Framing and managing the categorisation and adoption of a hybrid product by its potential customers in the Dutch healthcare arena

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Framing and managing the categorisation and adoption of a hybrid product by its potential customers in the Dutch healthcare arena

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Preface

This master thesis marks the end of my ‘career’ as a student at the Eindhoven University of Technology. I carried out this last project of the master programme Innovation Management at Dolphys Medical B.V. My research focused on redesigning the current marketing strategy for the ‘expiratory ventilation assistance’ concept to make a successful expansion of the product portfolio possible. The completion of this project would not have been possible without the help of many others and I would like to express my gratitude to them.

First, I would like to thank Prof. Dr. Ed Nijssen and Dr. Ing. Joost Wouters: thank you for your constructive criticism, many useful comments, and interesting discussions throughout this project. Our meetings provided me with clear insights on how to proceed. I am happy to have been guided through my graduation project with you as my university supervisors.

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Finally and most importantly, I want to thank my parents, brothers and sister, and friends for their inexhaustible mental support. They are the ones who kept me right on track to make me really proud of the final result.

At times it was difficult to strike the right balance between academic rigour and a practical solution design for Dolphys. In the end, I can convincingly say that I added to both goals.

Simon Doomernik
Eindhoven, 18 March 2014
Management summary

High tech entrepreneurs look for product applications based on their technology to maximise their economic value and grow their business. As potential customers have never seen these products before, they do not really know what to expect from these radical innovations. In an on-going negotiation process between the high tech entrepreneur and the customer, a new product market stabilises over time. While some research has been done on this issue in B2C, research focused on B2B is very limited. Based on the above the objective of this study is to understand adoption of radical innovations with no obvious categorisation in a B2B context.

To achieve the aforementioned scientific objective a case study was carried out at Dolphys Medical B.V. Dolphys is an entrepreneurial firm that markets ventilation solutions in the field of anesthesiology. Originally, Prof. Dr. Enk identified a need for a new ventilation technology to ventilate patients with an obstructed airway more effectively and developed a first prototype. As Dolphys is responsible for the marketing and sales of Enk’s invention, it is an interesting case to illustrate clinical marketing.

The case study design followed the regulative cycle and started with a preliminary analysis to define the business problem. Three gaps could be identified in the Dolphys interaction with potential customers. First, anesthesiologists tend to misperceive ‘expiratory ventilation assistance’ (EVA) as communicated by Dolphys (gap 1). Second, anesthesiologists’ perceptions are partly formed on their expectations (gap 2). Third, Dolphys’ understanding of anesthesiologists’ expectations needs to be verified (gap 3). The main business problem was defined as follows:

Anesthesiologists’ expectations of EVA do not match with their perception of EVA, which seems to be a crucial antecedent in the adoption process, causing limited adoption and sales growth of the EVA product portfolio.

This research focus is mainly on Dolphys learning more about the adopter side in order to make their marketing activities more effective and efficient. Moreover, this research seeks to answer the following main research question:

How can Dolphys more effectively and efficiently communicate EVA’s attributes to anesthesiologists in order to at least meet their expectations?

In order to answer the main research question, a set of four sub research questions was formulated: (1) How do Dolphys’ marketing activities affect anesthesiologists’ perception of EVA?; (2) What is the effect of anesthesiologists’ expectations on how they perceive EVA?; (3) Is Dolphys’ understanding of anesthesiologists’ expectations correct?; and (4) How can Dolphys improve its marketing activities towards anesthesiologists?. Sub research questions 1-3 are posed to diagnose Dolphys’ business problem in Part I of this report, whereas sub research question 4 looks for a solution in Part II.

To answer sub research questions 1-3 and to validate and solve the business problem, a research design was set up that included two subsequent field researches. In the exploratory phase of the project ten interviews were held to determine whether Dolphys’ aim to create a new product category for EVA was valid and how the marketing mix could be used to achieve this goal. As a follow-up, a series of five in-depth open interviews was held to understand the effects of anesthesiologists’ expectations of EVA on their perception. Also, it was checked whether Dolphys’ understanding of anesthesiologists’ needs and wants is correct.

A theoretical framework that focuses on the adoption process of radical innovations guided the analysis. The main antecedents of the adoption decision include the objectively measured organisational innovation attributes and the subjectively assessed product newness, which is mainly defined by the adopter’s ability to categorise the new product in either a familiar or a new category. Furthermore, category cues like product design, product label, product claims, and product demonstration may increase categorisation certainty. In other words, these category cues are likely to activate a consumer’s cognitions and beliefs, which directly influence their expectations of the innovation. In turn, word-of-mouth, personal needs, and past experience shape consumer’s expectations. By looking at anesthesiologists’
perception and expectations of EVA, Dolphys becomes aware of the gaps that hinder its marketing activities towards anesthesiologists. The underlying idea is that by changing the ‘settings’ of these category cues, the outcomes of the adoption process can be influenced.

The analyses validated that the business problem was real and provided important insights. It resulted in a diagnosis that indicated the main causes of the business problem. First, the hypothesis that EVA was likely to be misperceived as jet ventilation has been proven false. Thus, gap 1 was not the main problem. Second, dependent on the hospital unit and subspecialisation anesthesiologists’ expectations differ. As a consequence, gap 2 became visible. Third, Dolphys’ perception of anesthesiologists as a homogeneous group is too simple, which proves the existence of gap 3.

To address the identified gaps, several directions for the solution were formulated and subsequently combined into one final solution. Next, solution directions were evaluated in relation with the solution space, which is restricted by a set of solution design requirements.

The solution consists of 6 steps, being (1) selection of the ventilation philosophy; (2) identification of the clinical target indication; (3) definition of the required product benefits; (4) evidence gap analysis; (5) definition and execution of the clinical marketing programme; and (6) exploration of strategic expansion of clinical indications.

To aid realisation of the solution, an implementation plan was developed that maps the main objectives to be achieved and expected resistance against each of these objectives. In general, resistance is expected to be low. The main source of resistance is expected to spring from a lack of understanding or difference in opinion. Clear and timely communication, both within the Dolphys team and towards distributors and potential adopters, is therefore a key success factor in implementation. Dolphys should implement the solution as soon as possible. Finally, to build social support for the solution and assure feasibility, the solution was discussed with the whole Dolphys team.

Besides providing a solution to the business problem, this study also contributes to academic literature. The theoretical analysis resulted in a framework of the organisational adoption process of radical healthcare innovations in a B2B context. The empirical analyses provided insight into the effects of four category cues (product design, product label, product claims, and product demonstration) on categorisation certainty, which is considered as an important antecedent for the adoption decision. Also, the project's rigor and practical relevance were assessed to test to what degree the project's objectives have been achieved. As this is only an N=1 study, further research is needed to test and extend the findings of this project to other high tech industries.
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1 Introduction

1.1 Background of the study

1.1.1 Scientific context

Based on new technology, high tech entrepreneurs look for product applications to maximise their economic value and grow their business. In order to identify and fulfil customers’ latent needs, they must be totally market oriented. Because high tech entrepreneurs often face rapidly changing technologies and operate in turbulent markets, a proactive market orientation is necessary for new product success. Marketing activities and the entrepreneurial process are tightly integrated in firms. Webb, Ireland, Hitt, Kistruck, & Tihanyi (p. 537) describe the reciprocal relationship between the entrepreneurship process and marketing activities as “market orientation as enhancing a firm's opportunity recognition and innovation whereas marketing mix decisions enhance opportunity exploitation”. In this study the primary focus will be on the marketing aspects, because often driven by technology these firms face a major challenge of discovering the market and developing customers. In fact many entrepreneurs fail to survive. In their meta-analysis on survival rates of new technology ventures (NTV) Song et al. (2008) revealed that the survival rate of companies with more than five full-time employees, after four years is only 36 per cent. After five years, the survival rate dropped further to 21.9 per cent. This indicates the importance to research the success factors for NTV survival.

The problem of identifying the market and customers is particularly poignant for radical innovations. These are innovations people have never seen before. As a result customers first have to learn about the new product and develop their cognitions. This also involves negotiation of the new product’s categorisation between the first, innovative customers and the provider. Together the provider and first customers create so-called market stories that enable them to interact in the market. These product markets are neither imposed nor orchestrated by producers or consumers, but evolve from producer-consumer interaction feedback effects. Both producer and consumers’ expectations of these radical technology innovations are not stabilised yet, leaving room for producers to leverage the power of consumers’ existing knowledge to help them learn (Rosa, Porac, Runser-Spanjol, & Saxon, 1999). Moreover, as technology continues to facilitate the rapid creation of innovative new products, increasing the need for an accurate understanding of how consumers perceive these products.

While some research has been done on this issue in B2C, research focused on B2B is limited (Moreau, Markman, & Lehmann, 2001). In such markets things may be more complex due to the influence and role of decision-making units at multiple levels. Matters may also be more complex for regulated markets such as healthcare/pharmaceutical industry, because of strict taxonomies for product registrations, like CE and FDA, imposed by respectively the European Union and the US Food and Drug Administration complemented with standards of the national governments of individual countries within these economic zones.

An example of a healthcare innovation in B2B is Ventrain by Dolphys. This new product concerns a ventilator that makes use of the beneficial effects of the Venturi effect. Although the technology itself is not new, the application in a ventilation device is. Since Ventrain combines attributes of both conventional ventilation and jet ventilation in one optimal solution, anesthesiologists may feel cognitive strain when trying to make sense of the new ventilation concept.

Based on the above the objective of this study is to understand adoption of radical innovations with no obvious categorisation. I will focus on the healthcare industry and the actual case of Dolphys. Next, a short overview of Dolphys' current marketing strategy and the issues the company faces today are presented.
1.1.2 Case description of Dolphys Medical B.V.

Dolphys Medical B.V.¹ is a new technology venture founded in 2004 and develops and markets scientifically proven, innovative devices for the field of anesthesiology. Because Dolphys aims at developing revolutionary medical devices, it is an interesting case for a project about anesthesiologists’ adoption of medical devices that don’t fit in their familiar product categories.

Dolphys develops and markets a new ventilation concept, officially registered as EVA² (expiratory ventilation assistance). The EVA ventilation concept allows the anesthesiologist to fully ventilate a patient with a 2 mm (transtracheal or endotracheal) catheter. Through making use of the Venturi effect active expiration is reached. To put it simply, EVA can also be defined as ‘ventilation by suction’. For more in-depth information about EVA’s working principle, please refer to Appendix 1.

The stepwise introduction of EVA in clinical practice is best explained by Dolphys’ three-step innovation chain (see Figure 1), which shows the gradually extended product portfolio. At the time of writing, Dolphys targets the emergency market with Ventrain (manual ventilator) and Cricath (transtracheal catheter), which are sold as a package in an emergency kit or separately. Ventrain was developed in close cooperation with Dr. Enk’s clinical research group from University Medical Center Maastricht (azM). For now the intended use of Ventrain is limited to emergency situations only. As a next step, the firm aims at making the transition to the difficult airway market and later on to the elective & ICU market. CNB-catheter (endotracheal catheter) and Wanda (project name for the electronic ventilator) are still in the development phase. In this project, the focus lies on the adoption of the EVA ventilation concept as a whole. In this regard, the adoption of Ventrain together with Cricath, and Wanda together with CNB-catheter can be considered as means to achieve the ultimate goal to establish a new EVA product concept category.

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¹ Dolphys Medical B.V. is the firm’s legal name as registered at the Chamber of Commerce. In the remainder of this paper, I use Dolphys as a shortened alternative name when referring to the firm as an actor or stakeholder.

² Throughout this report the abbreviation EVA is used as the official name of the ventilation concept. The term ‘ventilation by suction’ is only introduced for illustration purposes here.

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In case of the Ventrain project, there is a direct problem from a commercial perspective. The sales figures are lagging behind. The following case reported by Dolphys’ distributor for the Dutch market illustrates this problem clearly. Mathieu Van Lent, commercial director of Medica Europe (NL), with over 30 years of experience in marketing and sales of medical devices, perceived a gap between anesthesiologists’ initial enthusiasm and their purchase intention. While potential customers are found to be extremely interested in Ventrain and acknowledge its added value compared to the standard ventilation solutions offered by competitors, the purchase decision is still negative.
In order to narrow down the scope of the observed difficulties in the field the so-called 'problem mess' needs to be structured. For this purpose, a preliminary cause-and-effect diagram is developed (see Figure 2). Next, the six most important issues, which were obtained through document study and explorative open interviews with key stakeholders (CEO and product manager of Dolphys), that should be dealt with are highlighted and explained. For reasons of clarity, a distinction is made between causes by the product concept, by the adopter side, and by the supplier side of the adoption decision.

First, Ventrain is developed based upon the EVA (expiratory ventilation assistance) concept, which marks a new technology standard. Since this ventilation concept is built upon a combination of 'standard' ventilation and jet ventilation, it's still unclear to many anesthesiologists that EVA is a new stand-alone ventilation concept. They often misinterpret Ventrain as a manual jet ventilation device, which it is not. A prerequisite for adoption of innovations is a valid perception of the new product concept.

Second, Dolphys decided to solely focus on emergency (CI/CV) situations in the early development phase of Ventrain (see also Figure 1). In the long run, Dolphys also wants to apply the EVA concept in fully automatic ventilation systems in elective situations, like for example ENT-surgeries (ear/nose/throat). Although, the market size for the situation at present is small, the growth potential is enormous, when Dolphys manages to enter the elective in the future as well.

Third, Dolphys lacks insight in the organisational adoption process. The decision-making unit (DMU) in hospitals consists of a number of stakeholders, but unknown for Dolphys. It remains unclear what the actual decision criteria exactly are and what power the individual stakeholders have. At the organisational, departmental, and individual level different motivations and interests might be at stake. Since Dolphys’ ambition to expand their business to other medical specialties (specifically cardiology and ENT-surgery) than anesthesiology as well, it’s important to keep in mind that physicians from these medical specialties are likely to have different values and norms in the adoption and implementation phases. This is likely to be reflected in the speed and rate of adoption of the innovation.

Fourth, when the DMU takes the adoption of Ventrain in consideration, adjustments to the hospital's airway management protocol might be required. Whether these changes are introduced before or after adoption of Ventrain is still unknown. This may be dependent on the hospital's characteristics (e.g. size, functional differentiation) and motivation (e.g. financial, technological). When the adoption decision is positive, and EVA is implemented in the hospital's routine, there's no feedback or whatsoever about the actual use of the product. Actually, this usage information is very valuable to Dolphys, if they want to improve their EVA-concept in order to enter the much bigger elective market in the future.

Fifth, the current marketing strategy is an ad hoc process for which no guiding framework is present. Human resources are allocated to specific countries, which could ultimately lead to rework.

Sixth, marketing activities are not validated. Documentation of the marketing activities is left out and there are no requirements to provide evidence for their effectiveness. For example, Dolphys developed an instructional animation video for Ventrain, which can be found on the product’s website (www.ventrain.eu) and is also available as an application for mobile devices. The instructional animation video hasn't been officially evaluated yet. Furthermore, there's no standard format. This again points at the ad hoc nature of the process.

In conclusion, three bottlenecks regarding the situation of Dolphys and Ventrain can be identified. First, as EVA is a new technology standard in the field of anesthesiology, anesthesiologists tend to have difficulties to categorise new products, because they have never seen these radical innovations before. Ventrain is often perceived as a jet ventilator, which is in fact another product category. This possibly leads to a misperception of the product’s attributes, which could negatively affect the adoption decision. Second, Dolphys’ perception of anesthesiologists’ perceptions and expectations of EVA might be incorrect. In
the past Dolphys may have relied too much on only Dr. Enk’s market knowledge and recommendations. This narrow focus may have left other potential customers out of sight. To reach this group, the current marketing strategy may be ineffective and/or inefficient. Third, anesthesiologists form their opinions on radical innovations such as EVA based on recommendations of their colleagues, their own personal needs and past experience. Dolphys’ view on anesthesiologists’ wants and needs might be too simplistic in the sense that ‘the anesthesiologist’ does not exist. Next, the most prevalent bottleneck, which is anesthesiologists’ misperception of EVA, is translated into a problem definition.

![Figure 2: Preliminary cause-and-effect diagram.](image)

### 1.2 Problem definition and research questions

#### 1.2.1 Three gaps between Dolphys’ marketing team and potential customers

After several iterations, Dolphys’ business problem was captured in a conceptual model (see Figure 3), where three gaps can be noted, which relate to the bottlenecks identified in the previous Section 1.1.2. The most prevalent one is gap 1, which represents...
anesthesiologists’ misperception of EVA. It is hypothesised that the product design of Ventrain and/or the explanation that Dolphys provides of EVA in its marketing activities add(s) to anesthesiologists’ confusion. Dolphys’ marketing team expects that anesthesiologists’ past experiences with conventional and jet ventilation cause this misperception. In order to see how anesthesiologists’ perceptions take shape, their expectations need to be known (gap 2). Results regarding gaps 1-2 should provide insight in the existence of gap 3. Possibly, Dolphys has a poor understanding of anesthesiologists’ expectations caused by the absence of a validation of the marketing activities.

Figure 3: Conceptual model the mismatch between Dolphys’ and anesthesiologists’ perception of EVA (Parasuraman, Zeithaml, & Berry, 1985).
1.2.2 Main problem and research questions

The focus of this research lies mainly on gaining an understanding of the adopter side, represented by the anesthesiologist. Based on the above the next problem was formulated:

Anesthesiologists’ expectations of EVA do not match with their perception of EVA, which seems to be a crucial antecedent in the adoption process, causing limited adoption and sales growth of the EVA product portfolio.

The research objective of this project is threefold. First, on the adopter side, the mismatch between anesthesiologists' expectations and perception of EVA needs to be resolved. In order to understand their expectations of EVA, it should be investigated how anesthesiologists make sense of newly introduced ventilators on the market. Especially, how and what attributes of these new ventilators are of importance to successfully evaluate the new product. Second, on the supplier side, Dolphys needs to rethink how they communicate EVA with anesthesiologists. Therefore, a redesign of Dolphys' current marketing strategy is made in order to influence anesthesiologists’ adoption process more effectively and efficiently. This involves an analysis of how Dolphys’ marketing team’s perception of anesthesiologists’ expectations of EVA has evolved and influences the attributes of EVA and how these attributes are translated into marketing activities. The solution also includes a hands-on implementation plan for Dolphys' marketing team. Third, the results of the empirical study are reflected upon and matched with the broader literature. These outcomes serve as guidelines in managerial practice.

As such, this thesis seeks to answer the following research question:

How can Dolphys more effectively and efficiently communicate EVA’s attributes to anesthesiologists in order to at least meet their expectations?

The main research question posed is quite broad to allow serendipitous findings to be incorporated in the investigation of the adoption and categorisation process of anesthesiologists. This is a key characteristic of case study research.

In order to answer the main research question, a set of four sub research questions was formulated:

1. How do Dolphys' marketing activities affect anesthesiologists' perception of EVA?
2. What is the effect of anesthesiologists' expectations on how they perceive EVA?
3. Is Dolphys' understanding of anesthesiologists' expectations correct?
4. How can Dolphys improve its marketing activities towards anesthesiologists?

This report's structure is based on the aforementioned research objectives. Figure 4 shows how science and design (or theory and practice) are systematically linked in this research (Eisenhardt, 1995). Part I Design-oriented research covers sub research questions 1-3 that are oriented towards an understanding of anesthesiologists’ categorisation and adoption processes. The results of theoretical and empirical analyses in Part I form the input of the suggestions for improvements of Dolphys' marketing strategy, stated as sub question 4, are made in Part II Science-based design. Finally, the overlap of both circles, where marketing science and Dolphys' business problem connect, places the empirical results in a broader scientific context in order to generalise the results.
In Section 1.1 and 1.2, the scientific and empirical context together with the business problem Dolphys faces, are already described. The structure of the remainder of the report is as follows. First, in Chapter 2 I review the academic literature related to categorisation and adoption of radical healthcare innovations and synthesise it into an overarching framework that guides data collection and analysis during the case study. Second, a description of the methods used for data collection and analysis is presented in Chapter 3. The report then describes the analysis and diagnosis of the business problem in Chapter 4. Part II of the report starts with a description of the methodology used for the solution and reflection in Chapter 5. The analysis of Chapter 4 serves as the input for the solution design, which is presented in Chapter 6. The report ends here with a reflection on the case study results and a conclusion. Dolphys will take care of the intervention and evaluation phases after completion of this project.
Part I Taking stock
2 Theoretical background & integrated model for Dolphys case

Two literature streams are relevant to validate Dolphys’ business problem. First, the organisational adoption process of healthcare innovations is reviewed. Numerous empirical studies have shown that healthcare innovation’s attributes are important antecedents for organisational adoption. Second, a review of studies on consumer’s perception and evaluation of hybrid products is presented. Finally, both literature streams are integrated in a theoretical framework that guides data collection and analysis for the Dolphys case.

2.1 Organisational adoption of healthcare innovations

2.1.1 Definition of innovation and adoption of healthcare innovations

Before starting an in-depth theoretical discussion, it is worthwhile to define the central constructs of this study. Here, the terms ‘healthcare innovation’ and ‘organisational adoption’ are defined and discussed.

Rogers’ (1995, p. 11) much quoted general definition of innovation is:

“An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption. It matters little, so far as human behaviour is concerned, whether or not an idea is objectively new as measured by the lapse of time since its first use or discovery.”

Especially when considering individual behaviour (e.g., when a clinical guideline might be classified as an innovation by a doctor or nurse), this definition is helpful. Though, at the organisational level (e.g., when a clinical guideline might be classified as an organisational innovation on a ward) it is less useful. For instance Frambach & Schillewaert (2002) point out that in B2B adoption of innovation is more complex and should account for decision making units. It suggests that a healthcare innovation in a B2B context involves organisational change, in terms of new structures and systems in the organisation, becomes a requirement for implementation. Individual adopters in the organisation need to do more than perceive the guideline as new; they must do something – adopt new roles, make different decisions, form new relationships, use new technology, develop new systems and so on. And this begs the question of how innovation differs from any other kind of organisational change.

Greenhalgh, Glenn, Bate, Macfarlane, & Kyriakidou (2005, p. 28) focused on innovation in healthcare, specifically health services. They define health service innovation as:

“An innovation in health service delivery and organisation is a set of behaviours, routines and ways of working, along with any associated administrative technologies and systems, which are (1) perceived as new by a proportion of key stakeholders; (2) linked to the provision or support of health care; (3) discontinuous with previous practice; (4) directed at improving health outcomes, administrative efficiency, cost-effectiveness, or user experience; and (5) implemented by means of planned and coordinated action by individuals, teams or organisations.”

Usually healthcare innovations include both technological and administrative innovations. (e.g. Kimberly & Evanisko, 1981). Technological innovations are directly related to the diagnosis and treatment of disease, which together constitute the basic work activity or mission of the hospital. Administrative innovations are only indirectly related to the basic work activity of the hospital and are more immediately related to its management. From the perspective of adoption research the distinction between technological and administrative innovations may not be so much that they serve different functions but that they imply...
potentially different decision making processes. This study only focuses on technological innovations.

More specifically, the Dolphys case is limited to medical devices, which can be considered as a sub group of technological innovations. The ISO definition states, in summary, that a medical device is any instrument, apparatus, implement, machine, appliance, implant, in vitro reagent or calibrator, software, material or other similar or related article that does not achieve its primary intended action in or on the human body solely by pharmacological, immunological or metabolic means and that is intended for human beings for: the diagnosis, prevention, monitoring, treatment or alleviation of diseases; the diagnosis, monitoring, treatment, alleviation of, or compensation for an injury; the investigation, replacement, modification, or support of the anatomy or of a physiological process; supporting or sustaining life; controlling conception; disinfecting medical devices; and providing information for medical or diagnostic purposes by means of in vitro examination of specimens derived from the human body (International Organization for Standardization, 2003).

Damanpour & Gopalakrishnan (1998), writing about the adoption of innovations in organisations, define it as:

“[A]n organisation’s means to adapt to the environment, or to pre-empt a change in the environment, in order to increase or sustain its effectiveness or competitiveness. Managers may emphasise the rate or speed of adoption, or both, to close an actual or perceived performance gap.”

Both these definitions imply that people and organisations choose rationally to adopt innovations because of some actual or perceived advantage. But, if adoption in individuals is a complex process, adoption of an innovation by an organisation is necessarily more complex still. Indeed, the term ‘adoption’ is probably misleading, and Meyer & Goes (1988) term ‘assimilation’ fits better, because it better reflects the complex adjustments that are often needed in the organisational setting. There is almost invariably a formal decision-making process at the organisational level, an evaluation phase or phases, and planned and sustained efforts at implementation. In other words, successful individual adoption is but one component of the assimilation of complex innovations in healthcare organisations.

2.1.2 Background literature on attributes of healthcare innovations
This section is about attribution studies, concerned with what attributes of healthcare innovations, as perceived by potential adopters, are associated with their successful adoption. Hundreds of empirical studies have been conducted on this topic, and although few specifically relate to healthcare innovations, the conclusions from the wider literature have important messages for this review. First, Rogers’ (1995) attributes are discussed in the light of healthcare innovations. Second, to overcome the increased complexity level of organisational adoption a set of operational attributes specifically for organisational adoption is presented.

2.1.2.1 Empirical studies on Rogers’ innovation attributes of healthcare innovations
Different innovations are adopted by individuals, and spread to other individuals, at different rates. Some are never adopted at all; others are subsequently abandoned. The study of Meyer & Goes (1988) supports the notion of key attributes of innovations (as perceived by prospective adopters), which explain a high proportion of the variance (37%) in adoption rates between healthcare innovations.

The five key attributes originally described by Rogers (relative advantage, compatibility, low complexity, observability, and trialability) are necessary but not sufficient to explain the adoption of complex healthcare innovations. A sixth attribute, potential for reinvention, may
be particularly critical in the organisational setting. An overview of these innovation attributes is given in Table 1. Next, each attribute is discussed below.

Table 1: Relationships between probability of innovation adoption and conventional innovation attributes.

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Reported relationship</th>
<th>Selected related research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative advantage</td>
<td>Positive</td>
<td>(Denis, Hebert, Langley, Lozeau, &amp; Trottier, 2002; Dirksen, Ament, &amp; Go, 1996; Rogers, 1995; Wilson, Ranamurthy, &amp; Nystrom, 1999)</td>
</tr>
<tr>
<td>Compatibility</td>
<td>Positive</td>
<td>(Foy et al., 2002; A. D. Meyer &amp; Goes, 1988; Rogers, 1995)</td>
</tr>
<tr>
<td>Complexity</td>
<td>Negative</td>
<td>(A. D. Meyer &amp; Goes, 1988; Rogers, 1995)</td>
</tr>
<tr>
<td>Trialability</td>
<td>Positive</td>
<td>(Denis et al., 2002; Rogers, 1995)</td>
</tr>
<tr>
<td>Observability</td>
<td>Positive</td>
<td>(Denis et al., 2002; Rogers, 1995)</td>
</tr>
<tr>
<td>Reinvention</td>
<td>Positive</td>
<td>(Denis et al., 2002; Rogers, 1995)</td>
</tr>
<tr>
<td>Radicalness</td>
<td>Positive</td>
<td>(Wilson et al., 1999)</td>
</tr>
</tbody>
</table>

**Relative advantage.** According to Rogers (1995) innovations that have a clear, unambiguous advantage in terms of either effectiveness or cost-effectiveness will be more easily adopted and implemented. Dirksen et al. (1996) support this notion in their study on the diffusion of six surgical endoscopic procedures in The Netherlands. ‘Extra benefit’, which the authors define as “value of the endoscopic procedure with respect to (clinical) effectiveness, morbidity, cost-effectiveness, etc.”, was found to account for a significant difference in the adoption rate among the different endoscopic procedures. Wilson, Ranamurthy, & Nystrom (1999) developed a multi-attribute measure for innovation adoption in the context of imaging technology, which included relative advantage and radicalness. This measure was validated in a study that examines the relationship between organisational climate and innovation adoption. Particularly, organisations with more risk-oriented climates tend to adopt innovations that provide greater relative advantage. Rogers (1995) points out that relative advantage is an absolute requirement for adoption. In other words, if a potential user doesn’t perceive relative advantage in an innovation, he or she does not consider it further. Nevertheless, in their study on the explanation of diffusion patterns for healthcare innovations, Denis, Hebert, Langley, Lozeau, & Trottier (2002) observe a mutual influence between innovations and adopting systems (key actors; interests, values, and power distribution; champions, resisters, forces pro and con) and the sometimes desirable and sometimes undesirable influences effects on adoption patterns. Thus, relative advantage alone does not guarantee widespread adoption.

**Compatibility.** Innovations that are compatible with the values, norms and perceived needs of both intended individual adopters and organisational adopters will be more readily adopted. Foy et al. (2002) conducted an observational study to identify attributes of clinical practice recommendations influence changes in clinical practice following audit and feedback. The main outcome measures were the association of each attribute with compliance and with changes in clinical practice. Recommendations compatible with clinician values and not requiring changes to fixed routines were independently associated with greater compliance at baseline and follow-up. However, recommendations seen as incompatible with clinician values are associated with lower compliance but greater behavioural change following audit and feedback. Compatibility with organisational or professional norms, values and ways of working is an additional determinant of successful assimilation. Meyer & Goes (1988) studied the contextual attributes, innovation attributes, and attributes arising from the interaction of contexts and innovations leading to the assimilation of healthcare innovations. Compatibility with existing patterns of medical specialisation was found to facilitate assimilation – the greater the number of potential beneficiaries of a particular innovation, the more likely the hospital is to adopt and implement it.

**Complexity.** Innovations that are perceived by key players as simple to use will be more easily adopted (Rogers, 1995). In their empirical study, Meyer & Goes (1988) found support for this proposition. After they eliminated all effects of environmental, organisational, and leadership variables, the set of innovation attributes in itself influence the adoptability of
healthcare innovations directly. From their correlations matrix, they derived that healthcare innovations that required relatively little skill, were more likely to be assimilated.

**Trialability.** According to Rogers (1995) innovations that intended users can experiment with on a limited basis will be more easily adopted and assimilated. Such experimentation can be encouraged through provision of ‘trialability space’. In healthcare settings, trialability is often similar to evidence-based practice. It should be noted that the evidence is accumulated in testing trials before the actual launch of the healthcare innovation. Usually, trial of healthcare innovations on patients is considered as non-ethical. Sometimes exceptions are made when a life-threatening situation arises. As Denis et al. (2002, p. 68) state it: ‘While the evidence-based decision-making model gives priority to scientifically based evidence as a privileged source for value judgments, we observed that the values used to establish legitimacy in specific cases might or might not be related to scientific evidence’. No empirical studies conducted in the healthcare industry were found to test the aforementioned proposition.

**Observability.** If the benefits of a healthcare innovation are visible to intended adopters, it will be more easily adopted. For example, in their cholecystectomy case, Denis et al. (2002) found that scientific evidence was slow in emerging. However, the highly visible benefits to patients successfully treated combined with relatively invisible risks made the treatment extremely attractive. So, initiatives to make the benefits of an innovation more visible (e.g. through demonstrations) increase assimilation.

**Reinvention.** If a potential adopter can adapt, refine or otherwise modify the innovation to suit his or her own needs, it will be more easily adopted. Reinvention is especially critical for innovations that arise spontaneously as ‘good ideas in practice’ and spread through informal, decentralized, horizontal social networks (Rogers, 1995).

In summary, the attributes associated with adoption by individuals, discussed above, are well established and broadly consistent between studies. However, some issues may arise in organisations. Although Roger’s model clearly suggests that actors will weigh pros and cons of innovations which results in adoption or rejection of an innovation, some authors have further emphasized this process and its particularities.

As Adler, Kwon, & Singer (2003) point out:

“... innovations that put additional cognitive or economic burdens on professionals will not diffuse effectively unless they afford sufficient compensating advantages. Relative advantage helps explain why, for example, so many areas of medicine are under-computerised ... Moreover, diffusion is considerably slowed if it requires learning different kinds of skills. Innovations in hospital practice such as multidisciplinary care teams involve managerial skills for which medical professionals have not been trained. To the extent that the acquisition of these new kinds of skills is more costly in time and resources than the acquisition of new medical skills, diffusion will be further slowed.”

Wejnert (2002) suggests that the diffusion of innovations in professional settings (e.g. healthcare) will be less sensitive to the innovation’s cost advantages for the professional, and more sensitive to (perceived) quality advantages for the patient. However, despite looking explicitly for studies exploring these distinctions in perceptions of relative advantage in different members of organisations, I was unable to find any.

There is also the notion that ‘relative advantage’ as defined by stakeholders outside the organisation can be a driving force for change within the organisation. Adler, Kwon, & Singer (2003) for example, suggest that, in the healthcare context,

“under environmental pressure to adopt innovations that offer important advantages to clients and other stakeholders but are less compatible with traditional professional
norms and the modus operandi of professional organizations will evolve to facilitate diffusion.”

Again, this is an enticing hypothesis that calls for empirical testing.

2.1.2.2 Extra attributes of innovations in the organisational context
The ‘standard’ attributes (which, apart from reinvention, are extensively cited) are necessary but not sufficient to explain the adoption and assimilation of complex innovations in organisations. Additional operational attributes, especially relevant for organisational innovations, include the relevance of the innovation to a particular task, the complexity of its implementation, and the degree of risk associated with adoption in a particular organisational and environmental context. These additional attributes are listed below.

Table 2: Relationships between probability of innovation adoption and organisational innovation attributes.

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Reported relationship</th>
<th>Selected related research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radicalness</td>
<td>Positive</td>
<td>(Wilson et al., 1999)</td>
</tr>
<tr>
<td>Fuzzy boundaries</td>
<td>Positive</td>
<td>(Denis et al., 2002)</td>
</tr>
<tr>
<td>Risk</td>
<td>Negative</td>
<td>(A. D. Meyer &amp; Goes, 1988)</td>
</tr>
<tr>
<td>Task issues</td>
<td>Negative</td>
<td>(Foy et al., 2002; A. D. Meyer &amp; Goes, 1988)</td>
</tr>
</tbody>
</table>

Radicalness. In their study on innovation adoption in the context of imaging technology, Wilson, Ranamurthy, & Nystrom (1999) found that organisations with a more risk-oriented climate tend to adopt more radical innovations. Adler et al. (2003) define radicalness of a technological process innovation as: (1) the extensiveness of the knowledge/skill required to exploit satisfactorily the technology’s capabilities; (2) the degree to which the technology is a radical (rather than an incremental) departure from existing/previous practices; and (3) the degree to which the technology breaks new ground in the hospital industry.

Fuzzy boundaries. Complex innovations in organisations can be conceptualised as having a ‘hard core’ (the irreducible elements of the innovation itself) and a ‘soft periphery’ (the organisational structures and systems that are required for the full implementation of the innovation); the adaptiveness of the ‘soft periphery’ is a key attribute of the innovation (Denis et al., 2002).

Risk. If the innovation carries a high degree of uncertainty of outcome that the individual perceives as personally risky (in terms of level of risk of injury, death, or malpractice liability), it will be less likely to be adopted (A. D. Meyer & Goes, 1988). Denis, Hebert, Langley, Lozeau, & Trotter (2002) state that the risks and benefits of an innovation are not evenly distributed in an organization. This can be explained by the fact that adopting systems are not unified rational actors. Also, different people may have different degrees of power to influence the process as well as different individual appreciations of the same risks and benefits. In conclusion, the more the risk-benefit balance maps to the power base of the organization, the greater its chance of assimilation.

Task issues. Meyer & Goes (1988) proved that the skills (manual skills or specialized training requirements) required for appropriate use of the innovation negatively affect the probability of assimilation. In an organisational setting, Foy et al. (2002) found that required organisational change and changed routines decrease the compliance with recommendations.

2.1.3 Conclusion
Literature on the effects of ‘standard’ attributes on the adoption of healthcare innovations is widely available. Also, reported relationships are very similar to other industries. Due to the more complex B2B context, a number of additional attributes is required. Though, attribution studies tend to have quite an objective perspective on the adoption decision. This is
especially problematic for consumer’s sense-making process of radical innovations. Therefore, Section 2.2 zooms in on a more qualitative aspect, which is product newness.

2.2 Newness perception of hybrid products: the relationship between category cues, categorisation certainty, and newness perceptions

In Section 2.1.2.2 it was posed that radical innovations are more easily adopted by healthcare organisations with a more risk-oriented climate. In a negative sense, potential adopters may experience difficulties in making an adoption decision. Apart from the adoption literature another important literature stream concerns research regarding new product categorisation. Newness perceptions occur early in the adoption process. Newness perceptions are subjective, and therefore potentially hazardous to new product adoption. However, the debate on the impact of product innovativeness on new product performance is not settled yet (Y. Lee & O’Connor, 2003). Where attribution studies focus on new product superiority, new product categorisation studies describe consumer’s difficulties with radical products that they have never seen before.

2.2.1 The importance of newness

Thousands of new products are launched each year, and despite the significant odds of failure, the number continues to increase. One factor that may account for the substantial failure rate is the fact that manager’s perceptions of their product’s innovativeness is not always shared by consumers (Calantone, Kwong, & Cui, 2006). Recent research notes a disconnect between what marketers deem new and innovative versus what customers actually perceive (Calantone et al., 2006; Gourville, 2006). Many factors may contribute to this.

A product that is perceived as new can instigate demand, speed adoption, and may have the potential to redefine major aspects of consumption. Consumers are also willing to pay more for products that are new. From a marketer’s viewpoint, a consumer’s recognition of a product’s newness is invaluable to establishing success in a competitive marketplace. If assessing a product’s newness is initially difficult, however, the benefits of innovation may never be fully appreciated.

Like the important distinction made by Calantone et al. (2006), my conceptualisation of newness perceptions is distinct from the perceived relative advantage or overall evaluation of a product. Following prior research, newness perceptions are defined in terms of how unique, different, innovative, creative, or novel a consumer perceives a product to be.

The literature emphasizes that newness of an innovation impacts categorisation. Two dimensions of newness can be distinguished (Gourville, 2006). On the one hand there is technological newness. On other hand level of required behavioral change to adopt and use a new product. Not the first but send dimension mostly impacts the categorisation of a product as new. Second, firms often believe their product is very innovative and new, representing a new category. However, customers often disagree, either by rejecting the innovation all together or by classifying it along existing lines.

2.2.2 Category cues and categorisation

Before healthcare organisations decide to adopt or not adopt a technological innovation, they go through an attitude formation process. Categorisation has been shown to have a significant influence on consumers’ beliefs about an object, and consequently, attitudes toward the object can vary based on how the object is categorised.

The current literature has not paid much attention to when and why consumers may create new mental categories for hybrid products. Instead, most studies have examined the mental representation of these products into existing categories, suggesting that the classification and evaluation of hybrid products entail a focused processing of individual product properties (e.g. Sujan & Bettman, 1989). Furthermore, research also indicates that
consumers, despite an apparent enthusiasm for a large range of products, can at times be overwhelmed by a non-transparent product range, which makes it even more interesting to study consumer’s reactions to hybrid products in more detail. Another important issue associated with hybrid products is the term the “single category belief” problem. A consistent finding in past research on such objects is that when objects have the properties of two or more categories, they are typically categorized into a single pre-existing category (rather than new categories being created for them), and beliefs about the objects are consistent only with the category that is selected (Gregan-Paxton, Hoeffler, & Zhao, 2005; Moreau et al., 2001; Rajagopal & Burnkrant, 2009). This is a problem for marketing managers since it implies that consumers may ignore important product attributes while making product evaluations. From a managerial standpoint, therefore, the single category belief problem poses a unique challenge to marketers in terms of finding means by which beliefs about both categories can be elicited in consumers; that is, multiple category beliefs can be elicited.

Categorisation bases are the concepts or cognitive building blocks that underlie categories in general. Product categories and subcategories are important knowledge-organizing tools for producers (Goode, Dahl, & Moreau, 2013) and consumers (Porac, Thomas, Wilson, Paton, & Kanfer, 1995), particularly in complex product markets. New products are evaluated on the availability and diagnosticity of category cues and prototypicality of new product’s visual aesthetics.

According to Goode, Dahl, & Moreau (2013) the availability of category cues is an important antecedent for the categorisation of new products. Category cues may be used to identify a product’s category and may be derived directly from the product’s design (e.g., function) or sources external to the product’s design (e.g., brand name).

Research on the relative diagnosticity of conceptual versus perceptual information in the inference generation process has yielded mixed results (Gregan-Paxton et al., 2005).

Prototypicality is defined as the degree to which an object is representative of a category and is an important aspect to consider in visual product design (Veryzer & Hutchinson, 1998). New products can differ immensely in how closely they resemble a typical category member. With a new product that is more prototypical in its visual aesthetics, category membership should be readily identifiable, enabling one to easily establish a point of comparison from which to assess a product’s newness more accurately and with certainty.

Marketers and consumers make sense of hybrid products through the use of category cues. Category cues can be elicited from product design, product label, and product demonstrations.

Product design. Consumers are placing an increasing value on the visual aesthetics of product design, and many companies are leveraging visual aesthetics as a way to differentiate in saturated markets (Bloch, Brunel, & Arnold, 2003; Page & Herr, 2002). However, despite the potential for product design to elevate a company’s success in the marketplace, there has been little attempt to determine how innovative visual aesthetics influence newness perceptions and product evaluations. It is acknowledged that product newness is a vital selling point” and “widely respected” (Bloch, 1995, p. 15). Visual design is often a central focus of new product managers; yet the psychological process through which visual aesthetics influences consumer perceptions is not well understood. A product’s visual design is the first thing consumers notice in an innovation, and thus, design immediately communicates information about the product’s category membership (Bloch, 1995). When a new product’s visual exterior does not deviate substantially from other category members, categorisation and a subsequent assessment of the product’s newness are likely to occur with ease, and thus, a consumer will be certain of a product’s category. In contrast, genuinely innovative product design may interfere with a consumer’s ability to categorize a new product with certainty.

Product label. Product labels, which shed light on object’s category allocation and thus provide information beyond similar features, play a crucial role in categorisation. Firstly,
because a label draws attention to categorical features and applies exclusively to a category, it has higher cue validity and its optimally suited for intercategorical differentiation. Thus, inferences about a new object are often influenced by the applicable category label. From the perspective of schema congruity, a label integrates a category’s typical properties as an associative network. Indeed, Sujan (1985) shows that allocating a well-known category label to a new product triggers the transfer of knowledge from the category to the product, as a result of which preferences may be more strongly influenced by the label than the product’s attributes.

Product demonstrations. Product demonstrations may reduce consumer’s uncertainty regarding innovations (Wood & Moreau, 2006).

The influence of sources of category information captured in category cues as discussed in Section 2.2.2 on newness perceptions is mediated by categorisation certainty. Goode et al. (2013) proposed that how certain a consumer is in a product’s categorisation will influence newness perceptions. If consumers are able to categorise a new product with certainty, they are likely to perceive the product as newer, because they rely on a clear point of reference from which to compare, contrast, and evaluate. On the other hand, when the point of reference from which to assess the new product is too ambiguous, uncertainty in category identification might lead to more conservative newness perceptions.

2.2.3 Conclusion

All in all, a paradigm shift in categorisation research is taking place. Around 1990, studies mainly described categorisation processes of non-hybrid products into existing categories (Meyers-Levy & Tybout, 1989; Ozanne, Brucks, & Grewal, 1992; e.g. Sujan & Bettman, 1989). Ten years later, studies on how consumers cope with incrementally new products and the creation of new categories were published (e.g. Moreau et al., 2001). Recently, consumer studies emphasise on radical new products (Goode et al., 2013; Uekermann, Herrmann, Wentzel, & Landwehr, 2010). Furthermore, the categorisation research programme only covers the adoption of consumer electronics, and thus excludes the more complex B2B context.
2.3 Integrated theoretical framework

Based on the above an integrated theoretical framework was developed, which is depicted in Figure 5. Three processes are distinguished. It should be emphasised that the subjective and objective evaluation processes are complementary. Most likely, both are nested and highly integrated. Consumers ‘subjectively’ evaluate the new product, as they must typically first identify what is different or novel about a product. In case the product newness is evaluated to be low, ultimately the adoption decision will be negative without further consideration of the objective innovation attributes. When consumers perceive the product as new, they subsequently evaluate the objective innovation attributes and decide to adopt or not adopt the new product. Next, the adoption process is related back to the central problem statement and research aim of furthering the market orientation and marketing activities of the entrepreneur.

First, the consumer evaluates the product newness. While in Section 2.1.2 a number of innovation attributes have been identified that influence new product preferences and adoption, the majority of the studies assume product newness to be objectively perceived and appreciated by potential adopters. In contrast, in Section 2.2, a unique perspective was introduced by conceptualising newness perceptions as highly subjective and dependent on the certainty of underlying categorisation processes and the availability of category cues. Categorisation takes place in early stage of innovation life cycle, i.e. by the more adventurous customers (innovators and early adopters). Because the market shaping shared knowledge between market actors (suppliers and customers) changes as product markets develop, it gradually becomes easier for market actors to understand one another. When the product market has finally stabilised, for later customer groups the product category will be a given (Rosa et al., 1999; Rosa & Spanjol, 2005). This implies that the adoption rate and number of adopters increases during the market stabilisation period, which triggers diffusion in the market.

Second, two types of innovation attributes are considered by the consumer. In a B2C context, only the ‘individual’ innovation attributes would be relevant (please refer back to Section 2.1.2.1). However, in a B2B context the complexity of the adoption process increases as the new product should also ‘fit’ in the organisation. Therefore, an additional set of ‘organisational’ attributes was introduced in Section 2.1.2.2.

Third, because newness perceptions are inherently comparative, they depend on underlying categorisation processes, which importantly may be influenced by marketing actions. Especially when the product market has not been stabilised yet, the role of marketing is a very significant one, because customers’ ability to categorise a product with certainty is still relatively low. The categorisation certainty may vary as a function of the availability and diagnosticity of visual and/or verbal category cues by the entrepreneur. For an entrepreneur to successfully communicate these category cues, (s)he should have a thorough understanding of the marketplace and specific customer journeys of innovative customers. They will negotiate meaning of the products and how to categorise them. In other words, the entrepreneur should be aware of the customers’ perceptions and expectations of a new product.

In this study, the subjective evaluation process, which directly covers gap 1, was the focus of attention. However, as it should not be regarded as a stand-alone process, gap 2 and 3 are investigated as well, but to a lesser extent.
Figure 5: Integrated framework of marketing's influence on consumer's new product evaluation process with indicated the relevant gaps.
3 Methodology for a design-oriented empirical research

This chapter discusses the methodology used for Part I, which can be considered as a blueprint for fulfilling the aforementioned objectives and answering sub research questions 1-3, used to carry out this master thesis project. First, anesthesiologists’ perception of EVA is measured to detect any differences with Dolphys’ actual presentation of EVA (gap 1). Second, anesthesiologists’ expectations about EVA are measured in order to identify any possible discrepancies between their perceptions and expectations (gap 2). Third, Dolphys’ perception of anesthesiologists’ expectations of EVA needs to be checked on (gap 3). The methodology for the solution of Dolphys’ business problem and the reflection on the case study’s findings is elucidated at the start of Part II (Chapter 5).

3.1 Analytic strategy, data collection, data analysis, and research quality

3.1.1 Analytic strategy for empirical research

A key methodological decision is determining the general analytic strategy, which influences how both data collection and analysis are to be performed. The explorative nature of the research questions and the lack of a comprehensive framework at the start of this project lead to the decision to adopt the grounded theory method as a general analytic strategy. Grounded theory method starts with data collection rather than a hypothesis. From the data collected, the key points are marked with a series of codes, which are extracted from the text. The codes are grouped into similar concepts in order to make them more workable. From these concepts, categories are formed, which are the basis for the creation of a theory, or a reverse engineered hypothesis. This contradicts the traditional model of research, where the researcher chooses a theoretical framework, and only then applies this model to the phenomenon to be studied (e.g. Goulding, 2002).

This project is a case study of the embedded type, meaning that there are multiple units of analysis per case (Yin, 2009). This is an important decision for the research design because it affects the levels at which data will be gathered and analysed. Central in this study is the individual anesthesiologist or intensivist affiliated with either an academic or top clinical hospital located in The Netherlands, which is Dolphys’ home market.

First, for the hospital type the hospital care structure in The Netherlands, which includes general, academic hospitals, and peripheral hospitals, was used. A general hospital is a concentration of facilities for research, treatment and care. In addition, in a general hospital both physicians and nurses are trained. An academic hospital has a number of functions that corresponds with the general hospitals, namely regular patient care, top clinical care and the training function for medical specialists. In addition, the university medical centre has a top reference function, a workshop function (research and education for the medical school) and a development function (development of new medical technologies and treatments). A peripheral hospital focuses on a particular category of patients. In some rehabilitation centres are the main group. Other examples of specialised hospitals have asthma centres, cancer centres and dialysis centres (RIVM, 2013). It is hypothesised that academic hospitals and peripheral hospitals with a top clinical status are most likely to adopt medical innovations first, because in these hospitals the more difficult patients are treated.

Second, the respondents’ medical specialty should either be anesthesiology or ENT-surgery. Dolphys’ primarily targeted anesthesiologists in the early commercialisation phase of Ventrain. At the time of writing, the marketing team explores new clinical indication areas for EVA. ENT-surgery seems to be the most interesting medical specialty to target next. As the nature of this project is explorative, Dolphys suggested including both anesthesiologists and ENT-surgeons in the sample. However, obtaining access to ENT-surgeons proved
difficult. In general, ENT-surgeons replied that ventilation was not their responsibility but of the anesthesiologist instead. This argument was verified during the interviews I held with anesthesiologists. Some of them referred me to an ENT-surgeon within their hospital, but even these referrals did not lead to any appointment at all. In the end, ENT-surgeons were excluded from the research.

Third, anesthesiologists could be working in the OR, ICU, or both. The emergency department (ED) is only relevant for Ventrain and therefore out of the scope of this research. Also, in practice anesthesiologists are called in from the OR. So, they are included in the research anyway. Within the ICU, anesthesiologists and internists who are subspecialised in intensive care medicine are employed. Only anesthesiologist-intensivists are relevant for this research. Thus, internist-intensivists were not included at all.

3.1.2 Data collection
Data were collected in two subsequent phases to analyse gap 1, 2, and 3. A general case selection procedure was used for both phases. Table 3 provides an overview of the selected hospitals along with the rationale for selection. Of the 8 academic hospitals in The Netherlands 6 were requested by email and by phone to participate in the study. In addition, 14 out of 28 top clinical hospitals were contacted as well. In Appendix 4 the cover letters sent to potential participants can be found. After initial contact 4 academic hospitals (response rate 67%) and 8 top clinical hospitals (response rate 57%) were willing to participate in the case studies through personal meetings at the hospital site. The intention was to interview three individuals at each hospital type and medical specialty in order to achieve triangulation (Yin, 2009).

Table 3: Physicians initially contacted for interviews ([..]) means request declined)

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Medical specialty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic</td>
<td></td>
</tr>
<tr>
<td>Academisch Medisch Centrum, Amsterdam</td>
<td>Anesthesiology</td>
</tr>
<tr>
<td>Erasmus Medisch Centrum, Rotterdam</td>
<td>Anesthesiology (ENT-surgery)</td>
</tr>
<tr>
<td>Leids Universitair Medisch Centrum, Leiden</td>
<td>Anesthesiology (ENT-surgery)</td>
</tr>
<tr>
<td>Universitair Medisch Centrum St. Radboud, Nijmegen</td>
<td>Anesthesiology (ENT-surgery)</td>
</tr>
<tr>
<td>Universitair Medisch Centrum, Utrecht</td>
<td>Anesthesiology (ENT-surgery)</td>
</tr>
<tr>
<td>VU Medisch Centrum, Amsterdam</td>
<td>Anesthesiology (ENT-surgery)</td>
</tr>
<tr>
<td>Top clinical</td>
<td></td>
</tr>
<tr>
<td>Albert Schweitzer Ziekenhuis, Dordrecht</td>
<td>Anesthesiology</td>
</tr>
<tr>
<td>Amphia Ziekenhuis, Breda</td>
<td>Anesthesiology</td>
</tr>
<tr>
<td>Atrium Medisch Centrum, Heerlen</td>
<td>Anesthesiology</td>
</tr>
<tr>
<td>Canisius-Wilhelmina Ziekenhuis, Nijmegen</td>
<td>Anesthesiology</td>
</tr>
<tr>
<td>Catharina Ziekenhuis, Eindhoven</td>
<td>Anesthesiology (ENT-surgery)</td>
</tr>
<tr>
<td>Haga Ziekenhuis, 's-Gravenhage</td>
<td>Anesthesiology (ENT-surgery)</td>
</tr>
<tr>
<td>Jeroen Bosch Ziekenhuis, 's-Hertogenbosch</td>
<td>Anesthesiology (ENT-surgery)</td>
</tr>
<tr>
<td>Maasstad Ziekenhuis, Rotterdam</td>
<td>Anesthesiology</td>
</tr>
<tr>
<td>Máxima Medisch Centrum, Eindhoven</td>
<td>Anesthesiology</td>
</tr>
<tr>
<td>Meander Medisch Centrum, Amersfoort</td>
<td>Anesthesiology</td>
</tr>
<tr>
<td>Onze Lieve Vrouwe Gasthuis, Amsterdam</td>
<td>Anesthesiology</td>
</tr>
<tr>
<td>St. Antonius Ziekenhuis, Nieuwegein</td>
<td>Anesthesiology</td>
</tr>
<tr>
<td>St. Elisabeth Ziekenhuis, Tilburg</td>
<td>Anesthesiology</td>
</tr>
<tr>
<td>VieCuri Medisch Centrum, Venray</td>
<td>Anesthesiology</td>
</tr>
</tbody>
</table>

The classifications in this table differ somewhat from the classifications that can be found in the analysis of the cases later on. This is because the in-depth information obtained during case studies sometimes led to a revision of the classifications. However, it were preliminary classifications that guided case selection and therefore those are shown here.
Exploration of Gap 1 – Anesthesiologists’ (mis)perception of EVA

The first stage during the data collection procedure was about the identification of gap 1, which was about the mismatch between the presented ventilation concept and how anesthesiologists perceive it. Data collection took place primarily through semi-structured interviews. The concepts from the theoretical framework were operationalized into interview questions. Appendix 5 and appendix 6 contain the list of interviewees and the complete interview protocol respectively.

Dolphys wishes to differentiate itself from the competition through an innovative ventilation concept and does not want anesthesiologists to allocate Ventrain and Wanda to an already existing category but rather explicitly aims to establish a new category. Hence, in this case Dolphys would need to match the ventilation concept with a new, neutral label that does not allow for transfer of existing knowledge. Nonetheless, I postulate that labels may affect information processing even in these cases by increasing the likelihood that anesthesiologists will form a new category.

Apart from influencing the outcome of the categorisation process, labels may also affect how much cognitive strain anesthesiologists experience during processing. More specifically, I propose that new category labels may increase or decrease cognitive strain, depending on how ambiguous the product is. When ambiguity is low, anesthesiologists may tend to assimilate the product into an existing product category. In this case, an unfamiliar category label may undermine this assimilation process, increasing cognitive strain. When ambiguity is high, on the other hand, a label provides an integrative description for hard-to-assimilate heterogeneous information, thereby facilitating the creation of a new category and decreasing cognitive strain.

Together with Dolphys’ marketing team I made a shortlist of the leading ventilator manufacturers in The Netherlands. Anesthesiologists did not report any missing brands and ventilator models. None of them was aware of fabian+nCPAP developed by Acutronic. Therefore I conclude that Dräger, Hamilton, GE, and Maquet are the main direct competitors for Wanda. Ventrain’s direct competitors are to be found in the emergency niche market, which particularly include devices found on a difficult airway trolley in the OR.

In the first part of the interview, anesthesiologists were asked to group a set of standardised photos of ventilators with the product name following a card-sorting procedure (see Figure 6). First, anesthesiologists’ awareness of the presented products is checked. In case the anesthesiologist had never seen the product before, the card was removed from the table. Also, anesthesiologists could add extra cards to the set if they felt that this was necessary for the task. Upon completion, anesthesiologists were presented with the Ventrain brochure, website, and animation video, and clinical indications and technological specifications of EVA and were asked to form an opinion of both Ventrain and EVA. Following this, anesthesiologists were asked about the dependent variables, the manipulation check, and the control variables.

Since I was interested in exploring the relationship between the perceived ambiguity level of Ventrain and EVA, and categorisation, one of my main dependent variables to be examined was if participants group Ventrain and/or EVA into an existing category or create a new category. I accounted for individual knowledge structures by asking anesthesiologists to group each of the ventilators into different categories based on similarity. Following this, participants had to assign the target ventilators (Ventrain and EVA) into one of the formed categories or had to create a new one.

A number of control variables that may affect the dependent variables were included in the analysis. To account for anesthesiologists’ knowledge about ventilators anesthesiologists were asked to rate their knowledge about ventilators available on the Dutch ventilation market. Lastly, also anesthesiologists’ level of familiarity with the Dolphys brand was controlled for.
In addition of the card-sorting task, direct observation of anesthesiologists’ interaction with Medica Europe gave some interesting insights in the social processes relevant to the adoption process. The yearly symposium of the Dutch professional association of anesthesiology (NVA) took place during the time this project was executed and I attended the event to gather data about anesthesiologists’ negotiation process with Medica Europe’s sales representative. These observations contributed to the study because Dolphys’ external communications are concentrated around trade fairs and symposia. Themes and issues that were observed are described in Appendix 7.

Finally, documents were also an important source of evidence. Included were websites of competitors active in the Dutch ventilation market for the development and interpretation of the card-sorting task and Dolphys’ own marketing materials.

**Exploration of Gap 2 – The effects of anesthesiologists’ expectations on their perception of EVA**

After the evaluation of the first phase a brainstorm session was organised with the CEO and the product manager to come up with a shortlist of questions in order to verify the marketing team’s expectations of anesthesiologists’ perceptions of EVA. These questions can be found in Appendix 8. This series of interviews was concluded with a presentation and discussion with the anesthesiology team of the Canisius-Wilhelmina Hospital in Nijmegen.

As a follow-up of the first round semi-structured interviews, 5 additional open interviews were held to extend the preliminary findings. This was deemed necessary because an understanding of only gap 1 was not sufficient to come up with suggestions for improvement of Dolphys’ marketing strategy. Because anesthesiologists’ expectations drive their expectations, these needed to be investigated as well.

Some additional criteria for the case selection were required in this phase. From this point onwards, I decided to solely focus on anesthesiology and abandon other related medical specialties. Another important finding of the previous phase was the sharp distinction between OR and ICU within the field of anesthesiology. Moreover, in the second phase a number of anesthesiologist-intensivists were selected.

**Exploration of Gap 3 – Dolphys’ perception of anesthesiologists’ expectations**

Lastly, Dolphys’ marketing team’s perception of anesthesiologists’ expectations needs to be verified. A baseline measurement of Dolphys’ knowledge of anesthesiologists’ expectations resulted from the interviews held with the CEO and product manager to define the problem. These notions are compared with anesthesiologists’ comments made in the two series of interviews.
3.1.3 Data analysis

Figure 7 gives an overview of the complete research process, which can broadly be divided in three stages corresponding with the aforementioned gaps. First, the research started with a baseline measurement of Dolphys’ perceptions of what anesthesiologists expect from EVA. This was done to check for the possible existence of gap 3 afterwards. Second, we hypothesised that not all anesthesiologists perceive EVA as a new product category. Therefore field research 1 was carried out to understand anesthesiologists’ adoption process better (gap 1). Memos were written from the card sorting interviews and observations. This lead to the identification of a number of concepts that seemed important for anesthesiologists’ adoption decision. These concepts were highly related to their expectations of a ventilation system and formed the foundations for field research 2. Third, gap 2 was analysed in field research 2. Again memos were written from the interviews and related back to the previously formed concepts. Finally, the identified gaps were prioritised to determine what the solution design should cover at last.

![Diagram](image-url)
3.1.4 Research quality
The quality of the project’s results is assured by an assessment of the validity and reliability. Yin (2009) proposes a set of case study tactics that address these issues and which are shown in Table 4.

Construct validity refers to the use of correct operational measures for the phenomena that are studied. In this project multiple sources of evidence were used. In field research 1 data were mainly collected through semi-structured interviews and the card-sorting task. Additional evidence was found through document study and direct observation at a trade fair. Field research 2 used solely open interviews. Mentioning sources throughout the report secured clear linking of data to conclusions. Also, the interviews were evaluated with the other colleague who attended the interview as well. These evaluations resulted in a number of field notes. Furthermore, the company supervisor, and two university supervisors reviewed intermediate project results. After a series of interviews with Dolphys’ team members, I presented them the problem statement and the project approach to make sure that the interview results were processed correctly.

Internal validity refers to the validity of causal inferences that are made in the analysis and diagnosis of the business problem. This type of validity was addressed mainly by the use of pattern-matching logic.

External validity refers to generalizability of the study beyond the present case. While case studies have often been criticized for their supposed lack of external validity it should be kept in mind that case studies do not rely on statistical, but analytical generalisation (Eisenhardt, 1995). In other words, the results from a case study should not be generalised to other cases but to a specific broader theory. The issue of external validity is dealt with in the reflection chapter.

Finally, reliability refers to the question whether a replication of the study would have led to the same results. While errors and bias may be impossible to avoid completely, working in a structured way and maintaining the chain of evidence by documenting (intermediate) results increased the reliability of this study.

Table 4: Quality criteria for research, based on (Yin, 2009).

<table>
<thead>
<tr>
<th>Quality criterion</th>
<th>Advised case study tactics</th>
<th>Used case study tactics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construct validity</td>
<td>Multiple sources of evidence</td>
<td>Field research 1: Semi-structured interviews, direct observation, and document study</td>
</tr>
<tr>
<td></td>
<td>Establish chain of evidence</td>
<td>Field research 2: Open interviews</td>
</tr>
<tr>
<td></td>
<td>Use of key informants to review report</td>
<td>Field notes, interview evaluations</td>
</tr>
<tr>
<td>Internal validity</td>
<td>Do pattern matching</td>
<td>Control empirical results with theoretical model</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use of matrices to uncover patterns</td>
</tr>
<tr>
<td>External validity</td>
<td>Use replication logic in multiple-case studies</td>
<td>To be discussed in Chapter 7</td>
</tr>
<tr>
<td>Reliability</td>
<td>Use case study protocol</td>
<td>Use of clear case selection criteria and interview questions</td>
</tr>
<tr>
<td></td>
<td>Develop case study database</td>
<td>Use specific folder structure to save interview transcripts and documents</td>
</tr>
</tbody>
</table>

3.2 Conclusions
This chapter started with a description of how Dolphys’ business problem (as stated in Section 1.2) was formulated and embedded in the theoretical context. Parasuraman, Zeithaml, & Berry’s (1985) model of service quality turned out to be a very useful overarching framework for this case, because it not only shows the mismatch between consumers and suppliers, but also incorporates the underlying causes. Next, this study emphasised on gaining an understanding of anesthesiologists’ adoption process, which can possibly be impeded by gap 1 and 2 (see Figure 3). Later on, the theoretical analysis, which initially focused on adoption studies in a healthcare context, shifted to consumer studies on categorisation. In order to reduce anesthesiologists’ categorisation uncertainty, several studies suggest the use of category cues. To be able to overcome gap 1, data were collected and analysed through a card-sorting task combined with a semi-structured interview in field research 1. The main conclusion of the findings of the first analysis was that gap 1 was not
too problematic and a deeper investigation was needed. At this point gap 2 became more prominent. Therefore, a series of open interviews was held in field research 2. In the end, Dolphys’ business problem was diagnosed. Next, the results of the empirical analysis are presented in Chapter 4, which is the formal ending of Part I of this report.
4 Results

This chapter seeks to answer sub research questions 1-3. First, anesthesiologists’ perception of Dolphys’ current marketing activities is evaluated, which is based on field research 1. Second, as anesthesiologists are likely to rely on word-of-mouth, personal needs, and past experience, when forming an attitude towards EVA, their expectations have been discussed in open interviews in field research 2. Third, the baseline measurement of Dolphys’ knowledge on customer needs and wants is evaluated.

4.1 Gap 1: The mismatch between the presentation and perception of EVA

4.1.1 Position of EVA in the Dutch ventilation product market

Dolphys’ assumption that anesthesiologists form a homogeneous customer group was found to be incorrect. Instead, within the field of anaesthesiology subgroups of specialised anesthesiologists do exist. This important finding was first noticed when anesthesiologists seemed really surprised to see a complete overview of ventilators available on the Dutch ventilation market. Some commented that they were only aware and knowledgeable of the ventilators installed in the hospital they were currently working or where they were educated in the past. A clear difference between anesthesiologists’ and intensivists’ awareness level of ventilators was found. Where anesthesiologists are only knowledgeable of anesthesia workstations with a gas exchanger, intensivists focus on ICU ventilators. Hendriks explained that it is easier for anesthesiologists to learn about ICU ventilators than for intensivists to operate an anesthesia workstation. As a consequence, anesthesiologists heavily relied on prototypical visual cues to sort ventilators that they had only heard or read about.

Considering the number of ventilators from which to choose, anesthesiologists’ knowledge of technological capabilities was too limited to compare all ventilators only on objective data. Because they only have experience in working with a very limited number of ventilators, their practical knowledge is limited. However, for unfamiliar ventilators they tended to rely on tradition and the immediately available technology, rather than evidence-based medicine. To make sense of unfamiliar ventilators, anesthesiologists link the product design directly to possible clinical indications. Hereby, the technological capabilities of the ventilator become less relevant in the categorisation decision. In fact, in their opinion all ventilators were based on the same established technology. Manufacturers use different names for comparable ventilation modes (see Appendix 9, which increase the fuzziness level even further. As a result, anesthesiologists are likely to renew existing service contracts. As the team is familiar with the operation of the installed system, individuals are unlikely to switch to another manufacturer when they are not convinced of a real clinical advantage. Since the perceived technology risk was very low, product differentiation should be based on something else. One anesthesiologist explained that manufacturers differentiate their product portfolio mainly on operational philosophy. Basically two main target segments can be distinguished: fully automatic and operator-controlled. Fully automatic machines require very little user intervention, while operator-controlled machines allow the anesthesiologists to adjust the settings manually.

4.1.2 Organisational adoption of EVA by academic and top clinical hospitals

Many organisational researchers have argued that the structural characteristics of an organisation significantly influence its adoption behaviour. The contention is that certain features of hospitals themselves either facilitate or encourage adoption of EVA. Kimberly & Evanisko (1981) found four organisational variables related to hospital adoption of technological innovations explaining 62% of the variance. These include centralisation, specialisation, size, and functional differentiation and have been included in this analysis.

Nearly all researchers hold that centralisation is important in a theoretical sense. Although, the relationship between centralisation and adoption of innovation as been found
to be positive in some cases, in others the relationship has been negative. Rarely, if ever, has it been found to make no difference whatsoever. In the absence of a persuasive and comprehensive theory about the effects of centralisation on innovation adoption, the evidence suggests that the nature of the relationship may depend on the type of innovation in question and its relationship to key decision makers. An innovation in the core technology where that technology is applied by professionals, who are more or less autonomous, as in case of anesthesiologists working in hospitals, might be adopted more frequently in decentralised authority structures. All interviewees reported that purchasing decision-making was separately organised for the OR, ICU and ED. Usually the units had their own materials committee supervised by the departmental professor, who was in charge to evaluate and select new equipment. Van Gaalen, who is head of the materials committee in the AMC, commented that about 80% of innovations anesthesiologists recommended to the materials committee were not adopted in the end. Mostly, after a thorough evaluation the relative advantage is too limited.

Specialisation represents the number of different medical specialties found in the hospital. To the extent that large numbers of different specialties are linked to the hospital’s medical specialisation, it can be said to be highly specialised. In The Netherlands three degrees of specialisation exist: academic, top clinical, and peripheral hospitals. Huitink, airway management professor at VU medical centre, pointed out that numerous anesthesiologists do not recognize CICV situations when they occur or too late. Anesthesiologists affiliated with top clinical hospitals more often reported that the incidence level of CICV situations was too low and therefore they were not looking for alternative interventions like Ventrain. Thus the validity of this notion cannot be checked. The low incidence level of these CICV situations at top clinical hospitals may also be explained by the fact that patients with more unique airway problems are redirected to academic hospitals instead. Thus anesthesiologists are more likely to recognize CICV situations, because they are more experienced due to the higher incidence level and thus better trained. This reinforcing effect can be considered as a positive feedback loop. Employment of a variety of specialists perforce provides access to broader knowledge of new ideas, techniques, and products.

The third organisational variable, size, is generally held to be positively related to adoption. Most frequently, this relationship is attributed to economies of scale, which enhance the feasibility of adoption. This variable we have taken as input variable – we have excluded anesthesiologists from peripheral hospitals from the research sample - and could therefore not be verified.

Lastly, functional differentiation represents the extent to which the hospital is divided into a number of subunits. Generally, functional differentiation is hypothesised to lead to increased adoption of innovations. The rationale for this hypothesised positive relationship is based on the premise that a functionally differentiated organization creates multiple interest groups and multiple demands for elaboration of the core technology. Inasmuch as innovations in respiratory disease technology support developments in other medical technologies such as ENT-surgery, Dolphys posited that hospitals that are highly differentiated functionally would be adopters of technological innovations. Though, this assumption has been proven to be false. I invited 6 hospitals to contribute to this research, but the ENT-departments were not interested in applications of an innovative respiratory device. They responded that they had no voice in airway management issues whatsoever. Only anesthesiologists are considered to be responsible for ventilation. I verified this response with the anesthesiologists group by asking them whether they collaborated with other medical specialties. They confirmed ENT-surgeon’s view on this matter. However, of course Dolphys could still target ENT-surgeons as a separate group. To do this successfully the message should be adjusted to specific ENT-surgery cases. Alternatively, anesthesiologists who are specialised in ENT-surgery could serve as product champions in order to convince ENT-surgeons.
4.1.3 The influence of category cues on anesthesiologists’ categorisation certainty

In this section the case studies are presented that were executed at several academic and top clinical hospitals. Each case study focused on one anesthesiologist that evaluates the Dutch ventilators market as a whole (as described in the previous paragraph) and positions Ventrain and Wanda. In Table 5 only a short description of the category and attitude formation of anesthesiologists is provided.

Table 5: Overview of case studies.

<table>
<thead>
<tr>
<th>Anesthesiologist</th>
<th>Category and attitude formation</th>
</tr>
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<tbody>
<tr>
<td>Marc Buise</td>
<td>He used his personal experience with ventilators as a guide to make sense of the ventilator market. Because he had never used Ventrain and Wanda in clinical practice, he was unable to categorise them. In his perception CI/CV-situations only occur 4-5 times a year in the Catharina Hospital. Also, he considers himself as perfectly capable of conducting a tracheostomy (est. 30 yearly). Lastly, he mentioned he once had a very bad experience with the Quicktrach cricothyrotomy set of VBM Medical, which is a direct competitor of Dolphys, and would never use such a device ever again.</td>
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<tr>
<td>Ronald Drost</td>
<td>The usage location was leading for the categorisation. He distinguished between ICU, OR, Emergency, and Transport systems. Ventrain’s product design was considered similar to Manujet (VBM Medical), which led to the placement in the Emergency category. The brochure and animation confirmed his decision about the Emergency category, but he acknowledged that Ventrain’s working principle of the Venturi effect is totally different. Ultimately, Ventrain was found to be a subcategory within the Emergency group. Overall, he was really positive about Ventrain’s active expiration principle and interested to try Ventrain in his hospital.</td>
</tr>
<tr>
<td>Wouter Dijkman</td>
<td>His background as internist-intensivist is slightly different than the rest of the population. As a consequence he used the level of applicability at the ICU as the criterion for the sorting procedure. He perceived Ventrain as only useful at the ICU as an emergency device. He did not see any added value in Wanda for the ICU. No studies on the effects of negative pressure ventilation on lung physiology can be found at present. For the OR Wanda should be developed and promoted as an add-on ventilation mode for the installed anesthesia workstations.</td>
</tr>
<tr>
<td>Ilze Hendriks</td>
<td>Using the usage location, she made four groups: ICU, OR, Transport/Prehospital, and Manual. By looking at the product design, she decided that Ventrain was a manual ventilator like the AMBU resuscitators, which can be used anywhere anytime. In comparison with the three-way stopcock, Ventrain can not only oxygenate, but also ventilate the patient. Finally, she created a standalone category for Ventrain. She perceived Ventrain as a manual “jet” ventilator only to be used in emergency situations, but not for elective situations.</td>
</tr>
<tr>
<td>Hans Hutink</td>
<td>He created three groups with ventilators similar in power source: (1) AMBU resuscitators and manual rescue devices; (2) battery-powered transport ventilators; (3) anesthesia workstations, IC-ventilators, and HFJV-systems. He perceived Ventrain as a “lifesaver”, a manual rescue device on the difficult airway cart. In general, he was positive about the product features, but worried about the low incidence level. He stated that anesthesiologists are risk-averse towards innovations, because these innovations are difficult to defend for the medical-ethical commission in case of malpractices. Also, Ventrain’s product design is not self-explanatory in panic situations. Repeated training of anesthesiologists is very important to make users feel comfortable in emergency situations.</td>
</tr>
<tr>
<td>Markus Klimek</td>
<td>He made five groups: (1) IC ventilators; (2) anesthesia machines; (3) transport ventilators; (4) emergency HFJV devices; and (5) manual resuscitators. He decided that Ventrain belongs to the HFJV emergency category. He reported that he preferred to use a three-way stopcock instead, because of economic reasons. At the same time he worried that EVA could create under or over pressure in the patient’s lungs. No passive expiration is possible. More technical specifications are needed to categorize Wanda. Though, using Wanda for single-lung ventilation could be an alternative for HFJV. He felt that EVA is a ventilation concept looking for an indication. Also, the installation location is explanatory in panic situations. Placements of a cuff in the patient’s airway is debatable.</td>
</tr>
<tr>
<td>Patrick Meijer</td>
<td>Five groups could be distinguished: (1) daily OR systems (adults); (2) daily OR systems (neonates); (3) emergency usage; (4) manual devices; and (5) transport ventilators. Ventrain’s product design was found to be very similar to the Enk Oxygen Flow Modulator (EOFM). Both products’ designs suggested that they were suitable for ventilation. After reading the brochure, he described Ventrain as a temporary emergency solution between oxygenation and ventilation. Wanda’s specific feature was that it could be used with a cuffed catheter. He focused mainly on the OR clinical situation of single-lung ventilation, because</td>
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<tr>
<td>Erik Scholten</td>
<td>He used the mobility of the ventilator as the selection criterion. Five groups were created: (1) transport ventilators; (2) emergency devices; (3) mobile ICU ventilators; (4) OR ventilators; (5) standby OR ventilators. Ventrain is similar to Manujet. Wanda can be understood as a mobile OR ventilator. It is advisable to develop Wanda as an add-on to an anesthesia station.</td>
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</table>

Overall, anesthesiologists’ knowledge of the Dutch ventilator market is limited to their own usage experience. Anesthesiologists usually are either working in the OR or at the ICU, not both. Their knowledge of the ventilator market is limited to their clinical experience, which is
directly related to the market segments communicated by manufacturers. Also, only in a few academic hospitals mechanical jet ventilation systems are in use. Alternatively, all anesthesiologists are used to conventional ventilation systems. Since manual resuscitators can only oxygenate, but not ventilate, patients do not exist on anesthesiologists’ mental schema of the ventilation market. Normally manual resuscitators are used in combination with a ventilation system.

Before I held the interviews, I hypothesised that a ventilation concept is a complete solution package comprising both the ventilator itself and the airway catheter. Following this line of reasoning, the question rose whether the selection of the ventilator (mode) or the airway catheter was leading in the decision to ventilate a patient. This is directly related to negotiation process about the appropriate ventilation strategy at the OR between the anesthesiologist and, for example, an ENT-surgeon. It turned out that anesthesiologists are responsible for the whole treatment in the end, not the ENT-surgeon. Thus, the choice of ventilator is leading in this matter.

After all ventilators were sorted out by the anesthesiologist, I subsequently introduced the category cues (product design, product label, product claims, and product demonstration) that were found in the categorisation literature one by one to see whether these category cues affected anesthesiologists’ categorisation decision. Below, the effects of the category cues on the categorisation of both Ventrain and Wanda are presented.

**Product design**

After the ventilator sorting procedure, I presented Ventrain to the anesthesiologist. Before giving a detailed explanation of Ventrain I asked him/her to share his/her first impressions and associations with the device, when only looking at the product design. Two out of eight respondents had already heard about Ventrain. None of them had significant user experience. Thus, it should be noted that their answers might be coloured.

In all cases Ventrain was grouped together with ventilators that could be named “emergency jet devices”. Usually these devices are found on difficult airway carts in the OR. Mostly Ventrain was directly compared with Manujet III (VBM Medizintechnik GmbH), see Figure 8. Since Manujet III was also included in the set of cards during the sorting procedure, anesthesiologists’ activated mental schemas might have been activated already. It is important to note that Manujet III only is an oxygenation device in difficult airway situations, not a ventilator. Huitink and Hendriks commented that anesthesiologists often mix up the definitions of “oxygenation” and “ventilation” ultimately leading to misunderstandings and incorrect product categorisations. Furthermore, Ventrain’s product design seems to be very simplistic with few features, which made Hendriks initially believe that it is too light and fragile to work properly in practice. For most anesthesiologists it was not immediately clear where the tubes should be connected with patient on the one side and an oxygen bottle or outlet on the other side. It was immediately clear how to hold the device, but the controls were not obvious. Not much attention was paid to the pictograms explaining how to use Ventrain. Especially in emergency situations pictograms are not sufficient for anesthesiologists to feel confident enough to safely work with Ventrain. Repeated training is recommended as a means to stimulate the use of innovative devices in clinical practice.

Because the Wanda project is still in the R&D phase, no product design is available yet. To overcome this hurdle and get the discussion started I introduced two clinical situations and a shortlist of technical specifications. Dijkman suggested that Wanda, “Ventrain with an electronic thumb”, would only have added value as an add-on ventilation mode to the anesthesia workstations in the OR, but saw no added value for the ICU. The add-on ventilator should be as simple as possible to be used in emergency situations. For example, disposable parts could be used. He perceived EVA as a negative pressure ventilation mode, which is very uncommon in ICU ventilators. He added that no studies of the effects of negative pressure ventilation on patients’ lung physiology are available yet, which made him worried. Two anesthesiologists (Buise and Drost) compared Wanda with Neopuff Infant T-piece Resuscitator (Fisher & Paykel Healthcare). Neopuff is a resuscitator to
oxygenate babies with a mask by placing and removing the thumb on a T-piece to allow inspiration and expiration. The main objective of this manually controlled operation is to inflate and recruit alveoli to achieve gas exchange using the lowest possible pressure to protect the immature infant’s lungs.

**Figure 8:** Manujet III (VBM Medizintechnik GmbH).  
**Figure 9:** Neopuff Infant T-piece Resuscitator (Fisher & Paykel Healthcare).

**Product label**  
The product label of EVA clarified a great deal of what Ventrain and Wanda are really about. The concept of “expiratory ventilation assistance” specifically triggered anesthesiologists to create a new mental category instead. The concept label was the main trigger for the final categorisation of Ventrain and Wanda. Expiratory ventilated assistance, or in other words “ventilation by suction”, is the distinct feature for anesthesiologists to create new product categories for both Ventrain and Wanda.

**Product claims**  
Both technical specifications and clinical situations are of importance to make sense of EVA. Initially, we believed that clinical situations are leading in this respect, because generally anesthesiologists are used to problem-based learning. However, anesthesiology was told to be quite a technical medical specialty, making technical specifications more relevant to evaluate EVA.

When triggered by the concept label, a description together with a technical drawing of Ventrain further clarified the ventilation concept. At this point anesthesiologists were sure that they made the right categorisation decision in the previous round. The exploded view drawing of Ventrain together with the term “Venturi effect” reduced the perceived ‘simplicity’ of Ventrain. At first sight of the outside product design EVA seems very simplistic, but the T-piece on the inside explains the working principle.

Ventilation through a cuffed narrow bore catheter was sometimes seen as counterintuitive. When the patient’s airway is artificially blocked with a cuff, passive expiration becomes problematic. This situation can best be described as ‘breathing through a straw’.

One clinical situation for the OR and one for the ICU were presented to show examples of elective use of Wanda. For the OR a single-lung ventilation case was prepared. The ventilator-induced-lung-injury (VILI) case was not discussed in great length, because ventilator induced pneumonia is fully controlled with antibiotics in The Netherlands and not regarded as a serious health problem. In a discussion with two anesthesiologists from the Máxima Medical Center in Eindhoven the application area of oral surgery was mentioned to be interesting for a clinical study.

**Product demonstration**  
After examining Ventrain physically and reading the product brochure, anesthesiologists had a thorough understanding of its working principle and how to control it. The animation did not
really add much to this. So no one made changes regarding to the categorisation of Ventrain. Still, in other circumstances like for example at trade fairs, where it is not possible to read through the complete brochure it is expected to be a nice alternative. At first some anesthesiologists had difficulties with the user controls of the animation video. After some trial and error they found out that the index finger is not necessary for ventilation, but only a safety measure in order to prevent the creation of overpressure in the lungs of the patient.

In general, when asked to group Ventrain and Wanda to one of the categories or create a new one, all of them suggested the creation a new product category. Some of them commented that the assistance during the expiration was not found on any other device. This feature can be regarded as a distinct feature from jet ventilation devices. However, not all anesthesiologists were convinced easily. The level of ambiguity of Ventrain and Wanda was high in the beginning and lowered when additional information became available. All anesthesiologists confirmed that they completely understood the working principle of EVA after reading the Ventrain brochure. The term “Venturi” effect in combination with the technical drawing usually was enough information to understand the product. The product label of “expiratory ventilation assistance” turned out to be a sticky one. The Ventrain animation video did not further decrease the level of ambiguity.

Therefore, first and foremost the complexity of EVA needs to be reduced before adoption can take place. As already described above the product label and a display of Ventrain’s internal T-piece completed with a short statement about the Venturi effect are very helpful in understanding how the ventilation concept “works”. Second, now the focus in the communication about EVA is mainly on emergency situations, which makes it difficult to discuss elective uses with anesthesiologists. Because the number of CICV-incidents reported is very low, anesthesiologists do not really need a device specifically designed for this unique situation only.

4.2 Gap 2: The mismatch between anesthesiologists’ perceptions and expectations of EVA

The interviews provided a previously missing qualitative insight into the effects of word-of-mouth, personal needs, and past experience on anesthesiologists’ expectations about EVA. This section addresses these issues.

A major source of influence on anesthesiologists’ beliefs about EVA is word-of-mouth (WOM). More specifically, some mechanisms were noted during observation. A competitive attitude of anesthesiologists towards other hospitals, and sometimes even towards specific individual anesthesiologists, was observed. For example, when interviewees found out that EVA is invented by Dr. Enk in Maastricht, they adjusted their product evaluation negatively. Also, at the trade fair of the NVA it became clear that anesthesiologists tend to judge other hospital’s way of working. As a result of this rival attitude anesthesiologists do not easily accept evidence and information from colleagues affiliated with other hospitals.

Here, a number of key findings about anesthesiologists’ beliefs is presented. First, a number of bad experiences with emergency airway devices like Manujet were reported. As a result anesthesiologists indicated that they prefer to perform a tracheostomy on the patient. Especially in academic hospitals often an ENT-surgeon is called in the OR for this procedure. Another reason mentioned for this is that Ventrain is only useful as a temporarily airway later to be replaced with a tracheostome. Second, mostly in top clinical hospitals, the relative advantage of the use of a smaller transtracheal catheter over an endotracheal tube in elective surgeries is minimal. For example, according to anesthesiologists ENT-surgeons do not report too limited space at the surgical site. Thus, a smaller tube is not considered as advantageous. In one academic hospital apnea is used to perform surgery, which does not need the use of a catheter at all. A disadvantage of small-sized catheters is that they tend to kink easily. Transtracheal catheters are preferably not used in children, because serious trauma is done. Third, another comment made by Klimek referred to the creation of either
underpressure or overpressure in the patient's lungs when using EVA. In case too much air is inspired the patient will be blown up. This problem can also occur when using jet ventilation, but for EVA the airway is (artificially or by trauma) blocked. In jet ventilation passive expiration is possible through the natural airway, if not (partially) obstructed. In EVA the airway is blocked with a cuff only allowing expiration via the catheter. Klimek expressed his worries about the catheter being too narrow for the expiration. To illustrate this situation he explained that breathing through a straw is simply impossible. Fourth, the available evidence of EVA's benefits is still very limited. Anesthesiologists consider clinical studies to various degrees and user experiences from colleagues as valuable evidence of benefits. About 10 cases were reported both within and outside Ventrain's intended use in the past years. Dolphys aims to start two clinical studies in the near future. One study will be conducted with Catharina Hospital, UMC Utrecht, and AZM Maastricht. The other study will be in close collaborations with Maxima Medical Center. Due too the start-up phase of Ventrain's diffusion the number of users is limited to spread the message.

Moreover, personal needs directly affect anesthesiologists' expectations of EVA. Mostly, these personal needs were directly related to the hospital unit. First, the clinical indication requires specific product needs. Second, the ventilation philosophy (quantitative or qualitative) should be taken into account.

Key findings on this matter are explained next. First, most anesthesiologists reported that CICV-situations almost never occur, especially not in elective surgeries. Because of the low incidence level anesthesiologists prefer to rely on the devices they feel comfortable working with. In order to introduce new innovative devices successfully repeated training is very important. Second, it should be noted that the discussion about EVA was usually mainly focused on emergency situations, not on the elective use of EVA. At the moment of writing only Ventrain is on the market with an intended use for emergency situations. Wanda is still in the R&D phase, which made it difficult to discuss with potential adopters in detail. Still, Wanda was found to be suitable to use for single-lung ventilation and oral surgery procedures. Even more so, Máxima Medical Center is planning to do a clinical study on the use of Ventrain in oral surgery cases.

Lastly, anesthesiologists' past experience with devices that they perceive to be similar to EVA contributes to their expectations of EVA. Next, some examples are highlighted.

First, in interviews with Dolphys employees in the beginning of the project, they told me several times that in their conversations with anesthesiologists over the last couple of years EVA often was perceived as a hybrid ventilation concept. In academic textbooks, like Benumof's Airway Management Handbook, conventional ventilation and jet ventilation are mentioned to be the core ventilation concepts in airway management. Since EVA has a mixture of characteristics of both of these two ventilation concepts, it is highly ambiguous. These mental categories were not found in the card-sorting task performed by the interviewed anesthesiologists. For almost all of them jet ventilation was seen as old-fashioned. Instead, the ventilation market can be split up according to the units (OR, ICU, transport) in the hospital. In conclusion, EVA is not so ambiguous after all. Moreover, anesthesiologists do have a clear picture of the mental categories present in the ventilation market. Second, sometimes anesthesiologists (Huitink, Hendriks) emphasized that the definitions of "ventilation" and "oxygenation" are used interchangeably leading to communication problems. Therefore Dolphys should clearly communicate the appropriate definitions for its products.

In general, two groups of anesthesiologists' expectations could be formed. One group believed that hospitals, who perform jet ventilation (mainly academic hospitals), don't 'need' EVA at all. They believe that jet ventilation is sufficient in all situations. The other group claims that conventional ventilation is adequate in all clinical situations they experience. Jet ventilation is perceived as old-fashioned and only adopted by a small number of hobbyists. The incidence level of CICV situations is way too low and the relative advantage of full
ventilation through a small airway-catheter is not recognized. In some cases, anesthesiologists were skeptical that it was possible to fully ventilate through a straw. Thus, it does not make sense to compare EVA with jet ventilation at all. In general, there are too many negative associations and experiences in relation with jet ventilation.

Also, some suggestions to bridge Gap 2 have been made by anesthesiologists. The debate on the importance of clinical indications versus technical specifications of EVA remains unsettled. Where some argued that clinical indications were helpful to evaluate the product, others preferred a simple list of technical specifications of the product. Also, training was found to be important. Although, the individual anesthesiologist is responsible for his/her own education, they expect manufacturers to provide them with (e-)learning material. Repeated training is especially important for Ventrain as it is used in emergency situations, which reduces the chance that anesthesiologists gain experience with the device. Consequentially, the device is not used at all and not ordered again.

4.3 Gap 3: Dolphys’ perception of anesthesiologists’ expectations of EVA
Dolphys’ current definition of the market should be reinvented, because a number of issues regarding market segmentation, target groups, and functionality have been identified. Next, these issues will be discussed.

Dolphys’ marketing team expected ENT-surgeons to be of special interest. Seven hospitals were contacted by phone and/or email to invite ENT-surgeons to participate in the research as well. As all requests made were rejected, I also asked interviewed anesthesiologists for a referral to a colleague at the hospital’s ENT-department. This way I was able to contact specific ENT-surgeons hereby increasing the likelihood of participation in the research. Still, nobody was interested to be interviewed. This made me ask anesthesiologists about ENT-surgeons role in deciding the appropriate ventilation method. They told me that solely anesthesiologists are responsible for this decision and little negotiation takes place about a preferred catheter size.

Dolphys’ belief that anesthesiologists distinguish between ventilators on functionality, i.e. jet ventilation and conventional ventilation was not true. Instead, they distinguished between ventilators on the hospital unit where it is installed, which can either be OR, ICU, or emergency.

Furthermore, ‘the anesthesiologist’ does not exist. Dependent on the hospital unit where the anesthesiologist works, their expectations of EVA differ. The conversations with anesthesiologists with different backgrounds in terms of education and experiences provided insight into the heterogeneity of the group. Before I held the interviews I hypothesized that there is only one type of anesthesiologist. Along the way it became clear that in line with the three units (OR, ICU, and First Aid) where anesthesiologists work, other goals, experiences, and preferences were important. In short, anesthesiologists who work at the OR are knowledgeable about anesthesia workstations, which include a gas distribution system, and are more into technical features. In contrast, anesthesiologist-intensivists (or internist-intensivists) work at the ICU and are more focused on lung physiological aspects instead. They were aware of ventilators limited only to their work location. For anesthesiologists in the OR it was relatively easier to think of ICU ventilators than for intensivists to think of anesthesia workstations, because they are used to the high level of complexity of anesthesia workstations.

In summary, the existence of gap 3 has been proven by the above. As long as the heterogeneity of the anesthesiologists group is not acknowledged and translated in different target groups, this gap cannot be closed.

4.4 Prioritising the gaps
This section presents the diagnosis of the business problem and combines the insights from the analyses of gap 1, 2, and 3 into a coherent explanation. The issues that were identified
relate to the following areas: market segmentation, target groups, functionality, hospital unit, and product perception.

First, Dolphys’ market segmentation should be limited to the field of anesthesiology, other medical specialties, like ENT-surgery, are irrelevant for the adoption decision as only the anesthesiologist is held accountable for safe and effective ventilation of patients.

Second, anesthesiology as a market segment is not well defined. ‘The’ anesthesiologist does not exist. Instead, the ventilation market can be divided in three major segments: OR, ICU, and transport ventilators. Each market segment has its own characteristic visual aesthetics and functionalities that allow anesthesiologists to categorise the ventilator more easily. No difference was found between academic and top clinical hospitals.

Third, Dolphys marketing teams assumption that anesthesiologists make sense of the Dutch OR ventilation market by using functionality (conventional ventilation or jet ventilation) as a criterion has been falsified. An explanation for this finding might be the intense collaboration of Dolphys with Dr. Enk from AZM. As Dr. Enk is only one individual, working in one specific hospital, his perception of the Dutch ventilation market might not have been reliable.

Fourth, Ventrain’s product design suggests that it fits within the manual emergency devices group. The product label convinced anesthesiologists to create a new product category.

The issues mentioned above provide an adequate explanation of the business problem. In summary, gap 1 was proven irrelevant, whereas gap 2 and 3 are important to pay attention to. Here, Part I of the report ends. Next, Part II starts with a description of the methodology that was used to come up with a solution to cross gap 2 and 3, which is presented in Chapter 5. The final solution including an implementation plan is explained in Chapter 6.
Part II Towards a solution
5 Methodology for a science-based solution design for Gap 2

Since the project aimed at improvement, it did not stop when a valid and reliable analysis and diagnosis of the business problem had been made. Based on both the theoretical analysis and the empirical analysis, a solution for Dolphys’ business problem was designed. There are two main products that resulted from the design activity, being the object design and the realisation design (Van Aken, Berends, & Van der Bij, 2012). While the object design is the description of the actual solution, the realisation design explains how the solution is to be created in reality.

5.1 Decisions of solution design process

Since this project’s aim is to deliver a solution for Dolphys’ marketing team, this solution design follows the principle of minimal specification of design requirements. According to this principle, Dolphys’ marketing team that realises this solution design creates a second solution design by the very act of interpreting and acting on the instructions in the original solution design and incorporating it into their existing activities. This implies that the solution design I propose in this research should be interpreted as a means to an end instead of a strict recipe to follow.

In Figure 10, the process that led to the detailed solution design is presented. The first stage aimed at a definition of the solution space, which is restricted by Dolphys’ organisational context. In parallel alternative solution directions were developed based on the theoretical and empirical analyses. The second stage evaluated the alternative solution directions given the previously defined solution space. Finally, in the third stage the object design and the realisation design were detailed. Below, each stage is explained in more detail.

The outcomes from the diagnosis were used to formulate design requirements (functional requirements, user requirements, boundary conditions, design restrictions) for the solution design. Input for these design requirements came from several interviews with Dolphys’ employees during the project to be able to come up with a tailor-made solution design.

Also, in parallel five alternative solution directions were formulated. The design activity is fundamentally different from the analysis and diagnosis that precedes it. For design, issues of validity and reliability are no longer of interest since it does not focus on answering questions about reality, but at improving reality. An important aspect of designing
is that there is no single best way to reach the goal. This is why several directions for the
solution design were explored.

Next, these solution directions were synthesised into a final solution design, which fits in the
remaining design space. Both an object design and realisation design were included in the
solution design and then were worked out in detail. The object design was guided by the
interviews held with anesthesiologists and employees of Dolphys’ marketing team to a large
extent. In addition, the practical clinical marketing framework developed by Appelt & Hauser
(2006) was used to guide the detailed solution design.

The realisation design primarily identified and addressed the objectives of individual
members of the marketing team in order to develop an action plan guiding the organisational
change process. Although not followed to the letter, the 8-step process as described by
Kotter (1996) did inform the action plan. To this end, the implementation plan should guide
organisational change and help Dolphys become a mature organisation. In addition the
paper of Sashittal & Jassawalla (2001) on marketing implementation in smaller organisations
proved to be helpful given the phase Dolphys is currently in. The authors suggest that
marketing implementation emerges as organisation’s adaptive response to day-to-day
market events that is rarely scripted by plans and as a process that involves purposeful
actions and improvisations as much as stop-gap actions and fire fights. The nature and
extent of implementation-related improvisations appear to directly affect a firm’s market
orientation, rate of growth, and strategic effectiveness. The last step of the design science
process involves solution design testing. However, being a graduation project of limited time,
the actual intervention and its evaluation are not carried out. The change plan provides a
blueprint of how implementation could take place. From this point onwards, it is up to
Dolphys’ marketing team to implement, evaluate, and possibly adjust the new design. In case
the solution design is proven unsatisfactory, an extra iteration of the design science process
might be required. In this way the design process was hierarchically decomposed into two
levels of increasing detail (see Figure 10).
6 The solution and implementation plan addressing Gap 2

Part I of this report ended with ‘analysis and diagnosis’. A major conclusion was that gap 2 should be addressed first, because most issues that anesthesiologists dealt with were related to a mismatch between anesthesiologists’ perception and expectations of EVA. In this chapter I present the ‘plan of action’, which involves solution design and design of the change plan. The set of formulated design requirements (Section 6.1) globally determines what the solution design will look like. Within the remaining solution space five specific directions for the solution design are presented (Section 6.2) and combined into one solution design (Section 6.3). Hereafter, the solution design is detailed (Section 6.3). Finally, the implementation plan is presented next (Section 6.4).

6.1 Solution space: set of design requirements

Using the solution design theory from Van Aken et al. (2012), four categories of requirements are to design the solution. Functional requirements form the core of the requirements and specify the required performance of the solution design in order to solve the business problem. User requirements are those demands to the solution design that are important from the Dolphys marketing team’s point of view. Boundary conditions are constraints to the solution space that must be met unconditionally and solution design restrictions are constraints to the solution space that are negotiable. Table 6 shows the solution design requirements.

<table>
<thead>
<tr>
<th>Functional requirements</th>
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<tbody>
<tr>
<td>1. The solution design should promote the adoption of Ventrain, Cricath and in the future of Wanda, CNB-cath by anesthesiologists and intensivists.</td>
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<tr>
<td>2. The solution design should leave room for the introduction of additional products for the EVA portfolio in the future.</td>
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<td>3. The solution design should create a new product category for EVA and improve the product evaluation.</td>
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<td>4. The required time and effort of Dolphys’ marketing team should not exceed the expected increase in sales.</td>
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<table>
<thead>
<tr>
<th>User requirements</th>
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<tr>
<td>5. The solution design should take into account the competences of individual team members of the Dolphys marketing team.</td>
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<tr>
<td>6. The solution design should be user-friendly for the Dolphys marketing team.</td>
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<tr>
<th>Boundary conditions</th>
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<tbody>
<tr>
<td>7. The solution design should be delivered at the start of April 2014.</td>
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<tr>
<td>8. The solution design should take into account the current instructions for use of Ventrain conform the CE-mark.</td>
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<td>9. The solution design should be implemented in phases and adjusted to secure Dolphys’ current client base.</td>
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<tr>
<th>Design restrictions</th>
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<tr>
<td>10. The solution design should be cost-neutral, i.e. not require too much effort on part of the Dolphys team, unless the acquisition of additional resources is also part of the solution design.</td>
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<tr>
<td>11. The solution design should change as little as possible to Dolphys’ present business system.</td>
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6.2 Solution directions

The key decision in solution design is the choice of the solution concept. In total 5 solution directions that were sketched via synthesis iterations are presented and related to the specific issues they seek to address in Section 6.2.1-6.2.5. These issues cover the following areas: target groups (Section 6.2.1), market segments (Section 6.2.2), functionality (Section 6.2.3), work location (Section 6.2.4), and product perception (Section 6.2.5). Finally, these solution directions are elaborated in one complete solution concept (Section 6.2.6).
6.2.1 Solution direction 1: Target anesthesiologists and intensivists separately

Solely anesthesiologists and intensivists (either with a background in anesthesiology or internal medicine) are responsible for safe and effective ventilation of patients in respectively the operating theatre, the intensive care unit or emergency unit. Surgeons from other medical specialties are not really involved in the decision-making about airway management. For them the advantages of EVA lie in a free non-moving surgical site, not in ventilation matters. Thus, in the early commercialisation phase EVA should be marketed directly to anesthesiologists and intensivists. It is likely that they will propose to use EVA for example for heart surgeries to cardiologists. In this case anesthesiologists educate their colleagues of the cardiology department about EVA's benefits. This might lead to case publications in journals of cardiology in addition to journals of anesthesiology. This way EVA will slowly diffuse to medical specialisations other than anesthesiology.

It should be noted that the field of anesthesiology covers both airway management and pain relief management. As Dolphys only markets respiratory devices, only anesthesiologists in airway management are of interest.

Anesthesiologists’ and intensivists’ perspective on airway management slightly differ, because they treat patients with different lung conditions. Anesthesiologists usually ventilate patients with healthy lungs, because patients who undergo surgery not necessarily have a poor lung condition. Moreover, anesthesiologists tend to have a more technical point of view by emphasizing on quantitative measures as I/E-ratio and minute volume. Contrary to anesthesiologists, intensivists treat patients with sick lungs. Thus, intensivists mainly focus on lung physiological aspects, which can be considered as qualitative measures.

Recently, the gap between anesthesiologists and intensivists is widening as the OR and ICU are getting more isolated departments with their own staff and purchasing head. Also, as technology more and more takes over tasks of anesthesiologists in the OR, some argue that the role of anesthesiologists is rapidly taken over by machines and anesthesiologist-assistants. This would imply that there is no future for the specialization of anesthesiology in the OR, but only in the ICU.

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**Figure 11: Medical specialty vs. hospital unit.**

In short, the relationships between the medical (sub-) specialties and hospital units are visualised in Figure 11. Internists are out of the scope of this research, except for internist-intensivists. Together with anesthesiologist-intensivists, they control the ICU. Anesthesiologists without a subspecialisation in intensive care solely work at the ICU. Dependent on the patient who arrives at the emergency department, an anesthesiologist, anesthesiologist-intensivist, or internist-intensivist is called in for assistance. It should be noted that anesthesiologists that work at a trauma centre within a hospital or are part of a hospital.
Mobile Trauma Team (MMT) usually also work at the OR. However, in The Netherlands there are 11 trauma centres of which three have an MMT.

6.2.2 Solution direction 2: Differentiate between anesthesiologists with subspecialisations
Within the anesthesiologists target group, as already mentioned in solution direction 1, further differentiation based on subspecialisations is possible. EVA can be advantageous for highly specialised treatments, especially for difficult airways, where other ventilation concepts fail to deliver safe and effective ventilation. Many anesthesiologists in The Netherlands have subspecialisations in for example cardio-surgery, thorax-surgery, or children and neonates. On the national level the government appointed these subspecialisations to a number of academic and top clinical hospitals aiming at creating highly specialized health care centres. Following this trend patients with complex and/or rare diseases are referred to these specialised hospitals.

Instead of pushing EVA to all hospitals, Dolphys should make a shortlist of specialized hospitals that can directly benefit from EVA. By clustering these hospitals per clinical indication, marketing becomes more effective. After the number of innovators and early adopters amongst anesthesiologists affiliated with specialised centres reaches a stable level, anesthesiologists from other general hospitals are likely to follow soon.

6.2.3 Solution direction 3: EVA as an add-on ventilation mode
In terms of functionality, EVA has been introduced as a new ventilation mode that is not available on the ventilators from the competitors. For emergency situations it can be introduced as a replacement of a tracheostomy usually performed by an ENT-surgeon. This way the anesthesiologist stays in full control during the whole procedure without calling in an ENT-surgeon. Especially in top clinical and peripheral hospitals, this is a real advantage. For elective situations, EVA can be marketed as suitable for single-lung ventilation, which is usually performed with a conventional ventilator. In conclusion, EVA should be communicated as an alternative ventilation mode for both jet ventilation and conventional ventilation.

6.2.4 Solution direction 4: Hospital unit-specific product designs
Anesthesiologists deduct from a ventilator’s product design whether it is to be used at the OR, ICU, or ED. Since Dolphys claims that EVA is applicable to all four usage locations, four different product designs should be made. Alternatively, a universal product design that serves the whole ventilation market is unlikely to be accepted by anesthesiologists, because they may not believe it. Marketing three product lines can be advantageous for Dolphys sales volume, but disadvantageous from a viewpoint of standardisation and production.

From the user's point of three product lines fit with the classification of the ventilation market. OR, ICU, and transport ventilators each have their specific visual cues. When a new ventilator matches with one of these established categories, the user relies on his knowledge, beliefs, and experience with that category. Following this line of reasoning, in case the ventilator is to be used for the ICU, OR and the transportation between the hospital units themselves, one product design would be more sensible. At the same time human errors are more likely to occur and anesthesiologists might hesitate to actually use a ventilator that looks like one from another hospital unit.

6.2.5 Solution direction 5: Overcoming psychological barriers
EVA is communicated as ‘ventilation by suction’. As a result, sometimes EVA is associated with negative pressure ventilation. Today all ventilators on the market work with positive pressure. Negative pressure ventilators are not available anymore, because they have been proven to have negative lung physiological effects. Thus, anesthesiologists are likely to feel uncomfortable to adopt EVA.

Dolphys’ claim that EVA can fully ventilate a patient with an airway catheter of only 2 mm inner diameter is not easily accepted despite the availability of a number of clinical
studies. Because the patient’s airway is completely blocked with a cuff, expiration is only possible via the cuff, making passive expiration to the natural airway impossible. The airway catheter is likely to be perceived as too narrow for full ventilation or sucking out slime from the patient’s lungs, as ‘breathing through a straw’ is impossible. Plus, anesthesiologists do not take the risk of a kinked airway catheter lightly.

6.2.6 Alternatives based on combinations and selection
Next, the solution directions described above were evaluated on the extent into which they conform to the solution design requirements. Based on this evaluation and the mutual (in)compatibility of the different solution directions, a selection and synthesis of the solution directions leads to an integral solution design that is further detailed in the next section. Table 7 below shows the results of the evaluation of the solution directions.

Table 7: Evaluation of solution directions (* means selected for final solution design).

<table>
<thead>
<tr>
<th>Solution direction</th>
<th>Violated solution design requirements</th>
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<tbody>
<tr>
<td>1. Target anesthesiologists and intensivists separately</td>
<td>-</td>
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<tr>
<td>2. Differentiate between anesthesiologists with subspecialisations</td>
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<tr>
<td>3. EVA as an add-on ventilation mode</td>
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<tr>
<td>4. Hospital unit-specific product designs</td>
<td>-</td>
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<tr>
<td>5. Overcoming psychological barriers</td>
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All solution directions fit within the given solution space. None of the solution directions are mutually exclusive and therefore the final solution design attempts to incorporate a much of the positive features of the different solution directions. The final solution is mainly a combination of the first four solution directions.

6.3 Detailed solution design: the clinical marketing approach
The exhibition at the Anesthesiology 2013 is illustrative for the increasingly important role of evidence in marketing medical devices. Manufacturers are now following in the footsteps of the pharmaceutical industry, where EBM (evidence-based medicine), which includes clinical, research and experience evidence, is the standard. Figure 12 shows a strategic clinical marketing framework of how Dolphys should communicate EVA with potential customers. The clinical framework consists of six important steps: (1) selection of the ventilation philosophy; (2) identification of the target indication; (3) definition of the required product benefits; (4) evidence gap analysis; (5) definition and execution of the clinical marketing programme; and (6) strategic expansion of the product indications.

Figure 12: Clinical marketing framework (Appelt & Hauser, 2006).
Each of the steps of the clinical marketing framework will be elaborated in the sections below.

**Step 1: Selection of the ventilation philosophy**
The first step of the framework involves the selection of a ventilation philosophy, which can either be quantitative or qualitative. These philosophies are directly linked with anesthesiologists’ quantitative perspective and intensivists’ qualitative perspective on the expected performance of a ventilator.

**Step 2: Identification of the target clinical indication**
The identification of the target clinical indication is the most crucial step in the process as it determines the subsequent steps to a large extent. First, the ‘golden standard’ treatment for the target clinical indication should be identified and analysed in order to emphasize the need for the adoption of an innovation therapy, which in this case is EVA. Dependent on the selected target clinical indication, target organizational and individual adopters can be selected and approached. For this matter, the potential organizational and individual adopters that are considered to be the early adopters of EVA are introduced below.

*Merge academic and top clinical hospitals into one target segment*
Moreover, narrowly bounded and well-characterized market segments should be the target of all subsequent clinical marketing activities. The market penetration of any new technology can be described by the technology adoption life cycle with respect to different types of users that are applying the product throughout its lifecycle. In Graph 1 can be seen that given the fact that there are only eight academic hospitals located in The Netherlands, they still account for a large proportion (64%) of all different types of available treatments. Furthermore, I expected that since academic hospitals mostly treat patients that cannot be treated elsewhere, they are more likely to be the first group to adopt EVA. However, this hypothesis was proven false. Instead of the hospital type, the clinical experience mostly determined an anesthesiologist’s attitude towards EVA. In turn, clinical experience is directly related to treatments offered by a specific hospital, either academic or top clinical. Therefore, for the redesign of the marketing strategy it is important to consider both academic and top clinical hospitals as equally important target customers.

However, each of the potential market groups is characterised by a different marketing response. According to Moore (2002), it is very critical in the development of the market to achieve the transition from an early market dominated by a few visionary customers (early adopters) to a mainstream market (early majority) dominated by pragmatists. The gap between the early and the mainstream market is called chasm, which is very difficult to cross on one side and essential for the whole business success of high-tech innovations on the other side. For crossing the chasm, it is necessary to focus exclusively on achieving a dominant position in one or two narrowly bounded market segments. To define these market segments as early and as precise as possible is therefore an essential part of the clinical marketing framework.

The appointed level of the ICU can also define the Dutch ventilation market. All eight academic hospitals have level 3 ICUs, which treat the most difficult patients. 16 out of 28 top clinical hospitals have the same level 3 ICUs. The other twelve top clinical hospitals have level 2 ICUs (DHD-databank Kwaliteit, 2012). Academic and top clinical hospitals that are equipped with a level 3 ICU should be targeted first as these hospitals are most likely to treat patients with difficult airway problems.
Spread of specialisations over Dutch academic and top clinical hospitals
In Appendix 8 a shortlist of the most promising clinical indications for the marketing of EVA is presented. The online TRF-portal of the Nederlandse Federatie van Universitair Medische Centra (NFU) lists all clinical indications sorted per academic hospital or medical specialty.

Selection of most promising clinical indications
The list of clinical indications as presented above was discussed with Dolphys’ product manager in order to see which clinical indications have the largest sales potential. Mainly, cardio-thoracic surgery, upper airway surgery, and surgery on neonates form the largest market opportunity for Dolphys. In addition, trauma centres should be targeted next. Finally, CICV situations can occur in any hospital, thus non-specialised hospitals are likely to form the late majority.

Step 3: Definition of the required product benefits
The next step is to define the claims and analyse the evidence to support them (the term claim is equal to a product benefit in the proposed framework). In order to identify the claims that really ‘matter’, the clinical benefits, safety and economical outcomes of EVA need to be evaluated. There are also other possible benefits for the users of EVA like the ease of use or the product service. These categories were not included in the proposed framework because they are not closely related to the principles of EBM.

To help identify the relevant product benefits, a clinical advisory panel formed from experts in a defined segment (Key Opinion Leaders (KOLs)) can play a vital role in prioritising the real anesthesiologist requirements. The KOLs are also excellent sources for the identification of competitive products and treatments. For example, Dr. Enk is regarded as a KOL in difficult airway management and neonates. KOLs in other subspecialisations should be identified later. Qualitative and quantitative market research is a valuable tool in order to evaluate the relevance of the initially identified product benefits for a broad range of potential target group anesthesiologists.

Additionally, market research provides a better understanding of the anesthesiologist’s perception of competitive products, particularly in comparison to the defined claims of the new product. Internal evaluations include other functions such as R&D, product management and marketing, which can help provide information about the required product benefits in addition to the input coming from the potential market.

The required product benefits can be prioritised based on input from advisory boards and market research. The prioritisation is a key step in order to efficiently plan and execute the elements of the subsequent clinical marketing programme.

Step 4: Evidence gap analysis
The aim of the evidence gap analysis is to evaluate the highest available level of evidence for all of the required product benefits. In their study on diffusion of medical innovations in the UK, Lang, Wyer, & Haynes (2007) found that there was little correlation between strong
scientific evidence and opportunities for widespread translation of medical innovations. Thus, anesthesiologists are likely to use other forms of evidence during their adoption process.

The framework of Glasziou & Haynes (2005), which is depicted in Figure 13, represents the trajectory that evidence must take to be incorporated in clinical practice. The first stage involves getting the evidence straight, illustrated by increasingly more applicable information drawn from valid and important clinical research. The evidence-to-practice pipeline represents the trajectory that research evidence must take to be incorporated into clinical practice. In this process knowledge translation is viewed as encompassing four major disciplines (resource development and access, bedside evidence-based medicine, clinical quality improvement, and the use of decision aids), all of which improve the path from awareness to adherence.

However, there is no universal trajectory for the uptake of EVA. The discussion on the importance of evidence showed that anesthesiologists might enter the trajectory at any point, dependent on their personal preference. For example, some anesthesiologists emphasised the need of animal and clinical studies, whereas others believed that case reports in combination with a product demonstration are sufficient to make an adoption decision.

Figure 13: A model for closing the evidence-to-practice gap (Glasziou & Haynes, 2005).

**Step 5: Definition and execution of the clinical marketing programme**

Following the distinction between a quantitative and qualitative perspective on ventilation, the category cues that can be used to close the gap between anesthesiologist’s expectations of EVA and the message communicated by Dolphys. This is done by introducing EVA as an add-on ventilation mode that can be interpreted as an extension of the installed ventilator that is to be used for specific clinical situations, like difficult airways. Thus, EVA’s product design should have certain similarities with transport ventilators.
Table 8: Definition of category cues for both ventilation philosophies.

<table>
<thead>
<tr>
<th></th>
<th>Anesthesiologist - quantitative</th>
<th>Intensivist - qualitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product design</td>
<td>OR / transport ventilator</td>
<td>ICU / transport ventilator</td>
</tr>
<tr>
<td>Product label</td>
<td>spacious surgical site, in support of the surgeon</td>
<td>better lung physiology</td>
</tr>
<tr>
<td>Technical specifications</td>
<td>small-lumen, easy insertion</td>
<td>active slime removal through suction</td>
</tr>
<tr>
<td>Clinical indications</td>
<td>single-lumen ventilation</td>
<td>ventilator-associated pneumonia (VAP)</td>
</tr>
</tbody>
</table>

**Step 6: Exploration of strategic expansion of indications**

The strategic expansion of indications is a crucial step in order to expand market potential and future revenue predictions. The clinical marketing framework can be extremely helpful for the systematic exploration of new indications as well for EVA devices that are already established for particular target indications. The proposed work stream is the same – starting with the characterisation of the target indication followed by the definition and execution of the clinical marketing programme.

The solution design includes the EVA marketing strategy, which is described above, and the systems used to support this strategy. It is an integral solution that mainly addresses solution directions 1 and 2 for the solution design into one final solution. The next section describes the implementation plan for Dolphys.

**6.4 Implementation plan**

The implementation plan is the realisation design, which provides a model of the process through which the object design is to be realised in Dolphys’ organisation. It defines how the changes that were proposed in the previous sections can be put into practice. To this end, first a ‘delta analysis’ is presented which identifies the main objectives of the solution design, the expected resistance against each of these objectives, and possible countermeasures to overcome this resistance. Next, the action plan describes the actions that are to be taken to realise the objectives of the solution design. Kotter’s (1996) eight-step model for organisational change was used as an outline for this implementation plan. To achieve the main objectives of the solution design several actions must be undertaken. Furthermore, action is needed to create social support for the implementation. Some of these actions were already carried out during the project.

**Step 1: Establish a sense of urgency**

Establishing a sense of urgency is crucial to gaining needed cooperation. The CEO, and founder, of Dolphys takes the lead in this process by taking the following actions:

1. Stop measuring sub-unit performance based only on narrow functional goals. Insist that the R&D team and marketing & sales team be held accountable for broader measures of business performance;
2. Send more data about distributor and anesthesiologist satisfaction and financial performance to more employees. Especially information that demonstrates weaknesses vis-à-vis the competition;
3. Insist that people talk regularly to unsatisfied distributors and anesthesiologists, unhappy suppliers, and disgruntled investors;
4. Use consultants and other means to force more relevant data and honest discussion into management meetings;
5. Put more honest discussions of Dolphys’ problems in speeches. Stop “happy talk”;
6. Bombard people with information on future opportunities on the wonderful rewards for capitalising on those opportunities, and on the organisation’s current inability to pursue those opportunities. For example, an increase in revenue for the EVA product portfolio can be used for development of new technology. The CEO launches the initiative in a ‘kick-off’ event.
Step 2: Create the guiding coalition
The transformation should be guided by a coalition. As this research focused on the adopter side, the marketing & sales team has the broadest expertise and highest credibility to lead the R&D team through the change process. Trust should be created with joint activities and a common goal should be developed to assure commitment of both teams.

Step 3: Develop a vision and strategy
The most critical factor for a successful change process are the vision and strategy for the short and long term. The CEO is the visionary in this matter. He identified the market opportunity for EVA and wrote the business plan. Because the CEO, product manager, and account manager alternately accompanied the interviews with anesthesiologists and discussed the solution design in several meetings, they are knowledgeable of anesthesiologists’ perceptions and expectations of EVA. Due to this, they are able to guide the R&D team and marketing & sales team through the change process. Being closest to the market the marketing & sales team are able to translate anesthesiologists’ perceptions and expectations in improved marketing tactics and operations. In the end, they can inspire others to participate and contribute to the change.

Step 4: Communicate the change vision
During this project the change vision was extensively communicated within the marketing & sales team. Also, each of them participated in the interviews with potential adopters. Furthermore, the new marketing strategy was evaluated with the CEO and product manager. The end of this project is marked with a final presentation for the whole Dolphys team, which directly serves as a kick-off meeting to start with the actual implementation. Afterwards, this implementation plan will be validated in the field and customized to Dolphys’ needs if necessary.

Step 5: Empower employees for broad-based action
The impact of the new marketing strategy on Dolphys’ culture and systems is also of significant importance. By comparing the current situation with the proposed solution design, the main objectives to be accomplished were determined. The objectives are the goals to be achieved in order to reach the desired state of affairs. The new marketing strategy was matched with Dolphys’ current issues that were identified in Figure 2 to identify the following main objectives:

1. Improve Dolphys’ perception of anesthesiologists’ expectations of EVA.
2. Target anesthesiologists and intensivists as separate market segments.
3. Target clusters of hospitals specialized in the same treatments.
4. Start research projects with specialized hospitals to close the evidence gap and increase the number of product champions.
5. Develop marketing materials separately for specific clinical indications.
6. Rethink Ventrain and Wanda’s product designs.
7. Training of distributor for The Netherlands.

Table 9 plots the main objectives against the five sources of resistance mentioned in Van Aken, Berends, & Van der Bij (2012). If resistance can be expected from one or more stakeholders, the cell is marked with an X. The stakeholders in this solution design are Dr. Enk, the Dolphys team and the investor. In general, little resistance is expected, because, so far, the Dolphys team has positively received the solution design.
A lack of understanding is a possible source of resistance for the evaluation of the product designs of Ventrain and Wanda. This is possibly the most rigorous intervention for Dolphys. In case adjustments have to be made, this affects the complete chain from R&D to marketing & sales. In general, little resistance is expected as Wanda currently is still in the development phase.

Differences in opinion may also play a role, especially concerning the redefinition of the market segments. While Dr. Enk’s invention of EVA was triggered by his own personal needs and experiences at the OR, applications of EVA in other market segments may have been neglected at the time. Also, each stakeholder’s perspective on market research differs leading to a lack of consensus.

Low willingness to change can also be an issue. Especially if Dolphys’ team members do not see many problems in the current situation, the lack of a feeling of urgency may result in low willingness to implement the solution design. However, since Ventrain is just the first product of the newly introduced EVA product portfolio and the product market has not been stabilised yet, this kind of resistance is expected to be low.

The analysis of the resistance is the basis for the design of the intervention strategy. This design of the intervention strategy builds on Tichy’s TPC-model (Tichy, 1983). Of the three general intervention types – technical, cultural, and political – the main type that should be used to counteract resistance is technical intervention. For the solution design to bear fruit, the stakeholders must be provided with information to understand the business problem itself and its strategic context, and the new business system that should solve the problem. If the rationale behind the solution design and its value for the stakeholders are made clear, resistance due to a lack of understanding, differences in opinion, and low willingness to change should decrease. Furthermore, participation of all stakeholders should be encouraged.

**Step 6: Generate short-term wins**
In order to increase commitment, thus easier implementation, short-term wins should be generated. First, Medica Europe’s replacement orders give a good indication of the actual sales. Special attention should be given to sales levels over longer time periods to identify trends and be able to verify sustainable market growth. Second, people who made the wins possible should be visibly recognised and rewarded. Third, case reports of potential adopters should be well documented to allow employees to evaluate customer satisfaction.

**Step 7: Consolidate gains and produce more change**
The increased credibility of the change vision can now be used to change all systems, structures, and policies that don’t fit the transformation vision. Now Dolphys is becoming more and more mature as a firm, more specialised skills are required to further penetrate the ventilation market. To produce even more change extra professional people could be hired that can train the other team members.

**Step 8: Anchore new approaches in the culture**
To reach a sustainable situation the new approaches should be anchored in Dolphys’ culture. This situation can be reached by creating better performance through customer- and productivity-oriented behaviour, more and better leadership, and more effective management. The connections between new behaviours and organisational success can be
articulated by adoption metrics. The effectiveness of the new marketing strategy can be measured by the number of adopters and the adoption rate. The impact on business performance follows from the number of products sold via Medica Europe. Then, these metrics should be communicated frequently against the baseline measurement.

6.5 Conclusions
This chapter sought to answer sub research question 4. In total, five solution directions were identified and subsequently evaluated against the given solution space. The final solution design combined three solution directions with the clinical marketing framework of Appelt & Hauser (2006). The new marketing strategy as introduced in Section 6.3 follows a six-step process to better meet anesthesiologists’ expectations and ultimately increase Dolphys’ sales level. In Section 6.4 an implementation plan for the new marketing strategy based on the 8-step model of Kotter (1996) was presented. Next, the conclusions that can be drawn from Part I and II of this research are presented in Chapter 7.
7 Conclusions & discussion

7.1 Conclusions

In this project the challenges that high tech entrepreneurs face in market and potential customer identification for radical healthcare innovations have been studied. The empirical analysis consisted of a case study at Dolphys Medical B.V., an entrepreneurial firm that develops and markets a series of medical devices based on a new ventilation concept, which is officially registered as EVA (expiratory ventilation assistance). Dolphys initially focused only on the emergency market, but wants to make the transition to the much bigger elective market in the near future. Because the EVA ventilation concept has attributes of two well-established ventilation concepts (conventional and jet ventilation) on the Dutch ventilation market, it was a very interesting case for a study into effective external communications of the high tech entrepreneur to potential customers.

Dolphys had a direct problem from a commercial perspective, because the sales figures were lagging behind. Moreover, the marketing team had the feeling that anesthesiologists’ adoption decision was negatively affected by their confusion about the concept’s attributes. The problem was therefore defined as a mismatch between anesthesiologists’ perception and expectations of EVA.

To address this problem a research design according to the embedded case study set up was set up. It consisted of an analysis of anesthesiologists’ perception of EVA, which was mainly based on semi-structured interviews including a card sorting task with anesthesiologists from academic and top clinical hospitals, and a document study. Furthermore, anesthesiologists’ expectations from EVA were studied in-depth through open interviews. A theoretical framework that linked Dolphys ‘understanding of anesthesiologists’ expectations through their external communications to the adoption process guided the entire analysis. The adoption process includes both a subjective and objective evaluation of the new product. Where the subjective evaluation is about consumer’s cognitive response (categorisation and product beliefs) to a new product, the objective evaluation covers individual and organisational attributes that drive adoption.

The analysis revealed that categorisation uncertainty was not such much an obstacle as expected. In the current situation anesthesiologists’ evaluation of EVA is mainly guided by their past experience, word-of-mouth, and personal needs of similar products assigned product category. Their expectations are highly dependent on their professional background as either anesthesiologist or intensivist plus additional sub specialisations for specific clinical indications. Also, Dolphys’ assumptions about anesthesiologists’ needs and wants have been clarified. Previously Dolphys used the sharp distinction between conventional and jet ventilation in their market stories, but this was shown to be irrelevant in the discussion with anesthesiologists.

Based on the diagnosis five solution directions were identified. After the solution space was defined by a set of design requirements, the solution directions were combined into one final detailed solution. In the new marketing strategy six steps can be distinguished: (1) selection of the ventilation philosophy; (2) identification of target clinical indication; (3) definition of the required product benefits; (4) evidence gap analysis; (5) definition and execution of the clinical marketing programme; and (6) exploration of strategic expansion of indications. Also, an implementation plan was made to guide Dolphys through the transition to the new marketing strategy. It roughly followed Kotter (1996) 8-step plan for organisational change. The solution design and implementation plan were evaluated with the product manager. The session showed that the solution was feasible and that user acceptance was high. It also yielded some points of further attention.

For Dolphys the project has resulted in a new marketing strategy ready-made for the future expansion of the EVA product portfolio. To create social support for the solution it has been presented to and discussed with the complete Dolphys’ team.
All in all, the project has resulted in a solution that is both based on empirical analyses and grounded in relevant academic theory. Now that all the preconditions are in place, only time will tell whether the proposed interventions really have their desired effects.

7.2 Discussion
This project consisted of theoretical and empirical analyses, the results of which I now reflect upon. First, I present the contributions to the academic literature. Second, I assess the duality of rigor and practical relevance of this study. Third, I indicate the study’s limitations and explore the directions for future research.

7.2.1 Contributions to marketing science
The first contribution of this study to marketing science is that it yielded a model that incorporates both a subjective and objective evaluation of a new product. Moreover, in the currently available literature on adoption of healthcare innovations only the objective evaluation, which is affected by innovation attributes at the individual and organisational level, is addressed. This empirical study is the first study to acknowledge that the objective evaluation is preceded by a subjective evaluation of the new product.

Second, this study contributes to categorisation research in a B2B context. The available studies mostly described consumer’s categorisation process of consumer electronics. As high tech entrepreneurs usually target niche business markets, their power to influence the stabilisation process of a new product market is high. On the other side, early involvement of customers in the product development process may lead to a tunnel vision of the entrepreneur, whose perception of potential customers’ expectations of the new product is solely based on a limited number of sources. Therefore the entrepreneur should not limit the market research to the market knowledge of the inventor of the technology. They have to verify their assumptions of what potential customers might expect from their innovation by talking to them regularly.

Third, customer segmentation precedes the categorisation and adoption process. Category cues aid the categorisation process, when they match with customer’s knowledge and beliefs. Contrary, category cues cause more cognitive strain if the ‘wrong’ customer group is targeted. Thus, a sharp distinction between customer groups is crucial for effective and efficient communication.

7.2.2 Assessment of the duality of rigor and practical relevance
In Chapter 1 it was already stated that this project has two complementing objectives. First, Dolphys’ business problem should be analysed and solved. Second, in the tradition of grounded theory the empirical results found in this case study should also add to the development of an exploratory broader theory. In Table 10, the study’s objectives are evaluated against a set of eight criteria to assess the rigorousness of research as suggested by Shrivastava (1987). Rigor is measured by conceptual adequacy, methodological rigor, and accumulated evidence. Practical relevance is assessed by using meaningfulness, goal relevance, operational validity, innovativeness, and cost of implementation as criteria. Below each criterion is discussed.

<table>
<thead>
<tr>
<th>Rigor</th>
<th>Rigor variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conceptual adequacy</td>
<td>Literature stream is on healthcare innovations, whereas the Dolphys case focuses on a subgroup medical devices</td>
</tr>
<tr>
<td></td>
<td>All categorisation studies in B2C context, but Dolphys case is B2B</td>
</tr>
<tr>
<td>Methodological rigor</td>
<td>All collected data are qualitative</td>
</tr>
<tr>
<td></td>
<td>The nature of Dolphys’ business problem is very explorative</td>
</tr>
<tr>
<td>Accumulated empirical evidence</td>
<td>Limited to The Netherlands</td>
</tr>
<tr>
<td></td>
<td>Inclusion of academic and top clinical hospitals in research sample</td>
</tr>
<tr>
<td></td>
<td>The anesthesiology research sample was more fragmented than expected</td>
</tr>
</tbody>
</table>
Practical relevance | Practical relevance variables
---|---
Meaningfulness | Research preparation was carried out at case study site  
| Start and final presentation for Dolphys team  
| Marketing employees were actively involved in interviews with anesthesiologists
Goal relevance | Innovation and categorisation attributes are very relevant after target groups within anesthesiology have been pointed out
Operational validity | An implementation plan is part of this project  
| The internal organisation is not studied in-depth
Innovativeness | Non-obvious research findings that led to a redefinition of the anesthesiology market
Cost of implementation | Low, if new strategy is developed in parallel with the development and launch of Wanda

**Conceptual adequacy.** The theoretical framework that guides the research builds on organisational adoption of healthcare innovations and consumer studies on categorisation of new products. Dolphys largely fits within these research programmes, but has two minor shortcomings. First, Ventrain and Wanda are medical devices, which are in turn part of the group healthcare innovations. In several studies authors referred to patient data systems as healthcare innovations as well, inhibiting the generalisation of this case study finding to a broader theory. Second, it is likely that the B2B context of Dolphys is more complex than the categorisation of consumer electronics in a B2C context.

**Methodological rigor.** The methods used are relatively subjective, because they deal with qualitative data, interpretive data, and intuitive inferences. However, due to the exploratory nature of Dolphys’ business problem this strategy is legitimate. Future research is likely to include a quantitative analysis of gap 2 in the form of a survey.

**Accumulated empirical evidence.** The scope of this study is limited to Dolphys’ home market, The Netherlands. Therefore, empirical evidence cannot be directly generalised to other countries. Anyway, the inclusion of academic and top clinical hospitals in the research sample was proven correct. During the research I found that not only anesthesiologists, but intensivists as well should be included in the research sample. As a result, the number of intensivists interviewed is lagging behind. This issue also arose the inclusion of anesthesiologists working at trauma centres. Initially this group was left out of the scope of this research, because it was thought of as less relevant and the number of potential respondents was limited. Later, it became clear that they could be regarded as specialised anesthesiologists in difficult airway management.

**Meaningfulness.** The results and new marketing strategy were comprehensible for the Dolphys team. To assure meaningfulness, I carried out the research preparation phase at Dolphys’ office talking to all employees. Especially discussions with the CEO were helpful to refine the problem statement. At the start of the project I presented them my research plan to increase their commitment. In addition to this report, also a presentation was given to allow employees to discuss the organisational reality of the proposed actions.

**Goal relevance.** The innovation and categorisation attributes are very relevant to organisational and managerial goals. But, in order to detect differences caused by these attributes between potential adopters, Dolphys’ target groups should first be redefined as the heterogeneity of anesthesiologists is much more prevalent than expected by Dolphys.

**Operational validity.** To assure actionability an implementation plan was written. After this project it is up to Dolphys to evaluate and, if necessary, further improve or possibly abandon the implementation plan. Since Dolphys’ internal organisation was out of the scope of this project and not studied in-depth, it is likely that some adjustments need to be made afterwards.

**Innovativeness.** The research results are non-obvious to Dolphys, but maybe are obvious to other practitioners. This might be explained by the fact that in the beginning Dolphys heavily relied on Dr. Enk’s research group at Academic Hospital Maastricht for market information.

**Cost of implementation.** This study is timely available for the introduction of Wanda making implementation not too expensive. However, as this project proposes a marketing strategy for the complete EVA product portfolio, extra costs for adjustments for Ventrain are to be expected. For example, new brochures have to be designed and printed and Medica Europe has to be trained.
All in all, a dual orientation towards rigor and practical relevance is present, which is emphasised by using the design science methodology as a guideline in this project. Anyway, practical relevance outbalances rigor due to the explorative nature of the research question of this project.

7.2.3 Limitations and avenues for further research

During this project my role as a consultant was to alleviate Dolphys' business problem. This position was sometimes difficult to maintain, because (potential) interviewees perceived this as a conflict of interest. Even so, some of them refused to participate in the research because they were unwilling to give Dolphys strategic advice without receiving any payment. Another issue might have been the presence of a colleague of Dolphys during the interviews, even though they were introduced as my company supervisor.

Ventrain is not yet widely diffused in Dutch hospitals, which increases the likelihood of interviewees' awareness of Ventrain. This implies that user experience has no significant role in the product evaluation, only the information presented during the interview. This approach is beneficial for the reliability of the research results. However, Ventrain's working principle is quite intuitively, which would be an argument for a product demonstration.

Also, not all anesthesiologists were able to talk about Wanda. This may be explained by the fact that the product design and product features had not yet been determined at the time when the interviews were held which led to a poor understanding of Wanda due to a lack of information and unanswered questions.

As EVA is a new ventilation concept without a long track record in terms of user experience and clinical trials, some interviewees felt that they lacked information to adopt the concept. In some conversations this resulted in a dead-end street, because the interviewee was unable and/or unwilling to have an in-depth discussion. The same effect occurred when the anesthesiologist saw no added value to his/her clinical practice.

In the beginning of this project we solely expected that the market opportunities for the elective use of EVA would lie only on the OR and ICU, thus the ED was excluded from the research sample. Given the fact that EVA is also applicable at the ED, although the market size is much smaller, difficult airway management is largely concentrated in the EDs and trauma centres.

As this is a study with a sample size of N=1 with eight embedded case studies though – more research is needed to test if the results obtained in this project are robust and whether they can be generalized to other contexts. First, the framework used in this project should be further tested and refined by carrying out more projects related to marketing of healthcare innovations. Such projects should indicate whether the framework has rightly modelled the causal relationships between the variables. Furthermore, the ‘signs’ of these relationships, i.e. positive or negative, and their magnitude should be established more firmly. This study has resulted in a first assessment of these effects but in light of the limited empirical data on which they are based they should be treated as hypotheses.
References


Moore, G. A. (2002). *Crossing the chasm: Marketing and selling high-tech products to


Appendix 1 EVA working principle

In a ‘cannot intubate, cannot ventilate’ (CICV) situation, jet ventilation (i.e. transtracheal cannulation and subsequent high-pressure source ventilation) can be life-saving (Caplan, Benumof, & Berry, 2003). Although Henderson, Popat, Latto, & Pearce (2004) state that jet ventilation has a low morbidity in elective cases, numerous case reports underline the risk of high-pressure source ventilation in emergency situations (Jaquet et al., 2006).

To achieve effective ventilation through a small lumen catheter (inner diameter 2 mm) a high-pressure oxygen source (15 L/min) for injection of oxygen and a patent upper airway for the egress of gas are needed. In case of complete upper airway obstruction conventional jet ventilation is ineffective and even dangerous. Examples of causes of an obstructed airway include laryngospasm, oedema and anatomical distortion. In combination with overvigorous jet insufflation the risk of air trapping emerges with subsequent barotrauma and haemodynamic instability (Cook, Bigwood, & Cranshaw, 2006; Cook, Woodall, & Frerk, 2011; Craft, Chambers, Ward, & Goat, 1990). Suction-generated augmentation of expiration has been proposed to minimize the risk of air trapping (Kiyama, Koyama, Takahashi, & Fukushima, 1991; Schumacher, Stotz, Schneider, & Urwyler, 1992) and to increase the achievable minute volume through a small-bore airway catheter (Eger & Hamilton, 1958).

Therefore, Dr. D. Enk, an anesthesiologist at the University Medical Center Maastricht (azM) with more than 10 years of experience in airway management, fully committed himself to study the feasibility of ventilation by suction, using the Bernoulli principle and jet entrainment. This ventilation concept not only supplies oxygen in the inspiration phase, but also provides active removal of gas from the lungs in the expiration phase by suction. The removal of gas by suctioning has been defined as expiratory ventilation assistance (EVA) and implemented for the first time.

EVA can provide full ventilation with an inspiration/expiration ratio of about 1/1 in a (artificially) blocked upper airway. In other words, with EVA it is possible to have expiration as fast as inspiration, e.g. 2 seconds inspiration to 2 seconds expiration. In comparison with passive expiration, EVA allows for a faster removal of air and gas from the patient’s lungs (see Table 11). This is especially true for small-sized catheters as the air resistance is lower. In general practice the achievable minute volume through a 2 mm catheter at an oxygen flow of 15 L/min is approximately 4 L/min. EVA is more effective and can reach an adequate minute volume of up to 7 L/min.

Table 11: I/E-ratios for passive backflow and EVA for several catheter lengths with a 2 mm inner diameter.

<table>
<thead>
<tr>
<th>Catheter length (cm)</th>
<th>70</th>
<th>60</th>
<th>50</th>
<th>40</th>
<th>30</th>
<th>20</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/E-ratio, passive backflow</td>
<td>1/6.83</td>
<td>1/6.20</td>
<td>1/5.60</td>
<td>1/4.91</td>
<td>1/4.13</td>
<td>1/3.17</td>
<td>1/2.37</td>
</tr>
<tr>
<td>I/E-ratio, EVA</td>
<td>1/1.57</td>
<td>1/1.48</td>
<td>1/1.39</td>
<td>1/1.29</td>
<td>1/1.22</td>
<td>1/1.08</td>
<td>1/0.99</td>
</tr>
</tbody>
</table>
## Appendix 2 Empirical studies of attributes of healthcare innovations in the organisational setting

**Table 12: Empirical studies of attributes of healthcare innovations in the organisational setting.**

<table>
<thead>
<tr>
<th>Author/year</th>
<th>Field of study</th>
<th>Innovation</th>
<th>Target adopter</th>
<th>Type of study and number of participants</th>
<th>Attributes tested</th>
<th>Attributes found to predict adoption</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>(M. Meyer, Johnson, &amp; Ethington, 1997)</td>
<td>Australian public health care system</td>
<td>IT system for human resource management</td>
<td>Managers</td>
<td>Survey of 133 potential users (67 usable replies)</td>
<td>Innovation attributes (task relevance, task usefulness) plus adopter characteristics and organisational variables</td>
<td>Only 3 factors were significant in the final model: task relevance, task usefulness, and physical access to the innovation.</td>
<td>Conclude that innovation attributes dominate for innovations whose impact is on the individual; but organisational variables dominate at team level.</td>
</tr>
<tr>
<td>(Yetton, Sharma, &amp; Southon, 1999)</td>
<td>Canadian public health</td>
<td>Practice guidelines</td>
<td>Nurses</td>
<td>Survey (51 replies) plus semi-structured interviews</td>
<td>Complexity, competing agency demands, lack of time.</td>
<td>Complexity, competing agency demands, lack of time.</td>
<td>Small study of borderline methodological quality but shows creative use of free text questions.</td>
</tr>
<tr>
<td>(Lia-Hoagberg, Schaffer, &amp; Strohschein, 1999)</td>
<td>Ambulatory care</td>
<td>Electronic medical record</td>
<td>Clinicians, managers, administrators</td>
<td>Survey of 115 individuals (83% response rate)</td>
<td>Compatibility, ease of use, image, relative advantage, result demonstrability, trialability, visibility, voluntariness</td>
<td>Different groups rated different attributes differently. Doctors perceived the EMR significantly less favourably than nurses and non-clinical respondents.</td>
<td>Actual adoption was not measured, but the finding that perceived attributes differ between professional groups is important and possibly generalizable.</td>
</tr>
<tr>
<td>(F. Lee, 2000)</td>
<td>Ambulatory care</td>
<td>‘Smart card’ medical record</td>
<td>Doctors, nurses, pharmacists, paramedics</td>
<td>287 (66% response rate)</td>
<td>Perceptions of 7 attributes of the innovation, 3 of the system context, plus ‘satisfaction’ and ‘quality of support’</td>
<td>Ease of use, compatibility, perceived quality of support, voluntariness, and information were significant predictors of use of the record.</td>
<td>Possible Hawthorne effect</td>
</tr>
<tr>
<td>(Aubert &amp; Hamel, 2001)</td>
<td>Public health</td>
<td>Systematic reviews</td>
<td>Public health doctors</td>
<td>147 (96% response rate)</td>
<td>Relative advantage, ease of use, compatibility</td>
<td>Ease of use was the only attribute that proved significant in the final model.</td>
<td>Organisational attributes (size, differentiation, slack resources) did not influence use.</td>
</tr>
<tr>
<td>(Dobbins, Cockerill, &amp; Barnsley, 2001)</td>
<td>Gynaecology</td>
<td>Clinical practice recommendations</td>
<td>Gynaecologists</td>
<td>Over 4000 clinical records; number of clinicians not stated</td>
<td>13 attributes</td>
<td>Compatibility with values, no change needed to routines.</td>
<td>Incompatibility with values associated with greater change in behaviour after audit and feedback.</td>
</tr>
<tr>
<td>Author/year</td>
<td>Field of study</td>
<td>Innovatio n</td>
<td>Target adopter</td>
<td>Type of study and number of participants</td>
<td>Category cues tested</td>
<td>Category cues found to predict adoption</td>
<td>Comment</td>
</tr>
<tr>
<td>----------------------</td>
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<td>----------------</td>
<td>------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>(Bloch, 1995)</td>
<td>-</td>
<td>-</td>
<td>Consumer</td>
<td>-</td>
<td>Product form</td>
<td>The form of a product elicits beliefs about product attributes and performance, influences how the product is categorised within and among product classes. Product forms with a moderate degree of incongruity with respect to existing forms elicit more positive cognitive responses than forms with low or high levels of incongruity.</td>
<td>The author introduces a conceptual model and several propositions.</td>
</tr>
<tr>
<td>(Meyers-Levy &amp; Tybout, 1989)</td>
<td>Food</td>
<td>Beverage</td>
<td>Consumer</td>
<td>Experiment 1: 102 people from an upper middle-class suburb in Chicago Experiment 2: 54 middle-aged managers and their spouses Experiment 3: 75 male graduate students</td>
<td>Product description with attributes, taste</td>
<td>Products that are moderately incongruent with their associated category schemas are expected to stimulate processing that leads to a more favourable evaluation relative to products that either are congruent or extremely incongruent.</td>
<td>-</td>
</tr>
<tr>
<td>(Ozanne et al., 1992)</td>
<td>Consumer electronics</td>
<td>Digital camera</td>
<td>Consumer</td>
<td>Experiment 1: 128 undergraduates Experiment 2: 83 undergraduates</td>
<td>Category label (traditional film-based cameras vs. computer scanners)</td>
<td>The findings from experiment 1 suggest that when two plausible category labels are activated sequentially, the label presented first has a dominant influence on consumers' perceptions of a new product. However, experiment 2 demonstrates that this primacy effect can be somewhat mitigated by providing consumers with explicit mappings from each of the two categories.</td>
<td>-</td>
</tr>
<tr>
<td>(Moreau et al., 2001)</td>
<td>Consumer electronics</td>
<td>Personal Digital Assistant (PDA)</td>
<td>Consumer</td>
<td>Experiment 1: 209 undergraduates Experiment 2: 120 graduates Experiment 3: 184 undergraduates</td>
<td>Visual depiction (perceptual) Category label (conceptual)</td>
<td>The results of three studies suggest that when an ambiguous product is described in terms of conflicting conceptual and perceptual category cues, a single category inference strategy is employed when the perceptually cued category is more familiar than the conceptually cued category.</td>
<td>-</td>
</tr>
</tbody>
</table>
The results of three studies suggest that when an ambiguous product is described in terms of conflicting conceptual and perceptual category cues, a single category inference strategy is employed when the perceptually cued category is more familiar than the conceptually cued category. In particular, inferences are based largely on the perceptually cued category under these circumstances. However, when the perceptually cued category is less than or equal to the conceptually cued category in familiarity, a multiple category inference strategy is employed and inferences are based on both the perceptually and conceptually cued categories.

Findings from four studies indicate that if a consumer cannot affix a category label to a new product with certainty, as can happen with innovative aesthetics, a product's newness will be underappreciated and product evaluations will suffer.

<table>
<thead>
<tr>
<th>Author/year</th>
<th>Field of study</th>
<th>Innovation</th>
<th>Target adopter</th>
<th>Type of study and number of participants</th>
<th>Category cues tested</th>
<th>Category cues found to predict adoption</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Moreau et al., 2001)</td>
<td>Consumer electronics</td>
<td>Personal Digital Assistant (PDA)</td>
<td>Consumer</td>
<td>Experiment 1: 209 undergraduates Experiment 2: 120 graduates Experiment 3: 184 undergraduates</td>
<td>Visual depiction (perceptual) Category label (conceptual)</td>
<td>The results of three studies suggest that when an ambiguous product is described in terms of conflicting conceptual and perceptual category cues, a single category inference strategy is employed when the perceptually cued category is more familiar than the conceptually cued category.</td>
<td>-</td>
</tr>
<tr>
<td>(Gregan-Paxton et al., 2005)</td>
<td>Consumer electronics</td>
<td>GPS/radar MP3/voice</td>
<td>Consumer</td>
<td>Experiment 1: 209 undergraduates Experiment 2: 120 graduates Experiment 3: 184 undergraduates</td>
<td>Product picture, product label</td>
<td>When an ambiguous product is described in terms of conflicting conceptual and perceptual category cues, a single category inference strategy is employed when the perceptually cued category is more familiar than the conceptually cued category. In particular, inferences are based largely on the perceptually cued category under these circumstances. However, when the perceptually cued category is less than or equal to the conceptually cued category in familiarity, a multiple category inference strategy is employed and inferences are based on both the perceptually and conceptually cued categories.</td>
<td>-</td>
</tr>
<tr>
<td>(Rajagopal &amp; Burnkrant, 2009)</td>
<td>Automobile</td>
<td>Car</td>
<td>Consumer</td>
<td>Experiment 1: 137 undergraduates Experiment 2: 77 undergraduates Experiment 3: 79 undergraduates</td>
<td>Category label</td>
<td>A new category label can reduce the effects of ambiguity and can improve product evaluation.</td>
<td>-</td>
</tr>
<tr>
<td>(Uekermann et al., 2010)</td>
<td>Consumer electronics</td>
<td>Nintendo Wii video-game controller</td>
<td>Consumer</td>
<td>Experiment 1: 67 students Experiment 2: 148 students Experiment 3: 80 students Experiment 4: 158 students</td>
<td>Visual aesthetic design</td>
<td>Findings from four studies indicate that if a consumer cannot affix a category label to a new product with certainty, as can happen with innovative aesthetics, a product's newness will be underappreciated and product evaluations will suffer.</td>
<td>-</td>
</tr>
</tbody>
</table>
**Appendix 4 Cover letter**

**Anesthesiology recipients**

Geachte [aanhef] [naam],

Mijn naam is Simon Doomernik en ik ben bezig met een afstudeeronderzoek aan de Technische Universiteit Eindhoven dat tot doel heeft de communicatie over beademingsapparatuur tussen leveranciers en medisch specialisten te verbeteren. In opdracht van Dolphys Medical zal ik door gesprekken met medisch specialisten een structuur vormen voor de classificatie van de verschillende producten in de beademingsmarkt.

Ik zou het erg waarderen als u uw meningen en ervaringen over het huidige aanbod aan beademingsapparatuur in een interview zou willen toelichten. Dit zal ongeveer 60 minuten van uw tijd in beslag nemen.

De resultaten van dit onderzoek worden uiteraard vertrouwelijk behandeld. Antwoorden van individuele medisch specialisten zullen niet aan anderen bekend gemaakt worden. Indien u een samenvatting van de interview resultaten wenst te ontvangen kunt u dit tijdens het interview aangeven.

Als u denkt niet de geschikte persoon van uw afdeling voor deelname aan dit onderzoek te zijn, verzoek ik u dit te melden. Het staat u vrij deze uitnodiging onder uw collega's te verspreiden.

Uw eventuele vragen beantwoord ik graag. U kunt mij telefonisch bereiken op nummer 06-xxxxxxxx of via e-mail op s.r.a.doomernik@student.tue.nl.

Alvast heel hartelijk dank voor uw bijdrage.

Met vriendelijke groet,

Simon Doomernik
Afstudeerder Faculteit Technische Bedrijfskunde
Technische Universiteit Eindhoven
Geachte [aanhef] [naam],

Mijn naam is Simon Doomernik en in het kader van mijn afstudeerproject van de masteropleiding Innovation Management aan de Technische Universiteit Eindhoven doe ik onderzoek naar de toepassingen en markt van beademingsoplossingen.

Dolphys Medical heeft een nieuw ventilatiesysteem, genaamd Ventrain, met bijbehorende transtracheale en cuffed-narrow-bore katheters ontwikkeld. Met het totaalconcept kan een patiënt door een dunne katheter van slechts 2,5 mm binnendiameter worden beademd, terwijl de luchtweg verder wordt afgesloten door een cuff. Dit is mogelijk doordat de expiratie actief ondersteund wordt.

De afgelopen weken hebben we al gesprekken gevoerd met anesthesiologen. Naar verwachting verandert echter niet alleen de beroepspraktijk van anesthesiologen, maar ook van KNO-artsen door deze innovatie. Om op een passende manier met KNO-artsen de klinische toepassingen van Ventrain te kunnen bespreken zijn we ook zeer geïnteresseerd naar uw mening over dit product.

Ik zou het erg waarderen als u uw meningen en ervaringen over het huidige aanbod op de beademingsmarkt en de mogelijke positionering van Dolphys' beademingsoplossing in een interview zou willen toelichten. Dit zal ongeveer 60 minuten van uw tijd in beslag nemen.

De resultaten van dit onderzoek worden uiteraard vertrouwelijk behandeld. Antwoorden van individuele medisch specialisten zullen niet aan anderen bekend gemaakt worden. Indien u een samenvatting van de interview resultaten wenst te ontvangen kunt u dit tijdens het interview aangeven.

Als u denkt niet de geschikte persoon van uw afdeling voor deelname aan dit onderzoek te zijn, verzoek ik u dit te melden. Het staat u vrij deze uitnodiging onder uw collega’s te verspreiden.

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Alvast heel hartelijk dank voor uw bijdrage.

Met vriendelijke groet,

Simon Doomernik
Afstudeerder Faculteit Technische Bedrijfskunde
Technische Universiteit Eindhoven
Appendix 5 List of interviewees

**Academic hospitals**

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Name</th>
<th>Function</th>
<th>Date</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>VU Medisch Centrum</td>
<td>H. Huitink</td>
<td>anesthesiologist</td>
<td>08-04-2013</td>
<td>cancer anesthesia</td>
</tr>
<tr>
<td>UMC St. Radboud</td>
<td>I. Hendriks</td>
<td>anesthesiologist</td>
<td>10-04-2013</td>
<td>Mobile Medical Team (MMT)</td>
</tr>
<tr>
<td>Amsterdam Medisch Centrum</td>
<td>R. Van Gaalen</td>
<td>anesthesiologist-assistant</td>
<td>16-05-2013</td>
<td>head of purchasing</td>
</tr>
<tr>
<td>Erasmus Medisch Centrum</td>
<td>M. Klimek</td>
<td>anesthesiologist</td>
<td>24-04-2013</td>
<td>awake brain surgery</td>
</tr>
</tbody>
</table>

**Top clinical hospitals**

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Name</th>
<th>Function</th>
<th>Date</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Catharina Ziekenhuis</td>
<td>M. Buise</td>
<td>anesthesiologist-intensivist</td>
<td>03-04-2013</td>
<td></td>
</tr>
<tr>
<td>Jeroen Bosch Ziekenhuis</td>
<td>R. Drost</td>
<td>anesthesiologist</td>
<td>06-04-2013</td>
<td></td>
</tr>
<tr>
<td>Máxima Medisch Centrum</td>
<td>P. Meijer</td>
<td>anesthesiologist</td>
<td>18-04-2013</td>
<td></td>
</tr>
<tr>
<td></td>
<td>W. Dijkman</td>
<td>internist-intensivist</td>
<td>23-04-2013</td>
<td></td>
</tr>
<tr>
<td>Antonius Ziekenhuis</td>
<td>E. Scholten</td>
<td>anesthesiologist-intensivist</td>
<td>01-05-2013</td>
<td></td>
</tr>
<tr>
<td>VieCuri Medisch Centrum</td>
<td>A. Harms</td>
<td>anesthesiologist</td>
<td>10-06-2013</td>
<td></td>
</tr>
<tr>
<td>Onze Lieve Vrouwe Gasthuis</td>
<td>E. Bulder</td>
<td>anesthesiologist</td>
<td>24-06-2013</td>
<td>cardio anesthesia</td>
</tr>
<tr>
<td>Canisius-Wilhelmina Ziekenhuis</td>
<td>I. De Man</td>
<td>anesthesiologist</td>
<td>26-06-2013</td>
<td>children anesthesia</td>
</tr>
<tr>
<td></td>
<td>R. Van Maanen</td>
<td>anesthesiologist-intensivist</td>
<td>26-06-2013</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M. Peters</td>
<td>anesthesiologist-intensivist</td>
<td>26-06-2013</td>
<td></td>
</tr>
<tr>
<td>Maasstad Ziekenhuis</td>
<td>K. Gigengack</td>
<td>anesthesiologist</td>
<td>27-06-2013</td>
<td></td>
</tr>
</tbody>
</table>

---

4 Note that these are only the names of those persons with whom a (semi-)structured interview was held. In the course of the project many other persons have also been consulted.

5 Initially anesthesiology-assistants were not included in the sample. The AMC secretary referred me directly to R. Van Gaalen as together with the anesthesiology professor he is responsible for the acquisition of innovative medical devices for the anesthesiology department.

6 During a phone call H. Van Meggelen (anesthesiologist) suggested that I should also talk to his colleague W. Dijkman, who is an intensivist. Later on it became clear to me that W. Dijkman’s background lies in internal medicine, not in anesthesiology. However, the interview turned out to be very fruitful.
Appendix 6 Interview protocol

Goal of interview
The semi-structured interviews’ held with anesthesiologists primary goal was to gain an understanding of how they position Ventrain and Wanda in their mental categories of the Dutch ventilator market in order to improve Dolphys’ communication strategy. First, the criteria they used to distinguish between the most widely used types of ventilators were of my main interest. Second, whether and under what circumstances anesthesiologists either create a new mental category for Ventrain and Wanda or integrate them in existing familiar categories was relevant to verify if Dolphys’ strategy of claiming a new product category for its EVA product portfolio is viable. Third, the effect of creation of a new product category on product evaluation was considered in order to shed light on how Dolphys may position its products successfully.

Interview technique
To acquire anesthesiologists’ tacit knowledge of the ventilator market, I chose to conduct a card sorting technique. The basic idea of the card sorting technique was simply to ask anesthesiologists to sort ventilators into groups based on similarity. Only the anesthesiologist set the criteria for the creation of the groups. This technique was a useful way of eliciting anesthesiologists’ product categories, and of finding out how much agreement and disagreement there was between them about the categories. Especially, the hypothesized effect of hospital type (academic or top clinical) was taken into account.
Initially, Dirk Van Asseldonk and Paola Vasters provided me with a short list of well-established ventilators from different brands (Dräger, GE, etc.) available on the Dutch market. Generally, manufacturers create distinct product groups, but not always on the same criteria. Therefore, I decided to include ventilators in the cards set based on the current and future intended use of Ventrain and Wanda. These include anesthesia workstations, jet ventilation systems (both automatic and manual), IC systems, transport ventilators, and manual resuscitators. Home ventilators were considered out of the scope. Also, patient groups that should be included were adults, children, and neonates.

A thorough online search activity yielded a long list of ventilator models, see Table 14. The underlying purpose of this list of ventilators was to cover all ventilation concepts instead of a complete overview of all different brands and models. To make sure that the number of ventilators was still conveniently manageable for repeated single-criterion sorts without missing out on any ventilation concept, the initial set of ventilators was pre-tested during the first interview. By grouping ventilators from the same product line of a manufacturer together, the final number of ventilators was lowered to 29 (...
Table 15).
<table>
<thead>
<tr>
<th>Table 14: Initial set of ventilators.</th>
<th>Table 15: Final set of ventilators.</th>
</tr>
</thead>
<tbody>
<tr>
<td>v01 fabian+nCPAP Evolution (Acutronic)</td>
<td>v01 fabian+nCPAP Evolution (Acutronic)</td>
</tr>
<tr>
<td>v02 Mistral (Acutronic)</td>
<td>v03 Monsoon (Acutronic)</td>
</tr>
<tr>
<td>v03 Monsoon (Acutronic)</td>
<td>v02 Mistral (Acutronic)</td>
</tr>
<tr>
<td>v04 Mark IV (AMBU)</td>
<td>v04 Mark IV (AMBU)</td>
</tr>
<tr>
<td>v05 Silicone Oval Plus (AMBU)</td>
<td>v05 Silicone Oval Plus (AMBU)</td>
</tr>
<tr>
<td>v06 Spur II (AMBU)</td>
<td>v06 Spur II (AMBU)</td>
</tr>
<tr>
<td>v07 TwinStream (Carl Reiner)</td>
<td>v07 TwinStream (Carl Reiner)</td>
</tr>
<tr>
<td>v08 Enk Oxygen Flow Modulator (Cook Medical)</td>
<td>v08 Enk Oxygen Flow Modulator (Cook Medical)</td>
</tr>
<tr>
<td>v10 Babylog VN500 (Dräger)</td>
<td>v10 Babylog VN500 (Dräger)</td>
</tr>
<tr>
<td>v11 Evita Infinity V500 (Dräger)</td>
<td>v11 Evita Infinity V500 (Dräger)</td>
</tr>
<tr>
<td>v12 Evita XL (Dräger)</td>
<td>v12 Evita XL (Dräger)</td>
</tr>
<tr>
<td>v13 Evita 4 (Dräger)</td>
<td>v13 Evita 4 (Dräger)</td>
</tr>
<tr>
<td>v14 Carina (Dräger)</td>
<td>v14 Carina (Dräger)</td>
</tr>
<tr>
<td>v15 Savina (Dräger)</td>
<td>v15 Savina (Dräger)</td>
</tr>
<tr>
<td>v16 Oxylog 3000 plus (Dräger)</td>
<td>v16 Oxylog 3000 plus (Dräger)</td>
</tr>
<tr>
<td>v17 Oxylog 2000 (Dräger)</td>
<td>v17 Oxylog 2000 plus (Dräger)</td>
</tr>
<tr>
<td>v18 Oxylog 1000 (Dräger)</td>
<td>v18 Oxylog 1000 (Dräger)</td>
</tr>
<tr>
<td>v19 Fabius Tiro (Dräger)</td>
<td>v19 Fabius Tiro (Dräger)</td>
</tr>
<tr>
<td>v20 Perseus A500 (Dräger)</td>
<td>v20 Perseus A500 (Dräger)</td>
</tr>
<tr>
<td>v21 Primus Infinity Empowered (Dräger)</td>
<td>v21 Primus Infinity Empowered (Dräger)</td>
</tr>
<tr>
<td>v22 Zeus Infinity Empowered (Dräger)</td>
<td>v22 Zeus Infinity Empowered (Dräger)</td>
</tr>
<tr>
<td>v23 Aespire 7100 (GE)</td>
<td>v23 Aespire 7100 (GE)</td>
</tr>
<tr>
<td>v24 Aespire View (GE)</td>
<td>v24 Aespire View (GE)</td>
</tr>
<tr>
<td>v25 Aestiva 5 (GE)</td>
<td>v25 Aestiva 5 (GE)</td>
</tr>
<tr>
<td>v26 Aestiva 7900 (GE)</td>
<td>v26 Aestiva 7900 (GE)</td>
</tr>
<tr>
<td>v27 Aestiva MRI (GE)</td>
<td>v27 Aestiva MRI (GE)</td>
</tr>
<tr>
<td>v28 Aisys Carestation (GE)</td>
<td>v28 Aisys Carestation (GE)</td>
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<td>v29 Avance Carestation (GE)</td>
<td>v29 Avance Carestation (GE)</td>
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<tr>
<td>v30 Engström Carestation (GE)</td>
<td>v30 Engström Carestation (GE)</td>
</tr>
<tr>
<td>v31 Engström Pro (GE)</td>
<td>v31 Engström Pro (GE)</td>
</tr>
<tr>
<td>v32 iVent 201 (GE)</td>
<td>v32 iVent 201 (GE)</td>
</tr>
<tr>
<td>v33 G5 (Hamilton)</td>
<td>v33 G5 (Hamilton)</td>
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<tr>
<td>v34 C3 (Hamilton)</td>
<td>v34 C3 (Hamilton)</td>
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<tr>
<td>v35 C2 (Hamilton)</td>
<td>v35 C2 (Hamilton)</td>
</tr>
<tr>
<td>v36 C1 (Hamilton)</td>
<td>v36 C1 (Hamilton)</td>
</tr>
<tr>
<td>v37 T1 (Hamilton)</td>
<td>v37 T1 (Hamilton)</td>
</tr>
<tr>
<td>v38 MR1 (Hamilton)</td>
<td>v38 MR1 (Hamilton)</td>
</tr>
<tr>
<td>v39 Galileo (Hamilton)</td>
<td>v39 Galileo (Hamilton)</td>
</tr>
<tr>
<td>v40 Raphael (Hamilton)</td>
<td>v40 Raphael (Hamilton)</td>
</tr>
<tr>
<td>v41 Arabella (Hamilton)</td>
<td>v41 Arabella (Hamilton)</td>
</tr>
<tr>
<td>v42 Servo-I (Maquet)</td>
<td>v42 Servo-I (Maquet)</td>
</tr>
<tr>
<td>v43 Puritan Bennett 840 (Covidien)</td>
<td>v43 Puritan Bennett 840 (Covidien)</td>
</tr>
<tr>
<td>v44 Manujet III (VBM)</td>
<td>v44 Manujet III (VBM)</td>
</tr>
<tr>
<td>v45 MEDUMAT Transport (Weinmann)</td>
<td>v45 MEDUMAT Transport (Weinmann)</td>
</tr>
<tr>
<td>v46 MEDUMAT Standard (Weinmann)</td>
<td>v46 MEDUMAT Standard (Weinmann)</td>
</tr>
<tr>
<td>v47 MEDUMAT Easy (Weinmann)</td>
<td>v47 MEDUMAT Easy (Weinmann)</td>
</tr>
<tr>
<td>v48 MEDUMAT Easy CPR (Weinmann)</td>
<td>v48 MEDUMAT Easy CPR (Weinmann)</td>
</tr>
</tbody>
</table>
Procedure
Once the products had been chosen, it was necessary to prepare the items to be used in the
sessions, and to prepare the instructions for the anesthesiologists.

Preparing the items
I used a set of pictures of ventilators printed on cards for all sorting sessions. The pictures
were all of the same size and as similar as possible with regard to glossiness and other
extraneous but possibly distracting factors. The cards should likewise all be the same size.
Therefore, I used standard filing cards (A6). Also, it was easy to add more cards to the pack
during the session, if need arose, though this did involve handwritten cards. All items were
numbered for recording the results. The numbers should be clear and unambiguous (e.g.) ‘6’
and ‘9’ may cause confusion with object sorts, if it is not clear which way up the object and
number go).

Instructions
The instructions needed to make it clear what the anesthesiologists were expected to do,
using a ‘toy’ example to demonstrate this. The toy example was chosen from a completely
different domain, to reduce the risk of cueing, and should usually be familiar to the
anesthesiologist. In order to reduce the risk that the last few anesthesiologists would behave
differently from the first ones, the same instructions are used for each session. In Box 1
sample instructions can be found.

Conducting the session
Once the anesthesiologist had been given the instructions and understood clearly what was
involved in the session, the anesthesiologist was given the set of items and asked to filter
out the ventilators they did not know. At the same time they became fully aware of the full
range of ventilators to be sorted. Next, they were asked to sort the remaining cards into
groups, with one group for each category, using only one criterion for the sorting. The first
sort was the most likely to cause problems: anesthesiologists often did not realize that they
had the chance to use as many different criteria as they wanted on successive sorts and
proceeded as if they were having to cram everything into one sort. Normally, though,
sessions proceeded smoothly, and anesthesiologists usually grasped the basic concept
quickly.

What should then happen was that the anesthesiologist should sort the items into
separate groups, using a single criterion at a time. For example, since the items were all
types of ventilators, then the criterion may have been ‘ventilator mode’, and the categories
may have been ‘conventional ventilation’, ‘jet ventilation’ and ‘either conventional or jet
ventilation’. It was perfectly permissible to have ‘either ... or’ categories of this sort, as long
as they were clear ones. In this example, the anesthesiologist could be asked to clarify what
the last category involved: if the anesthesiologist meant that the ventilators in that category
could be used in either of two modes, then the category was acceptable, but if the
anesthesiologist was simply not sure which ventilator mode applied, then the category
should have been labelled ‘not sure’ or equivalent instead.

According to Rugg & McGeorge (2005) it is in theory more efficient to ask
respondents to say in advance what criterion they are about to use before each sort, in
practice this is inadvisable: respondents often change their mind during the sort, or even
during the recording after each sort.

The first thing to be done after the physician has stopped sorting is to find out what
the criterion was for that sort (e.g. ‘ventilator mode’ in the example above). If it is clear that
this is a single concept and that the physician is not lumping two or more criteria together,
then all is well so far; otherwise, it is necessary to explain what is needed, with another
example if necessary, and ask the physician to start again.

Once the criterion is known, the next stage is to go through each of the groups in
turn, asking what the category is which corresponds to each group (e.g. one group in the
example above would correspond to ‘conventional ventilation’, another to ‘jet ventilation’
etc.). The main source of problems with this stage is the ‘leftovers’, i.e. items which are not included in any of the groups. This may be because the physician has not realized that it is acceptable to have ‘don’t know’ or ‘not applicable’ categories; it may be because the physician has simply forgotten them. In such cases it is simply a question of clarifying what is allowable, and asking the physician to put the leftovers into the appropriate pile or to give them the appropriate group name.

Sometimes, however, the leftovers represent cases where the categorisation breaks down, and complex explanations are necessary. This can feel like a real nuisance at the time, but it is actually a valuable source of information and can make a huge difference to understanding the topic. It is advisable to clarify such cases immediately, in case the rest of the sorting session would be a waste of time. If the issue is clearly a complex one, then it may be advisable either to stop sorting and use the time to clarify the issue with whatever technique seems appropriate, or to book another session on another day to give you time to think and plan.

Once the criterion and the categories have been established, it is time to record the items in each group. The reason for asking these questions after the sort rather than before is that people very often change their minds during a sort, or make mistakes; it is much simpler for everyone involved to ascertain the criterion and categories afterwards.
Goal
In 2006 Dolphys launched Ventrain, a new manual ventilator. Currently, R&D is working on the Wanda project, a mechanical ventilator based on the same ventilation principle. In our experience, it is difficult to compare ventilators from different manufacturers (e.g., Dräger, General Electric, Hamilton). Each manufacturer uses its own language and ways of communication with (potential) customers. Therefore, we aim to gain an understanding of how anesthesiologists perceive the claims made by manufacturers. For Dolphys, it is important to know how its products relate or not relate to competitive systems in order to position Ventrain and Wanda properly. Hereby, the key question for Dolphys to be answered is how to qualitatively communicate our product portfolio with anesthesiologists.

Sorting
You will be given some cards to sort. Each card will have the name and picture of a ventilator depicted on it. I would like you to sort the cards into groups, using one criterion at a time. When you have finished sorting, please tell me what the criterion was for that sort, and what the groups were into which you sorted the cards, so that I can record this. Once this has been done, I would like you to sort the cards again using a different criterion, and then to keep sorting them until you have run out of criteria. For example, if the task was sorting different types of cars, your first criterion might be ‘place of manufacturer’ and the groups might be ‘British’, ‘French’, ‘American’, etc.; the second criterion might be ‘cost’, with the groups being ‘expensive’, ‘medium’, and ‘cheap’. You are welcome to use any criteria you like, and any groups you like, including ‘don’t know’, ‘not sure’ and ‘not applicable’.

The main thing is to use only one criterion in each sort – please don’t lump two or more in together. If you’re not sure about something, just ask. You may have noticed that the cards are numbered: this is for convenience when recording the results. The numbering is random, so please don’t use that as a criterion for sorting! If you have any comments or questions, then please say, and we will sort them out. Thank you for your help.

Positioning Ventrain
Now the ventilators are grouped together, I want to introduce Ventrain to you. I kindly ask you to tell me whether and for what reasons Ventrain fits in one of the groups based on the product design.
Here I show you the Ventrain brochure in which we explain our product. After reading the information, you can decide again to move Ventrain to another group if you think a better fit is possible. Please explain what information in the brochure was useful for your decision. Also indicate if the information is unclear or any cues are missing in your opinion. In addition to the brochure, Dolphys also developed an animation video for training purposes. Please take your time to further discover Ventrain’s working principle. In case you changed your mind about the positioning of Ventrain in the ventilator market, you can say so. Finally, I would like to hear from you how you feel about applications of Ventrain in your clinical practice.

Positioning Wanda
As I told you in the beginning of the interview, Dolphys is currently developing an automated version of Ventrain, which we now refer to as Wanda (project name).

label
⇒ Full mechanical ventilation through a 2 mm catheter for long-term ventilator-dependent patients.

clinical situations
⇒ Small lumen ventilation for ENT-surgery.
⇒ Handsfree EVA ventilation.
⇒ Single-lung ventilation possible.

technical specifications
⇒ Inspiration and active expiration (1:1) is automatically regulated.
⇒ Lung pressure is constantly monitored.
⇒ The inspiration flow can be set in a range from 4 up to 20 L/min.
⇒ The ratio of oxygen and air of the gas mixture can be set.
⇒ The expiratory gas exit can be connected with an anesthesia-evacuation system, if available.
⇒ The inspiration gas mixture is moistened.

Box 1 Sample instructions.
Recording the session

The main recording for a sorting session was paper-based. However, Rugg and McGeorge (2005) also advise the use of a voice recorder (for physicians’ comments if problems occur). Recording the items in the group can easily go wrong, for various reasons: people surprisingly often change their minds during the recording, for instance, and move items from one group to another. The method Rugg and McGeorge (2005) use is to write respondent number, date, facet used and any session codes, and then for each sort: the sort number and the criterion for that sort; the group=category names; the code numbers of the items in each group together with a mark to distinguish the end of one group from the start of another, and a comma between each number (so that ‘1, 2’ cannot be confused with ‘12’, for instance). I then counted the numbers to make sure that all the items are accounted for. If time permits, it is also advisable to account for each number individually (in case there are two ‘6’s and no ‘9’s, for instance). It was surprisingly easy to make recording mistakes. A recorded sort would therefore look something like:

Sort number 1:
Criterion: ventilator mode
conventional ventilation: v01, v03, v05
jet ventilation: v02, v08
conventional or jet: v04, v06, v07

Using code numbers rather than names saved a lot of recording time, and could have reduced the risk of cueing physicians towards a particular type of response. With object sorts the objects often only had code numbers rather than meaningful names anyway.

One point that needs to be stressed is that the only questions that I asked are ones involving clarification. It is highly inadvisable to comment on the physician's categorisation by, for example, telling them that they are wrong or asking them if they seriously mean that a particular set of items can be grouped together. The point of the session was to find out what the respondent’s categorisation is, not mine.

Once the sort had been performed and recorded, the items were returned to the physician for the next sort, using a different criterion. After the first sort, this usually proceeded smoothly.

Physicians usually started to run out of ideas for criteria after a while (mostly after one sort). It was worth recording the point at which this happens, since it may reflect a change from explicit knowledge to semi-tacit or tacit knowledge of some sort.

Eventually the respondent ran out of criteria and categories. Respondents were quite often apologetic about this, and it is both courteous and advisable to reassure them; after all, nobody could be expected to keep going forever. Another thing worth pointing out is that you want to find out what categories people actually use, not to find more categories than anyone else.

At the end of the session, it is advisable to check that all the paperwork is clearly identified and labelled.
Appendix 7 Observations at the Anesthesiology Days

Introduction
This report employs a case study method that uses participant observation to produce content analysis of the yearly-organised Anesthesiologists Days held at the MECC Maastricht conference centre on May 30-31, 2013. After a description of its methods, the report continues by describing the marketing of “innovation”.

Methods
Observations of the conference all took place in the exhibition area of the conference. No plenary sessions and parallel sessions were attended. Only informal interviews were conducted at the Medica Europe booth, which is Dolphys distributor for The Netherlands. Before approaching conference participants I asked for Medica Europe’s approval of asking anesthesiologists experiences at the stand. I introduced myself as a student in the field trying to better understand the contemporary context of anesthesiology, aiming not to deceive or compromise the privacy of those observed and interacted with. Shortly after each conversation I wrote notes from recall. These handwritten field notes were later word processed while the narrative evolved.

Marketing innovation
NVA, established in 1948, describes itself as an association for and by anesthesiology professionals providing quarterly newsletters and a yearly conference. Its mission is to contribute to a positive image of the field of anesthesiology and anesthesiologists in The Netherlands. It involves the development and execution of policies in the field of scientific research, medical technology, quality control and lifelong learning programmes.

This year the conference, called Anesthesiology Days, was scheduled on May 30-31, just before the start of the Euroanaesthesia Congress held by the European Society of Anaesthesiology (ESA) in Barcelona from June 1-4. In 2011 and 2012 there were three respectively four weeks in between both conferences. The 2014 dates of the conferences are again in different weeks, so it is likely to assume that the 2013 schedule is a coincidence and not a strategic matter. Some anesthesiologists confirmed that they planned to attend the Euroanesthaesia conference the next days as well. Still, it remains unclear if the target audiences for national and European conferences are similar.

The Anesthesiology Days is a large well-attended event (est. 1,300 participants) with strong industry sponsorship and presence. The 2013 Anesthesiology Days includes a large exhibition with over 70 stands displaying existing and new technologies in pain relief management and airway management. Only a very limited number of stands exhibited ventilation devices. No clear distinction was made in the arrangement between different clinical application areas, which made it more difficult for visitors to compare products. Of all presented medical devices, there are very few genuine innovations and many product-line extensions, which are ‘innovative’ only in that they work to differentiate a product from others on the market. These introduce small deviations of what is essentially the same product, changing little more than surface features or minor attributes. Also, Medica Europe, like many others as well, displayed devices of multiple manufacturers in the stand. Medica Europe’s sales rep explained that many devices are basically the same, so they try to create goodwill by social interaction. “Customers have to be willing to specifically buy from you.” She added that it would be helpful to display your product in a plenary or parallel session in order to stand out as an exhibitioner and thus increase participants’ awareness.

Industry-led conferences engaged in business-to-business marketing (the business being the medical device companies) have a vested interest in promoting products. The marketing bias at the Anesthesiology Days is evident in the selection of presentations at company sponsored plenary sessions which seek to present particular products in the best possible
light, with clinician satisfaction standing as evidence of effectiveness. For example, the satellite symposium by Mölnycke Healthcare promotes patient warming practices.

Whatever their power plays, presenters and attendees at conferences test their own and each other's reasoning with doubt. For example, once an anesthesiologist knew that Ventrain was in fact invented by a peer anesthesiologist from Maastricht Medical Center, he/she became sceptical about the product. They referred to "Maastricht' ways working" being different from their own experiences in their hospital. Medica Europe confirmed to have perceived this repeatedly at other sites as well. Especially, academic hospitals are competing heavily with each other to safely secure their own reputation and research position. Peer academic hospitals results are often mistrusted until the own clinical staff has repeated the same procedure. In general top clinical hospitals are more focused on hands-on treatment of patients than academic hospitals, who are more into scientific evidence. In short, clinical studies executed by other parties are not sufficient to adopt an innovation. The studies' findings have to be reflected in the potential adopters' personal experience. Full evaluation of presented data is a strict requirement.

Implementing innovations
According to Medica Europe's sales rep the key adoption problem is that there usually is no product champion in a hospital’s anesthesiology department present. The presence of a product champion is crucial for the adoption and continued use of an innovation. Only when this person is able to motivate and train his/her colleagues the product reordered.

In addition, partnerships of anesthesiologists affiliated with a hospital tend to have other goals and objectives than the hospital’s board members. This stand-alone position of a partnership could ultimately lead to be only self-authorised, neglecting patients’ voices.

Conclusion
Due to the combination of the exhibition of industry and the sessions led by researchers, the Anesthesiology Days should be labelled a trade fair instead of solely a (scientific) conference.

Anesthesiologists are intermediaries in the marketing channel that delivers medical devices to patients. Industry must constantly negotiate the barriers that divide conventions in medical research and practice from marketing objectives. Still, this observation might be false for other conferences in the field; clinicians who are critical of commercial goals may stay away.

Perhaps the gap between biomedical literature for clinical decision making is really designed for the communication between scientists and not for dissemination of practicalities. As a result miscommunications between anesthesiologists and marketeers are likely to occur.
Appendix 8 Follow-up interview questions

Perception of EVA
- Should Wanda be introduced as a ventilator model or a ventilation mode?
- Is Wanda an alternative or replacement of jet ventilation? Or should it not be compared at all?
- Should the EVA concept be explained apart from the specific ventilators? Is the active expiration feature sufficiently explained?

Adoption of innovative medical devices
- How important drivers of adoption are (1) individual preferences, (2) evidence of benefit, and (3) perception of benefits? What minimum level of evidence (research, clinical experience, and patient preferences) is needed? What about the value of evidence?
- How can we make anesthesiologists feel more comfortable using innovations in clinical practice? What are your concerns?
- Under what circumstances are anesthesiologists willing to use an innovative device when well-established alternative interventions are available?
- Are anesthesiologists more likely to first try innovative devices on ‘healthy’ patients to gain clinical experience or before treating patients with severe trauma?
- What is the psychological effect of artificial blockage of the airway?
- What do you think about design-driven innovation?
- Does an innovative product design add value to the user experience?
- Does medical innovation follow indications or the other way around?

Technologically-grounded clinical applications
- When you have to make a purchasing, are you more interested in a ventilator’s technological capabilities or the range of clinical applications?

Repeated training
- Who is responsible for anesthesiologists’ education of a new device? Anesthesiologist, manufacturer, or distributor?
- How would you describe the role of the manufacturer in this matter?
- How important is repeated training for Ventrain and Wanda?

Team decision-making
- Roles of anesthesiologists, assistants, nurses and purchaser?
- Should Ventrain and Wanda also be promoted to medical specialties other than anesthesiology?
## Appendix 9 Ventilation modes communicated by suppliers

Table 16: Unique names of modes found on four common ICU ventilators (ie, redundant names have been eliminated).

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model</th>
<th>Manufacturer’s mode name</th>
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</thead>
<tbody>
<tr>
<td>Dräger</td>
<td>Evita XL</td>
<td>Airway Pressure Release Ventilation</td>
</tr>
<tr>
<td>Dräger</td>
<td>Evita XL</td>
<td>Automatic Tube Compensation</td>
</tr>
<tr>
<td>Dräger</td>
<td>Evita XL</td>
<td>Continuous Mandatory Ventilation</td>
</tr>
<tr>
<td>Dräger</td>
<td>Evita XL</td>
<td>Continuous Mandatory Ventilation with AutoFlow</td>
</tr>
<tr>
<td>Dräger</td>
<td>Evita XL</td>
<td>Continuous Mandatory Ventilation with Pressure Limited Ventilation</td>
</tr>
<tr>
<td>Dräger</td>
<td>Evita XL</td>
<td>Continuous Positive Airway Pressure/Pressure Support</td>
</tr>
<tr>
<td>Dräger</td>
<td>Evita XL</td>
<td>Mandatory Minute Volume Ventilation</td>
</tr>
<tr>
<td>Dräger</td>
<td>Evita XL</td>
<td>Mandatory Minute Volume with AutoFlow</td>
</tr>
<tr>
<td>Dräger</td>
<td>Evita XL</td>
<td>Mandatory Minute Volume with Pressure Limited Ventilation</td>
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<td>Evita XL</td>
<td>Pressure Controlled Ventilation Plus Assisted</td>
</tr>
<tr>
<td>Dräger</td>
<td>Evita XL</td>
<td>Pressure Controlled Ventilation Plus Pressure Support</td>
</tr>
<tr>
<td>Dräger</td>
<td>Evita XL</td>
<td>SmartCare/PS</td>
</tr>
<tr>
<td>Dräger</td>
<td>Evita XL</td>
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<td>Evita XL</td>
<td>Synchronized Intermittent Mandatory Ventilation with Pressure</td>
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<td>Evita XL</td>
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<td>GE</td>
<td>Engström Pro</td>
<td>BiLevel Airway Pressure Ventilation</td>
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<td>BiLevel with Volume Guaranteed</td>
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<td>GE</td>
<td>Engström Pro</td>
<td>Constant Positive Airway Pressure/Pressure Support Ventilation</td>
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<td>Engström Pro</td>
<td>Non-Invasive Ventilation</td>
</tr>
<tr>
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<td>Engström Pro</td>
<td>Pressure Controlled</td>
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<td>GE</td>
<td>Engström Pro</td>
<td>Pressure Controlled, Volume Guaranteed</td>
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<td>Synchronized Controlled Mandatory Ventilation</td>
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<td>Maquet</td>
<td>Servo-i</td>
<td>Automode (Pressure Control to Pressure Support)</td>
</tr>
<tr>
<td>Maquet</td>
<td>Servo-i</td>
<td>Automode (Pressure Regulated Volume Control to Volume Support)</td>
</tr>
<tr>
<td>Maquet</td>
<td>Servo-i</td>
<td>Automode (Volume Control to Volume Support)</td>
</tr>
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<td>Servo-i</td>
<td>Bi-Vent</td>
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<tr>
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<td>Neurologically Adjusted Ventilatory Assist</td>
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<td>Servo-i</td>
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<tr>
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<td>Pressure Regulated Volume Control</td>
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<tr>
<td>Maquet</td>
<td>Servo-i</td>
<td>Volume Support</td>
</tr>
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</table>
Appendix 10 Overview of specialised hospitals in The Netherlands

Table 17: Overview of centres of excellence and last resort.

1 Source: Nederlandse Federatie van Universitair Medische Centra (2013).

<table>
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<th>Clinical indication</th>
<th>Number</th>
<th>Academic hospitals¹</th>
<th>Top clinical hospitals²</th>
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<td>Medisch Spectrum Twente Enschede</td>
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<td>Onze Lieve Vrouwe Gasthuis</td>
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<td></td>
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<td>-</td>
<td>St. Antonius Ziekenhuis Nieuwegein</td>
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<td>Upper airway surgery / ENT-surgery</td>
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<td>Traumacentrum</td>
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<td>Top clinical hospitals³</td>
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<td>Zwolle</td>
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<td>-</td>
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