

<< INSERT Exhibit 5 – Workshop process for identifying and exploring opportunities using roadmapping approach >>

The process is quite flexible, in terms of focus, numbers of participants and timing. The process has been applied 17 times to date (see Exhibit 6), covering a range of different sectors, technology areas and organization sizes / types, including firm and sector level applications. Workshops have ranged from 1-2.5 days in duration, and have included between 15 and 35 participants. The workshop process is described in more detail in Section 4, with particular reference to how activities are facilitated, and how the flexibility of the process can be exploited.

<< INSERT Exhibit 6 – Applications of roadmapping process for opportunity identification and exploration >>

4. Workshop approach

The ‘base line’ process is configured for a one-day workshop. A typical workshop agenda is presented below, including comments and areas where the process can be ‘flexed’ (particularly if more than one day is available).

The workshop approach has been designed to be fairly light in terms of facilitation – ideally, the process is self-sustaining, and the role of the facilitator largely focuses on time keeping. This requires careful planning, to ensure that the roadmap architecture is sound, and that appropriate participants are involved. Success is largely determined by the active involvement of those participating, and works best in an organization where there is a culture of openness. Some of the facilitation techniques that have been developed are described below.

Step 1 08:30 Introduction

Aims: To introduce participants to each other, and to the roadmapping process (background, aims and agenda).

Activities: Round-table introductions, followed by short presentation and questions / discussion.

Flexibility: The process may require more time for larger groups and when participants do not know each other, and can be extended to include more background on roadmapping.

Step 2 08:50 Business overview

Aims: To define the business context.

Activities: Presentation(s) and questions / discussion.

Flexibility: For longer workshops, more presentations can be included (several functional perspectives, or individual presentations from each participant).

Facilitation: If multiple perspectives are to be presented, then sending participants a short predefined template is recommended. This can vary in format, but the following five slides have been frequently used:

- 1) Title (name, position).
- 2) Business overview (facts & figures: markets, turnover, staffing levels, technology, etc.).
- 3) Current situation (business performance & issues facing the business now).
- 4) SWOT analysis (strategic context: strengths, weaknesses, opportunities and threats).
- 5) Priority issues & actions (things that should be done and issues that should be responded to), in the short-, medium- and long-term.

This approach has been found to be helpful for a number of reasons:

- a) The limited number of slides encourages participants to prepare for the workshop, putting effort into thinking about the strategic issues that the organization faces.
- b) The limited number of slides encourages shorter and more focused presentations. Exceeding the time available in this session is a key risk for the facilitator; if there are a large number of presentations, then the use of a timer is recommended. If all the presentations are loaded onto one computer, then the timing can be controlled better – the use of a timed screen-saver has been found to be helpful in providing a ‘soft’ warning to presenters, followed by a ‘hard’ warning from the timer alarm.
- c) The common template helps to compare different perspectives, and the format of the final slide in particular is key, as it is ‘roadmap-friendly’ (i.e. the time frames relate directly to the roadmap architecture, and the content of the presentations can be transcribed onto the roadmap wall chart).

Participants are provided with packs of sticky notes at the start of the workshop, and encouraged to capture issues that arise during the presentations and discussions on these notes, for transferal to the roadmap wall chart in the next session.

Step 3 09:30 Strategic landscape

Aims: To capture and share a wide range of perspectives, across a broad scope, to provide a resource / foundation for subsequent sessions.

Activities: Brainstorm using sticky notes on roadmap wall chart, in large group(s).

Flexibility: Additional points from ‘perspectives’ presentations can be captured on roadmap wall chart. Activity can be expanded to cover different zones of the roadmap in turn (e.g. top down vs. bottom up; forward vs. backward, etc.). Once the roadmap wall chart has been populated (i.e. brainstorm complete), it can be used as a resource to support discussion about a wide range of strategic issues, depending on the aims of the workshop.

Facilitation: A large wall chart forms the focus for this activity, structured using the roadmap architecture (see Exhibit 7). The wall chart is usually constructed from either four A0 sheets of paper, or eight flip chart sheets.

<< INSERT Exhibit 7 – ‘Strategic landscape’ workshop activity >>

Sticky notes are the primary mechanism for capturing participant views in the workshop. Each participant is provided with a pack, and encouraged to articulate clearly any view they feel is important, bearing in mind the scope and focus of the workshop. The roadmap architecture is used as a checklist to stimulate the generation of ideas, in terms of both layers and timeframes. Ideas can include current plans and activities, strategic milestones (past and future) and goals, future requirements, trends and drivers, options, risks, speculation, etc. The richer the set of views the better. The key metric used during this activity is the density and distribution of sticky notes. If links between perspectives are identified then participants are encouraged to capture these. Throughout the workshop participants can add views to the wall chart.

The way in which this activity is normally run is to encourage participants to generate 5-10 sticky notes initially, through discussion in pairs. Then participants take turns to place one or two sticky notes on the wall chart each, explaining their point to the group. This process continues until there is about 10 minutes left for this activity, at which point participants are encouraged to place their remaining sticky notes on the chart. The mix of 'serial' and 'parallel' brainstorming provides a balance between the need to share knowledge and keep to time.

Each participant is then provided with one or two arrow-shaped sticky notes, to identify the 'mountains, rivers, ravines and swamps' in the landscape (i.e. to identify the one or two most important issues that they feel passionately about). However, the participants are not allowed to point this arrow at one of their own sticky notes (this is to encourage participants to read the sticky notes that were captured during the parallel brainstorming activity). Each participant then briefly summarizes the issue/s they have identified, including discussion as time allows. The type of issues identified by the arrows depends on the aims of the workshop – the target can be quite specific (e.g. research priorities) or general (e.g. strategic issues). If time is short, then arrows can be pointed at opportunities and threats (allowing step 5 to be circumvented). If appropriate, then the strategic issues identified with arrow sticky notes can be prioritized using the 'sticker vote' technique described below (step 5).

The strategic landscape activity is essentially a type of brainstorming approach. The key advantages of this technique, compared to other brainstorming approaches, are:

- 1) It is structured by the roadmap architecture – each sticky note is positioned in terms of timeframe and layer.
- 2) It is efficient, due to the parallel element of the activity, which allows the timing to be managed even for large groups.
- 3) It is consensual / democratic, in the sense that all participants have equal rights to generate and capture their perspectives.

Step 4 10:30 Break

Activities: Refreshments & networking

Step 5 10:45 Strategic opportunities

Aims: To identify strategic opportunities and options that could be pursued, including product and process innovation.

Activities: Identify, cluster and prioritize strategic opportunities & options.

Flexibility: If less time is available, or for larger groups, the arrow sticky note activity in the strategic landscape session can be used to identify and prioritize opportunities directly, although this is not ideal as it is desirable to identify a rich and complete set of opportunities.

Facilitation: A traditional brainstorming technique is used here, with between 30 and 80 opportunities typically identified, captured on flip chart sheets. Similar ideas should be clustered and duplicates removed before the opportunities can be prioritized. A simple 'sticker vote' technique is used to prioritize the

opportunities, where each participant is provided with 5-10 small colored stickers (depending on how many opportunities have been identified). After a discussion about the assessment criteria (“how would you know a good opportunity if you saw one?”), each participant votes for the opportunities they feel have the most potential. The votes are then counted to identify the top 10-15 opportunities.

Step 6 12:00 Break

Activities: Lunch & networking

Facilitation: The break provides an opportunity for the facilitator, supported by a small group of participants (including the sponsor) to review the opportunities, to ensure that the set worked on during the afternoon are coherent with the aims of the workshop. Suitable small groups of 2-4 participants need to be identified to explore the opportunities in more detail, generally comprising a mix of technical and commercial expertise.

Step 7 12:45 ‘First-cut’ roadmaps for priority opportunities

Aims: To explore priority opportunities in more detail.

Activities: Small multifunctional groups (2-4 participants) use the roadmap template to articulate a priority opportunity and explore possible routes forward.

Flexibility: If more time is available it is possible to conduct several ‘rounds’, to cover more of the opportunities that have been identified.

Facilitation: Normally the identified groups are allowed to self-select the topic that they feel most competent to tackle. Each group is provided with a roadmap template (normally an A0 or one flip chart sheet, structured using a simplified roadmap architecture). The groups are challenged to use this template to explore the opportunity in more depth, in terms of articulating the nature of the opportunity, and then identifying possible routes forward, together with learning points. This is a creative challenge, and the approach adopted depends on the nature of the opportunity and the composition of the group. The participants are encouraged to think of the roadmap template as a ‘canvas’ and are provided with a rich ‘pallet’ of sticky notes and pens (colors and shapes). Showing participants a range of photographs of previous workshop outputs is helpful (see Exhibits 8 and 9).

<< INSERT Exhibit 8 – ‘Opportunity exploration’ roadmap activity >>

<< INSERT Exhibit 9 – Example ‘first-cut’ roadmap for opportunity >>

Step 8 14:30 Break

Activities: Refreshments & networking

Step 9 14:45 Feedback & review

Aims: To present, review and update the ‘first-cut’ roadmaps for each opportunity.

Activities: Short presentations from each group, together with questions & discussion.

Facilitation: Roadmaps should be considered as a combination of a ‘picture’ and a ‘story’. These first-cut roadmaps are often termed ‘topic’ or ‘narrative’ roadmaps, and articulating the content and logic of the roadmap is important. It is helpful to take notes to ensure that the narrative is captured.

Step 10 16:40 Way forward

Aims: To review progress and agree way forward and actions.

Activities: Discussion.

Flexibility: Aligning the roadmapping activity with other business systems and processes is a key success factor, in terms of sustaining the initiative. Thus, if possible, standard business templates are identified (e.g. a business case template to capture the narrative for each topic roadmap), and actions and deadlines are associated with business process milestones (e.g. feeding roadmaps into the annual strategic planning cycle or new product development process).

Facilitation: Three areas are generally covered:

- 1) Review of opportunities covered, to agree which ones are worth pursuing further (“who does what by when?”), and to identify which additional opportunities (not covered due to time constraints) should also be considered.
- 2) Review of learning points concerning the organization (e.g. knowledge gaps, business processes, structure, etc.).
- 3) Review of learning points concerning the roadmapping process, in terms of how successful the workshop was, and how best to implement the technique.

Step 11 17:00 Close

Facilitation: Participants are thanked for their contribution. All sticky notes are taped down, and all captured content from the workshop is translated into electronic form for distribution to participants, as soon as possible after the workshop.

5. Summary and conclusions

A new workshop-based process has been described, which uses roadmap templates to support the identification and exploration of strategic and innovation opportunities. The approach, which has been developed and tested in collaboration with industry, has proved to be flexible in terms of the range of strategic issues, organizations, sectors and technologies that can be addressed.

A key advantage of the approach is the communication that is engendered, both during the workshop and afterwards, using roadmaps as a common reference point and as language to support the ongoing dialogue that is essential for effective innovation and strategy development and implementation. In particular, the broad systems-based foundations of the approach, supported by appropriate workshop techniques, enable participants from very different backgrounds (disciplines, functions, countries and organizations) to communicate more effectively. The ‘hands-on’ nature of the process, where the group is responsible for building a common visual representation of their strategic context, is considered to be a key reason for the success of the process.

Research continues in this area, to further explore the application of roadmapping techniques. Of particular interest is how to support the exploration of early-stage technologies and technology ‘push’ applications. Also of interest is the use of roadmapping techniques to support specific sectors and technologies, such as environmental sustainability and emerging technologies.

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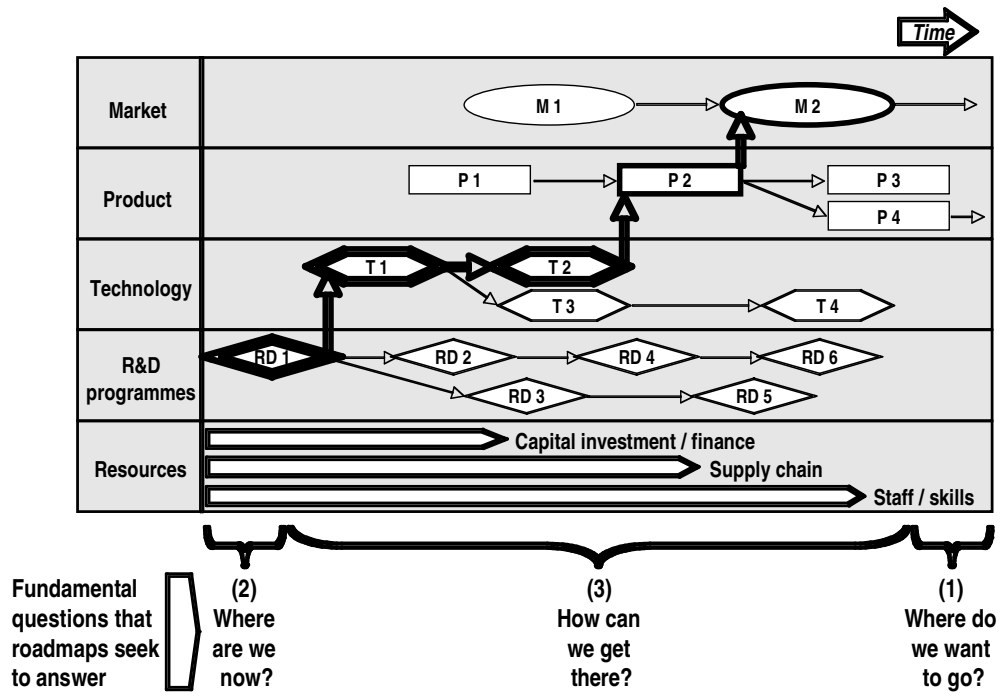


Exhibit 1 – Multi-layer roadmap structure supports alignment of strategic plans (adapted from, EIRMA, 1997)

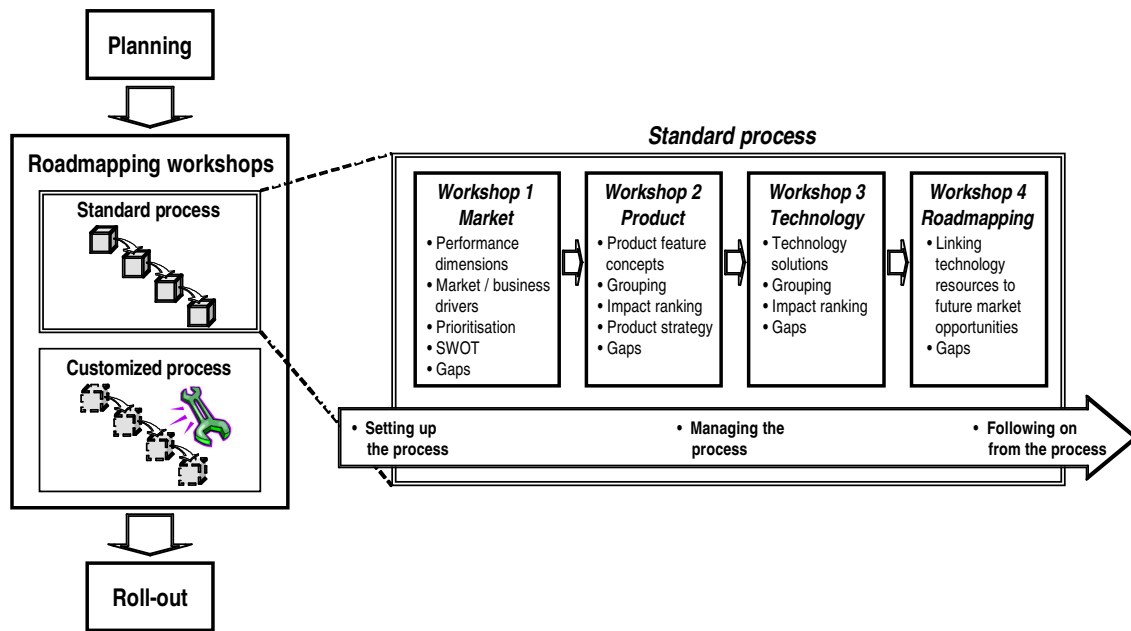


Exhibit 2 – T-Plan ‘fast-start’ roadmapping process (Phaal *et al.*, 2001)

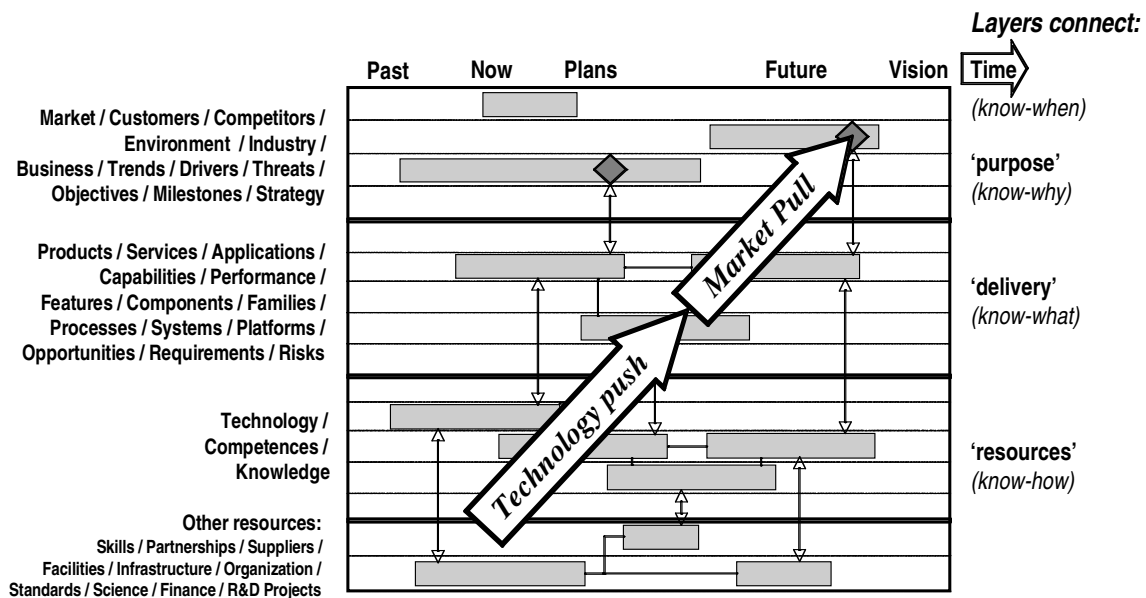


Exhibit 3 – Generalized roadmap form, showing example layer titles on left, and general form on right

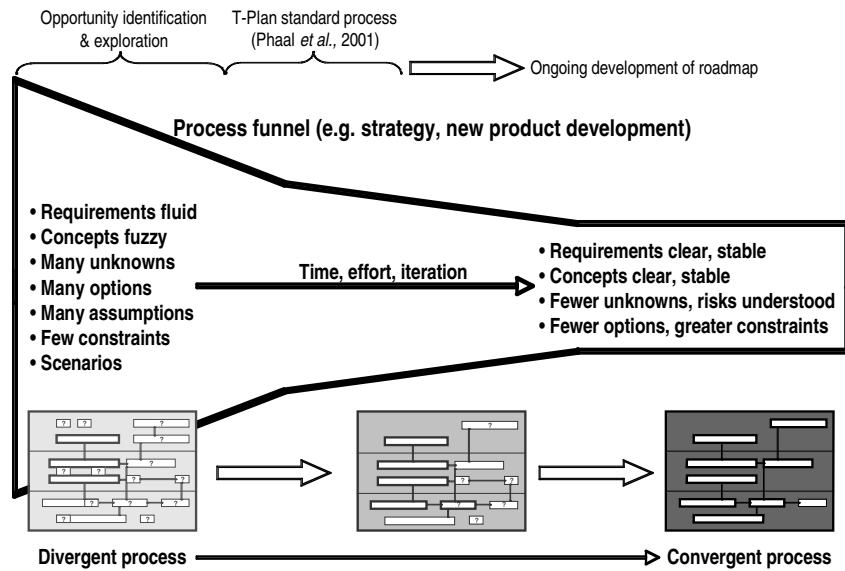


Exhibit 4 – Roadmaps can provide a unifying structure and focus throughout strategic planning and innovation processes

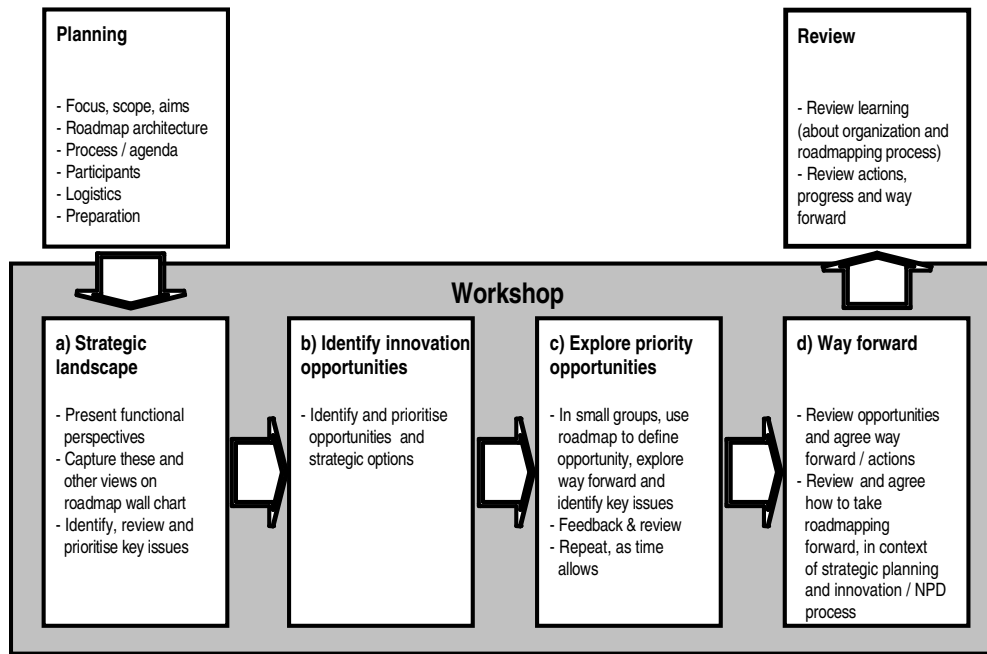


Exhibit 5 – Workshop process for identifying and exploring opportunities using roadmapping approach

<i>Case #</i>	<i>Sector</i>	<i>Context / comments</i>
1-4	Packaging	Metal / plastic; large global company; alignment of central R&D with BU requirements; large size (4 applications in different business units)
5-8	Technical consulting & contract research	Multiple technologies; UK-based / global customer base; medium size (3 applications – 1 covering full span of organization, and 3 for different business units)
9	Telecommunications	Satellites; UK-based / European consortium; large size
10	Energy management	Steam systems; UK-based / global distribution; medium size
11	Specialist adhesives	Semiconductors; US-based / global manufacturing; medium sized; sub-division of large global company
12	Aerospace	Civil aviation; European consortium / UK manufacturing focus; large size
13	Computational science	International consortium; research prioritization, policy & education agenda
14	Automotive	Construction; UK-based global; large size
15-17	Food processing, Chemical process and Healthcare	UK regional consortia; network development and regional priorities (including two applications by third party)

Exhibit 6 – Applications of roadmapping process for opportunity identification and exploration



Exhibit 7 – 'Strategic landscape' workshop activity



Exhibit 8 – ‘Opportunity exploration’ roadmap activity

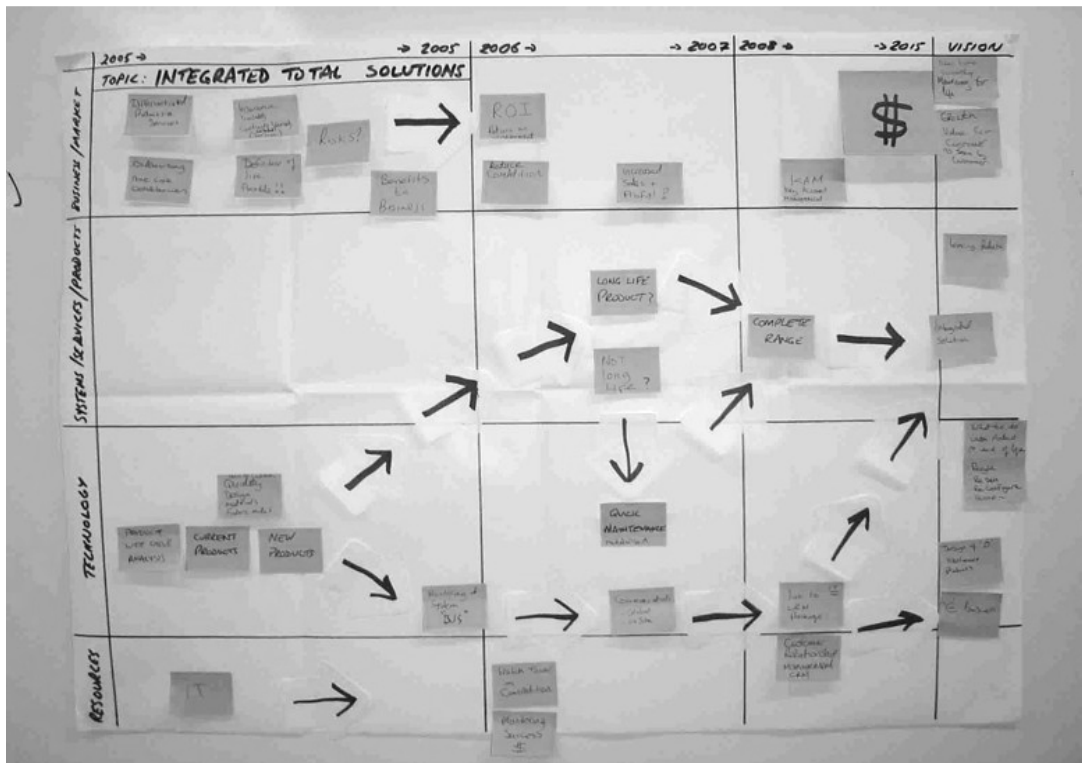


Exhibit 9 – Example 'first-cut' roadmap for opportunity