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Affiliations for all authors: Delft University of Technology, The Netherlands - Faculty Industrial Design Engineering: assistant professor & professor's strategic product design – product innovation management group.

Roadmap grounded as 'Visual portray': Reflecting on an artifact and metaphor

Lianne Simonse, Jan Buijs & Erik Jan Hultink, DUT, The Netherlands.
L.W.L.Simonse@tudelft.nl,

Abstract

> Road map:"1: a map showing roads especially for automobile travel.
> 2. a : a detailed plan to guide progress toward a goal; b: a detailed explanation.
> (MeriamWebster.com Dictionary, 2008).

The roadmap we use for navigating in the car, bringing us from A to B, showing alternative routes, provides a strong metaphor (Meyer, 1984; Cornelissen, 2005) for a roadmap used by practitioners. – Strategy is a journey, purposes are destinations, means are routes, and achievements are landmarks. - With this figure of speech, metaphors of roadmaps inspired numerous practitioners, to create a roadmap. In our research we explored the wealth of clarifications and explanations that have been put forward by roadmapping practitioners. We collected their publications, often written with purposes of establishing and exchanging best practices at Industry networks such as EIRMA in Europe (Groenveld, 1997; Phaal ea, 2008; Mohrle & Isenmann, 2005) and SEMATECH in the US (Browning, et. al., 1995; Burgelman, 2002). For our sample of qualitative data on roadmapping practice, we selected twelve stories with anecdotic evidence from firms like Motorola, Philips, Lucent, Siemens, Honneywell etc. In this paper we report from our inductive research on the concept of a 'roadmap'. We found that visual attributes are grounded in the concept of a roadmap. In this paper our qualitative findings and reflection on 'Roadmap as artifact' (Henderson, 1999; Carlile, 2002; Ewenstein

& Whyte, 2009; Barry & Meisink, 2010) and 'Roadmap as metaphor' (Schön, 1983; Cornelissen, 2005) for future research of strategic designers are presented.

Keywords: roadmap, visual representation, timeline, boundary object, metaphor.

Discovering a 'Roadmap' in Strategic Innovation and Design Management

On the origins of a roadmap we traced back that in the field of innovation research, in the organizations-oriented tradition (Brown & Eisenhardt, 1995), the importance of Motorola's article on a roadmap (Willyard & McClees, 1984) was noticed in 1992 (Wheelwright & Clark, 1992). In the strategic management tradition we traced back the term 'road map' as part of a recommendation for creating the future by creating your own roadmap (Hamel & Prahalad, 1994). We learned that Intel has a "roadmap for developing next-generation microprocessor" (Burgelman, 2002) in its high velocity environment and more recently a roadmap has been acknowledged explicitly as valuable in implementing product design and technology strategy (Ulrich & Eppinger, 2004; Ancona & Bresman, 2007; Cooper & Edgett, 2009) with references to Philips's - (Groenveld, 1997), Motorola's (Willyard & McClees, 1984) and Honeywell's (Whalen, 2008) articles. Over the years all very interesting publications with numerous guidelines for practitioners, however with little conceptual contribution.

Also, although roadmaps are used widely, so far they are barely studied by scholars. In Europe, some scholars provided an engineering perspective (Kostoff, & Schaller, 2001; Mohrle & Isenmann, 2005; Phaal ea, 2004). And in the US a PhD-study created an organization behavioral perspective (Kappel, 2001). Overall, research on roadmapping is still in the initial period of exploration, and a paradigm has yet to be developed (Garcia & Bray, 1997; Kappel, 2001). So far, a definition of the concept to understand the phenomenon of a roadmap is not established yet. To fill this theoretical gap, we started an inductive research for building a concept definition for the 'roadmap' in a useful and rigorous way. In this paper we provide a grounded definition for the key concept of a roadmap.

Collecting and analyzing qualitative Roadmap data

Our inductive research study involved several steps of reflection. We began with the collection of qualitative data documented by roadmapping practitioners. Then we compared

iteratively the practitioners documented experience with concepts already defined in theories of Innovation , Design – and Strategic management literature and generated roadmapping concepts by induction (Eisenhardt,1989; Pratt, 2009) .

For the first step of data collection we collected a sample of roadmapping publications that met two criteria. First we searched for widely cited articles about roadmapping. Second, we searched for articles by practitioners, with a profession inside a company or network organization. By this selection we excluded consultancy papers but including articles from managers and professionals working at these firms. Twelve articles met our criteria, listed in Table 1.

[About here Table 1 Sample of selected articles from roadmapping practitioners]

We used the qualitative method of datamatrix tabulation (Miles & Huberman, 1984). We started with a large datamatrix with extracted qualitative descriptions. From this datamatrix we separated category datamatrices. We then constructed an analysis matrix for induction, confrontation and deduction with existing theory concepts for each category datamatrix. And finally we compiled a synthesis matrix based on a similarity index of more than half of the company reports.

In more detail: we started with the extraction of the qualitative descriptions from the selected articles that held explanations or clarifications and classified these into our datamatrix. We had constructed this datamatrix with the basic categories from our research program questions. After collecting the extracted descriptions we had a massive qualitative datamatrix that we split up in category matrices.

Our first analysis was on the category datamatrix of 'What is a Roadmap'. We reflected on the fractured data overviews, by comparing the qualitative descriptions from the different company situations to each other and clustered comparable descriptions. From these clusters we extracted empirical indications into a new column.

Then from this matrix all clusters were extracted and compiled into an analysis matrix. Further analysis included a clustering of indicators with underlying uniformity interpreting the varying conditions of the different empirical situations. We generated a term for each cluster through compilation, simplification and rephrasing words used in the empirical indicators. By a next level of reflection, we generated a distinct cluster variable. This

overarching core cluster variable term was generated through clustering and distinguishing until contrasting conditions and theoretical distinctions were identified.

Finally, for grounding the concept description of a 'roadmap', we constructed a synthesis matrixbased on a rule of majority. Only those clustered variables where extracted of which more than half of the twelve firms report on.

Building the concept of a Roadmap

In table 2 a summary of the commonly mentioned elements of on the concept of a roadmap is presented .The majority of firms express that a roadmap results from a visualization of strategies. Some practitioners describe this as a 'graphically portray', in case of ABB, or a 'visual form', in case of BP; others expressed this as a 'snapshot', in case of Honeywell and Motorola or as a 'picture' in case of Lucas Varity and Lucent. – All synonyms for the clustered variable 'visual portray'. A further exploration on what then is portrayed, led to three roadmap characteristic concerning the content: 'Outline of Market -, Product - and Technology plans'. Moreover, at firms such as Hoogovens a value chain outline is depicted. At Sandia different semiconductor application areas are the outline of the roadmap. These roadmaps are applied on industry level where different markets are connected in value chain B-t- B relations and products are connected in streams of adding value to material, to components to modules, to systems and Technologies include both product and process technologies. Overall the twelve front running firms in roadmapping emphasize the outline characteristic of a roadmap portray providing a visualization of elements from the Market -, Product – and Technology plans.

Furthermore, a third characteristic of a roadmap is the time scale against which the elements are plotted or mapped. A time line, time axis or time scale is an essential part of the roadmap portray. Roadmapping practitioners at ABB and Lucent plot for example the evolution of models against time. Product families, product/market share and competitors share are among the elements that are plotted to time.

Overall, a roadmap appears to constitute a time scale. This appeared to be an essential element in the visualization of roadmaps. When we summarize our induction of empirical findings, we conclude with a compiled definition for a roadmap: a ***visual portray*** *of Market/Product/Technology plans plotted on a timeline.*

[About here Table 2 Roadmap concept grounded on core variables]

Theoretical Reflection on a Roadmap

Overall, this article attempts to contribute to the understanding of practitioners experience with an embedding into theory concepts. In contribution to the collective learning and body of knowledge of both scholars and practitioners we build concepts as a starting point for further research. We synthesized a key concept for a roadmap that opens up for future research and more exchange between practitioners and scholars.

The concept of a *roadmap* with the definition of what it is, includes 'plans plotted on a time line'. It may be perceived that roadmapping involves 'planning' of strategic innovation programs, however, 'planning' did not emerge from the 12 practitioners publications. 'Planning' did not appear as a widely mentioned empirical indicator in our analysis. Therefore a roadmap is distinguished from planning and program planning through the visual portray. As also illustrated by the visual examples of roadmaps, presented in figure 1. Some scholars closely related a roadmap to a portfolio planning. However, rather than overlapping concepts they emphasize the compatible characteristics (Farrokhzad, 2005; Cooper and Edgett, 2007). Portfolio planning in essence provides the financial estimations for comparing business opportunities. In contrast, a roadmap deploys a time perspective for a focused development and feasible recombination of the firms' capabilities. Roadmaps are also distinguished by the inclusion of all current innovation projects activities (Whalen, 2007).

[About here Figure 1-Visual portrays of roadmaps from Motorola, Philips & Lucent (Willyard & McClees, 1984; Groenveld, 1997; Albright & Kappel,2003)

By inducting the definition for the roadmap concept, our research results offer insights on what the nature of the roadmap object is. It's element of *'a timeline'* relates to a *temporal boundary objects* defined by Yakura (2002). In this perspective "timelines embody the key elements of a narrative: a beginning, a middle and an ending, and a focal topic" and are distinguished therefore as boundary objects. In coherence with a roadmap's role over time that is 'stable enough to enable coordination across communities of practice', (Ewenstein & Whyte, 2009). A 'timeline' in the visual design of a roadmap makes time concrete and negotiable for various groups of participants. The subject-object relations of a roadmap are multiple given the roadmap content characteristic that it holds at least three elements of technology, product and market plans. Coherent with this we build the concept of a roadmap

on an artifact with a 'timeline that is a helpful device in prospective sensemaking' (Weick, 1995). And on the use by multiple people 'to fill in their understanding of what will happen, even when the future is uncertain and unpredictable' (Bucciarelli, 1995).

Our research made explicit that a roadmap is 'a visual portray' holds a 'timeline' and holds multiple elements of 'Market, Product and Technology' plans. More research on the visual design of the roadmap, its time-based structure and particular features of interlinking is needed. Of particular use for this research direction can be the metaphoric analogy of the roadmap. A way to describe a roadmap for travelers is*: a visual portray* of auto routes and hubs, in a one page format. Weick (1974; 1990) already related cartographs to organization theory. As we learned from Cornelissen (2005) metaphors appeared to have a particular role in the earlier stages of theory building. Likewise the theory of 'organization identity' started with the identity metaphor. Metaphors lay out the groundwork for extended theorizing and research. Through its heuristic role, metaphors have the capacity to open up new ways of understanding. In this respect a source of inspiration is Schön's Design theory on 'Refelection-in-Action'. He defines a *generative Metaphor* as: " when two things seen as similar are initially very different from one another, falling into what usually considered different domains of experience, then *seeing-as* may play a critical role in invention and design, (Schön, 1983). In analogy to this design theory, in organization theory, Cornelissen (2005) suggests to go beyond a metaphor to create new knowledge and insights by a domain-interaction model: draw structural analogy between concepts in their respective domains. The travelers roadmaps can then be used as analogous artifact: 'evocative representations that do not serve immediate organisational purpose, yet invite inquiry and reflection by defamiliarizing organisational members habitual conceptions' (Barry & Meisink, 2010).

For future research we propose to use metaphors in 'research by design' approaches as a first valuable research path for building theory on the visual design of roadmaps. As a second valuable research path, we propose to compare roadmaps by visual observations and analysis.

Conclusions

In this paper we elaborated on roadmapping as phenomenon in the field of strategic, innovation and design management. We found that numerous insights gained by practitioners are valuable to base a theoretical reflection. We add to the initial scholary work on roadmapping, a theoretical contribution by providing a concept definition and further research directions.

We conclude that through the practitioners' literature we gained insight in the variables of a roadmap. Grounded in the experiences of roadmapping practitioners we defined the concepts of a Roadmap (1): A visual portray of Market/Product/Technology plans plotted on a timeline; Then we conclude that there are research implications for the future. We propose to further investigate the *Visual design of a roadmap* research path. The 'travellers' roadmaps, as referred to at the start of our article can serve as a analogous artifacts in creating more scientific knowledge contributing to strategic, innovation and design management.

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Table 1 Sample of selected articles from roadmapping practitioners

Authors (Practioners)	Firm Context	Sample references
Willyard & McClees (1987) Robert Galvin (1998)	Motorola	Under the leadership of its CEO initiated a corporate-wide process. For each of its many businesses a strategic plan based on the anticipated advancements in certain technologies.
Barker & Smith (1995)	BP	Group's strategy change from the technically-driven diversification approach to one of concentration on core activities; "around 20 Roadmaps were necessary to cover the whole range of activities requiring R&D in the 3 core Business Divisions."
Groenveld (1997) - EIRMA WG 52 report (1997) (i.s.m. Groenveld)	Philips	Introduced integrated 'Product-Technology Roadmapping' in 1993 with a small scale pilot which has extended throughout the company over the years. Implementation has been via a variety of methods including workshops, small-scale trails and integrated business unit approaches. 1. Division Lighting - 10 major application area roadmaps. 2. Division Domestic Applicances - product groups roadmaps (- air treatment, shavers, floorcare) 3. Division Semiconductors-Three layer roadmap by specialists. 4. Division Consumer Electronics - Cordless telephone handset roadmap example
EIRMA WG 52 report (1997) (i.s.m. Rudolph, De Roose & van Dongen)	Hoogovens	Technology Roadmapping an initiative pushed by the board. Each BU chose a specific product / market area to Roadmap. Two pilots: 1. Packaging steel Business Unit (BU) in Ijmuiden, Holland 2. Hoogovens Aluminium in Duffel, Belgium.
EIRMA WG 52 report (1997) (i.s.m. Robinson)	Lucas Varity	First used in 1990 to meet customer demand in the Aerospace market. Group wide application started in 1993 as part of the annual budget process. In 1996 a standard format for the Technology Roadmaps was introduced as the project was pushed through by the CEO. Technology Roadmapping is conducted at divisional level. The budgeting process requires a summary Technology Roadmap. A corporate group and technology 'user groups discuss similarities.
EIRMA WG 52 report (1997) (i.s.m. Schaub)	Asea Brown Boveri Ltd	.. a group of approximately 1,000 independent firms. Some companies hold/plan their own (product orientated) technology. All companies are profit centres. Introduced roadmapping to corporate Research in 1991 as part of the 'Strategic Technology Planning' (STP) process. Use of Roadmapping is wide-spread but not universal. The firms produce Product Roadmaps independently, ideally at business area (BA) level.Together with business plans, product and technology Roadmaps form a key part of the justification for R&D projects."
Garcia & Bray (1997)	Sandia National Laboratories	use technology roadmapping as a technology planning tool to better position themselves and their products.
Albright and Kappel (2003)	Lucent	Wireless terminals -industry data example.
Farrokhzad, Kern & Fritzhanns (2005)	Siemens	Erfolg versprechender Innovationsprojekte: Innovation Business Plan - Portfolio-basiertes Roadmapping
Vinkemeier (2008)	Aircraft Devices eines internationalen Stahl- und Aluminiumkonzerns	Aircraft Devices produziert Aluminiumhalbzeuge z.B. Groundfloors (Platten) und groEe Teile der Aufienhaut (Bleche) fur aircrafts." In 1998 istTechnologie-Roadmapping für das Geschaftsfeld zu gestarten. " hat erst einmal das Technologie-Roadmapping eingeführt, stellt sich die nicht minder wichtige Frage, Aktualisierung von Technologie-Roadmaps wie im Lauf der Zeit zu pflegen und zu aktualisieren sei....wie Umfeldeinflüsse wahrgenommen werden und in eine Aktualisierung der Technologie-Roadmap einfliefien können."
Weiss & Stuhlmann (2008)	SW GmbH	GmbH, einem Spezialsoftwarehaus zur intelligenten Document management und Geschaftsprozessoptimierung, 1998 von Insiders Technologies als Spin-Off des DFKI rum für Künstliche Intelligenz (DFKI) entwickelt. Im Rahmen mehrerer BMBF-
Whalen (2008)	Honeywell	From 1999 to 2002, creating a company-wide roadmapping practice in support of strategic and technology planning.

Table 2 Roadmap concept grounded on core variables

Core variable	Empirical indicators	Firm context
Visual portray	graphically portray the intended product strategy of the business area	ABB
13 quotes	a visualization of strategy or strategy elements to support any decision process.....snapshots of a "rolling" strategy at any moment in time...Note that the Gantt chart representation, while commonly used for roadmapping, is not	Honeywell
7 firms	Roadmaps which are visual descriptions summarizing the outcomes of numerous discussions....Outcomes of the analysis are presented in visual form as Roadmaps. ...The use of visual (as opposed to textual) outputs has been found to help greatly in making this consensus-building process both efficient and effective.	BP
	a current document-a snapshot of the present, but relies heavily on historical information as a tool for predicting the future	Motorola
	Bliek auf transparente und langfristig ausgerichtete Unternehmensziele	GmbH
	a picture to show expected technology developments given evidence of	Lucas Varity
	was essentially just a picture to show expected technology developments	Lucent
Outline of Market/Product/ Technology plans	Product Technology Roadmap is a compilation of documents that provides a comprehensive description of the product line—past, present and future—of a division or operating group...describes the marketplace and the competitive environment...defines technological capabilities; it analyzes our engineering and financial resources.	Motorola
13 quotes	The product–technology roadmap is organized into three main sections: market, product and technology. Each presents a high-level view of strategy... A-Market segmentation and trends-Competitive assessment B-Product roadmap-)Product drivers-Product evolution plan C-Technology roadmap (product/manufacturing)-Forward costing	Lucent
7 firms	easy-to-comprehend descriptions of customer needs, technology responses, and R&D programmes	BP
	contains a list of market requirements which the product is adressing. The technology section is then added to the fledgling roadmap front .	Lucas Varity
	zwei Grunddokumente: • Marktattraktivitats-Wettbewerbsstarke-Portfolio und • Technologie-Kompetenz-Portfolio.	Siemens
	It identifies (for a set of product needs) the critical system requirements, the product and process performance targets, and the technology alternatives and milestones for meeting those targets.	Sandia
	eine transparente und nachvollziehbare Übersicht aller Innovationsprojekte, einschliefilich einer projektbezogenen	Siemens
	to help identify product needs, map them into technology alternatives, and develop project plans	Sandia
	"Function Strategy roadmaps will be called Foundation roadmaps. Each Foundation roadmap contains only information that is pertinent to the roadmap owner's scope of responsibility.	Honeywell
	By clearly separating Foundation from Strategic Initiative roadmaps, the framework permits maintaining synchronization of strategy between individual roadmaps and integrated, higher-level strategies that may be combinations of pieces of several Foundation roadmaps.	Honeywell
	a better outline of strategy	Hoogovens
	analyses, gap closure plans, action plans, and alternative visual formats (e.g., decision matrices, bubble charts, spider diagrams) provide the necessary back-up to support fact-based decision making based on the strategy."	Honeywell
Plot against time scale	plot some characteristic against time....evolution of models within a product family against time (the product boxes typically show the range name model;	ABB
12 quotes	a rough graphical form which essentially unravels the technology/market framework **onto a time axis.** ...Displaying the interaction between products	Philips
8 firms	has the potential to provide a bridge between all the tactical decision processes, different business functions, and organizations through the **common element of time."**	Honeywell
	The product roadmap shows the evolution of the product family over time ... competitors' share of the market over time and product share of the market over time;	Lucent
	an excellent review of product direction and technology timing	Motorola
	Auch die relevanten Technologien haben sich im Zeitablauf erheblich entwickelt, allerdings fast vollstandig innerhalb der in den Roadmaps	Alum. Aircraft Devices
	technologische Sprünge antizipieren und für die Releaseentwicldung vorbereiten.	GmbH
	time-interval depends on type of products as well as the aggregation level, (3-4 years - portable audio products / 10 years optical storage).	Philips
	Viewing the time-scales involved demonstrates the necessity of undertaking technology developments now in order to be ready for future product	Lucas Varity

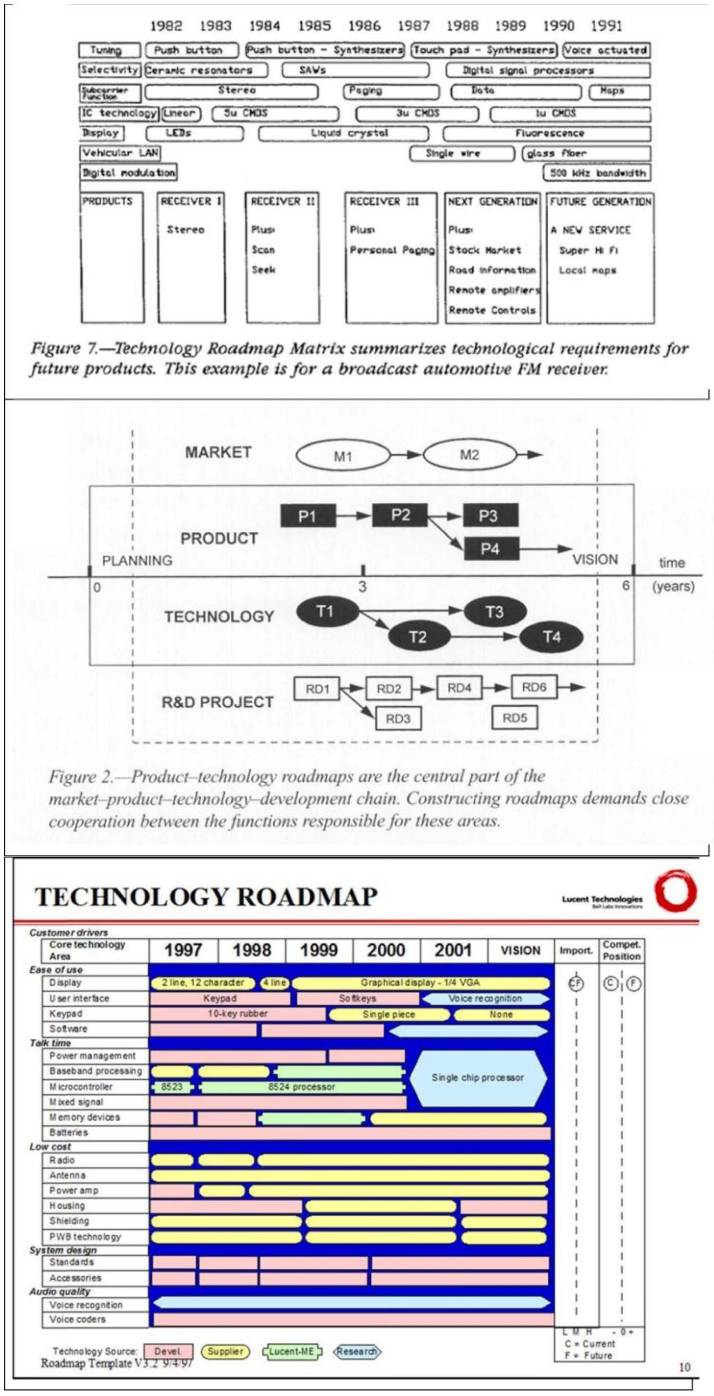


Figure 1-Visual portrays of roadmaps from Motorola, Philips & Lucent (Willyard & McClees, 1984; Groenveld, 1997; Albright & Kappel, 2003).