

INNOVATE OR PERISH:

NEW PRODUCT DEVELOPMENT AS A KEY DOMAIN
OF OPERATIONS MANAGEMENT

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INNOVATE OR PERISH:

NEW PRODUCT DEVELOPMENT AS A KEY DOMAIN OF OPERATIONS MANAGEMENT

Inaugural Lecture

Spoken at the acceptance of the Chair of Operations Management
at the Nyenrode Business University on August 27th, 2015.

By Prof. dr. Bo van der Rhee

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DEAR READER

In an attempt to make this written version of my inaugural lecture as enjoyable a read as possible, I have made extensive use of footnotes and endnotes rather than the more academic referencing style. Feel free to ignore these notes on your first (or second) read-through, but if you are interested in finding out more about a particular topic, rest assured that the information is available at your fingertips in the form of websites, textbooks, managerial books, Master's Theses, and academic articles.

Bo van der Rhee, Ph.D.

Professor of Operations Management

PS: I also refrained from showing any mathematics in the remainder of this work, but just in case you were wondering, here are those belonging to Figures 1, 2, and 7.

Figure 1: The coordinated supply chain profits, $\Pi_{sc}^c := p \cdot G_D(Q^c)$ with $Q^c := (F_D)^{-1}((p - \bar{c})/p)$ are lower than the decentralized supply chain profits $\Pi_{sc}^d := (W_2^d + c_1 - \bar{c})p \cdot G_D(Q^d)$, with $Q^d := (F_D)^{-1}((p - c_1 - W_2^d)/p)$.

Figure 2: The total safety inventory costs can be minimized as follows: $\text{Min}_{s_i} T = rz_{1-\alpha} \sum_{i=1}^N c_i \delta_i \sqrt{s_{i-1} + w_i - s_i}$, subject to: $s_i - s_{i-1} \leq w_i$ and $s_i \geq 0$. If stage i is not a fan-out point then stage i holds inventory ($s_i = 0$) if and only if: $s_{i+1} = w_{i+1}$ or $s_{i+1} = 0$ and $\frac{c_{i+1}}{c_i} > f\left(\frac{w_{i+1} - s_{i+1}}{s_{i-1} + w_i}\right)$, where $f\left(\frac{w_{i+1} - s_{i+1}}{s_{i-1} + w_i}\right) = \left(\sqrt{1 + \frac{w_{i+1} - s_{i+1}}{s_{i-1} + w_i}} + \sqrt{\frac{w_{i+1} - s_{i+1}}{s_{i-1} + w_i}}\right)$. If stage i is a fan-out point, then the latter changes to $\frac{c_{i+1}}{c_i} > \left(\frac{\sigma_{12}}{\sigma_1 + \sigma_2}\right) f\left(\frac{w_{i+1} - s_{i+1}}{s_{i-1} + w_i}\right)$.

Figure 7: in the expanded differentiated duopoly, the optimal prices, quantities and resulting profits for the new (N) and the original (O) product, are given by $p_N = \frac{2(1+c_N)-m_O-k+2e(1-k)}{4-k}$; $q_N = \frac{(2-k)m_N-m_O+2e(1-k)}{(1-k)(4-k)}$; $\pi_N = (1-k)q_N^2$ and $p_O = \frac{2(v_O+c_O)-km_N-kv_O+ek(1-k)}{4-k}$; $q_O = \frac{(2-k)m_O-km_N+ek(1-k)}{k(1-k)(4-k)}$; $\pi_O = k(1-k)q_O^2$.

INTRODUCTION

Rector Magnificus,

Dean,

Colleagues and former colleagues,

Students and alumni,

Members of the business community,

Family and friends,

And all other members of the audience who have shown an interest in the topic of this inaugural lecture by coming here today,

I have always liked order. For example, when I eat dinner, I separate the food and eat one bite of each type at a time. I am a total control freak. For example, the only place where I can truly, completely relax, is in an airplane where I know that my actions have absolutely zero effect on my survival. I have always been trying to find patterns and symmetry in seemingly random configurations. For example, the total number of words in this written inaugural lecture is 8879, which is my date of birth. I always strive for efficiency in everything I do. For example, I always take something that needs to go up or down when I go up or down the stairs. Yes, I have fallen down the stairs on several occasions, but clearly efficiency beats safety.

Since Operations Management is all about order, patterns, and efficiency, it is only logical that I became a Professor of Operations Management. And yes, being a control freaks was a prerequisite. But what exactly is Operations Management? And is it important for companies? And if so, is it important that Operations Management research is conducted? It is these questions that I address in my inaugural lecture.

Every company needs accountants to establish how much profits were made, financiers to ensure there is enough capital, organization behaviorists to make sure all employees are happy, strategists to steer the company in the right direction, and lawyers to protect the company's interests. Furthermore, as a society we need economists to tell us how we are doing as an industry, country, or even continent. However, in the end, every company needs to do just one simple thing: produce goods and deliver services¹ that its customers want. This is true whether the company is public or private, a multinational or a start-up, for-profit or not-for-profit, and B2B or B2C and whether the customers are consumers, guests, passengers, clients, users or buyers.²

For all of these types of companies and customers, Operations Management is vital since it is this discipline that takes inputs and transforms them into outputs in the most effective way. Marketing plays a critical role here as well in determining what the customers actually want and perhaps in shaping those desires. Therefore, I am lucky to be a member of the Center for Marketing & Supply Chain Management. Before I continue, it seems prudent to clearly distinguish Supply Chain Management and Operations Management.

¹ Collectively called "products" from now on.

² Notice that I take a broader perspective here than in Goldratt & Cox (2012) who state that the goal of a company is to make money; Goldratt, E. M., & Cox, J. (2012) *The Goal: a Process of Ongoing Improvement*, North River Press

OPERATIONS MANAGEMENT

According to MIT: “Operations Management deals with the design and management of products, processes, services and supply chains.”³ Within Operations Management, different domains can be identified, such as: project management (i.e., PERT/CPM),ⁱ inventory management (including e.g., the economic order quantity, MRP and ERP systems),ⁱⁱ capacity planning,ⁱⁱⁱ quality management (Six Sigma),^{iv} lean operations,^{4v} and supply chain management,^{vi} as well as tools and techniques such as forecasting,^{vii} optimization,^{viii} simulation,^{ix} decision analysis,^x and queuing.^{xi}

So what is the difference between Operations Management and Supply Chain Management? Basically, it is this: in Operations Management we try to do all of the above for a single company, while in Supply Chain Management we consider both up- and downstream supply chain partners. This follows the simple logic that the output of one company, for most companies, is the input for another company and vice versa.

For example, when a single company optimizes its order quantity when facing stochastic demand, it might decide to order too few units, which means that the other stages in the supply chain face higher cost. Through *collaboration*, the supply chain can be *coordinated*, such that the total costs can be minimized, for example by applying a revenue sharing contract (see Figure 1). As long as the proposed contract is incentive compatible, where each stage can reap the benefits of this collaboration, (also called the “win-win outcome”), all stages should *cooperate*.⁵

³ See <http://mitsloan.mit.edu/omg/om-definition.php>

⁴ The LEArN center at Nyenrode was opened by Jim Womack from Womack, J. P., Jones, D. T., & Roos, D. (2007) *The Machine that Changed the World*, Free Press

⁵ See for example Van der Rhee, B., Veen, J. A. A. van der, Venugopal, V., & Nalla, V. R. (2010). A new revenue sharing mechanism for coordinating multi-echelon supply chains, *Operations Research Letters*, 38(4), 296-301, and for a more managerial version: Van der Rhee, B., Schmidt, G., Veen, J. A. A. van der, & Venugopal, V. (2014). Revenue-sharing contracts across an extended supply chain, *Business Horizons*, 57(1), 473-482

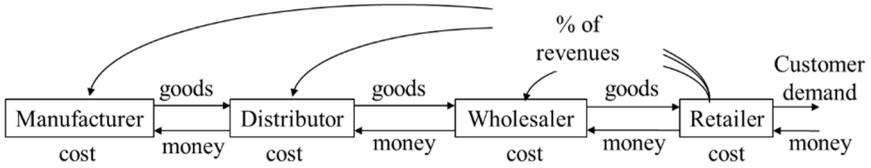


Figure 1: in a spanning revenue-sharing contract the retailer shares a percentage of its revenues with the upstream supply chain partners (from Van der Rhee et al., 2010)

Now consider another example, where the decision needs to be made of where to hold safety inventory in a similar setting with stochastic demand (see Figure 2) for two related products that can be manufactured up to a certain fan-out point as a generic product. If each stage operated in isolation, too much safety inventory would be kept, unnecessarily increasing the overall costs. A coordinated decision is also important here, but here is the twist: this situation could also describe a process with multiple steps within a single company, which brings us back to Operations Management.

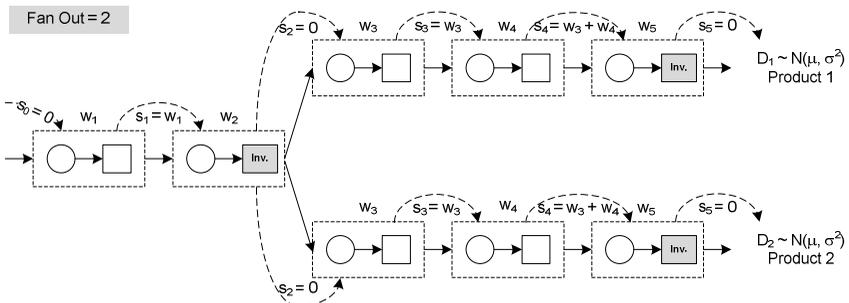


Figure 2 – A five-stage supply chain configuration with a fan-out point and inventory at stages 2 & 5 (from Van der Rhee et al., 2015)

NEW PRODUCT DEVELOPMENT

Now let us turn to one more domain, which is going to be the focus of the remainder of my inaugural lecture: new product development.^{xii} First of all, allow me to discuss why we should be interested in this domain. New products offer many advantages to companies: a possible gain in market share, first mover advantages in shaping customer expectations, and new products generally generate higher profit margins than existing products. Furthermore, on average 30% of a company's revenues come from products introduced within the last three years. This percentage is even higher in industries with a higher clockspeed,⁶ with tech-giant Apple for example at roughly 60%, and somewhat lower for industries with a lower clockspeed, such as commodity companies.

Secondly, why are we interested in research in this domain? Companies apparently realize that new products offer all these advantages and already realize on average 30% of their revenues from new products. Can't we just leave this domain up to the industry to figure out on their own? The short answer is no: new products fail more often than they succeed: "a typical supermarket introduces more than 5,000 new products to its customer base every year, and as many as 80 percent of those products are commercially unsuccessful".⁷

Management Scientists then look at this and first try to explain the past, for example by categorizing the different types of new products and determining which type was more appropriate for which firm at which time. Once the past is explained, and the present understood, the next step is to predict the future, and possibly even change the future for the better. In other words: plenty of room for research into how new product development works and how it can be improved.

⁶ Fine, C. H. (1999) *Clockspeed: Winning Industry Control in the Age of Temporary Advantage*. Basic Books

⁷ Boyer, K., & Verma, R. (2009) *Operations and Supply Chain Management for the 21st Century*. Cengage Learning

Thirdly, why look at new product development through an Operations Management lens? Some might argue that all innovation related issues, thus also new product development, belong solely to the Marketing discipline. As my Marketing colleagues are so fond of shouting at the top of their lungs: “Innovate or die!”⁸ While I agree that new products often fail because they are based on poor market research and as such leave plenty of room for research from the Marketing discipline, I will argue that Operations Management plays at least as important a role in new product development. Furthermore, it is the collaboration between these two disciplines that are required for successful new product development.

My first argument is that while Marketing might be the driving force in determining and shaping what customers want, when it comes to the actual development of new products, it is up to the engineers to deliver. Most Operations Managers have a background in engineering, and in fact, the whole Operations Management discipline was started by engineers who realized that their skillset was uniquely suited to fulfill a new need, namely transforming inputs into outputs in the most efficient way. For example, note that the before-mentioned innovation tech-giant’s appointed their former Chief Operations Officer as the CEO after the marketing genius passed away. Thus, Operations Management clearly plays a crucial role in the development of new products. My second argument is even stronger: since I am the only one talking for the next little while, I will by definition be unopposed in my view.

So by now I have established that new product development is important for companies, research into new product development is valuable, and Operations Management plays a crucial role in new product development. So what is new product development exactly? The Product Development and Management Association defines Product Development in their Toolbook for New Product Development as “The overall process of strategy, organization, concept generation, product and marketing plan creation and evaluation, and

⁸ There is a similar proverb in academia that goes like this: “Publish or perish”. The title of this inaugural lecture is an amalgamation of both of these.

commercialization of a new product”.⁹ In my lecture, I will initially assume that the company’s strategy related to new product development is fixed, and that the organization of the different departments is also out of scope. As such, I will predominantly focus on the new product development itself, from concept (or idea) generation, to commercialization of the new product.

One useful framework to consider these different stages in the new product development cycle, is the Stage-Gate® system as developed by Cooper,¹⁰ as shown in Figure 3. It starts with the idea generation, and only moves to stage 1, scoping, if it passes the first gate, the idea screen, which I will discuss in more detail later. The idea is then carried forward through the subsequent stages, where increasing resources are required, but only if the idea can pass through each gate. At each stage there should be some interaction with the market to determine if the, possibly changing, customer demands are still met. The funnel represents the decreasing number of ideas as the stages continue, and Cooper posits that the gates should be very discriminatory. He calls this “gates with teeth”. This to avoid the “sunk cost fallacy”¹¹ of sticking with a project because so many resources were already spent on it, that it would be painful to not see the project to completion, even if the expected pay-off from now on is negative. Therefore, Cooper also calls this “drowning some puppies”.

⁹ Belliveau, P., Griffin, A. & Somermeyer, S. (2002) *The PDMA Toolbook for New Product Development 1*. John Wiley & Sons

¹⁰ Cooper, R. G. (2011) *Winning at New Products: Creating Value through Innovation*. Basic Books

¹¹ See for example the Cambridge Dictionaries, <http://dictionary.cambridge.org/dictionary/business-english/sunk-cost-fallacy>

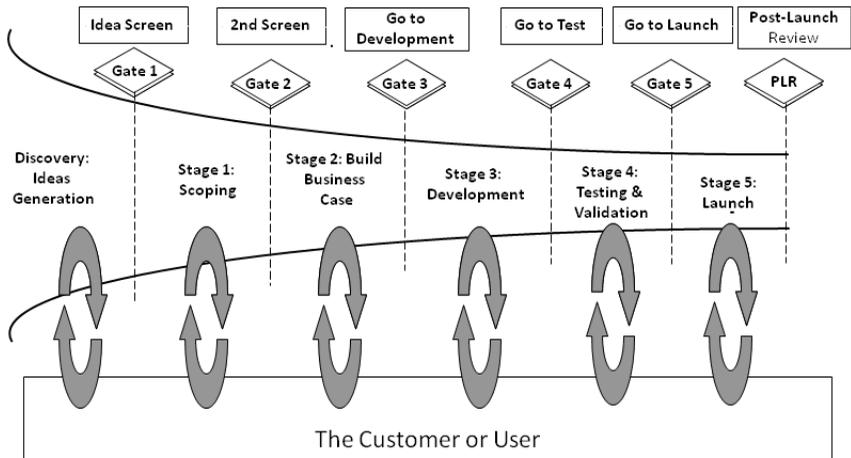


Figure 3 – the Stage-Gate® System (from Cooper, 2011)

The idea generation stage has long eluded researchers and industry alike: where do good ideas come from and how can we improve this process? The idea generation stage is therefore also referred to as the “fuzzy front end”.¹² However, some headway has recently been made in this area. For example, Griffin, Price and Vojak¹³ have identified the key characteristics of Serial Innovators, people who consistently come up with breakthrough innovations. One of these characteristic is that these serial innovators are most often engineers who are intimately familiar with the technology required for the breakthrough innovation, and are also deeply fascinated with the customer’s needs and desires. In other words: a perfect mix of Marketing and Operations Management skills.

¹² See for example a chapter in *The PDMA Toolbook for New Product Development* as mentioned in the footnote on the previous page, which can be found here:

http://web.stevens.edu/cce/NEW/PDFs/FuzzyFrontEnd_Old.pdf

¹³ Griffin, A., Price, R., & Vojak, B. (2012) *Serial Innovators: how individuals create and deliver breakthrough innovations in mature firms*, Stanford Business Books

Furthermore, the process of idea generation has been structured by Christian Terwiesch and Karl Ulrich.¹⁴ They posit, similar to Cooper, that the multitude of ideas should be screened in order to identify the best one. They have developed a Darwinator¹⁵ for this purpose, which can assist in identifying the best idea. One interesting insight is that while variability is generally conceived as a bad thing in Operations Management,¹⁶ in the idea generation stage of new product development, variability should be embraced. Consider this: if all ideas are average, then by definition no truly great ideas will be put forth, while with greater variability in the ideas, some truly awful ideas will emerge, but also some truly great ones. To demonstrate that there is nothing as practical as a good theory, Karl Ulrich runs a product design and development class, which delivers one actionable innovation every course, such as the Terrapass¹⁷ and the Xootr.¹⁸ Ulrich also runs one of the most successful Massive Open Online Courses on Coursera,¹⁹ once again underlining the importance of and interest in new product development.

So now we know the “who” and “how” concerning the idea generation of new products, and we have a system that allows us to move these ideas through the different stages until they can be introduced. That brings us to the actual introduction of new products: are all new products essentially the same? Or are there different types of new products? And if there are different types, how are they different and how are the different types of new products able to take away market share from existing products? It is these questions that I have been most concerned about with in my own research, but I was of course not the first to do so. In fact, there are many different ways in which we can classify new products, and I will discuss some of the most prevalent ones.

¹⁴ Terwiesch, C., & Ulrich, K. (2009) *Innovation Tournaments: creating and selecting exceptional opportunities*, Harvard Business School Press

¹⁵ See www.darwinator.com

¹⁶ See for example <http://www.supplychainedge.com/the-edge-blog/the-curse-of-variability-and-unintended-consequences/>

¹⁷ See <http://www.terrapass.com/>

¹⁸ See <http://www.xootr.com/>

¹⁹ See <https://www.coursera.org/course/design>

Note that a new product can be new from either the company's perspective, or the market's perspective. This allowed Ansoff²⁰ to make a two-by-two, something we Operations Management scholars love, back in 1957 as shown in Table 1, which includes some contemporary examples. The strategy discipline then took over and several scholars described how industries go through a period of incremental²¹ or conservative²² innovations until there is a discontinuity, also called a radical or breakthrough or competence-destroying innovation. The industry hit by such an innovation then needs some time to identify the dominant design,²³ after which the cycle starts over again with incremental innovations until there is another discontinuity. Consider for example the cell-phone industry which settled on two dominant designs after much experimentation: flip-phones and bricks. Likewise, smartphones have now settled on large multi-touch screens, while initially they also included keyboards. Recently, the strategy discipline has been far more concerned about whether the firm level or the industry level determines performance, so we'll leave them to that while we get back to more recent work in the new product development domain.

Table 1 – strategies for growth using different types of new products (based on Ansoff, 1957)

New Markets	Market Development (new to the market, but not new to the company, e.g., Apple's iPod Nano, Nintendo's Game Boy Advance SP with flip cover)	Diversification (new to the market and new to the company, e.g., Apple's first iPad tablet, Nintendo Wii with motion sensitive controllers)
Existing Markets	Market Penetration (neither new to the company or the market, e.g., different colors – Apple's iPod lineup, Nintendo's GameCube)	Product Development (new to the company, but not new to the market, e.g., Apple's first iPhone, and Nintendo's first gaming console)
Ansoff matrix	Existing Products	New Products

²⁰ Ansoff, I. (1957) Strategies for Diversification. *Harvard Business Review*, 35(5), 113-124

²¹ See for example Tushman, M. L., & Anderson, P. (1986) Technological Discontinuities and organizational environments. *Administrative Science Quarterly*, 31, 439-465

²² See for example Abernathy, W. J., & Clark, K. B. (1985) Innovation: Mapping the winds of creative destruction. *Research Policy*, 14(1), 3-22

²³ See for example Anderson, P., & Tushman, M. L. (1990) Technological discontinuities and dominant designs: a cyclical model of technological change. *Administrative Science Quarterly*, 35, 604-633

RECENT WORK IN NEW PRODUCT DEVELOPMENT

Let us start with a very well-known book by Kim²⁴ and Mauborgne²⁵ called “Blue Ocean Strategy”.²⁶ In this book, they posit that there are red oceans and blue oceans: red oceans in which the competition is fierce (and mostly populated with incremental innovations), and a blue ocean in which there is hardly any competition. They lay out a method that companies can use in identifying new markets for their new products, rather than trying to expand their market share in existing markets. Nintendo of America President Reggie Fils-Aime has repeatedly gone on record²⁷ stating how they used this strategy for their new products. For example, Nintendo’s DS attracted female players and their Wii attracted the elderly, both not typically considered gaming audiences. While Kim & Mauborgne’s ideas are themselves not radically new, their way of presenting them, including the very useful strategy canvas (see Figure 4), has made this book a must-read in many MBA and MSc programs.

²⁴ Chan W. Kim provided a seminar at Nyenrode in November of 2008. At that time, he was also interviewed on the Nyenrode estate for RTL Z, see <http://www.rtlx.nl/#!/rtl-z-nieuws-210334/77efb847-cb1c-3b44-b8f1-987f12463165>

²⁵ Kim and Mauborgne were ranked 2nd in the 2011 and 2013 Thinkers50 global ranking of management thinkers, see <http://www.thinkers50.com/t50-ranking/2013-2/>

²⁶ Kim, W. C., & Mauborgne, R. (2005) *Blue Ocean Strategy: how to create uncontested market space and make the competition irrelevant*, Harvard Business School Press

²⁷ For example, see <http://www.ioystiq.com/2011/03/28/reggie-fils-aime-on-the-competition-and-what-it-means-to-be-a-g>

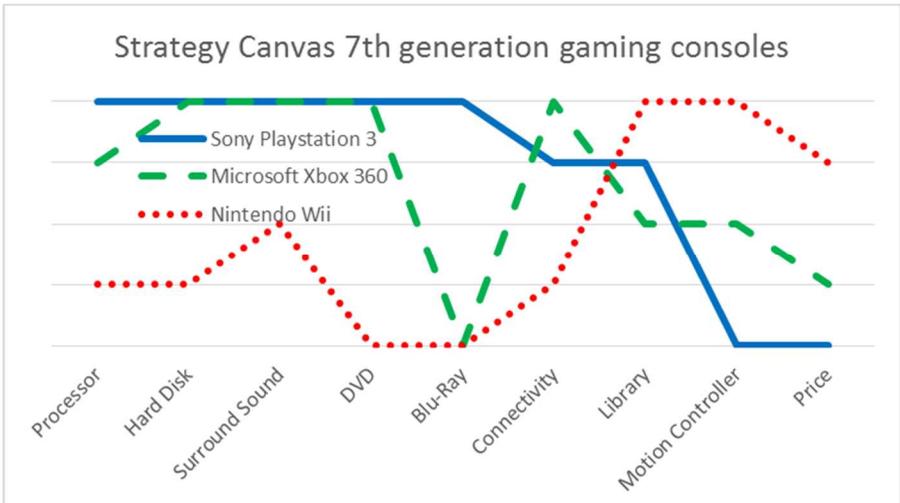


Figure 4 – the strategy canvas for the 7th generation of gaming consoles
(based on Kim & Mauborgne, 2005)

However, the most influential scholar in the area of innovation of the last decennia is undoubtedly Clayton Christensen,²⁸ who stormed on the scene with an international best-seller called “The Innovator’s Dilemma”.²⁹ He coined the term “disruptive innovation”,³⁰ which is probably the most used and misunderstood term in new product development today.

Allow me to explain: imagine a market consisting of two segments – a “high-end” segment and a “low-end” segment, the latter with a lower need for performance than the former. There is a current technology, which might not even meet the performance needs of the high-end segment, but since it is the best there is, both the high-end and the low-end segment purchase products with this technology.

²⁸ Christensen is ranked 1st in the 2011 and 2013 Thinkers50 global ranking of management thinkers.

²⁹ Christensen, C. (1997) *The Innovator’s Dilemma*, Harvard Business School Press

³⁰ He first called it a “disruptive technology”, but later made it more general.

Over time, the technology increases in performance at a faster rate than the customer needs, which also increase over time as shown in Figure 5. Then a new technology comes along, which has a lower performance than the original technology. His typical example is of the disk-drive industry: the new technology delivers a disk-drive with a lower capacity. However, the newer technology does something new, which in the disk-drive industry was simply that the new disk-drive was smaller, which allowed it to fit easier in smaller computers. This “something new” is generally associated with something the low-end customers appreciate, such as ease-of-use. In addition, the new technology is cheaper than the original technology, and over time it also improves (perhaps even faster than the original technology, which is at this point at a later stage in its lifecycle³¹). Therefore, the lower-end segment will switch to purchasing the new technology once it meets their needs. At this point, the market gets disrupted.

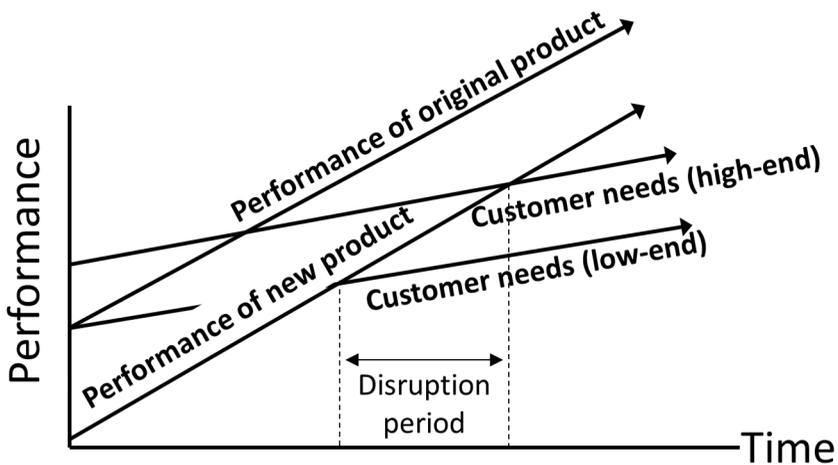


Figure 5 – how a new product can disrupt the market (based on Christensen, 1997)

³¹ See for example Kotler, P. (2000) *Marketing Management, Millenium Edition*, Prentice-Hall, Inc., as available here: http://dl.ueb.vnu.edu.vn/bitstream/1247/2250/1/Marketing_Management_-_Millenium_Edition.pdf Discussion on the product lifecycle starts in chapter 9, page 171

Here is what Christensen means by “disrupted”: the company that sells the original technology (referred to as the “incumbent”) usually doesn’t even mind that they lose their low-end customers, because they are the ones with the low profit margin anyway. However, as the new technology improves, even the high-end customers will eventually switch: the original technology is now offering a performance that only the highest of the high-end customers require, while the new technology is good enough to satisfy most customers’ needs and is of course cheaper than the original technology. This is how eventually the new technology, usually offered by a different company than the original company (referred to as the “entrant”), can push the old technology, and with it the former market leader, out.

There are many examples of where this disruption occurred: calculators disrupted slide rules, fluorescent lightbulbs disrupted incandescent lightbulbs, and are in turn now being disrupted by LED lights, cellphones have disrupted landlines, electric cars are (very slowly) disrupting gasoline cars, and *The Innovator’s Dilemma* was also touted by Nintendo of America’s president Reggie Fils-Aime in the same breath as the *Blue Ocean Strategy*.

So what exactly is the innovator’s dilemma? As companies innovate, they tend to listen to what their current customers want. And what their current customers want is more of the same, which leads to sustaining innovations (which could also be called incremental or conservative). As such, incumbents are blindsided by these disruptive innovations introduced by entrants.

So what is the solution? For that, all you need to do is read “The Innovator’s Solution” by, you guessed it, Christensen and Raynor.³² Here is a hint: the incumbent should set up a separate division that acts as an entrant, and companies have started doing exactly this.³³

³² Christensen, C. & Raynor, M. (2003) *The Innovator’s Solution*, Harvard Business School Press

³³ See for example this Deloitte report on an Australian bank (pages 18-21):

http://www2.deloitte.com/content/dam/Deloitte/au/Documents/Building%20Lucky%20Country/Deloitte_au_technology_digital_disruption_harnessing_the_bang_2014.pdf

As such, Christensen has certainly done what we can expect from a Management Scientist: he described what happened in the past, and through his theory of disruption he has also changed the future. However, there are quite a few researchers who have some trouble with the theory of disruption. First of all, some of the examples I just provided do not conform to Christensen's definitions, and can thus be seen as anomalies. For example: the original cell phone was not at all cheaper, while the Wii was introduced by the gaming incumbent Nintendo.

But perhaps the most often heard complaint is that disruption can only be noticed after the fact and as such can possibly explain, but certainly not predict. As Danneels³⁴ pointed out in a special issue of the *Journal of Product Innovation Management* on disruption, the Disruptive Growth Fund, co-founded by Christensen, "closed less than a year later ... having lost 64% of its value ... in comparison, the NASDAQ lost about 50% of its value during that same time period." Christensen has since vehemently denied that he had anything to do with the Disruptive Growth Fund³⁵ in a reply to a scathing report in *The New Yorker* by Jill Lepore.³⁶

What Lepore wrote about the inability to predict, is actually that according to her, disruption is a circular argument: "If an established company doesn't disrupt, it will fail, and if it fails it must be because it didn't disrupt." One of Christensen's academic nemeses, Tellis, has also repeatedly questioned Christensen's work,³⁷ including the post hoc definition of disruptiveness: "...after some new technology disrupts incumbents, it will be classified as disruptive. In that case, the theory becomes circular and has no predictive value."³⁸

³⁴ Danneels, E. (2006) From the Guest Editor: dialogue on the effects of disruptive technology on firms and industries. *Journal of Product Innovation Management*, 23(1), 2-4

³⁵ See, for example, the bottom of page 2 of this Businessweek interview by Drake Bennett with Christensen: <http://www.businessweek.com/articles/2014-06-20/clayton-christensen-responds-to-new-yorker-takedown-of-disruptive-innovation>

³⁶ The report can be read here: <http://www.newyorker.com/magazine/2014/06/23/the-disruption-machine>

³⁷ See for example Sood, A., & Tellis, G. J. (2011) Demystifying Disruption: a new model for understanding and predicting disruptive technologies. *Marketing Science*, 30(2), 339-354

³⁸ See page 245 of Tellis, G. J. (2013) *Unrelenting innovation: How to create a culture for market dominance*, John Wiley & Sons

Christensen vehemently denies this post hoc assertion as well in that same special issue and just to show you how much fun it can be to read academic literature, here is an excerpt:

“I have heard many people make the mistake of post hoc definition of disruptiveness, and I correct them whenever I hear it. If Danneels or Tellis have ever read about or have heard me commit this error, I ask them to point out specifically where I have been so sloppy, and I will issue a letter of apology and retraction. The term disruptive has many prior connotations in the English language, such as “failure” and “radical,” in addition to the phenomenon to which I applied it. I fear this is why we see so much post hoc definition by the uninformed. Grove [during the keynote speech at the Academy of Management conference] proposed that the phenomenon should be labeled the “Christensen Effect” to eliminate this source of misunderstanding. Possibly we should have taken his advice.”³⁹

Regardless of all the criticism, Christensen’s work has spawned a wealth of follow-up research. Just in the special issue alone, several other authors compare their classification schemes to that of disruptive versus sustaining innovations. For example, Markides⁴⁰ discusses the difference between business model innovations which provide the same product in a different way, usually cheaper, and radical product innovations which provide truly different products. Govindarajan and Kopalle⁴¹ discuss how radical innovations (remember those?) come from a technology push, while disruptive innovations come from a market pull.

³⁹ From page 42 of Christensen, C. M. (2006) The ongoing process of building a theory of disruption. *Journal of Product Innovation Management*, 23(1), 39-55

⁴⁰ Markides, C. (2006) Disruptive Innovation: in need of better theory. *Journal of Product Innovation Management*, 23(1), 19-26

⁴¹ Govindarajan, V., & Kopalle, P. K. (2006) The usefulness of measuring disruptiveness of innovations ex post in making ex ante predictions. *Journal of Product Innovation Management*, 23(1), 12-18

Even Tellis admits that some of Christensen's ideas hold merit, and adds the S-curve of technological evolution and visionary leadership to the discussion.⁴² Finally, Slater and Mohr⁴³ overlap the decision of which type of innovation to go with a strategic decision of the company to be either a prospector that goes for new products and market opportunities, an analyzer that cautiously follows prospectors but protects their current portfolio, or a defender that stays away from major innovations and sticks with their current products and customers.⁴⁴

⁴² Tellis, G. J. (2006) Disruptive Technology or Visionary Leadership? *Journal of Product Innovation Management*, 23(1), 34-38

⁴³ Slater, S. F., & Mohr, J. J. (2006) Successful development and commercialization of technological innovation: insights based on strategy type. *Journal of Product Innovation Management*, 23(1), 26-33

⁴⁴ The *prospector, analyzer, defender* typology comes from Miles, R. E., Snow, C. C., Meyer, A. D., & Coleman Jr., H. J. (1978) Organizational Strategy, Structure, and Process. *The Academy of Management Review*, 3(3), 546-562, and can be read in full here:

<http://www.wiggo.com/mgmt8510/Readings/Readings5/miles1978amr.pdf>

THE ENCROACHMENT FRAMEWORK

Other authors, among whom I count myself, have taken a closer look at the previously mentioned anomalies regarding the disruptive-sustaining framework and have attempted to fine-tune the different types of innovations to account for these. For example, Glen Schmidt and Sheryl Druehl⁴⁵ outlined how there are three distinctly different ways in which a new product can take away market share from an existing one starting with selling to the low-end customers. They called this process of taking away market share “encroachment”. The fringe low-end encroachment type is very similar to the disruptive innovation type of Christensen, in that it underperforms on the core attribute, but offers something new that a fringe market is interested in.

Then there is the immediate low-end encroachment type, which is similar to the incremental innovations as well as Markides’ business model innovation, in that an immediate low-end product simply underperforms and is cheaper without doing anything new. Finally, there is the detached-market low-end encroachment type, where the new product is so distinct, that the initial market for it is completely detached from the original products’ market. These products tend to be much more expensive upon introduction because they can do something completely new. The typical example is the cellphone,⁴⁶ which only really started taking away market share from landlines in the last decade or so. Other examples are the microwave oven and the digital camera: both initially outperformed on the core attribute, offered something truly new, and were introduced at very high prices.⁴⁷

⁴⁵ See Druehl, C. T., & Schmidt, G. M. (2008) A Strategy for Opening a New Market and Encroaching on the Lower End of the Existing Market. *Production & Operations Management*, 17(1), 44-60 as well as Schmidt, G. M., & Druehl C. T. (2008). When is a Disruptive Innovation Disruptive? *Journal of Product Innovation Management*, 25(4), 347-369.

⁴⁶ The first handheld mobile phone was introduced by Motorola in 1983, 10 years after the first phone call on a prototype had been made by developer Martin Cooper, at \$3,995 (about \$9,500 in 2014 money), see here: http://en.wikipedia.org/wiki/Motorola_DynaTAC

⁴⁷ The microwave oven was introduced in 1947 at \$5,000 (more than \$50,000 in 2014 dollars), and was able to heat up food very quickly, while a regular oven can heat up many more different types of food (see here: http://en.wikipedia.org/wiki/Microwave_oven). The first commercially available digital camera was introduced in 1990 at \$1,000 (more than \$2,000 in 2014 dollars), and could only take

Schmidt and Druehl based their analysis on the Linear Reservation Price Curve Model, which is a visual representation of a utility function with uniformly distributed demand,⁴⁸ as developed by Schmidt and Porteus,⁴⁹ which Schmidt⁵⁰ also used to show the difference between low-end and high-end encroachment. To show this basic difference, he used the reservation prices when the new product performs better (high-end) or worse (low-end) than the original product, without offering anything new. As such, in the late 2000s, Schmidt and his co-authors had described and modeled three types of low-end encroachment, and one type of high-end encroachment.

Recall my inherent need for symmetry? If there are three distinctly different types of low-end encroachment, shouldn't there also be three distinctly different types of high-end encroachment? And just like that, the encroachment framework was born, as shown in Figure 6. In it, we distinguish new products on two factors: how their performance is on the core attribute and to what extent it offers new attributes, as compared to the original product it is compared to. This led to a two-by-three, which by definition is 50% better than all two-by-twos out there.

pictures in black and white compared to a regular camera which could take much nicer pictures in full color but these had to be developed (see here: http://en.wikipedia.org/wiki/History_of_the_camera)

⁴⁸ See for example Moorthy, K. S. (1988) Product and Price Competition in a Duopoly. *Marketing Science*, 7(2), 141-168

⁴⁹ Schmidt, G. M., & Porteus, E. L. (2000) The Impact of an Integrated Marketing and Manufacturing Innovation. *Manufacturing & Service Operations Management*, 2(4), 317-336

⁵⁰ Schmidt, G. M. (2004) Low-end and High-end Encroachment Strategies for New Products. *International Journal of Innovation Management*, 8(2), 167-191

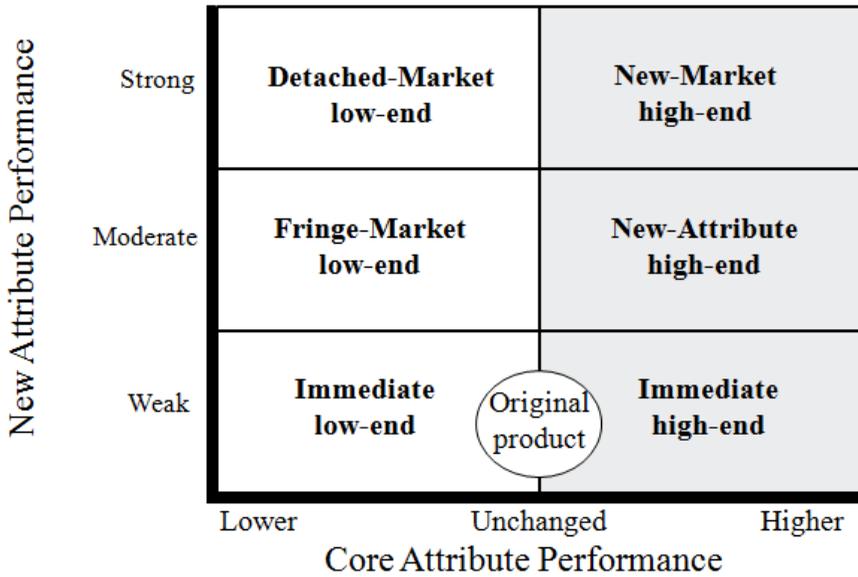


Figure 6 – Six encroachment types as determined by new product performance on core and new attribute dimensions (from Van Orden et al., 2010).

We formalized the analysis by applying the previously mentioned Linear Reservation Price Curve Model to the two additional high-end types, which we labeled the new attribute high-end and new market high-end encroachment types.⁵¹ The new-attribute high-end encroachment type is shown in Figure 7, which shows the profits (π) for both the new and the old product as a function of the reservation price curves, the prices (p), the costs (c), and the sales (q). Notice how the new attribute expands the market on the high-end with (e) new buyers who were not interested in buying this product until it offered this new functionality. Through this analysis, it can be shown that the six resulting encroachment types as shown in Figure 6 are mutually exclusive and collectively exhaustive, meaning that the encroachment framework is complete.

⁵¹ Van der Rhee, B., Schmidt, G. M., & Orden, J. van (2012). High-end encroachment patterns of new products. *Journal of Product Innovation Management*, 29(5), 715-733

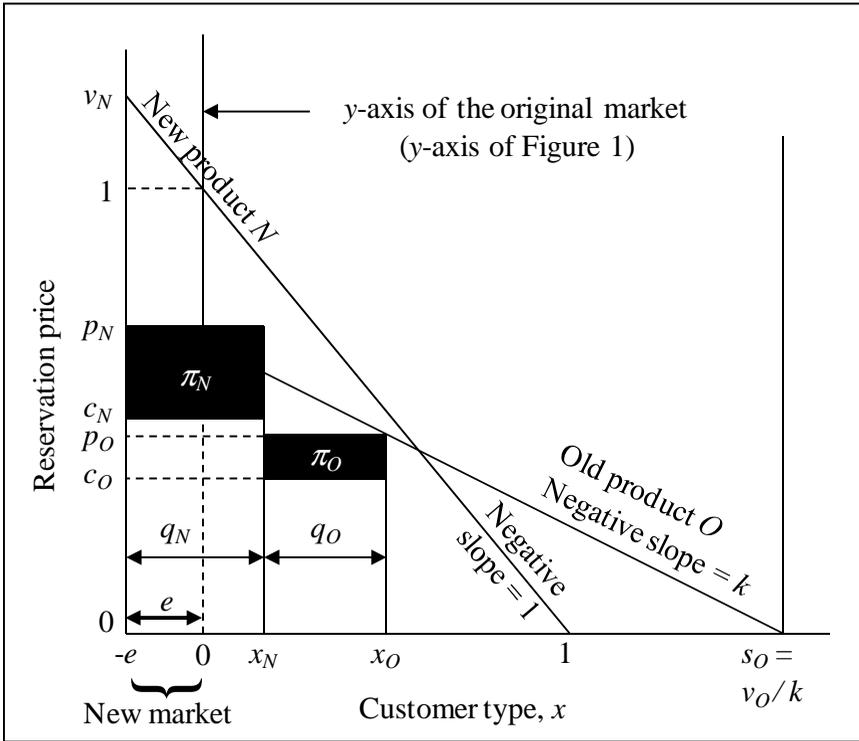


Figure 7 – the Linear Reservation Price Curve Model applied to the new attribute high-end encroachment type (from Van der Rhee et al., 2012)

We also empirically validated the framework by asking eight professors with an expertise in new product development from both Operations Management and Marketing to classify over 200 new products into one of the six types.⁵² We found that initially on average five of the eight professors agreed with our own classification, and when given a second choice, on average seven of the eight professors did. This is pretty amazing given that there are six options available for each product, which means that by random selection on average only two of them would agree. More importantly, as my academic colleagues can attest to, if you

⁵² Orden, J. van, Van der Rhee, B., & Schmidt, G. M. (2011). Encroachment patterns of the ‘Best Products’ from the last decade. *Journal of Product Innovation Management*, 28(5), 726-743

were to put eight professors in a room, you will have at least eight different opinions on any topic, even if there are only six available opinions. This is especially true when all have an expertise in the same area.

With the encroachment framework we can explain the past. For example, by applying the Linear Reservation Price Curve Model to the introduction of the iPhone, it becomes logical for Apple to decrease the price from \$599 to \$399, a one-third drop in price, after only 68 days. Initially, the iPhone was sold at a monopoly price, and continued to do so even when the new market was saturated, as shown in the first three panels of Figure 7. Thus, regular smartphone sales were not affected by the iPhone sales, until Apple dropped the price by one-third after 68 days, because at this point selling more phones at a lower price was more profitable than selling fewer phones at a higher price.⁵³

But explaining the past, and being readily understood, is not enough. We want to predict and possibly change the future by influencing what managers do. A first step in this direction was made by a recent publication in a more managerially focused journal,⁵⁴ but much work remains to be done before a special issue of the *Journal of Product Innovation Management* is dedicated to criticizing the encroachment framework...

⁵³ This can be seen by comparing the black rectangle in the lower left panel of Figure 7, representing Apple's daily profits at day 67 with the slightly larger surface of the black square in the lower right panel of Figure 7, representing Apple's daily profits at day 68.

⁵⁴ Schmidt, G. M., & Van der Rhee, B. (2014). How to position your innovation in the market place. *MIT Sloan Management Review*, 55(2), 17-20

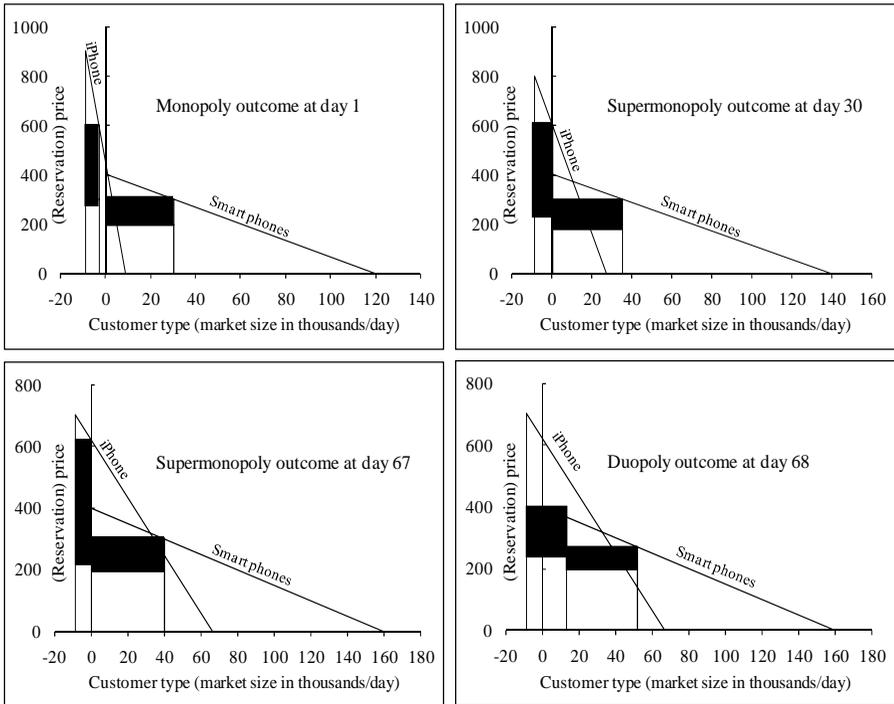


Figure 7 – the introduction of the iPhone as shown through an application of the Linear Reservation Price Curves (from Van der Rhee et al., 2012)

THE CHAIR AGENDA

This brings me to the agenda regarding my new Chair of Operations Management. First of all, you might wonder why the chair is not called New Product Development after the previous discussion. There are actually four reasons for calling it the Chair of Operations Management. First of all, I have demonstrated that Operations Management is a vital discipline for any company and that it has many different domains. From that perspective I will continue to work with Nyenrode students on their Master's Theses and Final Projects on all these different domains. The focus will be on combining academic rigor with managerial relevance, something that is not only top of mind at Nyenrode, but also within the wider Operations Management community.⁵⁵

A second reason for Operations Management is that the Chair's focus will initially be on two domains: in addition to new product development, the Chair will focus on supply chain optimization. In the beginning of my inaugural lecture, I briefly discussed two examples in this domain. The Chair will allow me to expand this research stream, in collaboration with national as well as international colleagues.

A third reason for Operations Management is that my Ph.D. from the University of Utah is in Operations Management, so it seems logical to continue in that direction. My dissertation already focused on new product development, which I have demonstrated to be at the interface of Marketing and Operations Management, and I will use this Chair to expand this research area. Research is currently being conducted on the idea generation phase, the Stage-Gate® system, disruption, the encroachment framework, and mass customization. I am looking forward to working with colleagues from both academia and the industry, as well as attracting Ph.D. students to this exciting field of research.

⁵⁵ For example, Professor Luk van Wassenhoven, the 2011-2012 Production and Operations Management Society President, mentioned in his inaugural address: "Relevance means developing the confidence to look at messy real world problems, and to avoid the separation between academic subjects and industrial practice." The complete article can be read here: www.poms.org/POMS%20Chronicle%20Vol%2018%20No%201%20Final.pdf

A fourth and final reason for Operations Management is that the Nyenrode Business University did not have a Chair of Operations Management yet. Given that Operations Management has so many different domains, the Chair will allow me to not only expand the research into supply chain optimization and new product development, but also to branch out to new developments in the field. As the world changes, and research not only explains how managers make decisions, but also influences managers to make different decisions, research in this exciting discipline will never be done. To quote one of my favorite artists: “The only constant I am sure of, is this accelerating rate of change.”⁵⁶

To summarize, Operations Management is a vital discipline for any company, the different domains of Operations Management are constantly developing, and research into Operations Management is exciting and continuously changing. I am grateful for being allowed the opportunity to develop the Chair of Operations Management with current and new colleagues, both nationally and internationally, and doing so in such exciting times both academically as well as in the industry.

⁵⁶ From “Downside up”, track 10 on OVO by Peter Gabriel.

ACKNOWLEDGEMENTS

That brings me to the last topic of my lecture, namely a few words of thanks to the people who have made it possible for me to stand here today. First of all, the rector Miša Džoljić, the Dean Leen Paape, head of faculty Roberto Flören, and former Director of Research Roland Speklé for their support and trust to allow me to become the youngest Nyenrode full professor (at least for now). Willem Burggraaf also deserves a special note of thanks for his role as Chair of my Appointment Advisory Committee as well as the members of said committee.

I would also like to thank all the students who I have had the privilege of teaching and advising since joining Nyenrode in 2007, some of whom are here today to celebrate this day with me. I can only hope that you have learned as much from me as I have learned from you. A special note to Robert de Lange, Ilya Samoilovich, Joost Oosterveld, Martijn van Doesburg, and Simon Schippers who were not only excellent thesis students, but are now also my co-authors. Also a special thanks to Jan van Steenderen who was convinced that I should be a full professor before I even started considering it.

Next a big thank you to all the colleagues in our Center for Marketing & Supply Chain Management who have made me feel welcome from the start and still support me to this day: Vijay Reddy Nalla and Loes van Kempen for showing me the ropes, Marie-Joelle Browaeyns for her always positive attitude, Edward Groenland for his extreme and refreshing objectiveness, Henry Robben for his perfect big brother role, Jack van der Veen and Venu for their keen insights and true cooperators in everything from teaching to research, Arie Buijs, Rim Posthumus, and Jan Wijbenga for their brotherhood in numbers and for being the only ones to attend my Randumbness stand at Nyenrode's 65th anniversary, and Tanja Winthouwer for her awesome support, most notably with the Academic Brown Bag Presentations. A special thank you to Kitty Koelemeijer for first sheltering me from the Nyenrode storm and then unleashing me when she believed I was ready. Perhaps she should have checked whether Nyenrode was ready for me as well...

I would be remiss if I did not also thank some wonderful colleagues from outside our center: Hanneke Beijer and Rilana Tobben for making my job as Chair of the Exam Committee a relative breeze. Without them, it would be impossible. Edgar Karssing for his great comradery and quest to always fight for the students' interests by looking for the spirit rather than the letter of the rules. And Jan Morsch for his ability to discuss video games, movies, and football with me while he is supervising 20+ Master's Theses. I hope we will share many more rides to and from Nyenrode!

A huge thank you also goes to my fellow musketeers Rob Blomme and Ivo de Loo who went through the apprenticeship for full professor with me. Without your help, support, sense of humor, ability for finding the right perspective, and altogether awesomeness, I am sure I would not have made it to this podium. I am truly grateful that I have got to know you better these past couple of years, and I wish you both all the best in your well-deserved roles as Full Professors.

Of course, a final academic thank you has to go to my co-promotors Rohit Verma, Cornell Hotel School and Glen Schmidt, University of Utah. If Rohit had not asked to consider a Ph.D. by asking me two pivotal questions, I would not stand here today. I still remember them from our lunch in the Crimson View restaurant, in May of 2002: "Do you like solving puzzles?" and "Do you like creating puzzles before solving them?" As described in my introduction, I am exactly such a nerd, and I applied for my Ph.D. the next semester. Our continued collaboration in teaching and research is a true joy which I hope we can continue for a long time. And the time between Amita Verma's well intentioned admonishments is always too long.

For Glen Schmidt, my words are perhaps not good enough. Actually, he usually Word-Schmidt's the last version of our manuscripts before we submit, so perhaps I should have just had him write his own thank you words. I did consider going over all 23f versions of our first publication to show his true dedication to perfection in our research projects, but even that would not do his intellect justice. I truly cherish how we work together, especially when we crank out several versions in one 24 hour cycle while being on opposite ends of the earth. A huge thank you also to Marie Schmidt for allowing me to stay with you over extended periods of time and for allowing me to throw not one but two parties at your house over the years!

To all my friends, who I have known since high school, and their wonderful girlfriends and wives that have joined our band of brothers over the years, I can only say, from the bottom of my heart: thank you for all the parties, the local and international trips, the vlaai run, the movie nights, the pool evenings, the barbeques, the shoarma feasts, the jam sessions, and your extreme willingness to collectively come all the way to Stockholm, Maine for an unforgettable time. I am truly grateful that even with the increasing number of little ones, we still share so much quality time together. I am looking forward to many more shenanigans, as long as whatever happens in Germany, stays in Germany. And a special note to the wonderful girlfriends and wives: don't worry, nothing ever happens in Germany... And to my Crossfit comrades I say: let us continue to get Faster, Stronger, and Fitter!

Now for the hard part: my family. First a huge thumbs up to all my generation companions and their significant others: my little big brother Joeri and his wife Jolanda, my sister Maaiké and her boyfriend who I am yet to meet, my cousin Isis and her husband Jon, my cousin Melvin and his wife Linda, my cousin Daan and his girlfriend Merel, and my cousin Catalina and her boyfriend Sem. It is truly awesome to see how each of you are enjoying life to the fullest. I hope all your current and possibly future children enjoy each other's love as much as I have enjoyed yours. And last but not least my brother Merlijn, who I did not forget: I wanted to give you a huge, double thumbs up for your astonishing perseverance; I am in awe of you.

On to the parents. Caro and Cees have not really seen eye-to-eye the last couple of decades. However, they have always given me the space to develop myself, the mental and financial support to follow my dreams and they have instilled a sense of curiosity in me that has lead me to this point in my career. They have always been ready with extremely valuable (if sometimes unsolicited) advice, and they had the great foresight to marry Bert and Gepke who they, and I, get along with marvelously. I also have to thank them from the bottom of my heart for the one time that they did see eye-to-eye when I told them I was going to Utah for an exchange semester. Their independent and identical feedback was: as long as you don't fall in love and stay there for longer than one semester...

Which brings me to my true companion. Anna, you mean the world to me, and it is safe to say that without you, I wouldn't be where I am today. Rohit's questions where nice, but without the opportunity to spend additional time with you, I probably wouldn't have pursued my Ph.D., let alone in Utah of all places. Through your love for cooking healthy food and your Crossfit coaching, you don't just make me want to be a better man, you actually physically make me a better man. And to reassure you: while efficiency is great in the workplace, I have learned there is one place where it should never be applied and that is in our relationship! Anna, I love how we have grown together, and I am looking forward to many more years of mental and emotional growth.

I have spoken.

ENDNOTES

Articles, textbooks, managerial books, and Master's Theses related to the different Operations Management domains.

i Project Management

Textbook: Klasterin, T. (2011) *Project Management: Tools and Trade-offs*, Pearson Learning Solutions

Master's Thesis: Jouk Snoek & Marnix Landkroon "Hoe de kwaliteit van de samenwerking tussen de Sales- en Operations afdeling bij technische projectorganisaties de winstgevendheid van projecten beïnvloedt."

Master's Thesis: Dennis Varkevisser "Kenniss delen gedurende simultaan ontwikkelen van nieuwe producten"

ii Inventory Management

Textbook: Piasecki, D. J. (2009) *Inventory Management Explained: A focus on Forecasting, Lot Sizing, Safety Stock, and Ordering Systems*, Ops Publishing

Master's Thesis: Annique Beukman & Sanne de Hoog "The effect of eliminating underperforming SKUs on the company performance in the business to business market"

iii Capacity Planning

Master's Thesis: Simon Schippers "Logistic Network Design as a strategic tool to obtain a Competitive Advantage in Supply Chain"

iv Quality Management

Textbook: Montgomery, D. C. (2012) *Statistics Quality Control*, Wiley

Master's Thesis: Nanne van Baar & Stefan Quak "Improving operational processes in insurance companies"

Master's Thesis: Mark Lammers & Michael de Roon "On optimizing quality management systems"

Master's Thesis: Sergio Paya & Fleur Seyffert "Achieving operational excellence in post-dictatorial Iraq"

v Lean Operations

Managerial Book: Womack, J. P., Jones, D. T., & Roos, D. (2007) *The Machine that Changed the World*, Free Press

Managerial Book: Goldratt, E. M. & Cox, J. (2012) *The Goal: a Process of Ongoing Improvement*, North River Press

Master's Thesis: Burcu Ozturk & Milly Suntjens "Efficiënt en effectief zorgproces door optimalisatie van klantlogistiek in de geestelijke gezondheidszorg door toepassing van lean management"

vi **Supply Chain Management**

Article: Van der Rhee, B., Verma, R., & Plaschka, G. (2009). Understanding tradeoffs in the supplier selection process: The role of flexibility, delivery, and value-added services/support. *International Journal of Production Economics*, 120(1), 30-41

Textbook: Simchi-Levi, D., Kaminsky, P., & Simchi-Levi, E. (2007) *Designing and Management the Supply Chain*, McGraw-Hill/Irwin

Master's Thesis: Vincent Casaburi & Mark Lingeman "Determining the best ICT outsourcing contract"

Master's Thesis: Tom Claessens & Ciska Harte "Physical freight, digital information: Steps towards a worldwide paperless supply chain"

Master's Thesis: Jan-Paul de Backer & Marco Smit "E-freight: The value added services"

Master's Thesis: Maarten Keijzer "De invloed van supply chain samenwerking op de concurrentievoordelen en prestatie van het midden en klein bedrijf"

vii **Forecasting**

Textbook: Bowerman, B. L., O'Connell, R., & Koehler, A. (2004) *Forecasting, Time Series, and Regression*, Cengage Learning

viii **Optimization**

Master's Thesis: Joost Coremans & Nicolaas van Dalen "Vice versa versus linea recta"

ix **Simulation**

Article: Van der Rhee, B., Schmidt, G. M., & Tsai, W. (2015) Hold safety inventory before, at, or after the fan-out point? *Under review at Production & Operations Management*

x **Decision Analysis**

Master's Thesis: Erwin Wijntjes & Bob van Turnhout "Risk analysis in low probability, high cost situations"

xi **Queuing**

Article: Lange, R. de, Samoilovich, I., & Van der Rhee, B. (2013). Virtual queuing at airport security lanes. *European Journal of Operational Research*, 225(1), 153-165

xii **New Product Development**

Article: Van der Rhee, B., Schmidt, G. M., & Tsai, W. (2015). Pre-commit to lower quality. *Working Paper*

Article: Wang, C., Schmidt, G. M., & Van der Rhee, B. (2015). Using Stage-Gate contracts to screen an agent with inside information in new product development projects. *Working Paper*

Article: Doesburg, M., Oosterveld, J., Van der Rhee, B., & Verma, R. (2015) An application of conjoint analysis in the B2B service environment. *Working Paper*

Article: Van der Rhee, B., & Koelemeijer, K. (2015) Market conditions under which vertical mass customization is beneficial. *Working Paper*

Master's Thesis: Matthias Getto & Kyle Yu "Developing an Apparel Recycling Programme for Nike"

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