How the Nike Vaporfly 4% Changed the Running Footwear Industry

Investigating the competitive advantages and subsequent implications related to the introduction of a new product

Master's thesis in Management and Economics of Innovation

CAROLINE ALMKVIST

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS

DIVISION OF SERVICE MANAGEMENT AND LOGISTICS
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2021
www.chalmers.se
Report No. E2021:055

REPORT NO. E 2021:055

How the Nike Vaporfly 4% Changed the Running Footwear Industry

Investigating the competitive advantages related to the introduction of a new product and subsequent implications on the industry and future innovation

CAROLINE ALMKVIST

Department of Technology Management and Economics
Division of Service Management and Logistics
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2021

How the Nike Vaporfly 4% Changed the Running Footwear Industry
Investigating the competitive advantages related to the introduction of a new product and subsequent implications on the industry and future innovation
CAROLINE ALMKVIST

Report no. E2021:055
Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Göteborg
Sweden
Telephone + 46 (0)31-772 1000

Gothenburg, Sweden 2021

How the Nike Vaporfly 4% Changed the Running Footwear Industry
Investigating the competitive advantages related to the introduction of a new product and subsequent implications on the industry and future innovation

CAROLINE ALMKVIST

Department of Technology Management and Economics
Chalmers University of Technology

Abstract

Sport product manufacturers are investing heavily on research and product development to improve the performance of athletes and be at the forefront of innovation. Ultimately, to win over market competition. In 2017, the Nike Vaporfly 4% was introduced as a new-to-the-world running footwear product. How did the introduction of this footwear product change the running footwear industry? How did the emergence of the innovation relate to the competitive advantages of the manufacturer and what implications did the product introduction have on the sport practitioners, future innovation and manufactures within the industry? The study of the specific product serves as a case example of a footwear manufacturer, Nike, at the forefront of sport product innovation. From idea to market launch and beyond, the thesis examines existing theories in product innovation and competitive strategies to explain Nike's positioning and the running footwear industry's evolution. Furthermore, the study identifies and investigates the industry implications of the temporary monopoly created by the introduction of the Nike Vaporfly 4%. To achieve this purpose, the method used was a qualitative approach with an inductive character. Semi-structured interviews were held and constitute the primary data. A literature review was conducted, focused on 1) new product development, 2) resources and capabilities and 3) strategic positioning and marketing mix. Secondary empirical data was collected continuously throughout the project and formed a relevant foundation for the empirical findings as presented and discussed. The thesis structures the findings, discussion and conclusion into three distinct areas; 1) historical origin and development of resources and capabilities, 2) the introduction of Nike Vaporfly 4% and 3) learnings for future footwear innovation. Conclusions were drawn, highlighting a history of strategic investments in innovation and a consumer-centered collaborative approach to product development. Nike's base of resources and capabilities establishes a strong foundation for its leading position in product innovation. The Vaporfly 4% confirms and re-emphasizes Nike's superior positioning as a leading innovator within the running footwear industry. Lastly, it concludes future innovative efforts within the industry to be strongly influenced by the emergence and development of advanced technologies.

Keywords: *Running Footwear Industry, Innovation, New Product Development, Competitive Advantages, Dominant Design, Technology S-curve, Strategic Intent, Marketing Mix, Nike Vaporfly, Advanced Footwear Technology.*

Acknowledgements

As the author of this thesis, I want to send my gratitude to all the participating interviewees. Without your curiosity, engagement, and willingness to contribute with your specific perspectives, opinions and experiences, this work would not have been possible. I am very grateful for the time you dedicated to share your knowledge and passion with me.

Further, I want to express certain gratitude to the thesis supervisor, Pernilla Gluch, for continuous feedback and support in navigating through the research and study process. In a situation where the global pandemic forces us to conduct all work digitally and remotely, your genuine interest and ongoing support throughout the process has been very important to me.

I want to dedicate special thanks to my empowering family, friends and devoted colleagues who have supported me with insights, recommendations, experiences, and discussions which brought further inspiration and perspectives to the study, thank you for bringing thoughts and ideas from other professions and disciplines into my academic research.

Thank you Grandpa, *Tack Morfar*, for competing with me on finalizing my master's studies before you reach your 90th birthday and for encouraging me to prioritize and focus on long-term perspectives with dedication and a strong foundation of grounded values.

Lastly, I want to highlight the power of running as an enabler for inspiration, focus and a balanced state of mind. Ultimately, pushing the boundaries of my mind whilst empowering the process of reaching my full potential.

Thank you.
Caroline Almkvist

Hilversum, 2021.

Terminology

AFT - Advanced Footwear Technology, capturing manufacturers various approaches to a footwear innovation system, comprised of a combination of a carbon fiber plate and highly responsive midsole foam, as referred to in running footwear products

Big5 - Adidas, Asics, Brooks, New Balance, Nike

Breaking2 - Broadcasted documentary on x-functional Nike project with the same name, with aim to break 2-hour-barrier on the marathon distance.

Consumer - End customer, product user

Cost of cushioning - The influence an increase of footwear mass has to increase the metabolic rate and decrease the velocity of the runner

EVA - Ethylene vinyl acetate; plastic compound material used in midsole foam

Natural Movement Path - Individuals' basic motion patterns with no external interference

PEBA - Polyether block amide; plastic compound material used in midsole foam

Pronation - Weight-bearing on the inside of the foot

Pull market - Method to generate demand for product among consumers

TPU - Thermoplastic polyurethane; plastic compound material used in midsole foam

WA - World Athletics; International Sports Governing Body of Athletics (Prior IAAF)

Table of Contents

Table of Figures

1. Introduction

The introductory chapter presents the background for this thesis, followed by aim, specification under investigation and lastly outlines the full thesis disposition.

1.1 Background

The marathon has been a discipline in the Olympic Games since 1896 for male athletes and was introduced in 1967 for female athletes. Today, distance running is one of the most popular and practiced sports worldwide. With the long history of running competitions and marathon events, the progress of world records can be fitted to a logistic distribution (Nevill & Whyte, 2005). The historically significant improvements and breakthroughs are explained by research findings and improvements in biomechanical physiology, nutrition, supplementation including prohibited substances and doping classified methods, and scientific research focused on endurance training (World Anti-Doping Agency, 2019). However, with the historical data of world records in running, researchers suggested a point in time for running performance to plateau due to physiological and human limitations (Balmer et al., 2012). There was general consensus established, that if world records were to be improved beyond the calculated maximum level of performance, it would require external intervention and technological innovation to elevate athletes even further (BASEM, 2020).

Sport product manufacturers are investing heavily on research within product development to improve the performance of athletes, be at the forefront of innovation and ultimately win over market competition. Technological improvements and sport product innovation have historically had a great influence on sports and athlete performances across several sports, whereas some novel technology require regulation to ensure the sport remains fair and accessible.

The Nike Vaporfly Elite and subsequent commercially available Nike Vaporfly 4%, hereafter referred to as VF4, was introduced in 2017 as a result of the market leading firm's large investments in research and development (R&D), history of athlete-centered product development and close partnership with world class elite sport practitioners already at the initiating stage of its processes (Nike, 2017a). The technological innovation of carbon fiber plated (CFP) running shoes revolutionized long distance running in terms of world elite athlete performance; achieving new world records beyond the limits of what historically has been deemed possible (Nike, 2019a). The implications for footwear manufacturers are seen

across several domains; changed market dynamics, shifted customer demands and governing bodies' enforcement of regulatory restrictions imposed on product development, to protect the nature of the sport whilst encouraging innovation.

1.2 Aim

By studying the technological advancements grounded in research of innovation theory, competitive advantages and strategy, this thesis aims to discuss and understand the dynamics of the running footwear industry evolution driven by advancement in product innovation. From an industry, market and organizational point of view, this study discusses the interrelationship between product innovation and business responses in competing manufacturers' strategies, and the implications for the sport and its practitioners. Studying a specific product and manufacturer facilitate a case example of a manufacturing firm, Nike, at the forefront of sport product innovation.

1.3 Specification of Issue under Investigation

Specifically, the objective of the thesis is to answer the following research questions:
Main Research Question (MRQ): How did the Nike Vaporfly 4% change the running footwear industry?
Research Question 1 (RQ#1): How does the emergence of the new technology relate to the competitive advantages of the manufacturer?

Research Question 2 (RQ#2): What are the implications of the new technology on the sport, innovation and competing manufacturers within the industry?

1.4 Thesis Disposition

The thesis is organized in the following seven chapters:

Chapter 1	**Introduction**	Background and aim of study are presented together with research questions
Chapter 2	**Methodology**	Methods for theoretical literature review and empirical data collection and analysis are presented and discussed. A review of research quality, validity and reliability is provided.

Chapter 3	**Theoretical Frame of Reference**	Theoretical frameworks and previous research within innovation theory, market competition dynamics and industry are presented. Concepts introduced in Chapter 3 cater a theoretical and academic foundation for the thesis discussion.
Chapter 4	**Empirical Background**	Historical information related to the running footwear industry's development and subsequent policy intervention is presented. Chapter 4 is based on a secondary data document study and provides contextual understanding prior to introducing empirical findings in the following Chapter 5.
Chapter 5	**Empirical Findings**	Empirical findings derived from research interviews are aggregated and presented together with the support of secondary empirical data. Findings introduced in Chapter 5 provides multiple perspectives on running footwear development and industry dynamics.
Chapter 6	**Discussion**	Empirical findings are discussed in conjunction with theoretical concepts and frameworks introduced in Chapter 3. Important perspectives and connections to previous research are highlighted and further evaluated to form answers to research questions.
Chapter 7	**Conclusion, Contribution to Academia & Further Research**	Building further from Chapter 6, Chapter 7 provides a contextual conclusion of the study and answers each of the thesis' research questions. Theoretical and practical implications of the thesis conclusion are discussed. Lastly, study significance for academia is presented and recommendations for further research are provided.

2. Methodology

The following chapter describes the methodologies and structure of the thesis work, including data types and collection, interpretation, and analysis. Moreover, Chapter 2 presents the link between the methods chosen for the body of work to the thesis aim and research questions.

2.1 Research Strategy & Approach

The topic this thesis explores is the market dynamics and consequences on the running industry resulting from the introduction of CFP running footwear. This was done by establishing an initial academic foundation of relevant theoretical concepts in literature coupled with obsessing available industry research, business reports and conducting interviews.

Bryman and Bell (2011) suggest the two overarching types of strategies: quantitative and qualitative. They define the quantitative approach to be centered around objective, quantifiable data which can be collected in large data sets. Bryman and Bell (2011) refer to the qualitative method to be focused on the subjective interpretation of collected qualitative information. The qualitative approach is feasible for small data samples, where the outcome is not measurable and quantifiable. Considering that the thesis topic and study was based on interviews, the obtained data was deemed subjective by the nature of how it was collected rendering this, a qualitative approach. Further, supporting suitability of a qualitative approach was the inclusion of processing of available prior research and relevant theory.

2.2 Research Process

The research was exploratory by nature, aimed to capture insights and develop output from interviews, by which Bryman and Bell (2011) suggest an inductive approach to the research process. Authors explain that an inductive approach is deemed viable for research where focus is refined based on previous interview interaction (Bryman & Bell, 2011). Due to the dynamic structure of the research process, where an iterative literature review was combined with primary data captured during interviews, supported by secondary data, the inductive approach was chosen. Once the theoretical foundation was established, the research was focused on collecting information from three different types of sources as visualized in Figure 1 below, i.e. 1) conducting interviews with market experts and industry actors, 2) data retrieved from interactions with professionals within relevant fields of academia and

governing bodies and 3) collecting secondary data comprising of previous research studies, external market and industry documents and publicly available business and running footwear product information.

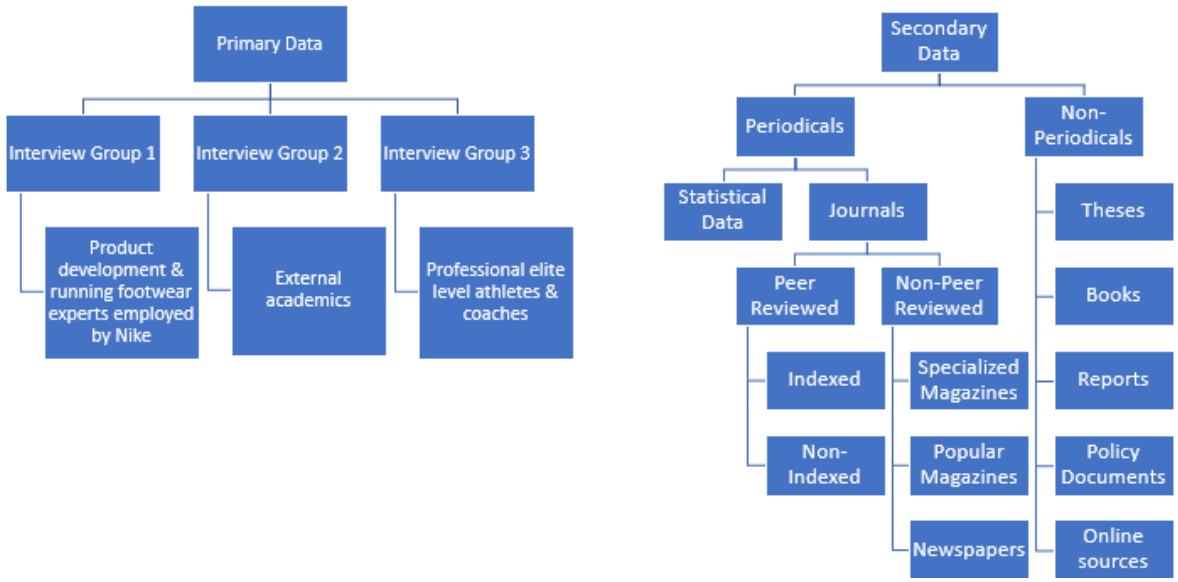

Figure 1: Primary & secondary data sources

2.2.1 Literature Review: Theoretical Framework & Secondary Data

To create a primary theoretical foundation for the thesis, the initial literature review comprised of articles including literature reviews and meta-analysis of research and peer-reviewed journal articles within the central focus areas and key search words:

1. Innovation, new product development, dominant design, competitive advantages
2. Technology S-curves, natural monopoly, industry transformation.
3. Strategic intent, marketing mix, marketing strategies, competitive positioning, sustained competitive advantages.
4. Running footwear, advanced footwear technology, carbon fiber plate, physiological requirements, biomechanical load, long distance running

As suggested by Bryman and Bell (2011) for inductive research, the initial literature review was conducted by taking a traditional narrative approach; studying articles which are repeatedly referred to and identifying experts within the area of study to provide a comprehensive overview of the development leading up to today's current thinking in the field of research. Literature was obtained from online indexes, guides, directories, on full-text and bibliographic databases accessed through Chalmers library by using the central focus areas mentioned above as search strings. Selected literature comprised of secondary sources of data as visualized in Figure 1 above. These were systematically summarized, evaluated,

critically reviewed, and compared to other research studies within the field. This approach supported in familiarizing with the area of study from a theoretical realm and further provided a theoretical foundation to identify and formulate problem statements and research questions to be answered.

2.2.2 Primary Data: Interviews

To access first-hand data to answer the main research question, interviews were selected as the primary source of qualitative information. Interviewees were asked general questions regarding the industry and their experiences, coupled with specific questions related to innovation and competitive advantages.

Interviews are conducted using one of the main approaches; structured or unstructured (Hauge, 1998). A combined approach, semi-structured, was deemed feasible for the topic of this thesis. The format allowed for the interviewees to express themselves more freely. By leveraging open questions, the interviewer could form questions based on the previous answer. Thus, the interviewer could retrieve qualitative data, letting concepts and theory emerge (Bryman & Bell, 2011). This enabled a format which was dynamic, agile and close to a real conversation. The different interview guides employed for the purpose of this study were created from the same initial overarching topics, whereby specific questions were added to customize the format based on the different interviewee. Andersson (1985) explains that also small differences in questions may affect the result of a survey. Therefore, interview guides were closely formulated to ensure each interviewee's perspective on the discussed topic is captured. The interview guides are presented in Appendix 1-3.

Interviewees were identified based on their extensive first-hand experiences from the running footwear industry and/or their professional achievements as elite athletes and coaches. Valuable experiences were regarded in dimensions of specific knowledge in the fields of; technology advancements and footwear innovation, dynamics of market competition, strategic knowledge within product positioning and sales strategies, and lastly, experiences of professional running training and competition. Each interview candidate contributed with diverse and valuable insights related to their field of expertise, respectively.

The interviews consisted of empirical data gathering from three groups of interviewees, namely; 1) sales managers, strategists and product developers with experience and knowledge

in running footwear product history and development 2) external academics with experiences in biomechanics and historical development of the running footwear industry, and 3) sport professionals with active participation in high-level elite running. The two groups of sources, 1) and 2), have different roles and experiences respectively. Group 1 contributed with insights from an internal market perspective on the running footwear industry dynamics and product innovation. The interviewees in Group 1 may have corporate interests and bias. Hence this information cannot be deemed objective in its nature. Data from interviews with Group 2 complemented Group 1 and constituted the information basis regarding innovation and industry analysis from an external, theoretical perspective relevant for the research. Thereafter, candidates were categorized into different interview groups to consider the differences in range of roles, previous experiences and current field of expertise. Due to the nature and limitations of time span for the thesis work, the number of interviews held were determined based on interview candidates' availability during a specific time frame. Table 1 below presents the interviews held and clarifies each interview candidate's unique position and contribution within their field of expertise.

Group	Candidate	Function/Experience	Organization	Date of Interview	Duration
1	**C1**	Product Development	Nike	22 Feb 2021	60 min
1	**C2**	Global Strategy	Nike	3 Mar 2021, 19 Mar 2021	30 min, 45 min
1	**C3**	Merchandising	Nike	11 Feb 2021	45 min
1	**C4**	Merchandising	Nike	9 Feb 2021	60 min
1	**C5**	Product Management	Nike	18 Feb 2021	60 min
1	**C6**	Sales	Nike	12 Feb 2021	45 min
1	**C7**	Product Development	Nike	9 Mar 2021	60 min
2	**C8**	Biomechanics	Swedish School of Sports & Health Sciences	10 Feb 2021	120 min
3	**C9**	Elite Running Coach		19 Feb 2021	75 min
3	**C10**	Sponsored Elite Athlete		10 Feb 2021	90 min
3	**C11**	Non-sponsored Elite Athlete		10 Feb 2021	90 min

Table 1: Primary data sources; list of interview candidates

2.2.3 Secondary Data: Empirical Background & Findings

To complement primary data collected through interviews, secondary data were gathered and reflected upon. Research constituting data collected and analyzed by an external party is considered secondary data analysis (Bryman & Bell, 2011). The purpose of utilizing secondary data was to get a comprehensive understanding of the industry and context within a limited time frame and supported in iterative knowledge gathering, mapping out and assessing the competitive landscape within the running footwear industry. Furthermore, secondary data provided additional details to topics discussed by the interviewees, i.e. supported in contextualizing historical events, product launches, technological breakthroughs etc. and enabling the researcher to build a holistic understanding on the topic of study. This included the specificities of product innovation and its subsequent impact on sport performance, financial performance, governing bodies regulatory shifts and consequently changed prerequisites for future innovation. Lastly, media coverage of industry specific events was included when relevant for the research aim and scope.

The sources used to obtain secondary data included books written by industry insiders, conversations with experts recorded at innovation summits, interviews and articles published by the industry-specific magazine Runners World, manufacturers' press releases and information available on their web pages and detailed articles shared through Nike's own publicly available repository for Nike stories, company and product information, Nike News. Further, World Athletics official regulatory documents were included in the search for secondary data. Lastly, search strings as; biomechanics, running economy, running performance, running fatigue, biomechanical load, Vaporfly, carbon fiber plate, advanced footwear technology, on Chalmers online library provided scientific research papers centered around biomechanics, physiology and running accessible at PubMed. A detailed overview of the types of secondary data, methods of collection, purpose and evaluation criteria respectively, is shown in Table 2 below.

Source	Method of Collection	Purpose	Quality Evaluation Criteria
Mass media, Newspaper, Magazines	Internet search, newspaper indexes. trade associations	Contextualize & validate primary data	Currency, nature, objective, dependability
Abstracts, Books	Library, indexes	Contextualize primary data & build historical foundation	Currency, nature
Business journals & research periodicals	Online library, bibliographic databases, guides, directories	Build industry foundation & interpret primary data with more insight	Currency, objective, dependability
Policy documents	Governing body's website	Understand scope and changes made to regulatory framework	Currency, nature
Scientific research papers	Online library / bibliographic databases, citation indexes	Build scientific foundation & validate primary data	Error and accuracy, objective, specifications & research design, dependability
Online sources	Internet search on companies' websites	Contextualize primary data	Currency, nature, dependability

Table 2: Secondary data sources; list of data source types.

2.2.4 Data Coding & Analysis

Bryman and Bell (2011) suggest grounded theory as a means for collecting and analyzing qualitative data. The method used for this thesis is in alignment with the approach of Gioia et al. (2012), emphasizing coding as the main process. Gioia et al. (2012) further elaborate on traditional grounded theory and present a phased methodology model for qualitative data collection and subsequent analysis, visualized in Figure 2.

Figure 2: Visualization of 3 phases in Gioia et al.'s (2012) methodology for qualitative data analysis.

The phased methodology was initiated by codifying the information in 1st order concepts with the purpose of capturing and categorizing all data, whilst maintaining the informant-centric terms as explained by Gioia et al. (2012). Similarities and differences were identified, and categories were reduced to a manageable amount and given labels where the potential significance for theory determines the level of importance. Thereafter, 1st order concepts were grouped in the 2nd order analysis and translated with a theory-centric approach into 2nd order

themes. The rationale for the thematic translation was to discern concepts connecting to the theoretical realm (Gioia et al., 2012). Subsequently, the concepts were organized to aid the study's objective, i.e. answering the research questions. Lastly, 2nd order themes were organized into 2nd order aggregate dimensions to assemble an organized data structure which captures terms, themes, and theoretical classifications.

As explained by Bryman and Bell (2011), the aggregate dimensions are abstract by nature as they capture conceptual representations of real-world phenomena. Moreover, Gioia et al. (2012) articulate the grounded theory approach to enable the researcher to transform a static data structure to dynamic theory modelling which allows for concepts and relationships to emerge and be iteratively refined. The empirical data consists of both interviews and empirical documents. Thus, thematic coding has been applied across both types of empirical data. See Figure 3 below for coding of primary and secondary data.

1st Order Concepts	2nd Order Themes	Aggregate Dimensions
Nike heritage, vision, strategic intent, design philosophy	Nike Heritage, Resources & Competencies	Competitive Advantages within the Running Footwear Industry
Resource & capabilities advancements 1970-today, path dependency		
X-functional collaboration, science-based R&D	R&D investments	
Organizational structure & departments		
Collaboration & partnership with elite runners	The Voice of The Athlete & Innovation Mindset	
Curiosity, passion for sports, understanding needs of athletes, 'voice of the athlete'		
Positioning, authenticity, credibility	Becoming a Market Leader	Competitive Landscape after VF4 Introduction
Temporary monopoly, expand & protect		
Challenger, entry barriers, followers passively capitalize on new tech once available on market	Market Challengers, Followers & Nichers	
Nicher, design language, market segmentation		
Innovation, supporting products, performance benefits, clear product identity	Product Proposition & Pricing	VF4 Strategy: From Idea to Market
Advanced technology, consumer perception		
Product as marketing tool, science-based research, Breaking 2 documentary, authentic storytelling	Product as a Marketing Tool	
Production constraints, marketplace dynamics, digital priority, authenticate globally	Go-to-Market & Distribution	
Limits sponsorship as a factor in performance	For Sport & Practitioners	Consequences of Policy& Regulatory Intervention
Improved running related injury protection		
Forced direction limiting opportunity in racing	For Product Innovation	
Innovation efforts targeting other domains		
Shifting requirements, lag in innovation	For Industry & Manufacturers	
Limiting effects of competitive advantages		
Improved materials, cushioning, AFT system	Injury Prevention	Learnings & Future Running Footwear Industry Outlook
Training regime, recovery, reduced load		
Process innovation, material engineering	Technological advancements	
Product innovation, wearable electronics		
Trail running, outdoor interest	Consumer trends	
Sustainability, responsibility, awareness		

Figure 3: Data structure for primary and secondary data

2.2.4.1 Data Analysis: Interviews & Secondary Data

The structure of the interviews allowed for dialogue and evolved dynamically around topics of certain interest with each individual interviewee. Hence, the interactive reasoning implied analysis was initiated during the time of the interview. Interviewees have different perspectives, geographical location, and professional background, respectively. Flick (2009) therefore implies thematic coding caters the grouping of different wordings and phrases used by interviewees. The analysis is described by Gioia et al. (2012) and structured in six stages; 1) collect data, 2) code data, 3) organize data around concepts, 4) form themes of related concepts, 5) elaborate patterns and linkages between themes and lastly 6) develop a theoretical explanatory model.

Applied in this research study, the six stage process is visualized in Figure 4 below and was applied as; stage 1) processed data in numerous formats (written communication, interview notes, video, audio) to understand the content from various perspectives of interviewees; i.e. considering industry experience, professional background, specialized knowledge etc. Stage 2) identified, interpreted, and labeled recurring concepts in interview data related to company specific innovation processes, organizational resources and capabilities, industry-wide trends and development and strategic management. Stage 3) leveraged contextual understanding of each interviewee's perspective to collate data into concepts, where each interviewees' background in a certain field provided additional insights for the interpretation of data. Stage 4) linked empirical data from interviewees to themes, explained by theories and frameworks presented in the theoretical frame of reference. Stage 5) organized themes into aggregate dimensions to build clear inter-thematic patterns with theoretical connection explaining the linkages between Nike's historical development of superior resources and capabilities, to its strategic intent and competitive positioning, and lastly Stage 6) suggest theoretical explanations to empirical findings linked to competitive advantages and product innovation and ultimately providing answers to the research questions.

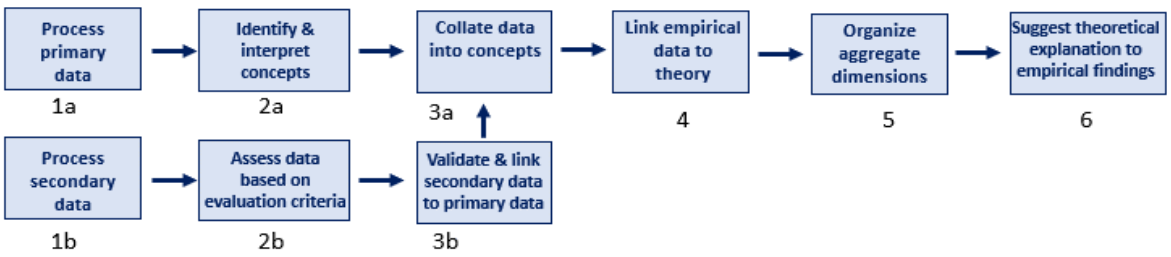

Figure 4: Visualization of 6 stages of data analysis and interplay between primary and secondary data

Following the structure for coding of data in Figure 3, the secondary data analysis was conducted in a similar manner as the primary data, with added caution taken to the evaluation criteria of various types of sources as presented in Table 2. The analysis builds upon the method of Gioia et al. (2012) where data is thematically coded and linked to the analysis of the primary data, as visualized in Figure 4 above.

2.2.4.2 Data Analysis & Connection to Theory

Finally, as result of the thematic coding process, inter-linkages between primary and secondary data form the foundation for theoretical connection and conceptual development, as explained by Gioia et al. (2012). The coded data structure and analysis including primary data, secondary data and the theoretical frame of reference is visualized in Figure 5 below.

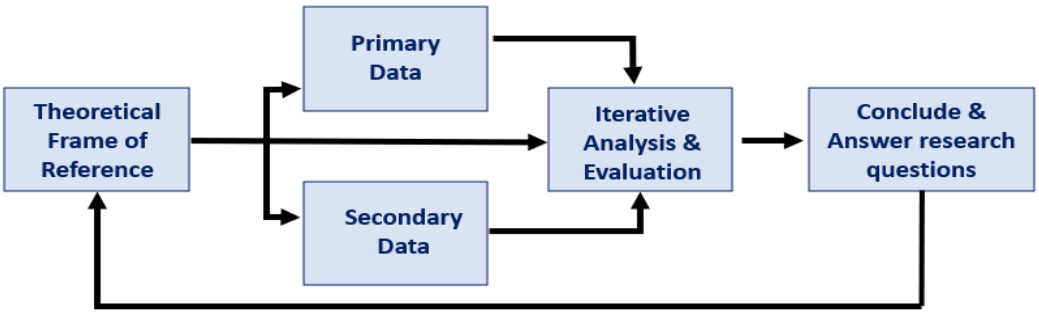

Figure 5: Analyzing the data from primary and secondary sources and its connection to theory

2.2.5 Data Quality Assessment

The quality of the material chosen to establish the research foundation was assessed in four dimensions mentioned by Flick (2009) as degree of authenticity, credibility, meaning and representativeness. The primary source of data is deemed genuine and unquestionably authentic, as interviewees bring first-hand information from within each field of expertise. Regarding credibility, data is of high accuracy and further validated and confirmed with secondary data sources in parallel. As for meaning of the collected data, it is distinguished and carefully recognized for the intended purpose of each interviewee and material publisher. In terms of representativeness, the selected interview sample included industry representatives from one single manufacturer and implied empirical findings are presented from one manufacturer's perspective. However, the secondary data was thoughtfully selected to provide a broader perspective and could therefore be seen as a complement to the specific and narrow interview sample. The secondary data was evaluated according to the six evaluation criteria presented by Malhotra et al. (2017), namely; specifications and research design, error and accuracy, currency (time of collection), objective (purpose of collection),

nature (content) and dependability, presented in Table 2 is a specification per each source type. The evaluation checks provided information on reliability and validity of the data and supported in determining whether information could be deemed generalizable and leveraged in this thesis.

The author of this report has professional experience from working within the running footwear industry and participating in elite level competition in long distance running. This supported the dynamic and semi-structured interview approach, opening for interesting follow-up-topics and simplified the contextual understanding of the interviewees' answers and opinions in the discussed areas. Being knowledgeable on the product offering among manufacturers and understanding the dynamics within the running footwear industry limited the potential risk of misinterpreting the interviewees responses.

However, a certain industry involvement also required a high level of responsibility in adhering to policies. All empirical data and imagery presented in this thesis were made publicly available prior to the time of writing this thesis and is referenced to throughout the report. Interview candidates have given their formal written consent to use and publish specific quotes extracted from the interviews. The thesis is written and supervised solely by Chalmers University of Technology and the views expressed in this thesis are representative of the author's own as a master's student at Chalmers University of Technology, and not to be associated or identified with Nike.

3. Theoretical Frame of Reference

This chapter connects literature within the four key areas; 1) innovation and new product development, 2) establishment of competitive resources and capabilities, 3) companies' strategies for positioning and 4) marketing mix. The four key areas combined form the basis for the analysis of market shifts and competitive advantages related to innovation within the running footwear industry and subsequent consequences on market dynamics, sport performance and further innovation. Lastly, 5) fairness of sport and governing body policy interventions provides a theoretical frame of reference and foundation for discussion of regulatory shifts.

3.1 Innovation & New Product Development

Section 3.1 introduces theory related to new product development and innovation. Further, connections are presented to theories of dominant design and technology s-curves to provide a foundational understanding of the subsequent impact on manufacturers.

3.1.1 Process of New Product Development & Innovation

To capture the term 'innovation' from a research perspective, Garcia and Cantalone (2002) provide the overall definition *"'Innovation' is an iterative process initiated by the perception of a new market and/or new service opportunity for a technology based invention which leads to development, production, and marketing tasks striving for the commercial success of the invention."* (Garcia & Cantalone, 2002, p. 112).

A simplified model of the iterative new product development (NPD) process is presented by Crawford and Benedetto (1994) and outlines the evolving in clarity and resulting increase in market value. The NPD process consists of five phases, as in Figure 6, representing activities, tasks and decision points required when progressing from opportunity identification to commercial product launch.

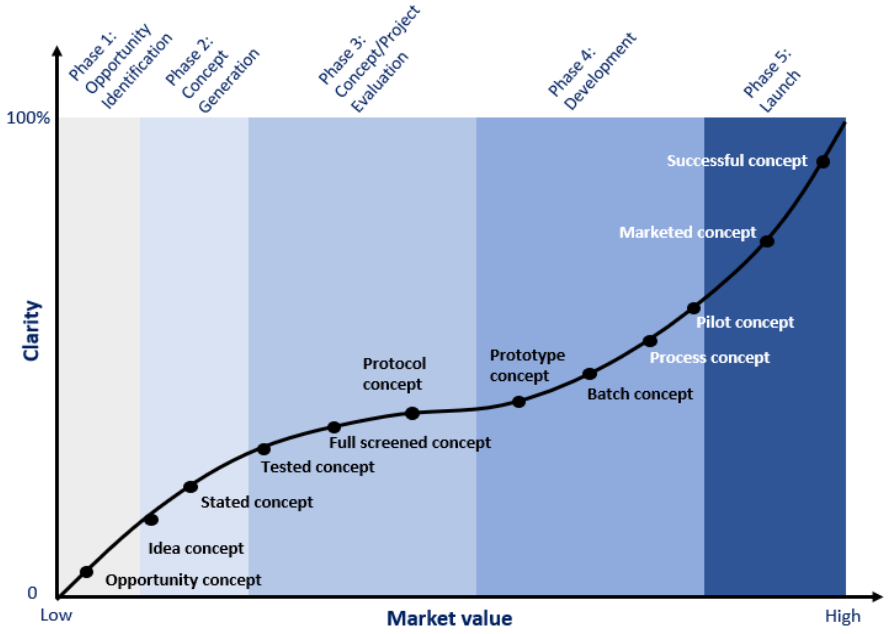

Figure 6: New Product Development Phased Process (Crawford & Benedetto, 1994).

Crawford and Benedetto (1994) describe NPD processes as multifunctional efforts where companies are increasingly involving customers at an early stage and throughout the process. Trott (2017) elaborates on the context around the model by Crawford and Benedetto (1994), explaining the linkages between market pull and technology push and their necessity for value creation and capture. Trott (2017) describes that the innovation process can be compared to knowledge transfer through complex communication paths with internal and external linkages. Supported by Rothwell and Zegveld (1985), Trott (2017) argues that innovation emerges as the dynamic result of marketplace insights, scientific advancements and organizational capabilities with strong interdependence and interacting stages of the complex process. However, Crawford and Benedetto (1994) explain that process stages are not subsequent but rather overlapping by nature. The phase overlapping is encouraged by firms to reduce the time to market for products, demanding effective communication within the project team and across corporate functional areas. The goal of the process is to manage resource allocation, limit the risk and uncertainty across the different phases and ultimately increase likelihood of success when launched. Building further on the reasoning of Crawford and Benedetto (1994) regarding success potential, Veryzer (1998) explains that due to the more exploratory nature of the discontinuous NPD process where the development team focuses on creating a product application of the emerging technology, the market opportunity is difficult to quantify.

3.1.2 Dominant Design & Technology Cycles

Abernathy and Utterback (1978) investigate the phenomenon of dominant design and present the process in three phases; the fluid, transitional and specific phase, visualized in further context in Figure 7.

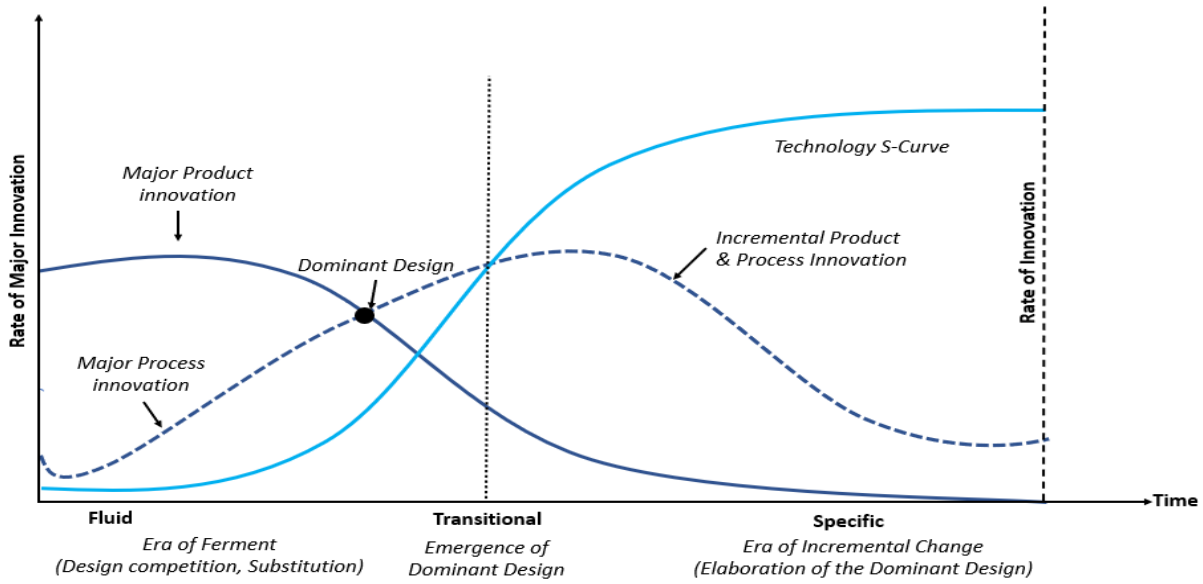

Figure 7: Visual representation of Utterback's (1994) three phases of innovation, dominant design, and linkage with Tushman & Rosenkopf's technology cycle (1992).

Trott (2017) elaborates on the model and explains the fluid phase, where different technologies compete, and developers make distinct changes which define novelties. Here, inventions are driven by (unconscious) needs of users. This is the era of ferment, where product is novel, and no dominant design has yet been established. Manufacturers are inspired by pioneers and focused on differentiating the product proposition, winning by providing superior perceived benefits for the customer (Trott, 2017). The main competition in this stage comes from the incumbent, established technology and current market competitors. As the potential applications of the technology itself have not yet been exploited, Abernathy and Utterback (1978) explain that at this stage, a company will focus its efforts in establishing its novel product as the dominant design. The firms which are not the leaders in establishing the dominant design will wait for its appearance and then adhere to the new standards, whilst securing the biggest possible profits through current product offering.

A dominant design prevails when moving into the transitional phase. Market competitors are centered around developing a cost-efficient production process to enable economies of scale. Moreover, the transitional phase includes supplementary technical features enhancing the dominant design, be it material selection, increased capacity of components or refinements of

other subordinate properties. Competing firms either align their efforts to embrace the emerging dominant design or withdraw as they lose customer interest and subsequently market shares, leading to a convergence pattern around a set design (Trott, 2017). The mark of the transition phase when a dominant design has appeared is explained by Utterback as *"features to which competitors and innovators must adhere if they hope to command significant market share following"* (Utterback, 1994, p. 24).

Once the dominant design is established, there are very limited changes in process and product fundamentals. Market actors are focused on cost-cutting and improving the quality of the offered product. Innovativeness in this phase is very low. The importance of winning the battle of the dominant design is due to the subsequent opportunity of monopoly rents; setting future industry standards and further enhancing the powerful position as the market leader, reaching the top of that specific technology S-curve, before a new technology emerges, as visualized in context in Figure 7. For new entrants, specialized knowledge, investment in development and patent protections are three of the pronounced entry barriers to overcome (Abernathy & Utterback, 1978) in product development. Additionally, Tushman and Rosenkopf (1992) explain that technological advancements are often subject to investigation and intrusive legislation, hence limiting the application of the technology in products. By so, impacting success potential of the product and competitive advantage of the firm.

3.2 Establishment of Competitive Resources & Capabilities

A company's competitiveness is largely determined on the company's assets and the interconnection between these. To assess the strategic importance of a firm's asset base, Section 3.2 introduces frameworks focused on the specific properties of resources and capabilities and presents four cornerstones to establish and sustain a competitive advantage. Further, Section 3.2 describes a theoretical approach to the competitive positioning based on the above frameworks and links to the company's strategic intent and marketing mix.

3.2.1 Resource Based View & Dynamic Capabilities Framework

Resources of the firm can be classified as tangible and intangible (Hall, 1992) and broadly defined as assets, organizational processes, firm attributes, information, and knowledge owned by the firm (Madhani, 2010). The Resource Based View (RBV) analyzes the firm's environment by taking an internal-external perspective with an emphasis on strategic internal

resources to establish and sustain a competitive advantage (Barney, 1991; Peteraf, 1993; Grant, 1996).

Barney (1991) explains superior performance and sustained competitive advantage of the firm can only be achieved when resources fulfill any of the 'VRIN' criteria, i.e. are either one of valuable, rare, inimitable, or non-substitutable. Derived from the 'VRIN' criterion, Peteraf (1993) presents four cornerstones of competitive advantage, being; resource heterogeneity, ex post limits to competition, imperfect mobility of resources and ex ante limits to competition, as visualized in Figure 8.

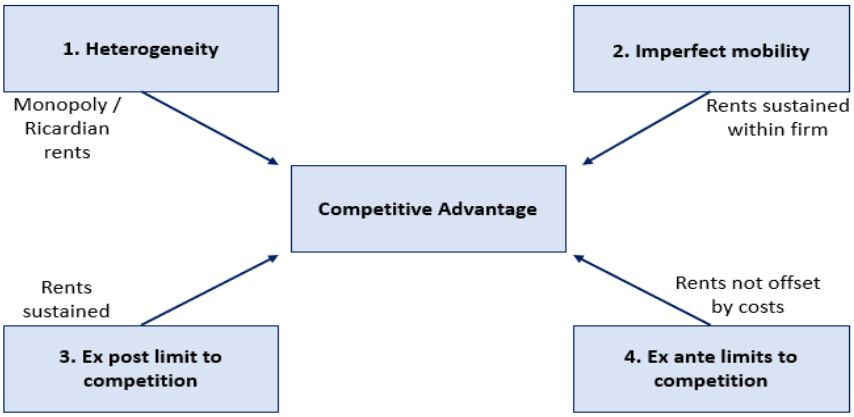

Figure 8: Cornerstones to competitive advantage (Author's own based on Peteraf, 1993).

Resource bundles are assumed to be heterogeneous across firms in the RBV. This implies firms have unique combinations of strategic assets and hence provided opportunities for competitive advantages through variations in the differentiated asset bases (Peteraf, 1993). Moreover, the variations in strategic asset distribution across firms result in Ricardian rents (Grant, 1991). Ricardian rents are created due to a limited supply of superior strategic assets which either 1) cannot be expanded across competitors, or 2) cannot be expanded rapidly (Peteraf, 1993). This results in competing firms introducing inferior resources to capture demand as long as price exceeds marginal cost of production, whilst superior firms are producing with restricted capacity to rapidly expand supply.

Heterogeneity of resources is also consistent with monopoly rents. Peteraf (1993) further explains the monopolistic profits which result from spatial competition, restricted intra-industry mobility or product differentiation. Thus, reflecting uniqueness in customer offering and geographical monopolistic circumstances, i.e. rather a deliberate restriction of output than inherent scarcity of resource supply. Ricardian and monopoly rents are considered the two

manifestations of competitive advantages derived from heterogeneous resources and capabilities (Teece, 1984).

As argued by Barney et al. (2001), the RBV only provides an overly simplistic view of competitive advantages whereas the market is characterized by unpredictable and ever-changing conditions. To complement the RBV presented by Barney (1991), Teece and Pisano (1994) suggest a view focused on the dynamic capabilities of the firm. The Dynamic Capabilities Framework (DCF) emerged as competitive advantages cannot be pertained solely through focusing on a company's resources in isolation. Researchers (Teece et al., 1997) suggest the dynamic capabilities to facilitate specific and imperfectly imitable opportunities to establish and sustain competitive advantage. Teece et al. (1997) further describe the DCF to analyze each subset of dynamic capabilities, namely; sensing and shaping opportunities and threats, seizing rising opportunities and lastly; enhancing, combining, protecting and re-configure strategic assets of the firm to sustain competitive advantage in the long term (Helfat et al., 2007).

3.2.2 Competitive Limitations due to Superior Resource

Peteraf (1993) presents the second cornerstone for competitive advantages as 'ex post limits to competition'. This refers to competitive limitations established after a firm having gained a superior position on the market. Heterogeneity of resources must be viable in the long term to add value. RBV research has mainly centered around imperfect imitability and imperfect substitutability to limit competition due to superior resources (Grant, 1991). Imperfect imitability was first referred to by Rumelt (1984) as isolating mechanisms. These are protecting the firm which has obtained the superior resource by hindering competitor imitation, hence enabling continued rent streams. Thus, ex post competition erodes the Ricardian and monopoly rents. Teece (2009) emphasizes the fundamental need of the DCF as capabilities change over time. Firms are shaped by their past capabilities; however, future trajectories and organizational skills are to be set and developed in co-evolution with the market. An organization's ability to adapt to changing customer and technological opportunities is determined by the effectiveness shown in reshaping and reconfiguring its specialized knowledge, strategic assets, and core capabilities (Teece & Pisano, 1994). The asset superiority is created through a highly path dependent process which competitors will find time-consuming and complex to identify and imitate, hence resulting in a time-lag and not providing the envisioned advantages.

3.2.3 Imperfect Mobility of Resources & Capabilities

As Peteraf (1993) suggests, imperfectly mobile resources are assets which are non-tradable between organizations. A resource's degree of mobility is inversely related to the potential degree of sustained competitive advantage which can be derived from the resource (Madhani, 2010). Moreover, factors as digitalization, globalization and diminishing industry boundaries both influence and lower the barriers for competitors. Thus, increasing the magnitude of consequences from immobility of resources (Teece, 2009). Ultimately, as technological development is rapidly increasing, the scattering of specialized know-how within innovation escalates across the market, resulting in less imperfect mobility of resources and capabilities.

In addition to the above, Peteraf (1993) further acknowledges that tradeable specialized assets need to be imperfectly mobile, i.e. bring more value when leveraged internally than if a competitor utilizes the same asset. Similarly, assets are imperfectly mobile if applied in combination where at least one of the two assets are firm-specific and the other not used for any other purpose but related with high transaction or development costs (Teece et al., 1997).

3.2.4 Limited Competition for Superior Resources

The last cornerstone for competitive advantage is limited competition for superior resources, which Peteraf (1993) names ex ante limits to competition. Meaning that firms with comparable abilities have equal opportunities to discover the superior resource. Once discovered, firms are intensely competing which will conclusively diminish the advantages of reaching the position of superiority. Hence, solely if a firm is alone in identifying and seizing the opportunity, it will capture profits beyond accustomed. Thus, Ricardian and monopoly rents are not at stake due to the hinders created by the limited competition for superior resources and capabilities (Grant, 1991).

3.2.5 Strategic Intent

Coupling the RBV and DCF provides a holistic analysis of the existing competitive advantages and positioning in the current market environment. Nonetheless, a firm's future is also largely influenced by the strategic creation and active management to sustain competitive advantages over time. Namely, moving the company from its actual position on a trajectory towards a desired position, whereas strategy addresses and bridges the gap (Drummond & Ensor, 2001). This is referred to as *Strategic Intent* by Hamel and Prahalad (1994), meaning the firm's ambition to establish a focus and motivation among employees to

jointly contribute to the overall targets. The strategic intent includes the mission statement, grounded in the corporate values and beliefs. It aims to bridge the gap between the scarce company resources and capabilities, and the corporate targets, i.e., by ensuring the most effective capacity utilization and resource allocation. This is reflected in knowledge development and opportunity seeking through managing competitive initiatives whilst conserving scarce assets. Hamel and Prahalad (2005) explain that firms with goals of considerably high risk are the ones with highest potential of reaching a market leading position if managed consciously. Thus, changing the rules of the game through competitive innovation rather than following in the footsteps of the current leader resulting in a pattern of imitation and suffering from time-lag.

3.3 Competitive Positioning

Firms build their positioning strategies on their specific set of competitive advantages, gained by offering consumers greater value through lower price or increased perceived benefits (Kotler et al., 2005). Porter (1980) presents three winning strategies for competitive positioning, being 1) cost leadership, 2) differentiation and 3) focus. Porter argues that companies are likely to be successful if they select and excel exclusively in one of the three. Companies that perform well overall in all three end up failing due to not being specialized enough in any area. Depending on a firm's resources, capabilities, objectives, and strategy, it will be positioned differently within the industry. Built on the reasoning of Drummond and Ensor (2001), Figure 9 visualizes the different positions of a market leader, the market challenger, market nicher and market follower whereas all of the mentioned have different challenges and levers to use in managing competition.

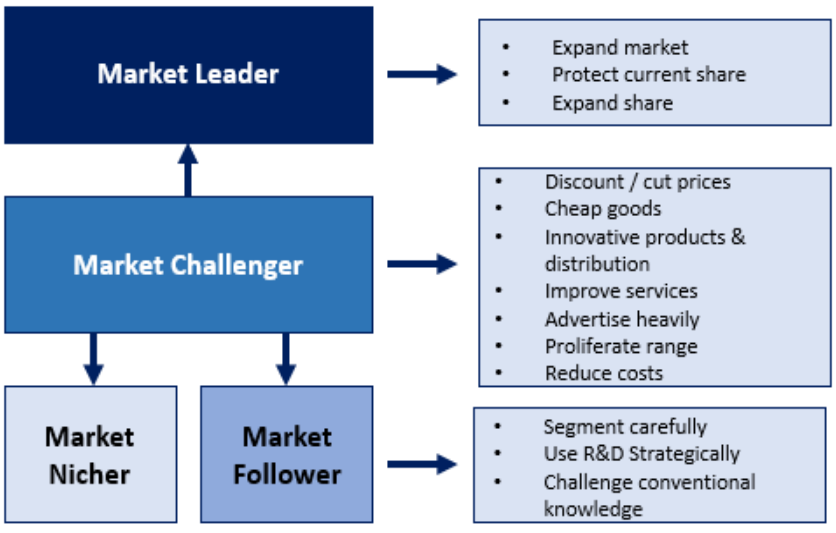

Figure 9: Market positioning (Author's own based on Drummond & Ensor, 2001).

The *market leader*'s main challenge is to expand the market through more users, new users and more usage, as it is the actor who relatively will benefit the most from increased sales. Defense strategies of the leading firm include protecting its position and market share to eliminate all potential gaps for competitors to attack. Lastly, market leaders strive to expand their market share to diminish competition (Kotler et al., 2005). The *market challenger* selects its targets and attacks the leader and/or other competing firms, with the goal of expanding its market share (Kotler et al., 2005). The *market follower* is less focused on pushing the limits and more focused on ensuring a flourishing core business. This through leveraging skills for market growth, resulting in a considerably high rate of return (Kotler et al., 2005). Lastly, the *market nicher* is specialized in an area which is less attractive by overall industry leading firms. They are subject matter experts within their field of operations and serve a small targeted consumer group (Kotler et al., 2005).

Independently of a company's position within the industry, Kotler et al. (2005) stress on maintaining a healthy balance between focusing on competitors versus consumers when building an effective strategy. An exaggerated competitor focus develops an alertness within the marketing team. However, it also risks resulting in reactive responses and a time lag in serving consumers. At the other end of the spectrum, an emphasized orientation towards the consumer results in higher potential in shaping and seizing opportunities whilst building long-term strategic plans.

3.4 Marketing Mix

Kotler et al. (2005) express the next step of the competitive positioning process, implementing the detailed plan of the firm's marketing mix. The *Marketing Mix* framework developed by McCarthy (1960) provides a set of controllable and tactical marketing tools to differentiate product offering and impact consumer needs and behaviors, split up in the 4P's, namely; *Product, Price, Place* and *Promotion* and visualized in Figure 10.

Figure 10: '4P' Marketing Mix framework visualization (Author's own based on McCarthy, 1960).

Kotler et al. (2005) describe *Product* as the first and foremost component of the conceptual framework as it is the foundational reason for the existence of the firm. The product provides the customer with a bundle of benefits through product attributes and varieties responding to the consumer's needs. In essence, the *core product* is the first level which delivers a solution to consumer problems. The second level designing the *actual product*, including perspectives on quality, styling, features, branding, and packaging. Lastly, the third level of a product is *augmented* to offer additional services, delivering warranty and customer support. Van Watershoot and Van den Bulte (1992) raise a concern with augmented benefits; they soon become expected, thus raising the required efforts for further differentiation to satisfy and delight the consumer. By offering a product line consisting of products with different segmenting, targeting, and positioning, firms fight the market competition. As Kotler et al. (2005) explain, the shape and set of product lines jointly make up the *product mix*. The product strategy is built on decisions determining the depth, length, width, and consistency of the company's product mix.

The second component in McCarthy's conceptual framework (1960) is *Price*. It refers to all contractual terms and conditions, discounts, payment, and pricing policies. This is highly dependent on the market for supply and demand and focused around either cost leadership or differentiation (Porter, 1980). *Promotion* comprises the third P of the framework and includes marketing tools leveraged for communicating the product, namely; branding, advertisement, public relations and corporate identity. Highly successful firms leverage the company's strategic intent to portray the corporate identity, based on values and beliefs of the firm and

its employees (Drummond & Ensor, 2001). The fourth P is *Place*, including distribution strategy of products, focused around channels and locations, ensuring an impactful consumer reach (Porter, 1980).

In addition to the tangible benefits delivered through product attributes as quality, design and functional features, Kotler et al. (2005) further emphasize the importance of brand differentiation through elements of design, name, and strategy. These are built on consumer values and beliefs to create long-term value and brand equity. Brand equity consists of brand awareness; identity; loyalty, and perceived quality (Drummond & Ensor, 2001). It takes time to build and is arguably one of the most effective drivers for firms to charge a premium price (Keller, 1998).

3.5 Fairness of Sport & Governing Body Policy Interventions

As seen in several able-bodied sports historically, innovative technologies to improve the performance of athletes have been used. These have subsequently also been regulated to eliminate unfair advantages of athletes in competition. Murray (2010) elaborates on the ethical notion of fairness in sport. Each sport requires commitment to perfect a talent through dedication in skillful and strategic employment. Fairness is achieved through a level playing field where talent and dedication determine the winner. This does not imply all athletes should be equal in all aspects, but rather that the nature and values of the sport shall remain unchanged. Hence, bringing a level foundation for meaningful participation and competition. Fairness of sport is systematically reviewed by Dyer (2020a), who classifies sports technology impact and groups the themes in the ten different criteria as in Table 3 below.

Summary of Sports Technology Impact
Criterion
Harm or health (to athlete/others)
Unnaturalness
Unfair advantage
Coercion
Safety and spectator appeal
Integrity of the game, 'spirit of the sport'
Deskilling & Reskilling
Dehumanization
Cost (or excess cost)
Internal goods of a sport
Equal opportunity or access

Table 3: Ten criteria for sports technology impact as classified by Dyer (2020a).

Dyer (2020b) discusses the multiple topics and highlights equal accessibility due to patent and intellectual property rights to be a potential area of concern for the VF4. However, the technology with CFP footwear is not unique, but rather provides a temporary competitive advantage as the emerging technology is first applied in the new product utilized by athletes in competition. Dyer therefore suggests equal opportunity and access to innovation to be discussed and potentially regulated by the sport governing body (2020b). Supported by Jones and Wilson (2009), Dyer (2020b) recommends a pragmatic approach by the governing body to manage innovation and technological product enhancements where there is an indication on performance improvements. The researcher concludes that longer periods without intervention by a governing body lead to arguable unfairness and negatively impact the 'spirit of sport' (Dyer, 2020b).

4. Empirical Background

This section presents information to introduce and contextualize the development and current settings of the running footwear industry. This is structured in two sections, being 1) running footwear industry and historical development and 2) running footwear innovation policy intervention, based on secondary data. Each section within Chapter 4 provides an informative background to Chapter 5, Empirical Findings, where results from the interviews are presented.

4.1 Running Footwear Industry & Historical Development

The global running footwear industry is valued to EUR 10 876 Mn in 2020 in and continues to grow at an CAGR of 4% (Market, 2020). With the industry's current trajectory of evolution and growth, manufactures have continued business opportunities to compete for to gain profits and expand their market shares. See Appendix 4 for further industry demographics. The running footwear industry of today has been shaped through the historical development of running footwear products. The industry has been influenced by multiple factors; scientific discoveries within physiology and biomechanics, technological advancements enabling improved material and design engineering as well as process innovation. Below, Figure 11 provides a timeline and overview of product innovations which have had an important role in shaping the running footwear products offered throughout history. The different product innovations also create a foundation for the specific characteristics in each of the industry eras.

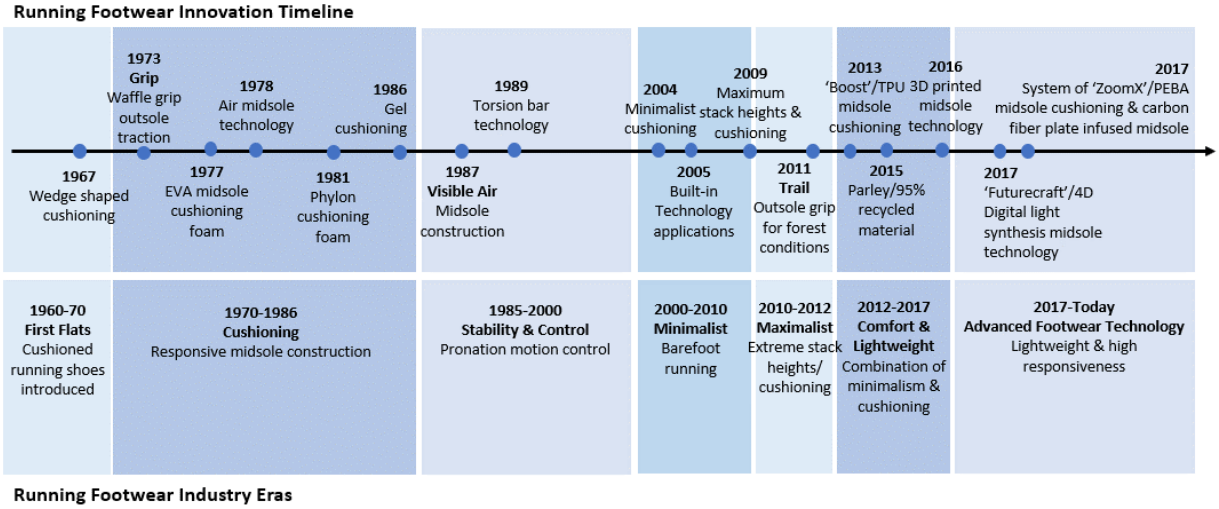

Figure 11: Timeline of Running Footwear Innovation & Subsequent Running Footwear Industry Eras

4.1.1 1970 - 2016: Industry Emergence & Trajectory of Innovation

Since the running footwear industry emerged, innovation has redefined the characteristics of running shoes, in terms of both performance and design concepts as well as revamped the promises running shoes are built on. See Figure 11 and Appendix 5 for detailed timeline of introduced product innovation.

In 1967, Onitsuka Tiger launched the *Cortez*, the first distance running shoe developed with a cushioned midsole for impact absorption, with design guidelines by Nike's original innovator, Bill Bowerman (Nike, 2015). Ten years later, in 1977, manufacturer Brooks introduced the *Vantage* based on podiatrist studies (Subotnick, 1979), to control '*pronation'*, weight-bearing on the inside of the foot. The Vantage grew in popularity and ignited the stability phase (Brooks, 2019). Researchers (Ryan et al., 2011; Knapik et al., 2009, 2010a, 2010b; Nielsen et al., 2013) show that the industry design principles which shoes were built on from the 70's; with stability (motion and foot pronation control) and impact protection (reduction of vertical ground reaction force, vGRF) have limited significant evidence. More recent research presents studies which determine no correlation between injury prevention and the need for a stability shoe based on the foot and plantar shape (Richards et al., 2009). Despite this, the technology is still marketed for consumers today. With Vantage, Brooks introduced ethylene vinyl acetate (EVA) foam to constitute the midsole which thereafter became industry standard. This sparked the intense growth and innovation phase in the new era of cushioned distance running shoes. See below Figure 12 for visuals of above-mentioned running footwear models.

Figure 12: Nike Cortez, Brooks Vantage (Nike, 2015; Brooks, 2019).

Followed by the focus on stability is then visual high-tech features and cushioning for vGRF impact absorption. In 1978 Nike was inspired by Frank Rudy's engineering work for NASA, first to bring air technology to the market in the *Nike Air Tailwind* (Nike, 2014a). In 1983, Nike released the *Pegasus* with air-cushioning in the midsole and continues to bring updates of the popular model in the line until today. In 1986, *Asics Gel GT-II* introduced the

manufacturer's signum Gel midsole and epitomized the high-tech stability era. This was soon followed by the *Nike Air Max 1* in 1987, enabling the runners to see the innovative technology and highlighted cushioning inside the midsole (Nike, 2014a). The rest of the market followed the innovative footsteps of Nike and brought their takes on air tech visibility. See below Figure 13 for visuals of above-mentioned running footwear models.

Figure 13: Nike Air Tailwind, Nike Pegasus, Asics GT-II, Nike Air Max 1 (Nike, 2012b; Nike, 2018; Asics, 2020, Nike 2014a).

Once stability and tech cushioning were established, the time between 1985-2000 brought little in terms of revolutionizing innovation, hence manufacturers rather focused on marketing and tweaks of the current product offering at the time. Again, later research by Nigg et al. (2003) clearly states that impact protection of vGRF by increased cushioning is proven not to have a significant positive effect on injury reduction. Further, Nigg (1997) implies that it consequently would imply faster runners are at higher risk for more frequent impact-related injuries, which has not been found significant. This research brought the minimalist era, where a preferred *natural movement path* was led by Nike's introduction of the company's *'Free'* platform in 2004. Stemming from Stanford research, Nike launched the innovative concept as a training tool for foot strength (Nike, 2014b). A niche manufacturer of barefoot sock-like shoes, Vibram Five Fingers, became the symbol for the minimalist era with the Vibram Five Fingers (Vibram, 2021) and skyrocketed their sales in the early 00's which forced the industry's '*Big 5*' (Adidas, Asics, Brooks, New Balance & Nike) to push innovative ideas forth. See below Figure 14 for visuals of above-mentioned running footwear models.

Figure 14: Nike Free 5.0, Vibram Five Fingers (Nike, 2014b; Vibram, 2021).

Researcher then concluded that natural motion shoes do not reduce injury significantly (Ryan et al., 2011; Knapik et al., 2009, 2010a, 2010b; Nielsen et al., 2013; Sun et al. 2020) and

consumers wanted cushioning. Moving on, in the mid 00's, the Internet enabled manufacturers to add technology to the shoes. *Adidas 1* was launched in 2005, incorporating sensors to optimize cushioning for the runner (NewAtlas, 2004) and concepts as *Nike+* collaboration with Apple brought to market in 2006 drove excitement with runners' ability to collect data (Apple, 2006). As a counterreaction to the minimalist era, Hoka One One introduced the *Bondi*, with the company's iconic cushioned, lightweight oversized midsole (Diard & Mermoud, 2021). The following decade, a variety of models were offered with different stack heights, heel-to-toe drops, cushioning, midsole foams and material uppers. Adidas introduced the brand defining lightweight cushioned versatile racing flat *Adizero Adios* in 2008 (Adidas, 2019) and Nike launched its innovative *Flyknit* knitted upper material and seen on the 2012 Olympic games (Nike, 2012a). Based on Swiss engineering, the niche and disruptive manufacturer On Running introduced *On Cloudracer* in 2013, with a new to market patented cushioning technology (On Running, 2020). This was then followed by Adidas launch of the signum *Boost* (thermoplastic polyurethane, TPU) midsole foam in 2013, providing a very cushioned and responsive ride experience in the model *Adidas Energy Boost* (Adidas, 2020). Continuing the advancements in material engineering, New Balance and Adidas launched models with midsoles printed using 3D and 4D technology respectively (New Balance, 2016. Adidas, 2017). See below Figure 15 for visuals of above-mentioned running footwear models.

Figure 15: Upper row from left: Adidas 1, Hoka One One Bondi, Adidas Adizero Adios, Nike Flyknit Racer. Lower row from left: On Running Cloudracer, Adidas Energy Boost, New Balance Zante Generate, Adidas Futurecraft 4D. (NewAtlas, 2004; Diard & Mermoud, 2021; Adidas, 2019; Nike, 2012; On Running, 2020; New Balance, 2016; Adidas, 2020).

4.1.2 2017 - Today: Development of Running Footwear

After the introduction of the VF4, long distance running shoes are built with focus on improving energy transfer, reducing fatigue, and attenuating important impact loads. Energy transfer focuses on minimizing the energy expenditure in the runner's motion from ground contact to propulsion. Several researchers have concluded the resulting reduction of required

muscle activation reduces the biomechanical load and gait changes of the athlete (Nigg et al., 2003; Mizrahi et al., 2000). The historical focus on cushioning to reduce vGRF has been complemented with research on horizontal ground reaction force (hGRF) to explain the friction between the foot and the ground, addressing the peak braking force at contact and subsequent acceleration force at propulsion (Mohr et al., 2017). Supported by Hoogkamer et al. (2018), Farina et al. (2019) present one of the key components of the new era of running shoes; the low-density plastic foam made from polyether block amide (PEBA). PEBA foam provides excellent mechanical characteristics and reduces the kinetic loads, i.e. fatigue related injury risk exposure, through recognizing and addressing the hGRF from peak braking and acceleration phases of the athlete (Farina et al., 2019). This also reinforces the earlier studies by Hoogkamer et al. (2016) on the '*cost of cushioning*', i.e. the influence an increase of footwear mass must increase the metabolic rate and decrease the velocity of the runner.

4.1.2.2 Carbon Fiber Plated Running Footwear & the Nike Vaporfly 4% Introduction

Research conducted by Hoogkamer et al. (2018) explains the midsole system combination of CFP and ultra-lightweight responsive patented *ZoomX* (PEBA) foam enables a higher percentage of the stored mechanical energy to be returned. To transmit the force developed in the leg muscles, Carrier et al. (1994) explain that the foot can act as a lever, propelling the body upward and forward. Incorporating a CFP into the midsole reduces the energetic costs by leveraging the ankle joint and foot-toe joint as the longitudinal bending stiffness increases (Roy & Stefanyshyn, 2006). Hoogkamer et al. (2018) conclude the combination of CFP and ultra-lightweight responsive cushioning significantly lowered the metabolic cost of running by 4% on average. This resulted from conducting tests of Nike's VF4 in comparison to the leading racing models for distance running prior to VF4 introduction. Initial research by Hoogkamer et al. (2018) was supported by multiple researchers (Barnes & Kilding, 2019; Guinness et al., 2020, Hebert-Losier et al., 2020; Hunter et al., 2019) and the researchers independently discuss and reach the conclusion that the reduction in energy expenditure can be derived from the CFP and ultralight responsive cushioning technology as applied in the VF4 shoe, as visualized by Nike (2017b) in Figure 16.

Figure 16: Nike Vaporfly 4% (Nike, 2017b).

The VF4 launch is a historical milestone for Nike's innovative investments and subsequently for future innovative trajectory within running footwear, and a hallmark for manufacturers strive to deliver top-class sports innovation. Thereby also enabling athletes to leverage footwear in prolonging the time until depletion, i.e. conditioning a longer period of preserved energy reserves; the '*Vaporfly effect*' (Jones et al., 2020). After the product's unprecedented launch, athlete performances wearing the VF4 created a spark of responses from competitors, with three attributes in common, namely, the CFP, high stack heights with lightweight foam, and the geometric rocker shaped midsole (Bartold, 2020).

4.2 Running Footwear Innovation Policy Intervention

The governing body of athletics, World Athletics (WA), published an update to the current *Technical Rules* on the sport of running in force on November 1, 2019 (World Athletics, 2020). The Technical Rules is subject to constant change to address emerging innovation and manage the influential factors of technological advancements. The purpose of the Technical Rules is to reserve the spirit of sport, reduce unnecessary conflicts and preserve fairness in sport. WA responds to new product innovations and trends once they are commonplace in competition, ensuring competition is conducted fairly to all (World Athletics, 2020). Amongst others, the update addresses detailed information regarding the thickness of the midsole foam, limited to a maximum of 40 mm. In addition to this, WA limits the number of CFPs to maximum one, in running footwear products for elite components of road running events (World Athletics, 2020). Furthermore, WA prohibits the usage of prototypes in competition by requiring the product to be accessible for purchase by any athlete on the open retail market for a minimum of four months prior to competition. If an athlete intends to use a

shoe which has not been previously used in an international competition, the athlete or athlete's representative is obliged to submit the product specifications, potential need for customization due to individualities in the athlete's foot and provide information on availability on the open retail market (World Athletics, 2020).

5. Empirical Findings

This section introduces the empirical data retrieved from interviews with key participants from the running footwear industry, namely; experienced employees from the leading manufacturers, stakeholders within the sport's governing body, subject matter experts from academia and elite athletes and coaches. The findings presented in this chapter provide an overview of the interviewees' perception of; 1) competitive advantages within the running footwear industry, 2) competitive landscape after VF4 introduction, 3) VF4 strategy from idea to market, 4) consequences of policy and regulatory intervention and 5) learnings and future running footwear industry outlook. Each section within Chapter 5 presents aggregated findings from the interviews and specific, meaningful quotes are presented when appropriate.

5.1 Competitive Advantages within the Running Footwear Industry

Interviewees highlight a set of factors to constitute the foundation for Nike's position and competitive advantages within the running industry. The set of factors highlighted are focused around the specialized asset base coupled with a strong focus on the consumer, *the Athlete*, and commonly mentioned and encouraged traits among employees; namely curiosity and an innovation driven mindset.

5.1.1 Nike Heritage, Resources & Competencies

The interviewees emphasize Nike's history and heritage as a footwear manufacturer driven by athlete focus and product innovation the key assets of the firm. The Nike Sports Research Lab (NSRL) was established in 1980. It is central to the company's achievements in product innovation and leading position in the industry. Nike continues to invest in improving the NSRL to ensure the company is placing innovation at the center and further connecting sports performance with technological advancements and product innovation. By cultivating knowledge and investing in top class talent, research and facilities, the company continues to push the boundaries of sport performance, coupled with product technology and design innovation.

Since its establishment, NSRL facilities have been built centered around physiology, biomechanics, perception, and athletic performance. A wealth of data facilitates insights and informed decision making, C5 explains and refers to the process leading up to the VF4; *"Studying and analyzing forces, human physiology and measuring something like running economy is not completely new. But understanding how testing methods like this could be*

applied, enabled us to use them as benchmarks to track if we were making progress in development. If we were making changes to the product, we also wanted to have our hypothesis tested and confirmed or scrapped based on data.". Further, C5 and C1 accentuate the team who work in the state-of-the-art facilities with athletes, sport data collection and product testing, to collect, analyze and incorporate data in the continuous improvement of the company's innovation and development processes.

The innovation team consists of experts in biomechanics, physicists, engineers and subject matter experts in multiple other regimes and sciences. They are employed by Nike with the purpose of exploring technologies and pursuing experiments to test, learn and progress. The innovation team is disconnected from the current ongoing business with time and space fully dedicated to research. C3 explains *"The Innovation Kitchen is great. Nike has combined researchers and experts in all different areas of science, outside of sports too, and lets them play. That is what the Kitchen is about, playing around with technologies, similar to what Bill Bowerman did with the waffle iron in his backyard back in the 60's"*. C3 further elaborates on Nike founder Phil Knight's old running coach Bill Bowerman, the original innovator at Nike, and his visionary ideas on creating, improving and customizing footwear products for the runners, with the waffle iron pattern shaped outsole to improve grip on the track surface, ultimately, enabling athletes to run faster, shown in Figure 17.

Figure 17: Bill Bowerman's waffle iron & Nike's first Waffle Trainer outsole prototypes (Nike, 2015).

C5 describes that today's relationship between product development and the innovation team builds on trust and mutual dependency. An effective development process involving innovation, product, and design teams is built on a strong foundation of trust in individuals' key expertise. *"Innovation at its best is really when the different teams come together and are creating these experiences. They are going away from the normative design principles of the product and focusing on creating an experience. 90% of it seems crazy at first, then the 10% that comes out of it; let's make a runnable experience out of it. If there's even a merit to a*

feeling or sensation in that prototype, which you wish for in a racing situation, then we've got something. That's where we connect the dots and build something really impactful" C5 explains.

5.1.2 The Voice of the Athlete & Innovation Mindset

What is noticeable among all interviewees is the emphasis on Nike's close collaboration with athletes in the product development process. They all mention *'the Voice of the Athlete'* to be at the center of product development. By listening to, spending time with and understanding the movement and needs of the athlete, the product development team can focus their work on delivering a product with performance features meeting the exact specifications and requirements of athletes.

Nike Senior Footwear Developer and elite athlete Carrie Dimoff describes how her own running influences her daily job and lets her connect and establish a greater understanding for the performance needs of the athletes (Nike, 2020b). Emerging out of the VF4 innovation process, Dimoff further elaborates on how the innovation team has deepened the relationship and close collaboration with world record holder and key elite athlete Eliud Kipchoge during the years of working together. Kipchoge highlights the success of working with Dimoff *"We've come a very long road with Carrie. I've ran fourteen marathons, and I've used eleven different shoes, and now Alphafly."* (Nike, 2020c).

Figure 18: Carrie Dimoff, Senior Footwear Developer, discusses footwear prototypes with Eliud Kipchoge (Nike, 2020).

VP of Innovation at Nike, Tony Bignell further describes Nike's point of view on the partnership with the top athlete as best in class; *"Eliud is amazing. He'll handwrite notes for us, we'll meet him many times a year, we do face calls, we have his information every single day for every single run. There's a constant dialogue to make us better and his standards are super high which is great - it really helps us."* (McGuire, 2020). Also, elaborating on the collaboration with the training group of world class runners, C5 says that it requires a mutual understanding and interest. *"To be able to see beyond the early samples and oddly looking prototypes does not come naturally for everyone. It does require a curious mindset, with an openness towards innovation and a willingness to be part of the process of perfecting it to the fullest."* C5 explains.

5.2 Competitive Landscape after VF4 Introduction

Manufacturers are somewhat differentiating their offerings to stand out in competition. But generally, the whole industry has been shaped by common innovation efforts and technological advancements, moving from one technology focus to another, as visualized in Figure 11. Noticeable in this journey, however, is the companies' ability to build their brand and market positioning on the company's origin and history within the sport of running.

5.2.1 Becoming a Market Leader

"What makes Nike unique, is that we originate from the sport and culture of track and field athletics. Our history is built on enabling world record breaking runners go faster, with podium placements confirming our market position and superiority throughout the years" C4 explains, referring to the company's credible positioning as a leader in innovation. In multiple of the industry's eras, Nike has been establishing the industry standard and moved the running footwear industry forward. When industry was focused on lightweight cushioning, Nike patented a solution where the foundational element was air. *"There's several innovations at Nike which transformed footwear. I'll mention air as the first and foremost one. It's genius really, how the teams back then built and patented the first model incorporating air for cushioning which then shaped the whole cushioning era and future of lightweightness. The airbags provide cushioning, durability, responsiveness, and needless to say, with no weight. There is no way to get a more lightweight solution than to use air."* C3 says.

Similarly, when bringing the VF4 to market in 2017, Nike filed multiple patents on the footwear system and components, incorporating the PEBA foam and CFP. C1 explains how this forced competitors to reengineer the innovative product to understand the construction, forces and features before they could bring their own take on the innovation; without access to Nike's patented formula of PEBA midsole foam, biomechanical research and exclusive design. With this, C1 and C5 emphasize this proved Nike holds the position as the leading innovator within the industry and introduced a new era of running footwear technology. By introducing a product which leveraged multiple successful technologies from several of the industry's eras, C5 explains how Nike could reap the benefits of being the only actor on the market with an AFT (advanced footwear technology) proposition for consumers whilst competitors worked hard to internally align R&D efforts towards incorporating and commercializing this new innovative system of technologies.

After launching the VF4, the development team continued working on refining the product system in close collaboration with athletes and incorporating feedback on potential improvements. The next generation of the product launched in 2019, the NEXT% series (Nike, 2020c), with an even lighter upper material and more PEBA cushioning underfoot for extra energy return. Dimoff says that "*Once we understood the plate and foam as a system, we started thinking about ways to make the system even more effective. That's when we struck upon the idea of adding Nike Air to store and return even more of a runner's energy and provide even more cushioning"* (Nike, 2020a). The iterative design process of pushing innovation boundaries has from the launch of the VF4 until today resulted in an expanded product line. The offering includes products with clear links in design language, and developed for different purposes, ranging from progressive to more democratic design language and degree of innovation.

5.2.2 Market Challengers, Followers & Nichers

C4 describes the challenging situation for competing manufacturers as the VF4 gained traction with consumers; *"How the Vaporfly was brought to market can never be repeated. Doing something for the first time will always be historical. Nike's moonshot project with breaking the two-hour-barrier for the marathon can only be done once and it just won't be as exciting the second or third time a manufacturer sets out on the same quest. Competitors cannot tell the same authentic story around their product. The whole industry knows where*

the innovation stems from, and it will remain authentic to the leading company which first introduced the innovation."

C1 agrees and shares his point of view on the AFT; emphasizing what makes the VF4 unique and first in its' kind is not each component by itself, but rather the interconnectedness and proportions between the CFP and PEBA midsole. C1 explains that competitors can respond and offer a CFP running shoe with responsive cushioning. However, to get the system working as intended is complex and will be the breaking point for competitors to innovate around in the pursuit of success.

C8 agrees with this and further discusses the movement of various niche industry actors where it becomes obvious, they are also influenced by the introduction of the VF4 and AFT. C8 explains that these niche actors focus on completely different design language, product features and distinctive shape, targeting specific market segments and not in direct competition with the '*Big 5*' of the industry. However, as AFT becomes the industry standard, they are also exploring opportunities to benefit from the market success of the VF4 innovation despite not being able to apply the technologies in a way which provides the consumer with the related performance benefits of the VF4 system.

5.3 VF4 Strategy: From Idea to Market

The work behind the Nike Vaporfly Elite and later consumer version VF4 started already in 2013 as a joint project involving designers, engineers, scientists and world-class elite athletes, four years prior to its launch in 2017, C5 explains. The process from ideation to market launch took approximately four years and required dynamic cross-functional collaboration to strategize and align globally on product proposition, pricing, promotion, and placement of the product.

5.3.1 Product Proposition & Pricing

The VF4 introduces the new-to-the-world combination of a CFP infused midsole and ultralight responsive *ZoomX* (PEBA) foam. Tony Bignell, VP of Footwear Innovation at Nike at the time, describes "*The groundbreaking new Nike ZoomX midsole and curved carbon fiber plate work together to provide responsive cushioning and minimized energy loss at toe off."* (Nike, 2017a). As published research shows (Hoogkamer et al., 2018; Hoogkamer et al., 2019); the product delivers a proven reduction of the metabolic cost of running on average of

4%. The interviewees all agree that getting the product right is first and foremost fundamental to succeed in bringing it to market. Furthermore, the product has a clear connection to the established product line in terms of branding and color application yet brings a system of responsive foam and plate together which offers an advancement in technology that is completely new within the industry. In addition to the VF4, there was an ecosystem of supporting products, ranging from color connected footwear, apparel and accessories, to training plans and related services through the company's digital platforms.

Figure 19: Nike Vaporfly 4%, Nike Zoom Fly, Nike Pegasus 34 (Nike, 2017c).

The VF4 was marketed and quickly sold out at EUR 249 (Caughlan, 2018). The offering among competitors at the time ranged between EUR 120-150 (Adidas, 2021a., Asics, 2017., Brooks, 2021, New Balance, 2018). The long-distance racing proposition Nike had prior to the VF4 was the Nike Zoom Streak, priced at EUR 100. The difference in price from the previous long-distance racing proposition as well as from competitors' products was significant, but so were also the technological advancements and scope of innovation offered with the shoe. C6 explains that the significant price increase was discussed and accepted by the marketplace. C5 and C6 further elaborates on the challenges with working with new materials as the PEBA foam and CFP formula, and the high-quality requirements imply that only a limited number of factories can meet these standards. With the context of materials, production capacity and the research that went into development of the shoe, C6 concludes that *"the price at retail is a measure and reflection of the strenuous efforts that was put into the process of getting the product to the market, and the value and experience the consumer benefits from."*

5.3.2 Product as a Marketing Tool

Initiating the project with the VF4, the cross-functional NSRL team had set out on the seemingly impossible quest to break the sub-two-hour barrier of a marathon. The project,

referred to as '*Breaking2'*, included recruiting the most promising athletes, developing individual training plans, building a nutrition strategy and finding the most optimal location and course for the attempt. Equally important part of *Breaking2*, where Nike's capabilities and resources in footwear innovation could be employed, was the development of long-distance running footwear. In the process of developing the VF4, C1 discusses the efforts and investments the company devoted to document the innovation process. This included material which captured all parts of the process, from product testing and working in close collaboration with world class athletes at their training facilities and in their home environments, to hands-on development work in the NSRL at Nike's world headquarters. This was leveraged in the production of a documentary named '*Breaking2*, created in collaboration with partners as National Geographic Studios, Dirty Robber Production, long-standing partnering agency Wieden+Kennedy and Nike, reaching millions of viewers across all platforms (Wieden+Kennedy, 2017). The production received numerous awards for its successful execution and reach, building on the long-standing and timeless belief in the power of sport. As referred to by C6; *"We believe in the power of sport to make you better; it unites, excites and it is one of those incredible forces that helps us all to become the best version of ourselves."*. C6 further describes *Breaking2* as so much more than a marketing initiative; *"It was really our teams' collective efforts to showcase that we can break the boundaries of human performance, while at the same time, it introduced consumers around the world to the innovation process and team behind the product."*

Figure 20: Nike Celebrates its Breaking2 Results (Nike, 2017d).

Eliud Kipchoge crossed the finish line after 2:00:25; 25 seconds above the 2-hour mark. Despite that Kipchoge did not succeed to break the 2-hour barrier on the Monza racing track in Italy in 2017, he did improve his personal best on the marathon distance with 2 minutes and 40 seconds (Nike, 2017d). The significant improvement in performance strengthened the team's belief and confidence in the quest to break the sub 2-hour limit for the marathon. A new attempt was broadcasted live from Vienna in 2019. This time, Eliud Kipchoge ran the full marathon distance in 1:59:40 (Longden, 2019), wearing the new Nike running footwear innovation, Alphafly NEXT%, incorporating a combination of components from the previous model coupled with purposeful improvements and air component innovation (Nike, 2020c).

C3 also discusses *Breaking2* and connects the company's approach to document and share the innovative process to Nike's heritage in sports product innovation. C6 accentuates that the foundation to build impactful marketing campaigns lies in the company's focus on authentic storytelling and refers to a quote by the company's founder Phil Knight; *"You have to be creative, but what really matters in the long run is that the message means something. That's why you have to start with a good product. You can't create an emotional tie to a bad product, because it's not honest. It doesn't have any meaning, and people will find out eventually. You have to convey what the company is really all about, what it is that Nike is really trying to do."* (Better is Temporary, 1992, p.97).

As mentioned by C1 and C3, product innovation is the first and fundamental component contributing to successfully bringing a new product to the marketplace. However, C3 describes design elements and functional features of the product as tools and components in the full marketing process. C3 and C6 discuss the historical growth trajectory of the firm and how the organization shifted perspective from its initial strong product-orientation to later becoming a marketing-oriented company. Nevertheless, C6 says this does not mean the product is deprioritized, but echoes the words of the company's founder, Phil Knight, who expressed the central value of the product; *"We've come around to say that Nike is a marketing-oriented company and the product is our most important marketing tool* (Better is Temporary, 1992, p.89).

5.3.3 Go-To-Market & Distribution

After the VF4 was shown on athletes in the live broadcasted *'Breaking2*' event, the consumer and marketplace demand to purchase the product grew exponentially. C2, C4 and C6 explain

the distribution of the shoe was strategically limited with the intent to target specific launch audiences and create demand. Nike intentionally underserved demand by restricting the commercially available quantities of product at launch. By creating a pull market, Nike established a powerful position as the industry leader while scaling commercial accessibility across the marketplace, building more demand and capturing the business opportunity.

Resulting from thorough marketing efforts, positive elite athlete, and consumer reviews, as well as media coverage tied to the *'Breaking2'* event, the VF4 rapidly grew its popularity among consumers (Nike, 2017b). C3, C4 and C3 mention that the strategic distribution of the VF4 was aligned with the company's overall strategy, mainly focused on digital channels. Nike's primary channel was the company's own platform where consumers participating in the company's membership program were granted early access to purchase the product innovation before its official marketplace launch date. C6 explains *"members are provided early access to high heat products, innovation and limited edition products. Our ecosystem of members across the globe provides us with data that lets us understand what makes them tick. Ultimately, it helps us to create products which not only serve our consumers' needs today but exceed their expectations"*. This, C4 and C6 discuss, is fully aligned with the company's strategy related to serving the global consumer base through digital channels and the future business opportunities linked to capturing, analyzing, and leveraging consumer trend data.

Outside of Nike's own digital sales channels, C4 explains product allocation was focused on the company's strategically important locations around the world to drive an impactful go-to-market-strategy. C4 further discusses how Nike built a global demand among consumers to get access to product by executing a phased launch. C2, C4 and C6 emphasize the importance of partnering with selected key retailers with capabilities to deliver and enhance authentic storytelling aligned with Nike's brand initiatives and positioning within the running footwear industry. *"The key partners are experts within running specialty and have a strong power and position in the marketplace to influence the true running consumer. They authenticate our position as the leader within running innovation and have the capabilities to be credible in their messaging to the consumer we want to serve."* C6 explains.

5.4 Consequences of Policy & Regulatory Intervention

The governing body changes to the policy for accepted running footwear result in changed circumstances for athletes, future innovation, and manufacturers within the industry. Interviewees discuss the changed regulatory framework from multiple perspectives and elaborates on the scope and impact of the implications for each group.

5.4.1 For Sport & Practitioners

The imposed regulations introduced in 2020 are being revised to capture the mechanical energy return of the footwear. C8 acknowledges that runners will benefit from the AFT footwear to various extents depending on individual externalities. C8 further explains the purpose of regulating elite in-competition footwear is to ensure the spirit of the sport is not challenged, remove unfair advantages among competing elite athletes and ensure access is not skewed. C7 discusses the complexity of enforcing the regulations on all competitions as it would force local race organizers on country and club level to ensure compliance. Hence, the WA regulatory framework is only imposed and controlled for during international competition.

Several interviewees reiterate the period between the Rio Olympics in 2016, when top runners on the podium were all wearing Nike's product, until competitors introduced their AFT offering, as significant to drive the discussion on footwear technology forward. C9 explains how sponsored elite athletes were placed in complex situations of being forced to comply with the terms of their sponsor contracts with footwear manufacturers, whilst their performances could be positively impacted by deviating from contractual obligations and leveraging the leading footwear innovation for in-competition events. From the VF4 market introduction in 2017 until the main market challengers responded, elite athletes explained the difficulties with meeting their contractual obligations due to sponsors' lag in innovation and limiting product offering. A variety of solutions were put in place, whereas sponsored athletes C9 and C10 elaborate on the general consensus within the running community and agree that the best outcome was allowing elite athletes to independently choose their footwear for competition. However, they further explain, this only applied given that the sponsor could not provide an equally good product itself. This lowered the pressure and trade-off for the athlete in weighing the financial support from the sponsor agreement, versus the potential in-competition performance and financial rewards related to race rankings.

Interviewees further discuss the effect of AFT footwear on performance and running efficiency outside of competition events. The AFT system enables the athlete to run at a higher pace, or for a longer duration with less fatigue. C9 describes the introduction of VF4 and AFT footwear have had an impact not only on in-competition performances, but also implied runners can increase the individual performances during training periods. This is further supported by C5, who elaborates on empowering athletes not only on race day, but throughout the training cycle; *"Just imagine how we can impact each individual athlete in training by simply providing a product which reduces the load on the body. Then it doesn't matter if it's an elite or recreational runner. No matter the level, we all want to feel good after a run. And of course, if we as Nike can provide this experience during a longer period in training leading up to a race, that will indeed have a positive impact on performance also on race-day."*. C8 and C9 agree on that athletes' expressed perception of less fatigue during and in connection with training enables opportunity for refinements in training plans and workout regime. Thus, C9 elaborates on the consequences resulting in more effective training, recovery and less stress on the body. Subsequently, C9 implies this also contributes to improved performance during in-competition events.

5.4.2 For Future Innovation

Interviewees all agree that there is a link between sport performance and technological advancements and product innovation. Developing, refining and challenging the current product standards have always been part of the sports product industry. The impact of a stricter regulatory system on products for elite in-competition use does put a restriction on running footwear innovation. C8 explains; *"The governing body would like to see the future footwear development take a different direction. The first priority is injury prevention and funding should be provided to support research within this field, available for all manufacturers to leverage as part of future innovation*". C8 further discusses the rationale behind the updated framework and expresses that *"WA hopes that manufacturers see the purpose and aim of the regulatory framework, respecting the spirit of the sport and investing innovation efforts towards areas which would improve the industry in other dimensions."*

After the VF4, C5 discusses the updated continued development and subsequent launch of the Vaporfly NEXT% and Alphafly NEXT% as seen in Figure 21. The last innovation launched by Nike is built with materials with an energy return of 80-90% and C5 expresses the aspiration to reach 99.9% energy return.

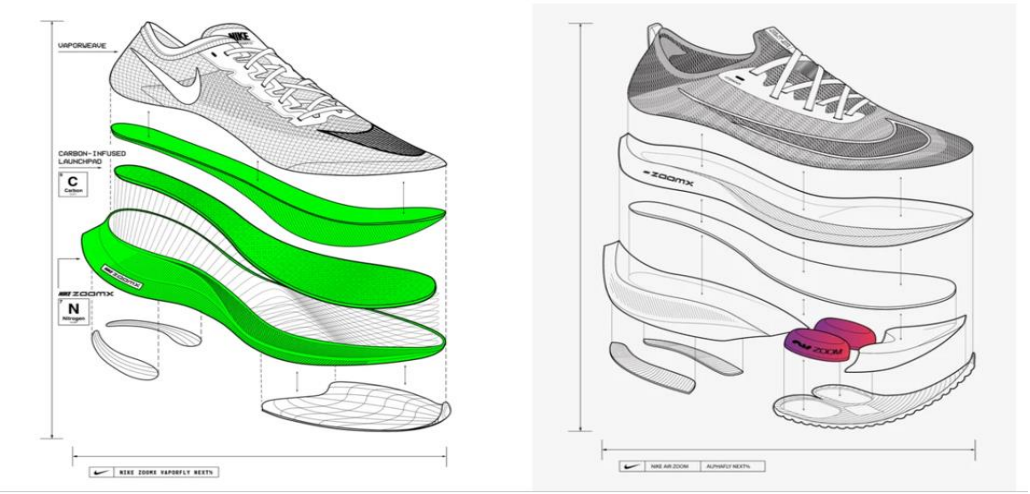

Figure 21: Nike Vaporfly NEXT%, Nike Alphafly NEXT% (Nike, 2021a; Nike 2021b).

C5 seeks a regulatory framework which does not put any constraints on technical build and design language of the footwear, but rather is formulated with a cap on the accepted energy return effect at 100%. By so, allowing the energy exerted by the athlete to be returned by the footwear. Thus, not allowing manufacturers to give the athlete more energy back than they put in.

5.4.3 For Industry & Manufacturers

C8 elaborates on the collaborative relationship between World Athletics and manufacturers; *"The main manufacturers have incredible resources and investments dedicated for product innovation. It is acknowledged, and the intent is to have a consensus in the regulatory framework and measurements taken with sufficient time for manufacturers to adapt and transition. WA has a working group which includes industry representatives to ensure both transparency and that manufacturers' input and feedback is considered throughout the process."* Manufacturers will be forced to adhere to the requirements. Hence, by opening for a collaborative approach in establishing the regulatory framework, WA hopes to reach a level of mutual trust and understanding of the purpose of the process.

C1 mentions that the development process of the VF4 took four years from product idea to complete product launch on the market. Competing manufacturers took approximately two to three years to respond and introduce a product incorporating a system of CFP and lightweight responsive midsole foam, or in other ways applying the AFT (see Appendix 5 for detailed introduction timeline). To shift direction in product development, supply chain, material engineering and production requires strenuous effort and investments. C1 and C5 describe the current complex situation for manufacturers, awaiting further direction from the governing

body on the scope of upcoming changes in the regulatory framework. With an approximate minimum lead time of 18 months required to bring a new product to market, manufacturers are forced into an innovation vacuum to ensure compliance with upcoming regulations with the aim to introduce, scale and maximize subsequent business opportunities.

However, C1 and C8 both accentuate that the current regulatory framework is only enforced on elite athletes in competition; i.e. does not limit the general public from buying, using and participating in events with the same footwear product which is deemed illegal in elite level competition. Hence, C8 explains that manufacturers can currently bring products to market, which do not comply with regulations, for recreational sport participants and non-competition use for elite athletes. This implies manufacturers' development of products with injury preventing and performance enhancing effects is not forbidden per se. With that, C8 pinpoints that the framework intrudes on, but does not diminish the commercial opportunity on the market for running footwear products.

5.5 Learnings & Future Running Footwear Industry Outlook

Aligned with several interviewees, C4 discusses the sub-parts of the VF4, mentioning that there was not a single specific technology that was the key to success, but rather leveraging the preceding successes and learnings from technologies that characterized previous eras. Nike refined the materials used and brought together design elements which historically had shaped the industry by taking a new perspective. The result was a completely new running experience, inspired by carbon plated track and field products for ultimate speed, influenced by the maximalist cushioning and ultralight minimalist trend. C5 explains this; *"Bringing together previous technologies, approaching them differently by taking a step outside of the box, let the team create something the industry hadn't seen before."*

Besides introducing a product which improved running economy, the VF4 also showed a reduction in muscle damage. C5 further explains that the initial approach to the moonshot goal of Breaking2, to go faster, resulted in an additional outcome, enabling a shorter recovery time and lowered the risk of getting injuries. C4 and C5 further discuss how this broadened manufacturers' perspectives and purpose with applying AFT in footwear products outside of long-distance racing shoes. Manufacturers are leveraging the insight and understanding of how reduced stress on the body leads to lower muscle fatigue, thus creating new space for new product propositions. Subsequently, this encourages development and consecutive

marketing of innovative products, distinctively developed, and positioned with features which are proven to reduce risks of running related injuries. C7 mentions that the development of the ZoomX foam also enabled Nike to expand the product proposition in another area; focusing on cushioning and injury prevention as part of the company's *Project Fearless* (Nike, 2021c) through the model Nike React Invincible Run, leveraging Nike's patented ZoomX foam as seen in the VF4, Vaporfly NEXT% and Alphafly NEXT%.

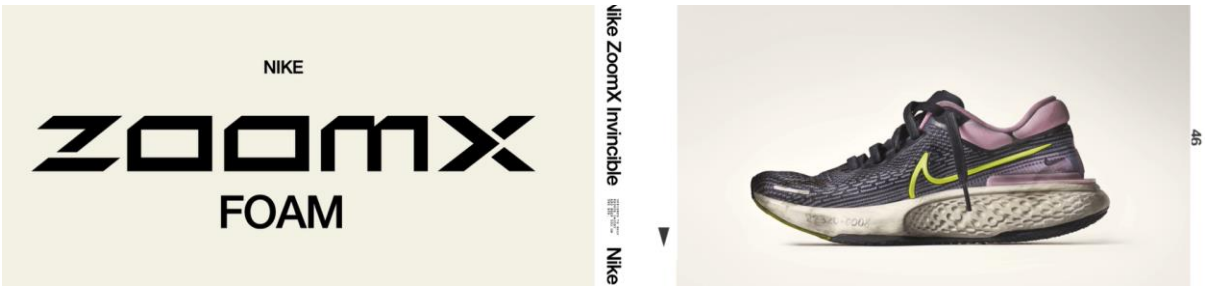

Figure 22: Nike ZoomX Invincible Run (Nike, 2021c).

Emphasizing how Nike's focus on collecting athlete insights is also moving into new formats, Bignell, VP of Footwear Innovation at Nike, further accentuates that data has a vital position in future product creation *"Data is really the new voice of the athlete, and by listening to that voice, we can challenge the current paradigms to do something previously unimagined."* (Runify, 2017). With a strong foundation in athlete data, Nike launched the company's lead intelligent product, a self-lacing basketball shoe, for perfect individual performance fit on the company's Adapt platform (Nike, 2019b). Nike's VP of NXT Innovation, Michael Donaghu explains the concept of footwear as a starting point in informing athletes on their sports journey, in which the athlete and footwear together creates data about activity and by so, informing personalized guidance from Nike through the company's service applications. The concept was initiated in basketball and will be expanded to other sports in the future, Donaghu says (Nike, 2019c). Working in the NSRL, Bignell expresses the needs of the athlete; *"Athletes ask us for three things, they ask us to make me better, to protect me and to inform me. The better you understand the needs of that athlete, the better you will make product."* (Runify, 2017). Further C7 and C5 discuss how data is the future of smart footwear, informing not only the team in the development process, but also the athlete wearing the product. C5 elaborates further on informing athletes better independent of performance level and how this can impact and contribute to each runner's training plan and progress on an individual level.

Moreover, interviewees all agree on technological advancements, also outside of the running industry, will influence running footwear in the future. Capturing the suggested shift in direction requested by WA and mentioned by C8 in Section 5.4.2, C1, C2, C3, C5 and C8 also discuss the many directions of innovation within footwear development and highlight the opportunities to innovate in other areas. C1, C3, C5 and C7 mention improvements in process innovation that have potential to be explored and contribute to sustainable manufacturing and footwear customization amongst others. Further, C7 emphasizes that material engineering and manufacturing will play equally important roles in making innovative product ideas commercially scalable. C7 also elaborates on how competitors within the industry fuel each other to continue push the boundaries and further innovate. Aligned with C7, C6 mentions Adidas and the company's Futurecraft Strung technology as an interesting example in a starting phase. Futurecraft is a combined data and textile innovation, building shoes with customized features based on input data from a specific runner profile (Adidas, 2021a).

To stand out among competitors in the future, C8 suggests targeted R&D efforts focused on a specific consumer segment or emerging macro trends as success enablers for competitors to excel and build success around. I.e. to build a niche positioning, diverging from the current industry norm and differentiating against competitors' offerings. C6 and C7 mention that manufacturers understand and acknowledge the rising trend among consumers to include sustainability as a factor in the purchasing process. With the goal of building more sustainable businesses, C7 discusses the alignment of manufacturers to come together around the joint purpose of building more environmentally friendly product development and manufacturing processes. C7 elaborates on manufacturers' different initiatives within the field and how they are all experimenting and exploring opportunities to leverage recycled content in production and create sustainable products through material selection, color dying, refined manufacturing processes etc. (Adidas, 2021b, Asics, 2019, New Balance, 2020, Nike, 2021d, Saucony, 2020).

6. Discussion

The main research question the thesis aimed to answer was; *How did the Nike Vaporfly 4% change the running footwear industry?* To answer the research question, the study was structured in two divisions, namely studying competitive advantages of Nike, answering the research question **RQ#1**; *How does the emergence of the new technology relate to the competitive advantages of the manufacturer?* This was then followed by investigating the subsequent impact on further innovation, business and sports, aimed to answer the supporting research question **RQ#2**; *What are the implications of the new technology on the sport, innovation and competing manufacturers within the industry?*

The following chapter analyzes and discusses the empirical findings as presented in Chapter 5. The findings are discussed in context of the theoretical frame of reference as outlined in Chapter 3 and empirical context in Chapter 4. The analytical discussion is separated into four sections, 1) competitive advantages, the VF4 introduction and its' connection to 2) new product development and dominant design and; 3) leading innovation and establishment of a new industry direction, and lastly 4) VF4 learnings.

6.1 Competitive Advantages: Established, Developed and Sustained

Aligned with Barney's (1991) VRIN-categorization of resources, Nike has developed their competitive advantage and market superiority based on an asset base which has evolved over time. Since the company was founded in 1964, Nike has a unique trajectory of developing specialized knowledge within product development, centered around sports innovation and athletic performance. Interviewees accentuated the continuous focused investment in scientific research, top-class talent, facilities, and equipment. The historical strategic reconfiguration of the firm's asset base and combination of heterogeneous resources build a strong foundation for the company's competitive edge, as referred to by Peteraf (1993). Results present how Nike continuously strives to push the boundaries of sport performance through offering product innovation and differentiation, leading to monopolistic profits.

As explained by interviewees, the company's leading position and advancements in innovation have historically been shaped and shifted the industry's development path. Establishing the NSRL and building close collaborative relationships with athletes in product development processes are part of Nike's heritage and explicit competitive assets of the firm.

Despite intangible, intellectual property resources as product development experience, key innovation- and industry expertise and specialized knowledge form the basis for value creation. As Madhani (2010) discussed, if transferred between firms, these resources constitute a significant threat to Nike's sustained competitive advantage. However, as explained by C5, the interrelationships between teams and the structure of processes are built on mutual dependency and trust, which have limited transferability across firm borders. Furthermore, the highly path dependent process of developing this asset base results in complexity for competitors to identify and imitate such success factors. Highlighted by interviewees, confirming with Peteraf's (1993) explanation of ex post limits to competition; innovation breakthroughs are inimitable and subsequent advantages are awarded to the superior firm, limiting competitors' opportunities to realize profits stemming from the same innovation. The evolution of the running footwear industry is characterized by several manufacturers' innovative product offerings. When Nike launched the VF4 in 2017 the company introduced the industry's first example of AFT footwear through a combination of CFP and ultra-responsive foam. This enabled the company to seize the commercial opportunity related to the now-to-the-world innovation, whilst building a stronger positioning as the leader in innovation and subsequently capture the related profits before competitors, referred to as ex ante limits to competition by Peteraf (1993). By so, forcing competing manufacturers to accept the technological shift and align around a common direction for footwear development.

Hamel and Prahalad (1994) emphasized the importance of strategic intent to build competitive advantages. Nike is a purpose driven company and as interviewees mentioned, the company's corporate values and beliefs permeate through all activities of the firm, centered around the power of sport. Employees are motivated to contribute as one team towards set goals, building a strong and sustainable foundation for effective capacity utilization. Conforming with researchers' (Hamel & Prahalad, 1994; Madhani, 2010; Peteraf, 1993; Teece & Pisano, 1994. & Teece et. al., 1997) point of view, Nike's historical focus on the firm's strategic intent and placing the athlete's need at the center enables the firm to effectively co-evolve organizational capabilities. However, interviewees also mention that the highly path-dependent process of building this culture has at times required intensified efforts and focused engagement from leadership to ensure the business strategically evolves in a direction which is authentic to the firm's purpose. Due to the dynamism and ever-changing nature of the marketplace, Nike and other manufacturers within the industry are forced to

constantly re-assess the organizational setup to accommodate emerging trends within the industry and marketplace. With that, identify growth opportunities and effectively allocate resources to the firms' growth areas in alignment with the overarching strategy. Ultimately, it can be concluded that Nike's resource allocation supporting the firm's portfolio of services and products requires a strong link to the firm's strategic intent. With this, Nike enhances the firm's competitive advantage through a powerful connection to sport.

Drummond and Ensor (2001) further elaborated on successful firms' ability to portray the strategic intent of the firm in its external marketing efforts. As discussed by interviewees, and referred to by the company's founder Phil Knight, Nike is a marketing-oriented company where the product is the fundamental marketing tool. Media materials capturing the details of the full process of bringing the VF4 to market was produced in a documentary and subsequently broadcasted and leveraged as part of the market launch. This way, Nike built emotional connections through authentic and meaningful storytelling centered on the company's key connection between the athlete, product development and sport. Ultimately, leveraging the unique portfolio of industry leading resources and capabilities and building an even stronger connection between the product and the strategic intent of the firm, all encapsulated in the offering to the consumer.

6.2 VF4 Introduction: New Product Development & Establishing a Dominant Design

As Crawford and Benedetto (1994) suggested in their model, NPD processes require multifunctional involvement. Interviewees explain the cross functional efforts and mutual understanding required in the innovation process from initial pre-development research, to product creation and ultimately product launch. Multiple functions are already at the pre-development stage, involved closely with athletes for iterative feedback on functionality features and performance cues as well as product testing for wear and durability.

Nike's strategic choice of separating 'the Kitchen' from the inline product development processes enables scientific researchers to explore, research, create and test freely. As emphasized by Trott (2017), innovation emerges from the triad of marketplace insights, scientific advancements, and organizational capabilities. Nike's structural setup manages to establish and facilitate the required linkages and connection points to successfully couple market pull with technology push by connecting the innovation center with athletes and

leveraging consumer data to support the R&D process. Thus, enabling scientifically research-based value creation and capture aligned with and supported by market demands.

Veryzer (1998) described the exploratory notion of new product development and underlined the difficulty to quantify the related market opportunity, as compared to non-innovative product development. The fundamental inline footwear development at Nike connected to the retail season calendar involves continuous improvement of current product line. This is achieved by a smaller scope of incremental changes to the existing products, through e.g. technical refinements and material upgrades with limited investment requirements. Nike's development process of the long-standing footwear model Pegasus, introduced in 1983, constitutes little product development risk as every yearly update consists of a gradual change to the previous version, as explained by C5. Highly innovative products on the contrary, are related to a higher risk and potential reward, if launched successfully. Hence, require significant investment in thorough pre-development work to safeguard against project risk and justify R&D investments to pay off. Abernathy and Utterback (1978) elaborated on the opportunity related with a product introduction built on an unexploited technology and emphasized the sizable opportunity linked with establishing the novel product as a dominant design. As explained by interviewees, in the process of developing the VF4, Nike invested heavily in biomechanical, physiological, and technological research. This, coupled with top-class material engineering and specialized manufacturing processes, built the foundation for a market wide adoption of the new footwear technology and product success. Thus, the VF4 marked the introduction of a new technology S-curve within the industry and established the system of a CFP and ultra-responsive midsole foam as the dominant design for future development. With this, Nike set a direction for future footwear development and profited from subsequent temporary monopolistic rents and strengthened the powerful position as the industry leader within running footwear innovation.

6.3 VF4 Introduction: Leading Innovation & a Common Industry Direction

Nike's approach to the product as the foundational marketing tool is aligned with researchers' (Kotler et al., 2005), emphasizing a superior product as the firm's first and foremost component. The VF4 was introduced on the market with a design language that diverged from the previously offered long distance running shoes. Interviewees expressed how the product was refined until perfection in collaboration with athletes. The strong focus on consumers enabled Nike to lead in shaping the future direction in running footwear

development, whilst seizing the business opportunity linked to introducing a radical innovation on the market. As Kotler et al. (2005) elaborated, this places competitors in a reactive position, forced to re-allocate resources internally to respond to the new innovation. Hence, resulting in a substantial time-lag in serving consumers and ultimately limiting the potential of their product to gain market share.

Trott (2017) explained that the leading manufacturer will gain market share through product differentiation and provide the customer with superior benefits as compared to the incumbent product offering on the market. Interviewees described how the VF4 was marketed with scientifically based research on improving running efficiency and subsequently, the expected benefits for runners using the product were not only the mere result of a successful marketing campaign, but confirmed in scientific results of actual product performance and testing. As emphasized by researchers (Drummond & Ensor, 2001), and further accentuated by interviewees, the proven benefits linked to the innovative application of the novel technology, coupled with a strong link to the company's strategic intent and authentic brand image as a historical running footwear innovator outweighed the price of the product. Moreover, the product positioning further enabled Nike to confidently price the product significantly higher than other racing footwear models on the market at the time as a reflection of the thorough work and research that went into the process of bringing the VF4 to market. Consequently, competitors could follow in the footsteps of Nike and price their AFT product offerings within this new, significantly higher, pricing segment. With this, manufacturers ultimately built and expanded competition for consumer demand within running footwear products.

Lastly, interviewees described the distribution strategy, where the radically new innovation was strategically distributed based on the dynamics of the marketplaces and cultural differences and characteristics of the consumer segments which Nike targeted. Porter (1980) accentuated the strategic importance of careful selection of distribution channels and locations to ensure an impactful consumer reach. Interviewees explained that the manufacturing constraints due to the advanced material and production processes forced an inevitable strategic product allocation across the market. Subsequently, distribution strategies had to be constructed with an understanding of the differences among the separate marketplaces, purposefully capturing the uniqueness of each, whilst creating the most impactful launch across the globe. Conclusively, building a powerful go-to-market plan which needs to consider and accommodate the complexity of product constraints,

marketplace differences, athlete involvement and sport moment connections etc. requires a high level of cross-functional and close cross-geographical involvement, collaboration and strategic alignment as one team.

6.4 VF4 Learnings: Future Direction of Innovation & Consequences for Industry

In the NPD model by Crawford and Benedetto (1994), several iterative concept stages of development take place which facilitate opportunities for learning. For the R&D team's capabilities, the dynamic process of testing, refining, and progressing is as valuable as the end-product. The interviewees expressed that the first and foremost objective in the development process was to build a shoe which made the athlete faster. In terms of technological advancements focused on road racing footwear specifically, the industry is likely to face a plateau as a consequence of the increasing maturity, exploitation and application of AFT in footwear. However, interviewees discussed the VF4 journey from ideation in 2013 to today from multiple perspectives and independently of each other mentioned the synergistic effects of the biomechanical and physiological discoveries made by the team in the R&D process. The combined innovation and research process built a substantial base for understanding how running footwear impacts the athletes' running efficiency and performance in training and racing. Interviewees emphasized how learnings drawn from the project to making an athlete faster, also resulted in opportunities to further refine how protection can be elevated to prevent injuries. Athletes, coaches, researchers, manufacturers, and the governing body are all aligned on protecting and reducing the risk of injuries among athletes is prioritized for the sport and for future footwear development. The insight of how to apply and combine a CFP and ultra-responsive midsole foam brought new product development opportunities related to injury prevention and protection of the athletes' bodies, not only within the product development team at Nike, but formed a general consensus and direction for future innovation within the running footwear industry and enabled refinements in athletes' training regimes.

The modifications of the governing body's regulatory enforcements put on racing footwear limit the breadth of future racing footwear innovation. It forces manufacturers to adhere to the industry wide regulations. However, the regulations imposed on product innovation in the racing footwear domain guide innovation to accelerate elsewhere. Interviewees instead expressed the opportunity and potential to leverage and apply AFT in other domains of running footwear. Both with the aim of preventing injuries, as well as within different

domains of running as a sport. Manufacturers are experimenting with AFT and are capitalizing on the emerging and rapidly growing popularity of trail running. As interviewees suggest, the accelerated consumer demand for trail running products is partly explained as a result of the ongoing COVID-19 pandemic and natural human instinct to seek nature in times of chaos. Additionally, the increasing environmental awareness among consumers also pressures manufacturers to allocate resources and invest on innovative efforts in sustainability sourced materials, material engineering processes and manufacturing.

Furthermore, the synergistic effects related to technological advancements in separate industries also have a significant impact on the running industry and its development. The interviewees accentuated the importance of data as an enabler both in the biomechanical research, innovation, and product development processes, as well as in the actual product offering. Interviewees also emphasized the athlete's expressed demand for performance, protection, and information. As technologies are refined and adopted, the potential to create and leverage consumer data through connected products and incorporated digital solutions are getting closer to reality. However, one can conclude that it is inevitable that an understanding of consumer susceptibility, market and technological maturity, as well as timing play fundamental roles to support product adoption among consumers. This is not limited to the running industry in particular, but any consumer goods industry in general where the use of technological applications can play an integral role to make or break the success of the product.

7. Conclusion & Recommendation for Further Research

Section 7.1 presents the thesis conclusion by answering the main research question, divided in the two research questions RQ#1 and RQ#2. Further, in section 7.2 learnings from this thesis and its academic contribution, connection to theory and suggestions for future research is provided.

7.1 Conclusion

Through a case study of the Nike Vaporfly 4%, this thesis investigate the connection between sport performance, product innovation and business development. The thesis analyze and discuss competitive advantages of Nike and the implications related with the new product introduction on future product development and manufacturers' positioning.

The competitive advantages of Nike are built in a path dependent process with focused investments on building industry-leading innovation capabilities. Since the company was founded, innovation has been core to the company's powerful positioning in the industry; consistently placing the consumer needs and demands at the center by listening to the *voice of the athlete*. Moreover, the foundational competitive advantage of Nike is the culture of sport inspiration and innovation among the employees. The company continuously succeeds to link the overall strategic intent of the firm to build an impactful purpose for employees to align around and common objectives to strive toward. Nike has a history of close partnerships with elite athletes and expert researchers in sports science in developing new products. With advancements in technologies and strategic investments in capabilities, Nike focuses efforts on data collection and analyzing consumer and trend insights. This information forms a deep understanding of the market and caters a strong knowledge base to power decision making and meaningful product development. For other manufacturers to compete with Nike, resources are suggested to be strategically invested in technology which supports data collection, analysis and utilization.

With the historical positioning as the innovator within the industry, Nike is an authentic and credible leader in footwear innovation. Despite the company's size, the organizational setup strategically empowers innovation experts to freely explore, test and develop their ideas in an environment which fully supports it. As the hub for exploration and innovation, 'the Kitchen' is at the heart of Nike. This is where innovators can excel at what they do by being supported

with top-class resources, while ensuring enough separation to avoid the drawbacks of a forced connection with the ongoing business of the multinational corporation. When the VF4 was introduced in 2017, Nike manifested the company's abilities to innovate and continued to claim the power of shaping the future of innovation within the running footwear industry. By understanding the impact of Nike's strategic organizational setup, other manufacturers can evaluate their own structure and make necessary changes to cater and enhance innovation.

The new technology introduced with the VF4 resulted in a subsequent shift, establishing the system of CFP and highly cushioned midsole as the accepted dominant design within the industry. For future innovation to build further on, the work leading up to the VF4 brought insights and opportunities for advancements in the structural setup for innovation. The innovation and development process demonstrated the excellence in the extensive cross-disciplinary collaboration between experts in the fields of 1) academia; sports, biomechanical and physiological research; 2) elite level sports participation and 3) product development and technological advancements. Collectively, bringing together the triad of academic research, sports and product development brought synergistic effects and advancements in footwear development with an approach that had not been taken before. Emerging from research, the VF4 proved previous perceptions of human limitations can, and shall, be challenged. Moreover, it brought insights and opportunities for further advancements in material engineering, manufacturing processes and data utilization.

Learnings regarding impact, load, and injury prevention features from the VF4 brought new ideas which were later incorporated in new product offering. For Nike, these learnings drove the creation of business opportunities in other fields of running footwear, focusing on injury prevention, to complement the road racing and fast positioning of the VF4 product proposition. Something that benefits the sport, athletes, and industry, keeping runners running. For other manufacturers, the VF4 innovation system provided a distinct direction for advancements in product development and design. For the athletes and the sport of running, the VF4 enabled athletes and coaches to think differently and structure the training in new ways, reducing the risks related to impact of training load on the body, whilst improving performance.

In conclusion, this thesis provides an industry specific case example adding to the existing research on management of innovation, by outlining how 1) innovation resources and

capabilities are created, nurtured and continuously developed over time, and 2) discussing the subsequent implications linked with the introduction of a specific product innovation on current dynamics and future development of the running footwear industry.

7.2 Academic Contribution & Further Research

The thesis contributes with research of the industry dynamics and the consequential reshaping of the current market offering within a specific industry setting. With this, the thesis provides a foundation for future comparison across other Olympic Sports where a performance plateau is identified potentially can be influenced by technological improvements of equipment or novel emerging strategies for physiological optimization.

The thesis demonstrates and elaborates on the theoretical connection between the three cornerstones: technological innovation, market competition and sport performance. The thesis strengthens the interconnected linkages in the triad of innovation, sport and business by connecting 1) sport performance and athlete partnership with 2) marketing and strategic management theories around competitive advantages, positioning and marketing mix with 3) new product development and technological development cycles. The thesis provides a concrete industry example of how the leading manufacturer's, Nike's, advancements in product innovation drive the emergence of a dominant design and subsequent technology shift within the industry. Furthermore, the study presents how the introduction of an innovative product leads to governing body policy intervention impacting future technological product innovation, the following market response and athletes' ability of breaking the boundaries of historical human performance.

Further research within sports performance and its link to technological innovation is encouraged to both support and critically discuss the findings of this thesis. The research conducted includes a small sample of interviews, presenting an interesting and engaging, yet narrow perspective on the topic. Further research is suggested to include a more diverse set of perspectives. The main rationale for this is to capture a broader set of interviewees' different perceptions of competitive advantages and market dynamics based on their professional background and manufacturer specific knowledge.

References

Online Journals & Newspaper Articles

Abernathy W.J. & Utterback, J.M. (1978). Patterns of industrial innovation. *Technology Review,* Vol. 80 (June-July).

Balmer, N., Pleasence, P. & Nevill, A. (2012). Evolution and Revolution: Gauging the impact of technological and technical innovation on Olympic performance. *Journal of Sports Science* 30, pp.1075–1083.

BASEM. (2020). Technological Fairness or Technological Doping? *British Association for Sports & Exercise Medicine*. Published on: 2020-07-15. Retrieved on: 2020-10-26. From: https://basem.co.uk/technological-fairness-or-technological-doping/

Barnes, K.R. & Kilding, A.E. (2019). A Randomized Crossover Study Investigating the Running Economy of Highly-Trained Male and Female Distance Runners in Marathon Racing Shoes versus Track Spikes. *Sports Medicine (2019)* 49, pp.331-342. Springer Nature, Switzerland AG.

Barney, J.B. (1991). "Firm resources and sustained competitive advantage". *Journal of Management,* 17(1), pp. 99-121.

Barney, J. B., Wright, M. & Ketchen, D.J. (2001). "The resource-based view of the firm: Ten years after 1991". *Journal of Management,* 27, pp. 625-641.

Carrier, D.R., Heglund, N.C. & Earls, K.D. (1994). Variable gearing during locomotion in the human musculoskeletal system. *Science* 265(5172), pp.651-3.

Dyer, B. (2020a). *The Controversy of Sports Technology: A Systematic review.* Faculty of Science and Technology, Bournemouth University, Fern Barrow, Poole, United Kingdom. SpringerPlus (2015) 4:524.

Dyer, B. (2020b). *A Pragmatic Approach to Resolving Technological Unfairness: the Case of Nike's Vaporfly and Alphafly Running Footwear.* Department of Design & Engineering, Bournemouth University, Poole, United Kingdom. For Sports Medicine SpringerOpen (2020) 6:21.

Farina, E.M., Haigh, D. & Luo, G. (2019). Creating Footwear for performance running. *Footwear Science* 11(1), pp. 134-135.

Garcia, R. & Cantalone, R. (2002*).* A critical look at technological innovation typology and innovativeness terminology; a literature review. *Journal of Product Innovation Management*; 19, pp. 110-132.

Gioia, D.A., Corley, K.G. & Hamilton, A.L. (2012). Seeking Qualitative Rigor in Inductive Research: Notes on the Gioia Methodology, *Organizational Research Methods*, 16(1), pp. 15-31.

Grant, R.M. (1991). The Resource-Based Theory of Competitive Advantage: Implications for Strategy Formulation. *California Management Review* 33(3), pp. 114-138.

Grant, R.M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17(winter), pp. 109-122.

Guinness, J., Bhattacharya, D., Chen, J., Chen, M. & Loh, A. (2020). *An Observational Study of the Effect of Nike Vaporfly Shoes on Marathon Performance.* Cornell University. Published on: October 2, 2020.

Hall, R. (1992). The strategic analysis of intangible resources. *Strategic Management Journal*, 13, pp. 135-144.

Hamel, G. & Prahalad, C.K. (1994). Competing for the Future. *Harvard Business Review* (July-August).

Hamel, G. & Prahalad, C.K. (2005). Strategic Intent. *Harvard Business Review* (July-August).

Hebert-Losier, K., Finlayson, S.J., Driller, M.W., Dubois, B., Esculier, J.F. & Beaven, C.M. (2020). Metabolic and performance responses of male runners wearing 3 types of footwear: Nike Vaporfly 4%, Saucony Endorphin racing flats, and their own shoes. *Journal of Sport and Health Science*. Published on: November 29, 2020.

Hoogkamer, W., Kipp, S., Spiering, B.A. & Kram, R. (2016). Altered Running Economy Directly Translates to Altered Distance-Running Performance. *Medicine & Science in Sports & Exercise. The Official Journal of the American College of Sports Medicine.* Accepted for publication on: June, 7, 2016.

Hoogkamer, W., Kipp, S., Frank, J. H., Farina, E. M., Luo, G. & Kram, R. (2018). A comparison of the energetic cost of running in marathon racing shoes. *Sports Medicine* 48 (4), pp.1009–1019.

Hoogkamer, W., Kipp, S. & Kram, R. (2019). The Biomechanics of competitive Runners in Three Marathon racing Shoes: A Randomized Crossover Study. *Sports Medicine* 49 (1), pp.133-143.

Hunter, I., McLeod, A., Valentine, D., Low, T., Ward, J. & Hager, R. (2019). Running economy, mechanics, and marathon racing shoes. *Journal of Sports Sciences* 37(20), pp.2367-2373.

Jones, A.M., Kirkby, B.S., Clark, I.E., Rice, H.M., Fulkerson, E., Wylie, L.J., Wilkerson, D.P., Vanhatalo, A. & Wilkins, B.W. (2020). Physiological demands of running at 2-

hour marathon race pace. *Journal of Applied Physiology.* Published on: November 5, 2020.

Jones, C. & Wilson, C. (2009). Defining advantage and athletic performance: The case of Oscar Pistorius. *European Journal of Sport Science* 9(2), pp.125-131.

Knapik, J.J., Swedler, D.I., Grier, T.L. Hauret, G.K., Bullock, S.H., Williams, K.W., Darakjy, S.S., Lester, M.E., Tobler, S.K. & Jones, B.H. (2009). Injury reduction effectiveness of selecting running shoes based on plantar shape. *Journal of Strength and Conditioning Research* 23 (3), pp.685–97.

Knapik, J.J., Brosch, L.C., Venuto, M., Swedler, D.I., Bullock, S.H., Gaines, L.S., Murphy, R.J., Tchandja, J. & Jones, B.H. (2010a). Effect on injuries of assigning shoes based on foot shape in air force basic training. *American Journal of Preventive Medicine* 38(1) pp.197–211.

Knapik, J.J., Trone, D.W., Swedler, D.I., Villasenor, A., Bullock, S.H., Schmied, E., Bockelman, T., Han, P & Jones, B.H. (2010b). Injury reduction effectiveness of assigning running shoes based on plantar shape in Marine Corps basic training. *American Journal of Sports Medicine* 38(9), pp.1759–67.

Madhani, P.M. (2010). The Resource - Based View (RBV): Issues and Perspectives. PACE. *A Journal of Research of Prestige Institute of Management*. 1(1), pp.43-55.

Mizrahi J., Verbitsky, O., Isakov, E. & Daily, D. (2000). Effect of fatigue on leg kinematics and impact acceleration in long distance running. *Human Movement Science* 19, pp.139-151.

Mohr, M., Meyer, C., Nigg, S. & Nigg, B.M. (2017). The relationship between footwear comfort and variability of running kinematics. *Footwear Science* 9(1).

Murray, T. (2010). Making sense of fairness in sports. *Hastings Cent Rep* 40(2), pp.13-15

Nevill, A.M. & Whyte, G.P. (2005). Are There Limits to Running World Records? *Medicine and Science in Sports and Exercise*, 37(10) pp.1785–1788.

Nielsen, R.O., Buist, I., Parner, E.T., Nohr, E.A., Sorensen, H.T., Lind, M. & Rasmussen, S. (2013). Foot pronation is not associated with increased injury risk in novice runners wearing a neutral shoe: A 1-year prospective cohort study. *British Journal of Sports Medicine* 48(6), pp.1–8.

Nigg, B.M. (1997). Impact forces in running. *Current Opinion in Orthopaedics* 8(6), pp.43–7.

Nigg, B.M., Stefanyshyn, D., Cole, G., Stergiou, P. & Miller, J. (2003). The effect of material

characteristics of shoe soles on muscle activation and energy aspects during running. *Journal of Biomechanics* 36, pp. 569–575.

Peteraf, M.A. (1993). The Cornerstones of Competitive Advantage: A Resource-Based View. *Strategic Management Journal*, 14(3), pp.179-191.

Richards, C.E., Magin, P.J. & Callister, R. (2009). Is your prescription of distance running shoes evidence-based? *British Journal of Sports Medicine* 43(3) pp.159–62.

Roy, J-P.R. & Stefanyshyn, D.J. (2006). Shoe midsole longitudinal bending stiffness and running economy, joint energy, and EMG. *Medicine & Science in Sports & Exercise* 38(3), pp.562-9.

Rumelt, R.P. (1984). "Towards a strategic theory of the firm". In Lamb, R.B. (Ed.), *Competitive Strategic Management.* Prentice-Hall, Englewood Cliffs, USA, pp. 556-570.

Ryan, M.B., Valiant, G.A., McDonald, K. & Taunton, J.E. (2011). The effect of three different levels of footwear stability on pain outcomes in women runners: A randomised control trial. *British Journal of Sports Medicine* 45, pp.715–21.

Sun, X., Lam, W-K., Zhang, X., Wang, J. & Fu, W. (2020). Systematic Review of the Role of Footwear Constructions in Running Biomechanics: Implications for Running-Related Injury and Performance. *Journal of Sports Medicine* 24(1), pp.20-37.

Teece, D.J. (1984). 'Economic analysis and strategic management', *California Management Review*, 26(3), pp.87-110.

Teece, D.J. & Pisano, G.P. (1994). "The Dynamic Capabilities of Firms: An Introduction", *Industrial and Corporate Change* 3(3), pp.537-556.

Teece, D.J., Pisano, G.P. & Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal* 18(7), pp.509-533.

Tushman, M.L., & Rosenkopf, L., (1992). Organizational determinants of technological change: towards a sociology of technological evolution. *Research in Organizational Behavior* 14, pp.311–347.

Veryzer R.W. (1998). Key factors affecting customer evaluation of discontinuous new products. *Journal of Product Innovation Management;* 15(2), pp.136–50.

Watershoot, W. & Van den Bulte, C. (1992). The 4P Classification of the Marketing Mix Revisited. *Journal of Marketing*, 56, pp.83-93.

Books

Andersson, B.E. (1985). *Som man frågar får man svar: En introduktion i intervju- och enkätteknik*. 2nd Ed. Göteborg: Elanders Digitaltryck.

Bryman, A. & Bell, E. (2011). *Business Research Methods*. Oxford University Press, 3rd Edition. Oxford, United Kingdom.

Crawford, M. & Benedetto, A.D. (1994). *New Products Management*, 4th Edition. Richard D. Irwin, Inc., Boston, USA.

Drummond, G. & Ensor, J. (2001). *Strategic Marketing: Planning and Control.* 2nd Edition. The Chartered Institute of Marketing. Butterworth-Heinemann. Oxford, United Kingdom.

Flick, U. (2009). *An introduction to qualitative research*. 4th Edition, SAGE Publications Ltd. Thousand Oaks, USA.

Grawe, S. (2020). *Better is Temporary*. Phaidon Press Ltd. London, United Kingdom.

Hauge, P. (1998). *A partial guide to market research*. Grosvenor House Publishing Ltd. Guildford, United Kingdom.

Helfat, C.F., Finkelstein, S. Mitchell, W. Peteraf, M.A., Singh, H., Teece, D.J. & Winter, S.G. (2007). *Dynamic Capabilities: Understanding Strategic Change in Organizations.* Blackwell. Oxford, United Kingdom.

Keller, K. (1998). *Strategic Brand Management: Building, Measuring, and Managing Brand Equity.* Prentice-Hall International. Hemel Hempstead, United Kingdom.

Kotler, P., Wong, V., Saunders, J. & Armstrong, G. (2005). *Principles of Marketing*. 4th European Edition. Pearson Prentice-Hall. Upper Saddle River, USA.

Malhotra, N., Nunan, D. & Birks, F.D. (2017). *Marketing Research - An applied approach.* 5th Edition. Pearson Education Ltd. New York, USA.

McCarthy, J. (1960). *Basic Marketing: A Managerial Approach*. Irwin. Homewood, USA.

Porter, M.E. (1980). *Competitive Strategy.* Free Press. New York, USA.

Rothwell, R. & Zegveld, W. (1985). *Reindustrialization and Technology*, Harlow. Longman, United Kingdom.

Subotnick, S.I. (1979). *Cures for Common Running Injuries.* 1st Edition. Anderson World Publications. September 1, 1979.

Teece, D.J. (2009). *Dynamic Capabilities and Strategic Management: Organizing for Innovation and Growth.* Oxford University Press. Oxford, United Kingdom.

Trott, P. (2017). *Innovation Management and New Product Development.* 6th Edition. Pearson Education Ltd. Edinburgh Gate, United Kingdom.

Utterback, J.M. (1994). *Mastering the Dynamics of Innovation.* Harvard Business School Press, Boston, MA, USA.

Webpages, Websites & Communication

Adidas. (2017). *Adidas unveils industry's first application of digital light synthesis with futurecraft 4D.* Published on: 2017-04-17. Retrieved on: 2021-02-18. From: https://news.adidas.com/futurecraft/adidas-unveils-industry-s-first-application-of-digital-light-synthesis-with-futurecraft-4d/s/20b2ff0a-4c7d-47a2-9beb-3373f6a5dad7

Adidas. (2019). *Adizero: Running shoes built to break records.* Published on: December, 2019. Retrieved on: 2021-01-18. From: https://adidas.com/us/blog/436134

Adidas. (2020). *What is Boost?.* Published on: February, 2020. Retrieved on: 2021-02-11. From: https://adidas.com/us/blog/373504

Adidas. (2021a). *Adizero Adios 5 Schoenen.* Last updated: 2021-01-29. Retrieved on: 2021-02-19. From: https://adidas.nl/adizero-adios-5-schoenen/FY2020.html?cm_mmc=AdieSEM_PLA_Google-_-GS-OPT-NL-Categories-SubBranded-CSS-Adult_Inventory-_-NEW%20SUBBRANDED%20-%20male-_-PRODUCT_GROUP&cm_mmca1=NL&cm_mmca2=&ds_agid=58700006641949905&gclid=Cj0KCQiA4L2BBhCvARIsAO0SBdbCkbTYnK1YPb_0duTGkMCb5vgosQXONxSY_K-0iFm7z0w4MhNyDLMaAoIDEALw_wcB&gclsrc=aw.ds

Adidas. (2021b). *The problem of plastic waste: why we need to act now.* Published on: February, 2021. Retrieved on: 2021-02-19. From: https://adidas.com/us/blog/629060-the-problem-of-plastic-waste-why-we-need-to-act-now

Apple. (2006). *Press Release: Nike and Apple Team Up to Launch Nike+iPod.* Published on: 2006-05-23. Retrieved on: 2021-02-14. From: https://apple.com/newsroom/2006/05/23Nike-and-Apple-Team-Up-to-Launch-Nike-iPod/

Asics. (2017). *Lightweight running shoes from Asics put every runner on the forefoot.* Published on: 2017-07-06. Retrieved on: 2021-02-21. From: https://corp.asics.com/en/press/article/2017-07-06-1

Asics. (2019). *Sustainability Report 2019.* Retrieved on: 2021-02-19. From: https://assets.asics.com/page_types/3305/files/ASICS_17-19_original.pdf?1590222792&_ga=2.242040966.506051517.1613747225-1240039654.1613747225

Bartold, S. (2020). *The race to build the super shoe.* Bartold Clinical. Published on: 2020-06-10. Retrieved on: 2021-02-18. From: https://bartoldclinical.com/race-to-build-the-super-shoe/

Brooks. (2021). *Transcend 7.* Last updated: 2021. Retrieved on: 2021-02-21. From: https://brooksrunning.com/en_us/transcend-7-mens-road-running-shoe/110331.html

Brooks. (2019). *Brooks - Our History.* Published on: 2019-06-07. Retrieved on: 2021-02-18. From: https://talk.brooksrunning.com/au/2019/06/07/brooks-our-history/

Caughlan, T. (2018). *Nike Zoom Vaporfly 4% Review.* RunningshoesGuru. Published on: 2018-10-10. Retrieved on: 2021-02-19. From: https://runningshoesguru.com/2017/08/nike-zoom-vaporfly-4-review/

Diard, J.L. & Mermoud, N. (2021). *Time To Fly.* Hoka One One. Last updated: 2021. Retrieved on: 2021-02-18. From: https://hokaoneone.eu/en/se/meet-hoka.html

Longden, R. (2019). *History is made.* INCH Magazine. INEOS AG, Rolle, Switzerland. Last updated: October, 2019. Retrieved on: 2021-04-08. From: https://ineos.com/inch-magazine/articles/eliud-kipchoge/history-is-made/

Market. (2020). *Running Shoes Market.* Published on: 2020-10-13. Retrieved on: 2021-04-23. From: Market. (2020). https://market.us/infographics/global-running-shoes-market/

McGuire, J. (2020). *'They're not just race shoes', Nike's VP of Footwear Innovation says of the Alphaflys.* RunnersWorld UK. Published on: 2020-10-03. Retrieved on: 2021-02-13. From: https://runnersworld.com/uk/gear/shoes/a31240752/what-nike-say-alphafly/

NewAtlas. (2004). *Adidas Launches the Intelligent Running Shoe.* Published on: 2004-06-04. Retrieved on: 2021-02-18. From: https://newatlas.com/adidas-launches-the-intelligent-running-shoe/2810/

New Balance. (2016). *New Balance to sell first 3D printed running shoe.* Published on: 2016-04-11. Retrieved on: 2021-02-18. From: https://newbalance.newsmarket.com/running/new-balance-to-sell-first-3d-printed-running-shoe/s/c795df88-b76f-4ed4-8a02-b186981dadf7?cultureSeoName=GLOBAL

New Balance. (2018). *Race Day - Competition.* Last updated: 2021. Retrieved on: 2021-02-18. From: https://nl.newbalance.eu/en/men/shoes/running/race-day-%E2%80%93-competition/?ICID=404_REDIRECT_NEW#style=M1500GW6

New Balance. (2020). *Responsible Leadership.* Last updated: 2020. Retrieved on: 20201-02-19. From: https://newbalance.com/responsible-leadership/product.html#

Nike. (2014b). *Inside Access: Natural Motion and Nike Free*. Published on: 2014-03-14. Retrieved on: 2021-01-29. From: https://news.nike.com/news/inside-access-natural-motion-and-nike-free

Nike. (2015). *Bill Bowerman: Nike's Original Innovator.* Published on: 2015-09-02. Retrieved on: 2021-01-27. From: https://news.nike.com/news/bill-bowerman-nike-s-original-innovator

Nike. (2017a). *Introducing the Nike Zoom Vaporfly Elite Featuring ZoomX Midsole*. Published on: 2017-03-07. Retrieved on: 2021-01-19. From: https://news.nike.com/news/nike-zoom-vaporfly-elite

Nike. (2017b). *The Shoes Athletes Say Will Change the Future of Running.* Published on: 2017-05-03. Retrieved on: 2021-02-10. From: https://news.nike.com/news/nike-vaporfly-4-review

Nike. (2017d). *Nike Celebrates its Breaking2 Results.* Published on: 2017-05-06. Retrieved on: 2021-01-18. From: https://news.nike.com/news/breaking2-results

Nike. (2019a). *Eliud Kipchoge is the Essence of Progress.* Published on: 2019-10-19. Retrieved on: 2021-01-30. From: https://news.nike.com/news/eliud-kipchoge-1-59-attempt-kit-nike-zoom-marathon-shoe

Nike. (2019b). *Breaking down the Nike Adapt BB.* Published on: 2019-01-15. Retrieved on: 2021-02-17. From: https://news.nike.com/news/nike-adapt-bb

Nike. (2019c). *The Promise of Intelligent Product.* Published on: 2019-01-15. Retrieved on: 2021-02-17. From: https://news.nike.com/news/michael-donaghu-nike-adapt-bb

Nike. (2020a). *The Science and People Behind Nike NEXT%*. Published on: 2020-07-02. Retrieved on: 2021-02-18. From: https://news.nike.com/news/what-to-know-about-nike-next

Nike. (2020b). *Nike Air Zoom Alphafly NEXT% | Behind The Design | Nike* [Video] YouTube. Published on: 2020-05-29. Retrieved on: 2021-02-18. From: https://youtube.com/watch?v=6fs1oT9cBgE

Nike. (2020c). *By Defying Expectations, Nike NEXT% Moves Athletes Forward.* Published on: 2020-02-05. Retrieved on: 2021-02-13. From: https://news.nike.com/news/air-zoom-alphafly-next-percent

Nike. (2021c). *Project: Run Fearless | Behind the Design | Nike* [Video]. Published on: 2021-01-08. Retrieved on: 2021-02-19. From: https://youtube.com/watch?v=z-C3oLD_A1U

Nike. (2021d). *Circularity - Guiding the future of design.* Last updated: 2021. Retrieved on: 2021-02-19. From: https://nikecirculardesign.com

On Running. (2020). *The On Story*. Last updated: 2020. Retrieved on: 2021-02-16. From: https://on-running.com/en-se/about

Saucony. (2020). *Biodegradable. For Good.* Last updated: 2020. Retrieved on: 2021-02-19. From:https://saucony.com/en/biodegradable/?icid=sustainabilitylp_biodegradable_learnmore

Vibram. (2021). *History*. Last updated: 2021. Retrieved on: 2021-01-18. From: https://us.vibram.com/company/about/history/

Wieden+Kennedy. (2017). *Nike: Breaking2.* Last updated: May, 2017. Retrieved on: 2021-02-16. From: https://wk.com/work/nike-breaking2/

World Anti-Doping Agency. (2019). *World Anti-Doping Code.* Retrieved on: 2020-10-26. From:https://wada-ama.org/sites/default/files/resources/files/wada_anti-doping_code_2019_english_final_revised_v1_linked.pdf

World Athletics. (2020). *Book C - C2.1 Technical Rules. 1 November 2019 - amended 31 January 2020.* Retrieved on: 2021-01-22. From: https://worldathletics.org/news/press-releases/modified-rules-shoes

Multimedia, Images, Videos & Audio

Adidas. (2019). *Adizero: Running shoes built to break records.* Published on: December, 2019. Retrieved on: 2021-01-18. From: https://www.adidas.com/us/blog/436134

Adidas. (2020). *What is Boost?.* Published on: February, 2020. Retrieved on: 2021-02-11. From: https://adidas.com/us/blog/373504

Asics. (2020). *History*. Last updated: 2020. Retrieved on: 2021-01-18. From: https://corp.asics.com/en/about_asics/history?decade=1980s

Brooks. (2019). *Brooks - Our History.* Published on: 2019-06-07. Retrieved on: 2021-02-18. From: https://talk.brooksrunning.com/au/2019/06/07/brooks-our-history/

Diard, J.L. & Mermoud, N. (2021). *Time To Fly.* Hoka One One. Last updated: 2021. Retrieved on: 2021-02-18. From: https://www.hokaoneone.eu/en/se/meet-hoka.html

NewAtlas. (2004). *Adidas Launches the Intelligent Running Shoe.* Published on: 2004-06-04. Retrieved on: 2021-02-18. From: https://newatlas.com/adidas-launches-the-intelligent-running-shoe/2810/

New Balance. (2016). *New Balance to sell first 3D printed running shoe.* Published on: 2016-04-11. Retrieved on: 2021-02-18. From: https://newbalance.newsmarket.com/running/new-balance-to-sell-first-3d-printed-running-shoe/s/c795df88-b76f-4ed4-8a02-b186981dadf7?cultureSeoName=GLOBAL

Nike. (2012a). *NIKE engineers knit for performance.* Published on: 2012-02-21. Retrieved on: 2021-01-18. From: https://news.nike.com/news/nike-flyknit

Nike. (2012b). *Reintroducing the Nike Tailwind.* Published on: 2012-01-25 Retrieved on: 2021-01-18. From: https://news.nike.com/news/reintroducing-the-nike-tailwind

Nike. (2014a). *Air Max Day: 24 Hours Honoring 27 Years of Greatness.* Published on: 2014-03-17. Retrieved on: 2021-01-29. From: https://news.nike.com/news/air-max-day

Nike. (2014b). *Inside Access: Natural Motion and Nike Free*. Published on: 2014-03-14. Retrieved on: 2021-01-29. From: https://news.nike.com/news/inside-access-natural-motion-and-nike-free

Nike. (2015). *Bill Bowerman: Nike's Original Innovator.* Published on: 2015-09-02. Retrieved on: 2021-01-27. From: https://news.nike.com/news/bill-bowerman-nike-s-original-innovator

Nike. (2017b). *The Shoes Athletes Say Will Change the Future of Running.* Published on: 2017-05-03. Retrieved on: 2021-02-10. From: https://news.nike.com/news/nike-vaporfly-4-review

Nike. (2017c). *Nike Redefines the Look and Feel of Fast Running.* Published on: 2017-07-17. Retrieved on: 2021-01-18. From: https://news.nike.com/news/nike-zoom-vaporfly-4-percent

Nike. (2017d). *Nike Celebrates its Breaking2 Results.* Published on: 2017-05-06. Retrieved on: 2021-01-18. From: https://news.nike.com/news/breaking2-results

Nike. (2018). *Nike Air Zoom Pegasus History and Facts*. Published on: 2018-05-18. Retrieved on: 2021-01-18. From: https://news.nike.com/news/nike-air-zoom-pegasus-history

Nike. (2020b). *Nike Air Zoom Alphafly NEXT% | Behind The Design | Nike* [Video] YouTube. Published on: 2020-05-29. Retrieved on: 2021-02-18. From: https://youtube.com/watch?v=6fs1oT9cBgE

Nike. (2021a). *Nike Air Zoom Vaporfly NEXT%*. Last updated: 2021. Retrieved on: 2021-01-18. From https://nike.com/nl/en/running/vaporfly

Nike. (2021b). *Nike Air Zoom Alphafly NEXT%*. Last updated: 2021. Retrieved on: 2021-01-18. From: https://nike.com/running/alphafly

Nike. (2021c). *Project: Run Fearless | Behind the Design | Nike* [Video]. Published on: 2021-01-08. Retrieved on: 2021-02-19. From: https://youtube.com/watch?v=z-C3oLD_A1U

On Running. (2020). *The On Story*. Last updated: 2020. Retrieved on: 2021-02-16. From: https://on-running.com/en-se/about

Runify. (2017). *Nike Sport Research: The Art of Science* [Video]. YouTube. Published on: 2017-01-20. Retrieved on: 2021-02-13. From: https://youtube.com/watch?v=paY4xxiQNEU

Vibram. (2021). *History*. Last updated: 2021. Retrieved on: 2021-01-18. From: https://us.vibram.com/company/about/history/

Appendix

Appendix 1 - Interview Guide - Candidate within Running Footwear Industry

1. Which are the key historical improvements/technological discoveries in running footwear development that shaped today's product and marketplace?
2. What other historical developments can be comparable with the performance improvements enabled with the Vaporfly?
3. What is the moment/product/innovation you value the most? Why?
4. Which resources and capabilities do you believe have been key to Nike's position as a leader in running footwear innovation?
5. What was the biggest learnings from the development of the Vaporfly 4%? When looking in hindsight; what would you have done differently?
6. In hindsight of the journey from the first work with the VF4% in 2013, to launching the Alphafly in 2020, what are the strong moments you will remember from the process?
7. What is your opinion on sport performance improvements and connection to technological innovation?
8. How do you envision the future of running footwear?
9. What opportunities and challenges are there to future innovation in running footwear?
10. How do you believe the WA regulations impact the future of Running in terms of: Footwear innovation? Industry? Sport?

Appendix 2 - Interview Guide - Candidate within Innovation Policy & Research

1. What is your opinion on the connection between sport performance and technological innovation?
2. What is an unfair advantage?
3. What is your opinion on the WA regulations regarding running footwear for competition?
4. What is the aim and purpose of the governing body when imposing regulations?
5. What protective and restrictive measures can be executed to influence and/or direct innovation within the running footwear industry?
6. What challenges and opportunities are considered in the process of establishing regulations?
7. How does WA reason on AFT on protection and injury prevention of the athlete, versus performance enhancing influence?
8. What is the determining factor in defining performance impact within World Athletics testing?
9. How is technology assessed to be reasonably available to all? How does this differ depending on the scope of the regulations?
10. If and how does WA collaborate with current market actors when developing and establishing a regulatory framework?
11. How does WA approach the trade-off between sports regulations and economic development?
12. What do you believe will be the consequences of the regulations in influencing product innovation, market dynamics within the industry and sport performance?
13. Based on your knowledge in sports technology research and WA processes, how do you envision the industry moving forward in the future?

Appendix 3 - Interview Guide - Elite Athletes & Professional Running Coach

1. What is your opinion on the running footwear industry and the development of running footwear products?
2. How has the industry's development impacted your performance? In training? Competition?
3. What other aspects of performance can be impacted through research and product development? How do you compare these with the performance improvements enabled with the Vaporfly?
4. What is the moment/product/innovation you value the most for running as a sport? Why?
5. What do you think has the biggest impact on your performance? What role does footwear play in your training and progression as an athlete?
6. (COACH): What significant differences in athlete training response do you draw to the VF4 & AFT introduction and connect to training/racing/performance of elite athletes?
7. What key moments do you remember from the VF4 introduction until now? Why?
8. What is your opinion on sport performance improvements and connection to technological innovation?
9. How do you envision the future of running footwear?
10. What opportunities and challenges are there to future product development and performance improvements in running?
11. How do you believe the WA regulations impact the future of Running in terms of: Sport? Performance improvements? Training regime?

Appendix 4 – Global Running Footwear Industry Demographics

Global industry value 2019	US$ 13,166.2 Mn
Projected global industry value 2029	US$ 18,861.9 Mn
Industry CAGR	3.9%
Top application type value	Men's Running Footwear, US$ 6,129,3 Mn
Top application type CAGR	Men's Running Footwear, CAGR: 4.4%
Top product type	Maximalist shoes: 37.2% of revenue shares
Top region	North America; US$ 4,532.9 Mn

Data retrieved from: Market (2020).

Appendix 5 - Table of Significant Events and Innovative Milestones within Running Footwear Industry Development

Year	Manufacturer	Model	Technology introduced/utilized
1960	New Balance	NB Trackster	Rubber ripple outsole, first distance running shoe with cushioning
1968	Onitsuka Tiger	TG-4 Marathon	Flexible barefoot feel
1968	Onitsuka Tiger	Bangkok Road Runner	Built-up heel & foam rubber midsole
1968	Onitsuka Tiger	Onitsuka Tiger Cortez	Sponge-rubber midsole & 2nd layer of wedge-shape cushioning
1972	Nike Inc.	Nike Cortez	Sponge-rubber midsole & 2nd layer of wedge-shape cushioning
1973	Nike	Nike Waffle Trainer	Waffle lugged grip & flex outsole
1977	Brooks	Vantage 1	EVA air-infused midsole foam & pronation motion control wedge
1978	Nike	Nike Air Tailwind	Air technology in midsole
1981	Nike	Nike Terra T/C	Phylon foam (compressed EVA foam)
1983	Nike	Nike Pegasus 1	Forefoot air cushioned midsole
1984	Asics	Asics Tiger X-Caliber GT	Plastic medial post for pronation control
1986	Asics	Asics GT-II	GEL foam midsole
1987	Nike	Nike Air Max 1	Visible air technology
1987	Asics	Asics Gel Lyte	Lightweight stability performance
1989	Adidas	Adidas ZX8000	Torsion stability bar system
1996	Nike	Nike Air Rift	Split toe box, ‘barefoot feel’
2004	FiveFingers	Vibram FiveFingers	Rubber lug outsole, ’barefoot’ look with minimal cushioning
2004	Nike	Nike Free	Minimalist cushioning & foot strengthening tool
2005	Adidas	Adidas 1	Built-in computer & pressure sensor
2006	Nike & Apple	Nike+	Built-in mileage & pace tracking pod

2008	Adidas	Adizero Adios	Lightweight cushioned versatile racing flats.
2010	Hoka One One	Bondi	Maximum cushioned midsole
2010	Saucony	Saucony Kinvara	High cushioning & low heel-to-toe drop
2011	Altra	The Instinct	Zero-drop
2012	Nike	Nike FlyKnit Racer	Knitted upper material
2013	On Running	Cloudracer	Niche midsole design innovation
2013	Adidas	Adidas Energy Boost	'Boost' (TPU) Responsive foam introduced
2015	Saucony	Triumph ISO, Guide	'Everun' Energy-return foam introduced
2015	Adidas	Adidas UltraBoost Parley Uncaged	Midsole from 95% recycled plastic
2016	New Balance	NB Zante Generate	3D printed midsole
2016	Adidas	Adidas PureBoost X	Upper detached from midsole
2017	Nike	Nike Vaporfly 4%	ZoomX (PEBAX) foam & Carbon Fiber Plate infused midsole
2017	Adidas	Adidas Futurecraft 4D	Futurecraft 4D Digital Light Synthesis (Oxygen & Light craft technology)
2019	Nike	Nike Vaporfly Next%	VaporWeave: light & breathable upper material construction ZoomX midsole & carbon fiber plate
2020	Nike	Nike Alphafly Next%	AtomKnit: Extremely lightweight & minimal water absorption material upper. Forefoot airpods for energy return coupled with ZoomX midsole & carbon fiber plate
2020	Adidas	Adidas Adizero Adios Pro	Lightweight & breathable Celermesh upper sock-like construction Carbon fiber infused 'energy rods' & heel plate Lightstrike (TPU) midsole foam
2019	Hoka One One	Carbon X	Responsive EVA midsole foam, carbon fiber plate
2020	Asics	Metaracer	FlyteFoam (cellulose) responsive

			midsole foam, carbon fiber plate
2020	Saucony	Endorphin Pro	PWRRUN (PEBA) responsive midsole foam, carbon fiber plate
2020	New Balance	FuelCell RC Elite	FuelCell (nitrogen infused TPU/EVA) responsive midsole foam, carbon fiber plate
2020	Brooks	Hyperion Elite 2	DNA Flash (nitrogen infused) responsive midsole foam, carbon fiber plate
2020	On Running	Cloudboom	Helion (EVA) foam, carbon fiber plate
2021	The North Face	Vective Flight (Trail)	Rocker shaped midsole, carbon fiber plate

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF SERVICE MANAGEMENT AND LOGISTICS
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden
www.chalmers.se

CHALMERS
UNIVERSITY OF TECHNOLOGY