ON THE ORIGIN OF PRODUCTS

THE EVOLUTION OF PRODUCT INNOVATION AND DESIGN

In this new work, Arthur Eger and Huub Ehlhardt present a "Theory of Product Evolution." They challenge the popular notion that we owe the availability of products solely to genius inventors. Instead, they present arguments that show that a process of variation, selection, and accumulation of "know-how" (to make) and "know-what" (function to realize) provide an explanation for the emergence of new types of products and their subsequent development into families of advanced versions. This theory employs a product evolution diagram as an analytical framework to reconstruct the development history of a product family and picture it as a graphical narrative. The authors describe the relevant literature and case studies to place their theory in context. The "Product Phases Theory" is used to create predictions on the most likely next step in the evolution of a product, offering practical tools for those involved in new product development.

Arthur O. Eger is a Professor of Product Design. He has a broad experience in industrial design engineering, wrote and edited more than fifteen books, and published more than 100 articles and papers. He is a member and Chairman of the Board of the Department of Industrial Design Engineering of KIVI, the Royal Institution of Engineers in the Netherlands.

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Preface

This book addresses the question of how new (types of) products come about and develop through time into a family of more advanced versions. The content of this book is organized around three topics. First, theoretical perspectives from different schools of thought deemed relevant are collected in order to provide an inclusive background. Second, the question of the origin of new types of products is explored based on the observation that products do not appear as a *generatio spontanea*,[1] but build on previously developed versions and/or accumulated learning. Case studies of various kinds are included to provide context. Third, using the perspective of accumulated learning, this book provides a low-risk new product development strategy that builds on recurring patterns in products introduced through time. For editorial reasons, these topics do not appear in a strict numerical order. Finally, using the maxim that products "are both the means and the ends of technology" (Basalla, 1988, p. 30, and Section 10.5 of this volume), a product-centric perspective is presented.

Since the dawn of mankind, we have been making things, tools, products. Today we live in a world that depends on technology and is characterized by abundant products: the consumer society. The twentieth century saw an explosion of ever more advanced products. During the past few decades, the process of developing new products was refined and became an engineering discipline. Until the late 1980s, product development was generally considered a linear process. Successful new (versions of) products were considered the next logical step in the continuous improvement of the product with regard to price and performance. The basic thought behind this idea was the – in practice nonexistent – principle of perfect competition, a term derived from neoclassical economic theory. According to this theory, a product can only survive in a market if it has an improved performance/price ratio, relative to its predecessors.

[1] Aristotle used this term to explain that new generations spontaneously arose as he observed eels and flies coming from cadavers.

In the last quarter of the previous century, this principle received a great deal of critique. Development processes (e.g., product development) seemed to be much less predictable and unambiguous than the linear model suggested. In different fields of interest in which innovation processes are studied, such as economics and technology studies, research was initiated to find new explanatory models that focus on the complicated way that innovation progresses. It is striking that this research, which is based on very different points of view due to the many research backgrounds, ended with the same type of explanations, namely evolutionary models. Nelson and Winter (1982) defined a new nonlinear view on the economy referred to as "evolutionary economy." Several authors – such as Steadman (1979), Petroski (1992), and Norman (1988, 1992) – engaged in the field of product development and suggested an evolutionary process, although the practical consequences of this point of view remained unnoticed for many years. The linear model remained the generally accepted theory in studies of product development and innovation management, as can be seen, for instance, in the approach followed in almost all introductory texts on design methodology. Despite this, those practical implications are far-reaching. A number of economic phenomena, such as partial path dependence, embeddedness, and technological lock-in, cannot be explained by the linear model and are therefore traditionally considered anomalies. However, they can be explained when technological innovation is regarded as an evolutionary process. This conception has been used to devise a low-risk strategy in new product development based on the observation that products commonly develop through phases.

Evolutionary Product Development is a framework that can be used for developing products that is based on the observation that new products are always based on previous versions and/or accumulated learning. This is an important reason for continuing to investigate the possibilities of an evolutionary vision of product development and innovation.

The theory of Evolutionary Product Development originates from the design practice of Van Dijk/Eger/Associates (nowadays referred to as WeLL Design), a leading Dutch design company founded in 1979. From the very beginning, Arthur Eger – one of the founders of the company – tried to describe the experience of the bureau in terms of a model. The first publication was realized in 1987 in *Dutch Design* (Eger, 1987) on the occasion of a large exhibition that five museums in the Netherlands had organized on the subject of design in the Netherlands. This publication identified five product phases. The sixth product phase, namely awareness, was first described in an article in *NieuwsTribune* (Eger, 1993), and afterward in the book *Succesvolle Productontwikkeling* (*Successful Product Development*) (Eger, 1996).

In the theory of Evolutionary Product Development, all matters that play a role in the evolution of products are the starting point. The model states that each of six product phases displays a typical pattern of product characteristics.

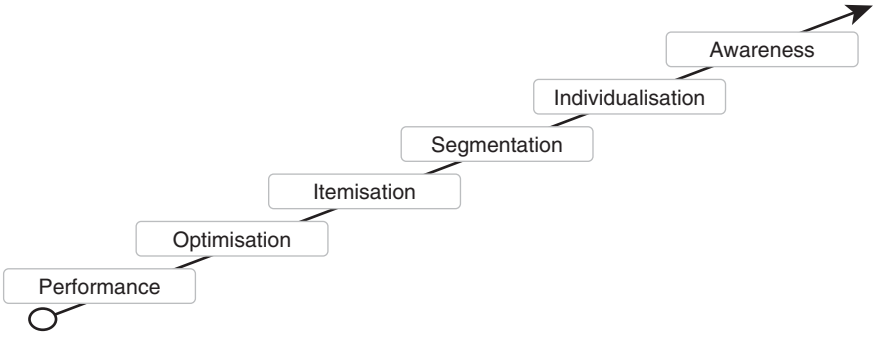

Figure F.1 The six product phases first version (1993) (Source: authors)

Any company making money through the development, production, or marketing of products will have to deal with this phenomenon. Managing it requires skills with respect to management of product development and design methodology, as well as a sound awareness of design history. In practice, products in each phase can be found on the market and specific knowledge is required for every phase.

Generally speaking, the emphasis in the first phase – performance – is on new technologies. New product functions are developed for which the functional performance of the products is the main challenge at this point. In the second phase – optimization – other knowledge is required. The market no longer accepts imperfections and other disciplines become important. Manufacturing technology and quality control become increasingly relevant. Product development is aimed at improving performance, reliability, ergonomics, and safety. In this phase, and in the following one, involving clients in the product development process is beneficial for both the product performance and the financial results of the company (Candi et al., 2010). In the third phase – itemization – high quality and safety no longer suffice. Here, ergonomics and styling are important success factors. Research in the field of man-machine interfaces also starts playing a role. The aim of product development is to develop extra features and accessories, including special editions of the product for different trade channels and target groups (segmentation).

According to the research presented in earlier publications (summarized in Eger, 2013) and in this book, the last three phases coexist (Figure F.2). Product development is either aimed at target groups that become increasingly smaller and differentiated according to specific needs (segmentation), or at mass customization or cocreation by which the customer is able to influence the final result (individualization). The ethical behavior of the company or organization behind the product is also becoming more and more important for customers (awareness).

When applying Evolutionary Product Development it is crucial to understand the history of the product in focus. Designers do not usually investigate

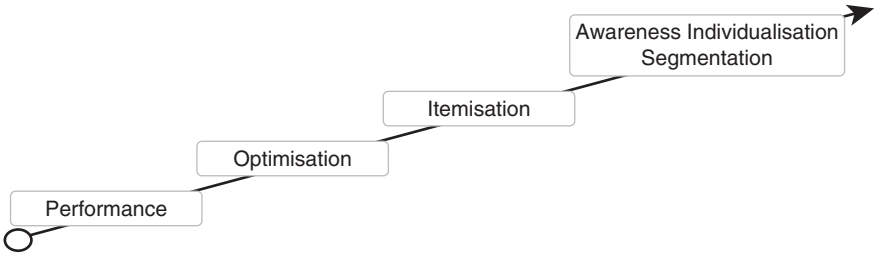

Figure F.2 The six product phases with the last three occurring simultaneously (Source: authors)

the development history of products, as this is a time-consuming activity normally reserved for economic historians or the like. In addition, traditional engineering and design courses lack embedding in the theoretical background of innovation studies required to recognize and interpret mechanisms and phenomena that shape the development history.

Given the aim to provide a method for mapping and extrapolating the development of products, a PhD research project was carried out entitled "Technological Innovation as an Evolutionary Process." This produced a thesis entitled "Product Evolution" (Ehlhardt, 2016) that presents the Theory of Product Evolution and the Product Evolution Diagram. The Theory of Product Evolution describes how the process of variation, selection, and retention drives the accumulation of "know-how" (to make) and "know-what" (function to realize) to provide an explanation for the emergence of new (types of) products and their subsequent development over time into a family of more advanced versions.

Using analytical concepts from innovation studies, the product evolution diagram (PED) is proposed as a systematic approach for analyzing the development history of products. This method uses two elements. First, a tree diagram similar to the family tree known from biology is used to map a product's development path. Second, a so-called PEST diagram is used to map the influences from the environment or ecosystem that affected the evolving product. A timeline reference connects the evolving product with the ecosystem. The Product Evolution Diagram is an analytical concept complementary to the product phases theory that is used as a guideline in new product development.

This book is intended for an audience of academics, students, design engineers, and others interested in new product development. It is an attempt to combine practical experiences from the field of new product development with theoretical insights from various academic schools of thought. The aim of this book is to provide a comprehensive answer to the question, "How do new products come about?" Besides this, it provides clues to the design direction of an evolutionary next version of products.

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