Chapter 11- TM Tools-Roadmapping

Course Contents: TM Tools-Roadmapping: Introduction, Where and why it is used, Process, Case study. [TB 1: Ch. 12)

Contents

Introduction

The technology roadmapping (TRM) method is used widely in industry. The primary role of TRM is to aid technology management and planning. In a business environment, TRMs are used to clarify the plan for the progression of a good, connecting commercial strategy to the development of the product features. The approach was originally developed by Motorola more than 25 years ago, to support integrated product-technology planning. Since then the technique has been adapted and applied in a wide variety of industrial contexts, at the company and sector levels. TRM is also adopted in many environments, including physical and service product planning, development of product family tree, and program planning.

TRM represents is a very flexible and powerful technique for supporting technology management and planning. As far as effective technology planning and cooperation for

businesses and their industries, technology road-mapping is a particularly relevant tool which works inside a broader framework of planning activities for ensuring that the needs of the company are aligned with the internal technological resources. Normally, it refers to many types of prediction studies such as visions and detailed expectations of future possible technological advancements, goods or environments.

It relies on needs that are utilized to understand and convey the various connections between organizational aims, technological resources, and the evolving environment. By singling out key facilitating technologies and gaps in technology, it helps to leverage R&D investments, technological investment and strategically planning.

TRM generally comprises of multi-layered time-based charts that enable technology developments to be aligned with market trends and drivers. It can take various forms, but the most common approach is encapsulated in the generic form proposed by EIRMA (1997) - see Fig. 2. The generic roadmap is a time-based chart, comprising a number of layers that typically include both commercial and technological perspectives. The roadmap enables the evolution of markets, products and technologies to be explored, together with the linkages between the various perspectives. Figure 2 shows a generic technology roadmap explaining how technology can become aligned to business strategy, good and service developments, and market opportunities.

Figure 2:

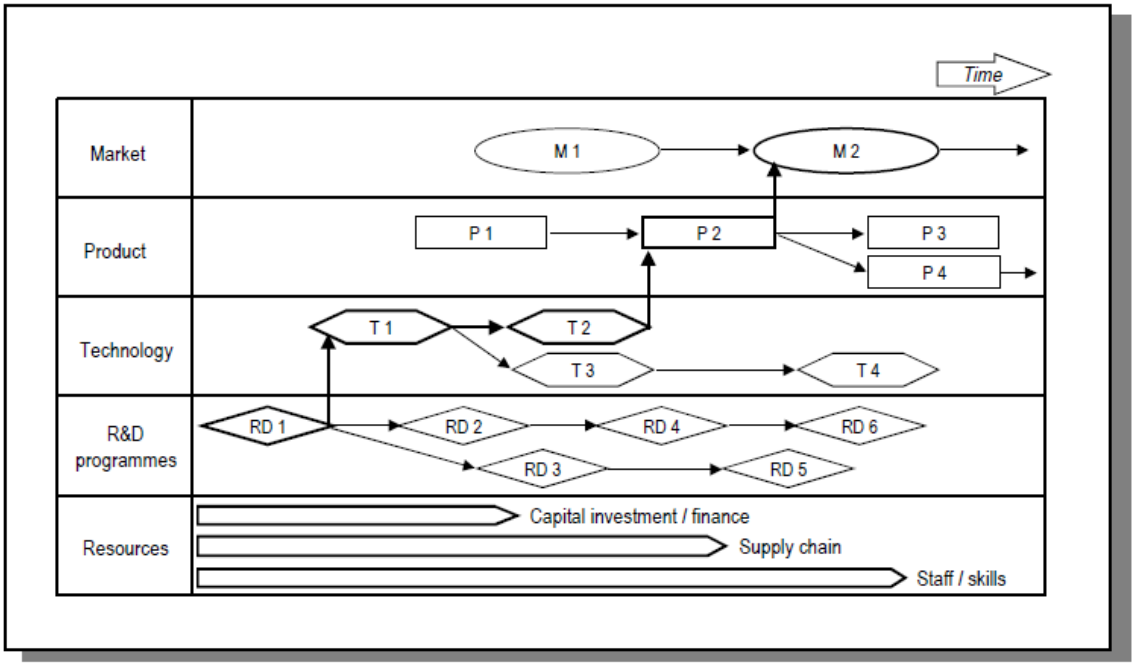


Fig. 2 - Schematic technology roadmap, showing how technology can *be aligned to product and service developments, business strategy, and market opportunities.*

At levels such as market, product and technology levels, TRM comprises many prospective benefits and uses. The primary advantage of TRM is the data that it provides facilitate improved technology investment decisions. This is achieved by singling out key gaps in technology or technologies that must be remedied to ensure future good performance targets are met. Some benefits of TRM can be listed in the following points:

1. It can facilitate the development of an understanding about a group of needs and the technologies needed to meet those needs.
2. It can offer a structure to aid planning and the coordination of technology developments both within a company or an entire industry.
3. From marketing viewpoint, a TRM can demonstrate that a business comprehends client wants and has access to or is forming the technologies to meet their needs.
4. It offers a method that aid experts to predict and forecast technology developments in specific areas.

TRMs obviously hold significant potential to help the progression and implementation of business, good and technology strategy, offering businesses with the data, systems and structure to create them.

Technology Roadmap

A technology roadmap is a plan that matches short-term and long-term goals with specific technology solutions to help meet those goals. It is a plan that applies to a new product or process, or to an emerging technology. Developing a roadmap has three major uses.

1. It helps reach a consensus about a set of needs and the technologies required to satisfy those needs
2. It provides a mechanism to help forecast technology developments
3. It provides a framework to help plan and coordinate technology developments

Technology Roadmapping Process

The technology roadmapping process conducts three phases: preliminary activities, the development of the roadmap, and the follow-up activities phase. Because the process is too big for one model, the phases are modeled separately. In the models no different roles are made; this is because everything is done by the participants as a group.

Phase 1: Preliminary phase

The first phase, the preliminary phase, consists of 3 steps:

1. satisfy essential conditions,
2. provide leadership / sponsorship, and

3. define the scope and boundaries for the technology roadmap.

In this phase the key decision makers must identify that they have a problem and that technology roadmapping can help them in solving the problem.

Satisfy essential conditions
In this step it must become clear what the conditions are (they must be identified) and if they are not met, who takes actions to meet them. These conditions include, for example:

- A need for the technology roadmap
- Input and participation from different parts of the organization (e.g., marketing, R&D, the strategic business units) with different planning horizons and perspectives.

All conditions should be satisfied (or an agreed-on party takes necessary actions) to continue to the next step. The participants can have zero or more conditions of their own. It applies to all conditions that have the attribute to be met or not.

Provide leadership / sponsorship
Committed leadership is needed because of the time and effort involved in creating a technology roadmap. Additionally the leadership should come from one of the participants, one of them provides leadership and sponsorship. This means that the line organization must drive the process and use the roadmap to make resource allocation decisions.

Define the scope and boundaries
In this step the context for the roadmap is specified. In the company a vision should exist and it must be clear that the roadmap can support that vision. If the vision does not exist one should be developed and clearly stated. When that is done the boundaries and the scope of the roadmap should be specified. Furthermore, the planning horizon and the level of details should be set. The scope can be further divided into the technology scope and the participation scope.

In table 1 all the different sub-activities of the preliminary activity phase can be seen. All the sub-activities have concepts as end products (marked in bold). These concepts are the actual meta-data model, which is an adjusted class diagram.

Table 1. Activity table for the preliminary activity phase

Activity	Sub-Activity	Description
Satisfy essential conditions	Identify essential conditions	When all the **participants** come together, essential **conditions** can be identified (e.g. what groups should be involved, what are the key customers and what are the key suppliers).
	Take action to satisfy conditions	For technology roadmapping to succeed, **conditions** from the **participants** must be satisfied.
Provide leadership / sponsorship		The part of **leadership** / **sponsorship** should be taken by line organization; they must drive the roadmapping process and use the roadmap to make resource allocation decisions.
Define the scope and boundaries for the technology roadmap	Clearly state vision	The already existing **vision** must be clear.
	Develop vision	The **vision** is developed and stated clearly.
	Define scope	The **scope** of the project can further define the set of **needs**, **planning horizon** and level of **detail**. The scope can be further divided into the **technology scope** and the **participation scope**.
	Define boundaries	The **boundaries** should also be included.

Phase 2: Development phase

The second phase, the development of the technology roadmap phase (see figure 3.), consists of 7 steps:

1. Identify the "product" that is the focus of the roadmap,
2. Identify the critical system requirements and their targets,
3. Specify the major technology areas,
4. Specify the technology drivers and their targets,
5. Identify technology alternatives and their timelines,
6. Recommend the technology alternatives that should be pursued, and
7. Create the technology roadmap report.

Identify the product focus of the roadmap

In this step the common product needs are identified and are agreed on by all the participants. This is important to get the acceptance of all groups for the process. In case of uncertainty of the

product needs scenario-based planning can be used to determine the common product needs. The participants and possibly the scenario-based planning provide the common product needs.

Identify the critical system requirements and their targets

Once it is decided what must be roadmapped, the critical system requirements can be identified; they provide the overall framework for the technology roadmap. The requirements can have targets like reliability and costs.

Specify the major technology areas

These are the areas that help achieve critical system requirements. For each technology area several technologies can be found. Example technology areas are: market assessment, crosscutting technology, component development, and system development.

Specify the technology drivers and their targets

In this step the critical system requirements from the second step are transformed into technology drivers (with targets) for the specific technology area. These drivers are the critical variables that select the technology alternatives. Drivers depend on the technology areas but they relate to how the technology addresses the critical system requirements.

Identify technology alternatives and their timelines

At this point the technology drivers and their targets are specified and the technology alternatives that can satisfy those targets should be specified. For each of the alternatives a timeline should be estimated for how it will mature with respect to the technology driver targets.

The time factor can be adapted suitable for the particular situation. The time horizons for e-commerce and software related sectors are usually short. Other distinctions can be made on scale and intervals.

Recommend the technology alternatives that should be pursued

Because the alternatives may differ in costs, timeline, etc., a selection must be made of the alternatives. These are the alternatives to pursue. In this step a lot of trade-offs must be made between different alternatives for different targets: for example, performance over costs and even target over target.

Create the report

At this point the technology roadmap is finished. In figure 3, it can be seen that the technology roadmap report consists of 5 parts:

1. the identification and description of each technology area,
2. critical factors in the roadmap,
3. unaddressed areas,
4. implementation recommendations, and
5. technical recommendations.

The report can also include additional information. In table 2 all the different sub-activities of the development phase can be seen.

Activity table for the development phase

Activity	Sub-Activity	Description
Identify the "product" the roadmap focuses on	Identify needs	This critical step is to get the participants to identify and agree on the **common product needs**. This is important to get their acceptance.
	Use Scenario-based planning	If there is major uncertainty about the common product needs, then **scenario-based planning** can be used. Each scenario must be reasonable, internally consistent and comparable with the other scenarios.
	State needs	These are the needs for the product.
Identify the critical system requirements and their targets	Define critical system requirements	The **critical system requirements** provide the overall framework for the roadmap and are high-level dimensions the technologies relate to. These include things like reliability and costs.
	Define targets	For each of the system requirements **targets** must be defined.
Specify the major technology areas	Transform requirements into technology oriented drivers	The major **technology areas** should be specified to help achieve the critical system requirements for the product. The critical system requirements are then transformed into **technology drivers** for the specific technology areas.
Specify the technology drivers and their targets	Select technology alternatives with their targets	**Technology drivers** and their targets are set based on the critical system requirement targets. It specifies how viable **technology alternatives** must be to perform by a certain date. From the available technology alternatives a selection must be made.
Identify technology alternatives and their timelines	Identify alternatives and their timelines	The **technology alternatives** that can satisfy the targets must be identified. Next to this the **timeline** from each alternative must be identified.
Recommend the technology alternatives that should be pursued	Select subset of technology alternatives must pursued	Determine which **technology alternative to pursue** and when to shift to a different technology. Consolidate the best information and develop consensus from many experts.
Create the technology roadmap report	Create the report	Here the actual **technology roadmap report** is created. This report includes: identification and description of the technology, critical factors, unaddressed areas, and implementation recommendations and technical recommendations.

Phase 3: Follow-up activity phase

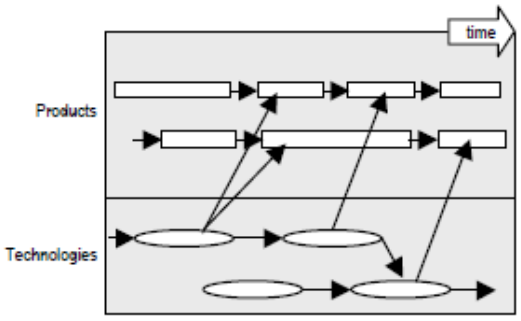
This is the moment when the roadmap must be critiqued, validated and hopefully accepted by the group involved in any implementation. This requires a plan developed using the technology roadmap. Next, there must be a periodical review and update point, because needs from the participants and the technologies evolve.

Technology Roadmapping Application Areas

The technology roadmapping approach is very flexible, and the terms 'product' or 'business' roadmapping may be more appropriate for many of its potential uses. Below are some examples of roadmapping in different areas.

1. Product planning

Description: This is by far the most common type of technology roadmap, relating to the insertion of technology into manufactured

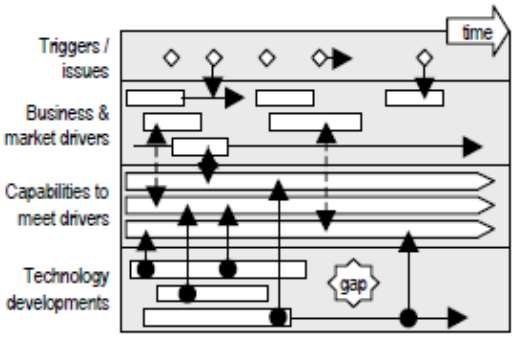


products, often including more than one generation of product.

Example: A Philips roadmap, where the approach has been widely adopted. The example shows how roadmaps are used to link planned technology and product developments.

2. Service / capability planning

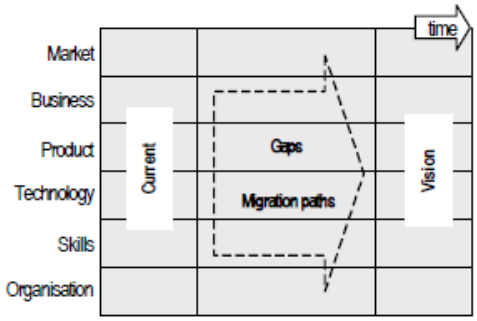
Description: Similar to Type 1 (product planning), but more suited to service-based enterprises, focusing on how technology supports organizational capabilities.



Example: A Post Office roadmap used to investigate the impact of technology developments on the business. This roadmap focuses on organizational capabilities as the bridge between technology and the business, rather than products.

3. Strategic planning

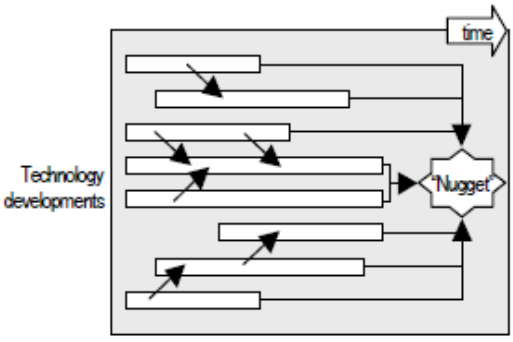
Description: Includes a strategic dimension, in terms of supporting the evaluation of different opportunities or threats, typically at the business level.



Example: A roadmap format developed using TPlan to support strategic business planning. The roadmap focuses on the development of a vision of the future business, in terms of markets, business, products, technologies, skills, culture, etc. Gaps are identified, by comparing the future vision with the current position, and strategic options explored to bridge the gaps.

4. Long-range planning

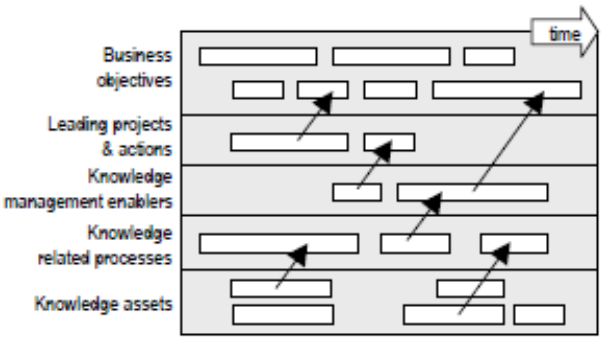
Description: Extends the planning time horizon, and is often performed at the sector or national level ('foresight').



Example: A roadmap developed within the US Integrated Manufacturing Technology Roadmapping (IMTR) Initiative (one of a series). This example focuses on information systems, showing how technology developments are likely to converge towards the 'information driven seamless enterprise' (a 'nugget').

5. Knowledge asset planning

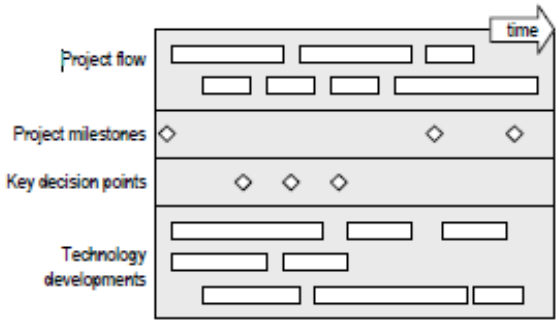
Description: Aligning knowledge assets and knowledge management initiatives with business objectives.



Example: This form of roadmap has been developed by the Artificial Intelligence Applications Unit at the University of Edinburgh, enabling organizations to visualize their critical knowledge assets, and the linkages to the skills, technologies and competences required to meet future market demands.

6. Programme planning

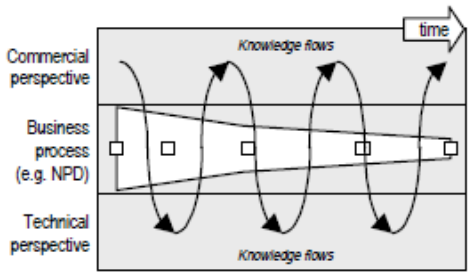
Description: Implementation of strategy and more directly relates to project planning (for example, R&D programmes).



Example: A NASA roadmap (one of many) for the Origins programme, used to explore how the universe and life within it has developed. This particular roadmap focuses on the management of the development programme for the Next Generation Space Telescope (NGST), showing the relationships between technology development and programme phases and milestones.

7. Process planning

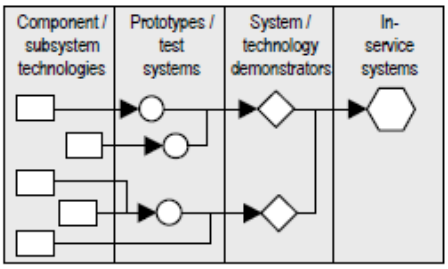
Description: Supports the management of knowledge, focusing on a particular process area (for example, new product development).



Example: A type of technology roadmap, developed using T-Plan to support product planning, focusing on the knowledge flows that are needed to facilitate effective new product development and introduction, incorporating both technical and commercial perspectives.

8. Integration planning

Description: Integration and/or evolution of technology, in terms of how different technologies combine within products and systems, or to form new technologies (often without showing the time dimension explicitly).



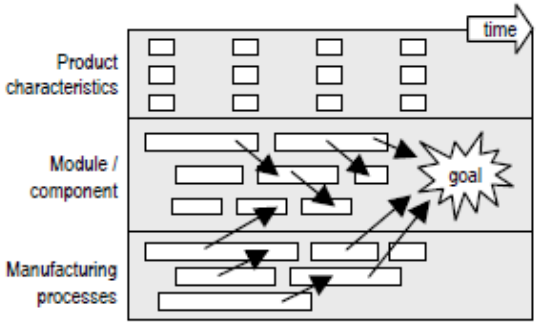
Example: A NASA roadmap7, relating to the management of the development programme for the NGST, focusing on 'technology flow', showing how technology feeds into test and demonstration systems, to support scientific missions.

Technology Roadmapping Format

Another factor that contributes to the variety of roadmaps that have been observed is the graphic format that has been selected for communicating the roadmap, with the following eight graphic types identified, based on observed structure:

a. Multiple layers

Description: The most common format of technology roadmap comprises a number of layers, such as technology, product and market. The roadmap allows the evolution within each layer to be explored, together with inter-layer dependencies, facilitating the integration of technology into products, services and business systems.



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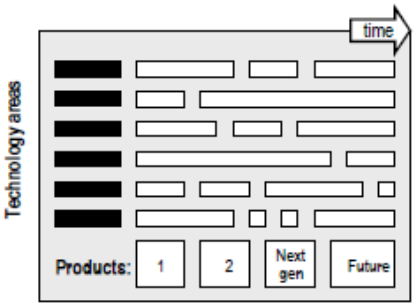
Example: A Philips roadmap, showing how product and process technologies integrate to support the development of functionality in future products.

b. Bars

Description: Many roadmaps are expressed in form of a set of 'bars', for each layer or sub-



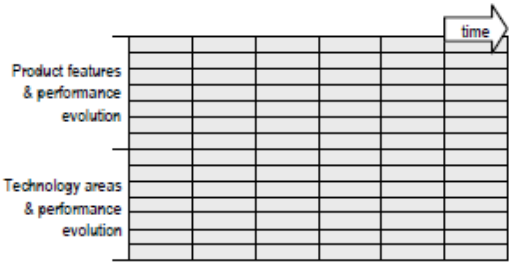
the layer.

This has the advantage of simplifying and unifying the required outputs, which facilitates communication, integration of roadmaps, and the development of software to support roadmapping.

Example: The 'classic' Motorola roadmap, showing the evolution of car radio product features and technologies. Motorola has subsequently developed roadmapping to new levels, with

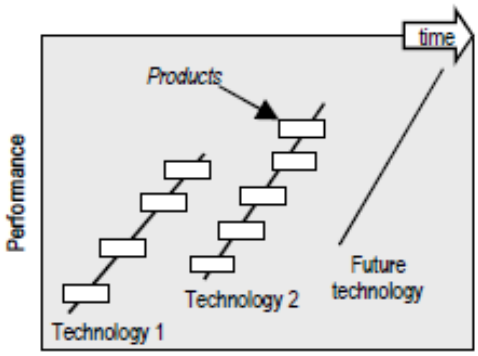
roadmaps now forming part of corporate knowledge and business management systems, supported by software and integrated decision support systems.

c. Tables



Description: In some cases, entire roadmaps, or layers within the roadmap, are expressed as tables (i.e. time vs. performance). This type of approach is particularly suited to situations where performance can be readily quantified, or if activities are clustered in specific time periods.

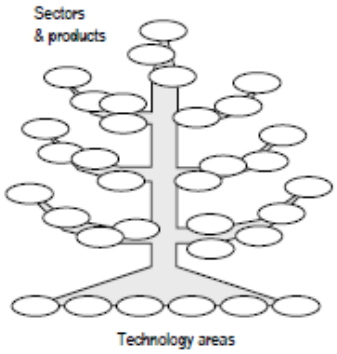
Example: A tabulated roadmap, including both product and technology performance dimensions.



d. Graphs

Description: Where product or technology performance can be quantified, a roadmap can be expressed as a simple graph or plot - typically one for each sub-layer. This type of graph is sometimes called an 'experience curve', and is closely related to technology 'S-curves'.

Example: A roadmap showing how a set products and technologies co-evolve.



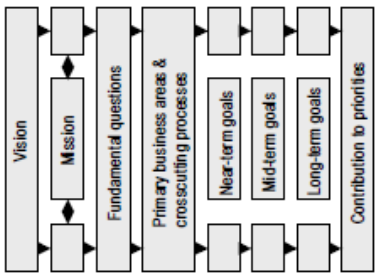
e. Pictorial representations

Description: Some roadmaps use more creative pictorial representations to communicate technology integration and plans. Sometimes metaphors are used to support the objective (e.g. a 'tree').

Example: A Sharp roadmap, relating to the development of products and product families, based on a set of liquid crystal display technologies.

f. Flow charts

Description: A particular type of pictorial representation is the flow chart, which is typically used to relate objectives, actions and outcomes.



Example: A NASA roadmap11, showing how the organization's vision can be related to its mission, fundamental

scientific questions, primary business areas, near-, mid- and long-term goals, and contribution to US national priorities.

g. Single layer

Description: This form is a subset of type 'a', focusing on a single layer of the multiple layer roadmap. While less complex, the disadvantage of this type is that the linkages between the layers are not generally shown.

Example: The Motorola roadmap, type 'b' above, is an example of a single layer roadmap, focusing on the technological evolution associated with a product and it's features.

h. Text

Description: Some roadmaps are entirely or mostly text-based, describing the same issues that are included in more conventional graphical roadmaps (which often have text-based reports associated with them).

Example: The Agfa 'white papers' support understanding of the technological and market trends that will influence the sector.

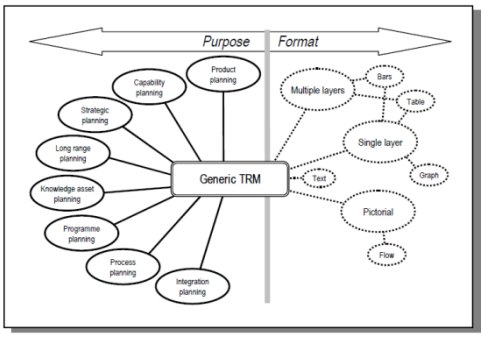


Fig. 5 - Characterisation of roadmaps: purpose and format

The range of roadmap types discussed above may be partially attributed to a lack of clear and accepted standards or protocols for their construction. However, it is considered that this also reflects the need to adapt the approach to suit the situation, in terms of business purpose, existing sources of information, available resources and desired use (the message being communicated). Roadmaps do not always fit neatly within the categories identified above and can contain elements of more than one type, in terms of both purpose and format, resulting in hybrid forms.

Technology roadmapping – T-Plan 'fast-start' approach

Phaal et al., (2001) developed the T-Plan 'fast-start' approach after developing 35 roadmaps in collaboration with a variety of company types in several industry sectors (see Table 1). T-Plan approach aims to:

1. Support the start-up of company-specific TRM processes.
2. Establish key linkages between technology resources and business drivers.
3. Identify important gaps in market, product and technology intelligence.
4. Develop a 'first-cut' technology roadmap.
5. Support technology strategy and planning initiatives in the firm.
6. Support communication between technical and commercial functions.

The T-Plan process supports the rapid initiation of roadmapping in the business comprises two main parts:

a. Standard approach, for supporting product planning (Phaal et al., 2000).
b. Customized approach, which includes guidance on the broader application of the method, incorporating many of the techniques included in the standard approach.

Table 1 - Applications of T-Plan fast-start TRM process

Sector / product	Focus / aims
Industrial coding (3 applications)	Product planning
Postal services (10 applications)	Integration of R&D into business; business planning
Security / access systems	Product planning
Software	Product planning
Surface coatings	New product development process
Medical packaging (2 applications)	Business reconfiguration
Automotive sub-systems	Service development & planning

Sector / product
Power transmission
Railway infrastructure tions)
National security infras
Building environmenta
Road transport
Technical consulting (6 tions)
Automotive / aerospac
Academic (2 applicatio
Bio-catalysis
Satellite navigation
Food processing

Pneumatic systems	Innovation strategy
Emerging technologies	Research priorities
Automotive	Innovation opportunities
Retail (2 applications)	Business strategy and product planning
Off road vehicles	Global production strategy

Standard process (integrated product technology planning)

The standard T-Plan process comprises four facilitated workshops – the first three focusing on the three key layers of the roadmap (market / business, product / service, and technology), with the final workshop bringing the layers together on a time-basis to construct the chart – see Fig. 6.

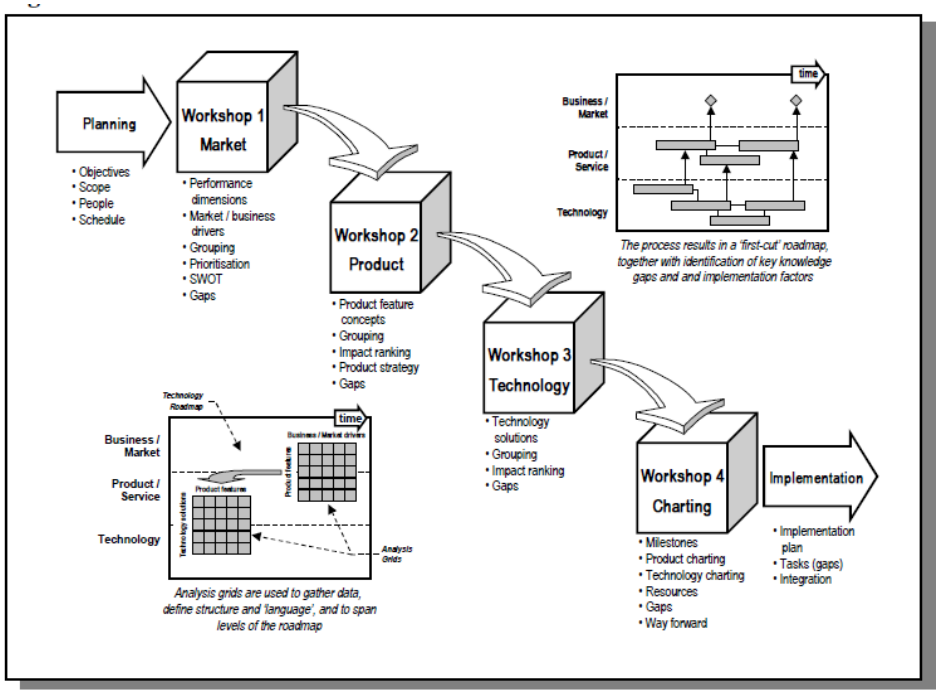


Fig. 6 - T-Plan: standard process steps, showing linked analysis grids

Also important are the parallel management activities, including planning and facilitation of workshops, process co-ordination, and follow-up actions. Simple linked analysis grids are used to identify and assess the relationships between the various layers and sub-layers in the roadmap.

Customizing the process

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 set of existing processes, tools and information sources in the firm, which the roadmap and roadmapping process need to integrate with.

Application of the T-Plan approach in a wide range of organizational and strategic contexts has enabled the flexibility of the roadmapping method to be explored. The approach can (and should) be customized to suit the particular application, in terms of roadmap architecture and the process for developing the roadmap.

The generalized roadmap shown if Fig. 7, based on observations of many roadmaps, illustrates the different layers and sub-layers that can be used to define the roadmap structure, which can be

tailored to fit the particular context. The multi-layered generic architecture allows key aspects of knowledge about the business to be captured, structured and shared, strategic issues to be identified, and actions agreed. Alignment of 'know-why' (purpose), 'know-what' (delivery), 'know-how' (resources) and 'knowwhen' (time) allows a balance between market pull and technology push to be achieved.

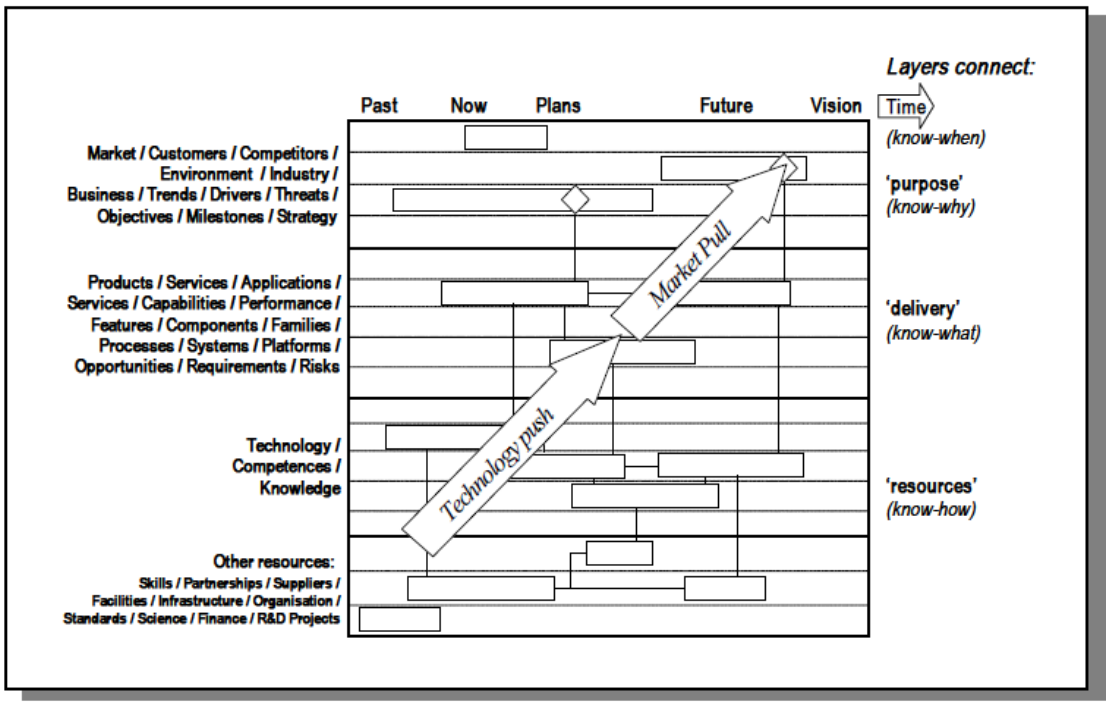


Fig. 7 - Generalised technology roadmap architecture

Customization needs to be considered during the planning phase, at the heart of which is a design activity, where both the roadmap architecture and roadmapping process need to be considered in parallel. As with all design activities, the process is creative, iterative and non-linear in nature. The following checklist is used in T-Plan applications, as a basis for focusing discussion, which continues until the parties agree a plan that makes sense to all involved:

- **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:
  - **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.

- **Architecture** – the structure of the roadmap, in terms of:
  - **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).
- **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.
- **Participants** – the people that need to be involved in the process and workshop/s, with the knowledge and expertise necessary to develop a well-founded and credible roadmap. Typically a multifunctional team is needed, representing both commercial and technical perspectives. The number of participants involved in the workshop/s depends on the specific context, and during the development and application of TPlan workshop groups ranged in size from 5 to 35 participants. The agenda and facilitation approach adopted will vary depending on group size, with the need to break into sub-groups (with plenary feedback) if the group size exceeds about 10.
- **Workshop** venue and scheduling – a suitable date and venue is needed for the workshop/s, large enough to allow participatory roadmapping activity by the group/s.

- **Information sources** – it is important that the roadmapping activity takes account of available information, although there is a practical limit as to the quantity of data that can be accommodated in a workshop environment. Relevant information should be assessed prior to the workshop, and consideration given to what information should be supplied to participants prior to the workshop, handed out at the workshop, built into the roadmap template, or incorporated after the workshop in the context of an ongoing roadmapping process.
- **Preparatory work** – activities that need to be performed prior to the workshop/s need to be identified and agreed, such as inviting participants, booking an appropriate venue, preparing briefing documents and facilitation materials.

Taking the process further

The development of an initial roadmap is the first, but very important, step on the way towards implementing roadmapping in a more complete and beneficial way, if that is deemed appropriate. The key benefit of the fast-start T-Plan approach, apart from the direct business benefits that arise from its application, is that the value of the method can be assessed quickly and economically. The learning that is gained by this initial application provides confidence about how to best take the process forward within the organization.

While some organizations choose to use the method for particular situations on a oneoff basis, others have taken roadmapping forward to form a significant part of their strategy and planning processes. Roadmapping can become the focal, integrating device for carrying the business strategy and planning process forward, bringing together the market / commercial and technological knowledge in the organization (Fig. 8). Key issues include deciding where the boundaries of the roadmapping process should lie, to what extent the method should be adopted, and how to integrate it with other systems and processes.

There are two key challenges to overcome if roadmapping is to be adopted widely within a company:

- **Keeping the roadmap alive:** the full value of roadmapping can be gained only if the information that it contains is current and kept up-to-date as events unfold. In practice, this means updating the roadmap on a periodic basis, at least once a year, or perhaps linked to budget or strategy cycles. The initial first-cut roadmap roduced by the T-Plan process must be captured, stored, communicated, researched and updated, which requires careful consideration of the process and systems needed to facilitate this.
- **Roll-out:** once the first roadmap is developed in an organization, it may be desired to facilitate the adoption of the method in other parts of the organization. Essentially there are two approaches to rolling-out the method:
  - Top-down, where the requirement for roadmaps is prescribed by senior management – the particular format may or may not be specified.
  - Bottom-up ('organic'), where the benefits of using the method are communicated and support provided for application of the method where a potential fit with a business issue / problem is identified.

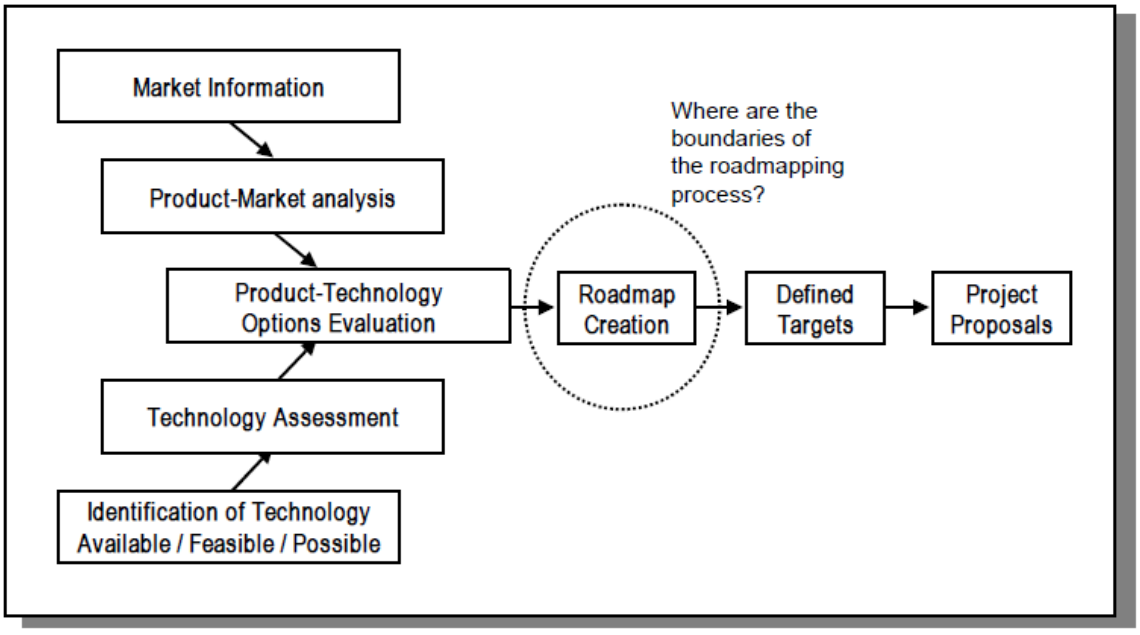


Fig. 8 – Roadmaps integrate commercial *and technological knowledge (EIRMA, 1997)*

In either case senior management support is important, in terms of enthusiasm for use of the method, but also in terms of ensuring that resources are made available (budget, time and facilitation), workshops scheduled and barriers removed.

A further issue to consider if the roadmapping method is to be used on an ongoing and more widespread basis is that of software for supporting the development, storage, dissemination and upkeep of roadmaps. Simple word processing, spreadsheet and graphics packages are suitable for the initial development of a roadmap, but more sophisticated software would be beneficial if the process is to be taken forward.

Software that is developed to support roadmapping should aim to provide the following types of functions:

- The multi-layer roadmap structure is recommended as the primary way of working with roadmapping data, owing to its simplicity and flexibility. Roadmapping objects (bars, linkages, annotations, etc.) can be defined in terms of their position in the layers, and on a time basis. The layered structure allows for a hierarchy of roadmaps to be developed, at any level of 'granularity' in the firm.
- Software should define a common architecture for building roadmaps in the firm, enabling data sharing and linkage, which requires specification of appropriate protocols and templates.
- The software should support management of the data that is associated with the roadmap, including data mining ('drill-down') and analysis, together with methods for managing the complexity of the data for the user (e.g. multiple perspectives on the data, critical paths, linkages, etc.). Inclusion of additional management 'tools', such as the analysis grids used in the T-Plan method and portfolio project selection matrices is desirable.
- The software should be as customisable as possible, in terms of setting up the layered structure, definition of roadmapping objects, choice of graphical representation, and inclusion of annotations, notes and supplementary information.
- One of the strengths of the roadmapping approach is its support for integration of information, processes and methods in the firm, and the supporting software should reflect this, proving facilities for importing and exporting data, together with linkages to other business and management information systems. In its broadest sense, the roadmapping process and supporting software can form a central element of knowledge and information management systems in the firm.
- The software should cater for both 'novice' and advanced users. The software should be able to 'grow' with the company as its use of roadmapping expands and matures. The software should provide support for the development of individual roadmaps, as well as support for enterprise-wide roadmapping (scalability). The software should support multi-user, distributed participation in the development of roadmaps, which require input from various perspectives in the firm. Roadmap elements should be dynamically linked (within roadmaps and between roadmaps), so that the effects of changes to roadmaps can be readily determined.
- Software should fit in with the human process that is a key benefit of the technique; the development of good roadmaps typically requires multifunctional workshops. There is scope for creative approaches to the development of effective software-user interfaces, such as the use of electronic whiteboard and brainstorming technology. The role of

software is to support the roadmapping process, and users should not expect that software alone will result in good roadmaps.