INNOVATION PROJECTS USING ROADMAPS

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Abstract

Roadmaps and their methodology (TRM, Technology roadmapping) are a planning tool for medium and long-term projects which are useful to any business or corporation. Roadmaps cover many aspects that must be taken into account in a company's innovation forecasting and its development over time, such as opportunities to launch new products or to change existing ones, marketing, new markets, competitors, capabilities and skills, weaknesses, results exploitation, goals...

The basic beginning information of the Roadmap is the result of research on internal and external factors of the company by asking questions like: What do we produce? Who are we in our sector? What do we want to / can we achieve? What or who is our competition? What do we have and what should we have?

This article deals with the historical development of roadmapping and the state of the art of its different methodologies as well as the clusters that generate them (EIRMA, Northwestern, Cambridge, Purdue, Nottingham...) and their distinguishing features.

Keywords*: TRM, Roadmaps, Innovation Projects.*

1. Introduction

A technology or innovation Roadmap is a medium or long-term plan to achieve one or more goals with technological/innovative specific solutions. This plan can be based on a new process, a new product or a new emerging technology. The development of this plan helps on three main aspects: it puts the needs of the project and the necessary technologies to satisfy these needs together, it offers a helping tool for the technology's evolution prediction and it creates a coordination framework for the project (Garcia et al. 1997).

When we apply the term "roadmap", we tend to think of a route to follow, and actually an innovation roadmap shares many characteristics with the course of a travel route although there are obviously some important differences in the format and the purpose.

A road map is used to determine the best route, in example, the driver locates the destination and, taking the present location into account, determines the route and the necessary resources. Acknowledging the exact locations (origin and destination) and the available routes with high precision (roads, highways, tolls etc.) is of great advantage; by evaluating these options and applying the chosen criterion (speed, economy, costs), we can decide the optimal route.

In an innovation roadmap we will also have an origin (present situation) and a destination (desired and predictable future), but unfortunately, the other circumstances aren't predictable as those of a journey planned on a map. In the first place, and even though it may seem obvious, it is not so easy to determine the present situation because not only the initial organization and its status must be deeply studied, but also its position and relationship to its

market environment. Second, the goal or destination isn't so obvious either because it is based on predictions that can't be guaranteed, although having been backed by reliable sources and deep studies. And finally, many of the circumstances of the innovation "route" from the origin to the destination will be unknown and some can't be controlled (crisis, behavior change among the consumers, new rules…).

Resuming, in an innovation roadmap these must be taken into account:

- Most of the facts about the starting point are known, but some, as those relative to the economy, the market or the innovation activities are out of reach.
- The future objective can be predicted, but not with complete accuracy.
- Many signs pointing to a certain innovation direction or goal can be gathered, although it cannot be known which should be taken into account.
- Social, economical and environmental changes could affect it, as well as other global situations that can't be controlled or foreseen.
- Present technological or innovation activities shouldn't be inferred in the future.
- It is important to propose changes in the product or the process in order to modify the consumers' perception and the probable satisfaction.
- Technological innovation as well as the new abilities or skills must be preferentially considered.
- Tool development that may help achieve the goals, such as new or more powerful software and databases of all kinds (market, competitors, intellectual property etc.), must be considered.

Other than these considerations, roadmapping is a very powerful tool for technology management and its planning (Farrukh et al. 2004), especially for exploration and communication of dynamic links between technological resources (Technology), organization goals (Products/services) and the changing environment (Markets). We can see these featured in Figure 1, where Markets (M), products/services (P) and technologies (T) relate to each other in order to achieve optimal developments and goals.

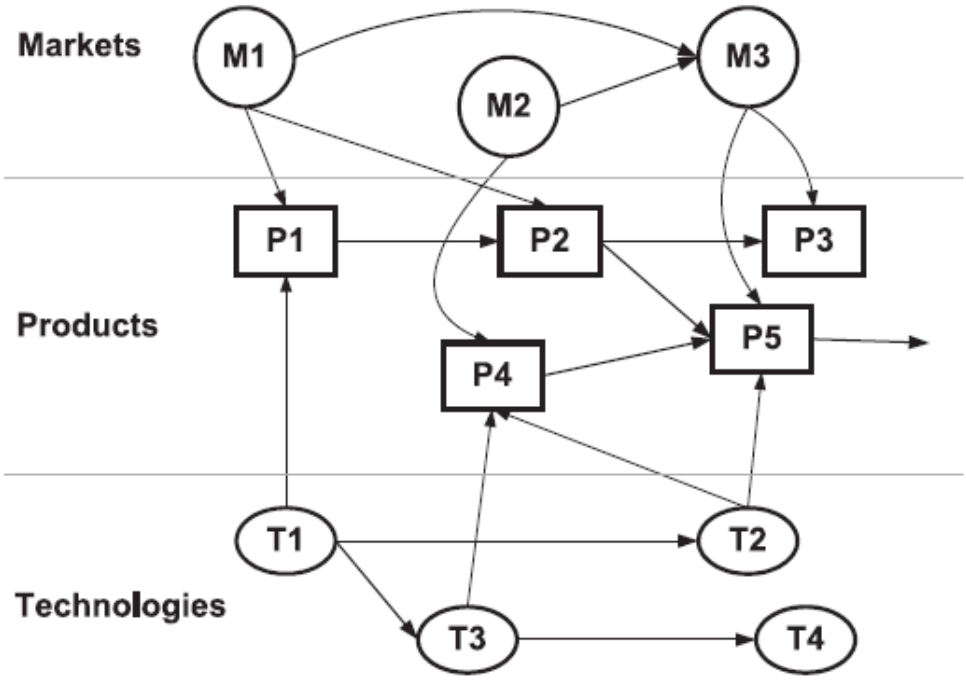

Figure 1. Generic technological roadmap (Rinne 2004)

Roadmapping has been widely adopted by industries in its multiple forms, both in a diverging way or looking for opportunities ("technology push") and to satisfy the market demand and its consumers ("market pull").

2. Types of Roadmaps

Roadmapping methodology is very diverse. Usually each organization, depending on their needs or characteristics, will represent it graphically in one way or another, the basic words such as product, market, innovation, business or strategy being present in almost every type of roadmap.

A sorting system for roadmaps (Phaal et al. 2004) would have to consider three criteria that are present in all of them and their consequent subdivisions: purpose, format and use.

2.1 According to the purpose

Up to 8 types of roadmaps can be distinguished according to their purpose:

9. Product planning: It is the most common type of technological roadmap. It includes technology into production and usually covers more than one product generation.
10. Planning of services and/or abilities: This type is more frequent in companies that offer services and are focused on how technology can support organizational skills. They establish a bridge between businesses and technology rather than production.
11. Strategy planning: It pursues the general strategic evaluation as for the different opportunities and threats; it is a typically commercial roadmap. It focuses on the development of future businesses, markets, products, technologies, abilities, culture, opportunities and weaknesses.

12. Wide scope planning: This type is used in plans that cover multiple horizons, they are usually made by national institutions of a certain industrial sector and can act as a radar with which the organization detects and identifies possible technologies and innovative markets.
13. Planning with knowledge as a value: In this roadmap (Figure 2) the value of knowledge and its innovations come together with economical goals, making it possible for organizations to visualize their critical knowledge values as well as their links to technological skills and abilities to know the demands of future markets (Macintosh et al. 1998).
14. Program and/or project planning: It is based on strategy implementation and, usually, specifically the planning of an R&D project or program. The NASA projects are a good example of this kind of roadmap and they show the relationship between technological development, program phases and their achievements.
15. Process planning: Knowledge management focused on a particular process in a certain area (such as the development of new products) is the goal of these roadmaps. They are centered on the flows of knowledge that are necessary to make an effective introduction of new products easier by including the technical and commercial prospects.
16. Integrated planning: It combines new and old products, systems and development of technologies, integrating them and reflecting how they interact with each other.

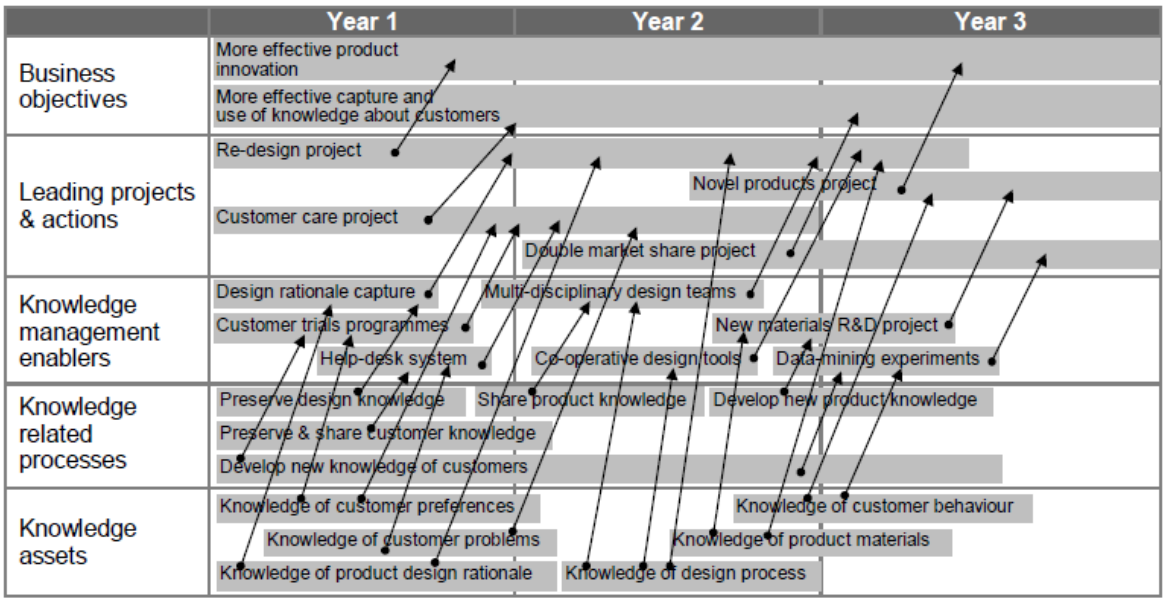

Figure 2. “Knowledge as a value” Roadmap (Macintosh et al. 1998)

2.2 According to the format

There are also 8 types of roadmap according to their format:

9. Multilevel: This is the most common format and consists on an indetermined number of levels such as technology, market, product and their consequent sublevels. This roadmap allows us to reflect the exploration and evolution in each level and also

their relationships, making the integrations of technology in the products or services easier and furthermore their marketing (Figure 3).

10. Bars: Some roadmaps are presented in groups of bars for each level or sublevel. This gives the advantage to simplify and unify the desired outputs, the integrations of different roadmaps and the development of possible support programs.
11. Tables: In some cases roadmaps or part of their levels are expressed as tables (normally time vs. acts or requirements). This type of roadmap is used in situations in which the actions to be made can be quantified or framed in a certain time period.
12. Graphs: If the technology or the product may be quantified, the planning can be expressed as a plain graph or drawing for each level. They are also sometimes known as “experience curve” and are expressed as S-curve technology.
13. Images: Some roadmaps use more “creative” images to communicate the integration of the technology into the planning, for instance, in a metaphorical way trees, houses, finish lines, etc.
14. Flow diagrams: This is a typical format used to explain goals, actions and results. It is useful for reflecting scientific questions, basic business areas and short/medium/long term goals.
15. One-level: Related to the multilevel type but in this case reflecting only one of them, it is obviously much simpler and does not usually reflect relationships between levels. They are focused on technological evolution associated to a product and its characteristics.
16. Text: Although less extended, some roadmaps are expressed almost completely in text form, they describe the same aspects as the other ones but in this case text is predominant over images.

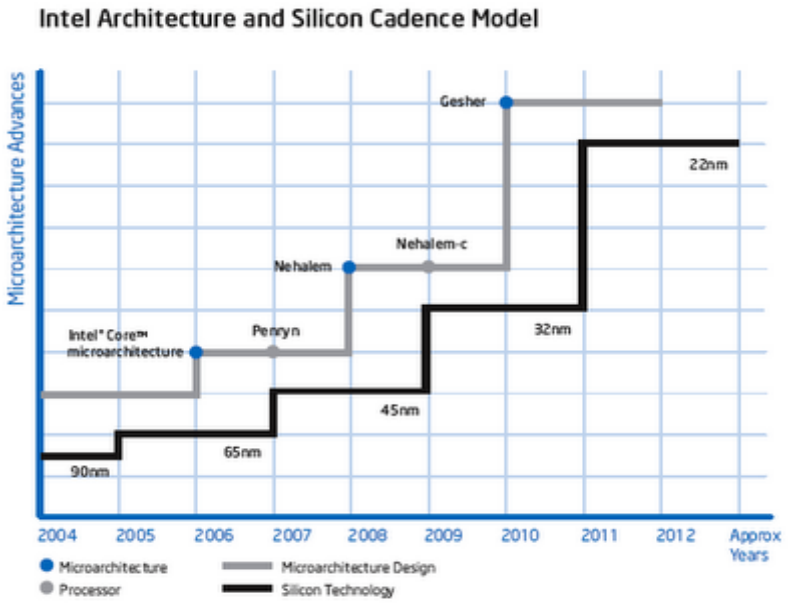

Figure 3. Roadmap example (Source: INTEL)

2.3 According to the use

There are different types of roadmap according to their use that obviously share some general elements, but each one has some differentiating peculiarities. Following the general guidelines of every roadmap, a company, the industry, a government department or any organization can create their own roadmaps through the adaptation of existing models to their needs or problems. They can so be divided in:

- Industrial roadmaps: Used mainly to evaluate and foresee the direction a certain market driven by demand will take, all this in a technological area, and to identify the necessary R&D strategy to satisfy those demands.
- Science and technology roadmaps: Focused mainly on the selection and evaluation of new emerging technologies.
- Product roadmaps: Used by companies to identify their technological processes as well as weaknesses, threats, opportunities and strengths that entails the development of a specific product or service.
- Program/project roadmaps: Medium or long-term planning of specific programs or projects by government or private organizations with which, among other things, it can be evaluated how emerging facts can affect them.

3. Current roadmap methodology

In the 1970s, Motorola (Figure 4) became one of the first companies to develop a roadmap that focused on technology to improve the product development. Besides being a precursor, it still remains a reference company for roadmapping (Gindy et al. 2008). Original roadmaps were printed and nowadays in digital format.

Moore's law from 1965, a prediction in which its author stated that the number of semiconductors that could be placed on an integrated circuit would be doubled every two years, encouraged the semiconductors electronics industry to make roadmaps to study and foresee the evolution of the sector. The SIA (Semiconductors Industrial Association) is an example of this case and since 1993 publishes very detailed multilevel roadmaps.

Bucher (2003) suggests that roadmap technology has been developed in two generations and a third one is being carried out at present:

- First Generation (1970-1980): Roadmapping methodologies meant to accomplish clear and specific forecasts.
- Second Generation (1980-1990): Roadmapping methodologies focused on improving strategic planning decisions.
- Third Generation (1990-present): Roadmapping methodologies focused on technology management integration with production activity.

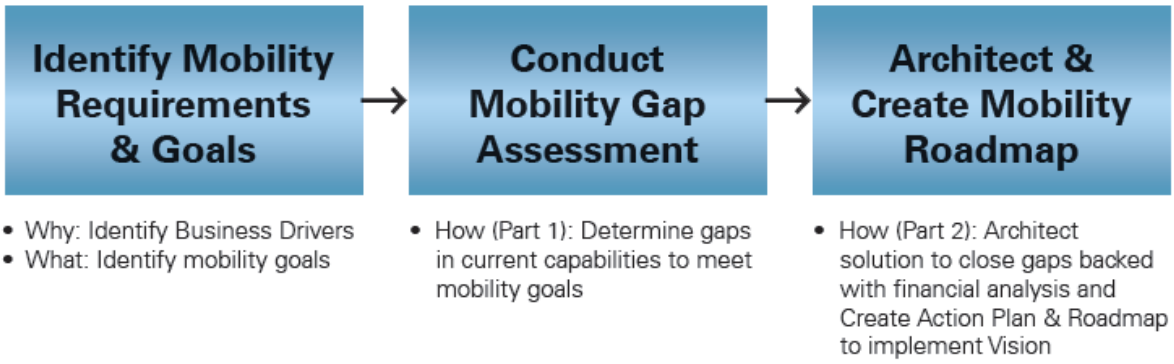

Figure 4. Detail of MOTOROLA's strategic planning (Motorola 2009).

There are nowadays many clusters that study and propose roadmapping methodologies that have meant a great development in this issue. The most important are:

- Cambridge University (England): due to its Engineering Department and its most prolific author, Dr. Robert Phaal, many initiatives and publications regarding roadmapping have appeared since 2000. Especially worth mentioning are the standardized methods T-Plan (Technology and product roadmapping) and S-Plan (Strategic roadmapping), focusing on the market concepts, products and resources (Farrukh et al. 2003; Phaal et al. 2003; Phaal et al. 2006; Phaal et al. 2001; Phaal et al. 2009; Shehabuddeen et al. 2006).
- EIRMA (European Industrial Research Management Association): One of the pioneering roadmapping organizations in Europe, their roadmapping methodologies consider the timing, the characteristics of the product or process, the know-how and the resources as main features (EIRMA 1996; EIRMA 2003b; EIRMA 2003a).
- Portland State University (USA) and Mahidol University (Thailand): They developed the TDE (Technology Development Envelope) and AHP (Analytical Hierarchy Process) methodologies, directed my Dr. Gerdsri and his collaborators Rinne and Kocaoglu. They are focused on technology management together with roadmap dynamism as for modifying and adapting them to the circumstances of each company (Gerdsri 2005; Gerdsri et al. 2007a; Gerdsri et al. 2007b; Rinne 2004).
- University of Nottingham (England): Its methodology proposal, STAR (Strategic Technology Alignment Roadmapping), focuses on the association of strategy, technology and R&D in roadmaps (Gindy et al. 2008) and it is the most active core together with Cambridge University.
- JAIST (Japan Advanced Institute of Science and Technology): Together with Singapore it is the main center for roadmapping methodologies in Asia. They focus on the integration of corporative and technological strategies besides insisting on market prospective (Kameoka et al. 2003; Lee et al. 2008; Lee et al. 2007; Lee et al. 2005).
- Singapore Institute of Manufacture Technology: They have developed the OTR (Operation and Technology Roadmapping) methodology regarding the implementation and development of roadmaps (Holmes et al. 2006), inspired by Cambridge's T-Plan and Nottingham's STAR.

- Northwestern University (USA): Action planning and its risks are the distinguishing characteristics of the roadmapping methodology proposed by this center (Radnor et al. 2004a; Radnor et al. 2004b; Kappel 2001; Albright 2003).

Conclusions

Roadmapping and its relationship to innovation projects is getting increasingly known and applied in organizations, and roadmapping methodologies increasingly extensive and assorted. However, its establishment in small and medium enterprises is difficult because of its image of complexity and low productivity. It is also true that innovation projects, although slowly, are getting to be seen as something necessary in this kind of businesses, people start believing in "innovate or die" and the fact that there are success opportunities if we innovate and a not good long-term prospect if we don't.

Some organizations may have doubts about the difference between a roadmap and a "simple" Pert or Gantt planning chart. The answer is that a roadmap goes much further than a task distribution in a specific time period; the consistence and development of a roadmap involve (or should involve) a huge amount of internal and external information about the company through which its future state could be precisely defined. We can't forget that a roadmap is a detailed picture of the internal and external state of the organization and this involves an exhaustive search that will be followed by a separation and analysis of the gathered data to get valuable information. Obviously, a Pert or Gantt chart won't contain all this information and scarcely strategic aspects or different scenarios to act on or how to do it.

The fact is that project planning methodology in the form of a roadmap has advanced much in the last ten years; there has been a great generation of proposals, articles, studies, etc. coming from all over the world and everything indicates it will be a very important field in innovation management and advice for enterprises. Indeed, there are already training and advice offers about roadmapping from private organizations.

As for evaluating the different methodologies, it's difficult to compare and establish a ranking, much more considering there are as many different roadmaps as organizations, because even having the same purpose, the distinctive features of each one of them will attach more weight to one aspect or another. Anyways, the present trend is focused on two basic aspects, the integration of corporative strategy in product, technology and market strategies on the one hand and the "customized" standardization on the other. This last trend, although seeming contradictory, consists on doing, simultaneously, a standardization of the roadmap so that it can be more easily applied and implemented (like T-Plan, OTR, STAR) and a customization offered by some centers and consultants to adapt the standard roadmap to each case. It would be similar to the case of a product with a common base that can be adapted or modified by adding or taking complements.

It is worth mentioning that the last roadmaps' proposals is the introduction of external databases which can be of great help for the prospective and right (or wrong) directions in certain aspects such as the product and the technology. In example, it is already indispensable to consider a relatively unknown subject as is intellectual property. There are now many databases that can be consulted and especially taken into account when directing innovation to some fields or others; if this aspect were always considered, many infraction risks in products and/or technologies –either already exploited or abandoned because of their non-viability– would be avoided and therefore so would be the loss of time and money they involve.

Another important point that should be improved by organizations to optimize their innovation roadmaps is, curious as it may seem, the definition and situation of the company itself internally and regarding its competition environment. Organizations often aren't described realistically (on expedience or unconsciously), either magnifying themselves or underestimating aspects of experience or knowledge that can be very valuable and decisive, and the same can happen when visualizing themselves towards the market, positioning themselves above or under the real situation.

The author considers the possibility of a new roadmapping technology that reflects the inside and outside view of the organization more clearly, while keeping the aspects that are common to all roadmaps. The inside view should answer questions like: Who are we? What do we do? What do we have? Can we do more? What do we need to do more? etc. The outside view on the other side would answer questions like: Who is in our environment and how are we perceived? Does the market want innovation or is it reluctant to changes? What do our competitors have? Self innovation or good licenses? etc.

In brief, this article wanted to display the interest of roadmaps in innovation projects (and in any other necessary project or planning) and their different forms, uses and methodologies. The final conclusion is that roadmaps can be a great support tool for companies and specifically for their innovation projects, and their use should be encouraged more extensively.

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