

## Chapter 3

# Are the Pre-Diffusion Phases Shortening?

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### ABSTRACT

*This chapter focuses on the pre-diffusion phases for high-tech products. These phases last from the first time a technology is mastered and demonstrated up to the start of the large-scale production and diffusion of products based on that technology. The purpose of this chapter is to underline the managerial relevance of the pre-diffusion phases. Two questions will be answered in particular: (1) How long do these pre-diffusion phases last for high-tech products? (2) Have these phases shortened or not over the last 150 years? Fifty-three cases of high-tech products, invented between 1837 and 1998, are investigated. The pre-diffusion phases are shown to last 16 years on average, but their length varies considerably per case. No proof for the shortening of these phases over time is found. The resources devoted to research and development in different fields of expertise may have increased but the length of the pre-diffusion phases has not shortened accordingly.*

### INTRODUCTION

Central to this chapter is the question whether the length of the pre-diffusion phases, *i.e.* the phases preceding large-scale production and diffusion, has shortened or not over the last 150 years for high-tech products. In this chapter we define high-tech products as products, materials or components based on breakthrough technologies and representing an

advance that is so significant that attainable price/performance ratios are altered dramatically or that entirely new kinds of applications are enabled (Tushman & Anderson, 1986). Examples of high-tech products that, at the time of their invention, shifted price/performance ratios include dynamite, in comparison to nitro-glycerin, and strong fibers like Kevlar, in comparison to contemporary fibers. Examples of high-tech products that enabled entirely new applications at the time of their invention include radar, laser and communication appliances

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like telegraphy and television. We define the pre-diffusion phases as the period between the invention of the technology and the start of the large-scale production and diffusion of products, materials or components on the basis of this technology.

## **Scientific Relevance**

In diffusion research, Rogers (2005) noticed an almost complete lack of attention to the pre-diffusion period. By ignoring this period, mainstream diffusion research seems to imply that large-scale diffusion starts directly after the market introduction of a new high-tech product. Large-scale diffusion is often represented by an S-shaped diffusion curve and that seems to imply that the diffusion process is quite predictable. In practice, that is hardly the case. Easingwood and Lunn (1992), for example, found different far more erratic patterns of diffusion for various telecommunication products and services. Rogers indicates that more attention should be devoted to the phases prior to the large-scale diffusion (the S-shaped pattern). Scientists outside the diffusion discipline indicate that these pre-diffusion phases usually last long (Agarwal & Bayus, 2002; Mansfield, 1968; Utterback & Brown, 1972). It is unknown, however, whether the length of these phases have changed or not in the course of time. In contrast, developments in the length of the product life cycle, *i.e.* the time period *after* these pre-diffusion phases, have evoked a lively debate. We want to extend this discussion to the pre-diffusion phases.

## **Scientific Focus**

Scientists from different disciplines have investigated factors that explain the speed of diffusion. Institutional economists, for example, focus on the institutions such as the laws enabling appropriation or organizations facilitating knowledge exchange in industries (*e.g.* North, 1990; Wil-

liamson, 1996). Diffusion researchers focus on characteristics of customers and their perception of the innovation to explain the diffusion (Rogers, 2005). In strategic management the characteristics of the market environment or the strategies and capabilities of the main companies that supply the innovation are used to explain the start of diffusion processes (for an overview of schools in strategic management see for example Teece and Pisano (1994)). Apparently, although the focus depends a bit on the discipline involved, variables explaining the start and the speed of diffusion processes seem to belong to a couple of categories such as: (1) the characteristics of the innovation; (2) the characteristics of the organizations that introduce the innovation; (3) the characteristics of the customers adopting the innovation or (4) the wider market environment in which diffusion processes occur. Ortt & Delgosaie (2008) made a similar categorization of factors affecting the length of the adaptation phase, after they studied 18 cases of high-tech products.

Some authors also specifically investigate factors determining the process *prior to* diffusion of innovations. Nerkar and Shane (2007) for example focus on determinants that determine the commercialization of inventions from academia. In the entrepreneurship literature many of the factors determining the success of entrepreneurial activities prior to large-scale diffusion are investigated (*e.g.* Bekkers, R., Gilsing, V., and van der Steen, M., 2006; Di Gregerio and Shane, 2003; Dowling and Helm 2006; Shane, 2004). We also focus on these pre-diffusion phases but rather than explaining the length of these phases using a selection of the variables from the four categories, we focus on the question whether the length has changed over time. This focus on time requires that we randomize over (or control for) the other categories of variables. That is the reason why we deliberately selected a heterogeneous set of high-tech products developed by completely different types of organizations in different industries and with different types of customers.

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