Operations Strategy for Evolving Customer Profiles

by

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Abstract

ResMed is a respiratory medical device manufacturer based on San Diego, CA. Founded in 1989, the company was a pioneer in the field of sleep apnea therapy using positive-airway-pressure machines for patients to use at home. ResMed has seen remarkable growth and success across their existing customer base - historically made up of medical equipment suppliers who buy products in bulk, distribute them to patients, and interface with the patient during the therapy setup process. Recently, ResMed has entered sales channels outside of its conventional B2B, medical supplier-focused roots that move them a step closer to the end customer. These channels involve shipping products directly to customers on behalf of medical suppliers and retailers, and taking more responsibility for the therapy start and setup experience. Sales growth in these new channels places a fresh set of demands on ResMed teams across product, operations, sales and beyond. ResMed's operations strategy needs to adapt to this increased focus on customer facing sales – this will require changes to people, systems and processes. This piece of research examines how ResMed can achieve success in the medical device world when selling directly to consumers and in-store retailers, assesses ResMed's current stage of development across functional areas that will contribute to this success, and then propose methods to close gaps going forward.

ResMed's two guiding goals are to ensure that customers can start therapy in a timely manner, and that patients adhere to their treatment regimen to maximize therapeutic benefits. The functional areas that most contribute to these goals are fulfilment and distribution operations; supply chain and manufacturing; and product design for setup. Underpinning success across all of these is a requirement for efficient internal communications to deliver results for the patient. Given these new customer profiles, a restricted global supply landscape and prevailing demand uncertainty throughout the COVID-19 pandemic, ResMed stands to benefit from being more agile in making operational changes that affect their guiding goals.

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The COVID-19 pandemic continued to rage on through those six months and the whole ResMed team did their best to make sure the internship remained an engaging and cohesive experience throughout, despite being largely remote. Many thanks to my superstar supervisor, Melissa Henggeler for her guidance, empathy and unbelievable rolodex of ResMedians who helped with my project and my research. Thanks also to Anthony, Bhavani, Dwayne and the rest of the Atlanta team for their support and hospitality during my Atlanta site visit. The open line of communication to the top of the organization and C-suite exposure was exemplary, and I very much appreciated the time that Mick, Rob, Andrew and Mike all gave up to add colour to the work I was doing and make me feel like an integral part of the ResMed org. Last, a big shout out to Alex Bierhuis for his consistent support and encouragement, as well as his overall engagement with the LGO program.

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Chapter 1

Introduction

1.1 Company and Disease Overview

ResMed is a respiratory medical device manufacturer based in San Diego, CA. Founded as ResCare in 1989 by Dr. Peter Farrell, the company was a pioneer in the field of sleep apnea therapy. Sleep apnea affects about 3% of healthy adults in the US, but this goes up to about 20% in obese adults. It is a condition where upper airway muscles relax during sleep and cut off the airway, causing temporary suffocation with episodes lasting up to 10 seconds each and happening every minute in severe cases. The largest risk factor with obstructive sleep apnea (OSA) is the lack of rest that the body ends up receiving - it can lead to long-term health problems including diabetes, heart disease and strokes[16].

The primary treatment for OSA is the use of a continuous positive airway pressure (CPAP) device while sleeping - these are prescribed by a physician. The device works by pumping humidified air into the patient's airway via a tight-fitting facial mask. This positive airway pressure prevents the suffocation episodes described earlier. The device has three main components (pictured in Figure 1-1): a mask with silicone cushions to form a tight seal around the mouth and / or nose; a hose to carry air to the mask (that can be heated to supply air at a more comfortable temperature); and the CPAP device itself. The device is an electronically controlled air pump, and can be programmed to supply air at different pressures and intervals depending on the

CPAP unit with humidifying tank *Mask with nasal pillow* *Heated air tubing*

Figure 1-1: ResMed CPAP Therapy Setup
Adapted from ResMed website [7]

patient's prescription.

This is the state of the art treatment that is commercially available today to patients - while there are some next-generation therapies being tested, these are invasive and involve surgeries or implants. CPAP devices sold in the US today are manufactured by 10 different medical device firms. That said, Phillips Respironics and ResMed are the two largest players by far in the US, with their sales responsible for about 80% of the market between them. ResMed holds slightly higher share than Phillips at around 50% of the US market [11]. However, in March 2021, the FDA recalled a large proportion of Phillips Respironics CPAP devices and effectively halted their sales going forward. At the time of writing a year later, the situation has not changed. As a result, during my internship ResMed was dealing with almost a doubling in demand, as potential Phillips customers switched to ResMed devices en masse.

1.2 Shift in customer preferences

Evolving customer preferences and the onset of the COVID-19 pandemic together have created a shift in ResMed's customer base. In the past, an overwhelming majority of ResMed's business came from traditional Hard / Durable Medical Equipment Suppliers (HMEs). ResMed's operations serve these customers well today, and satisfaction is high. Now, a growing proportion of the business is coming from consumers who

are ordering directly from ResMed, shopping at large retailers now carrying ResMed products, or ordering to their homes via an HME who in turn require ResMed to drop-ship the devices directly to the patient for an at-home setup. In-store retailers like CVS are stocking ResMed CPAPs and masks, and these retailers have stringent custom requirements for packaging and product changes separate to HMEs. This generates new pressures on the manufacturing and fulfilment network. These pressures are compounded by supply constraints and long shipping lead times (7 weeks by sea freight), as ResMed currently manufactures all their products in Sydney and Singapore, despite the US being their largest market.

As customer profiles and preferences change, the systems that serve these customers internally also need to evolve, and be able to do so quickly. This thesis proposes changes ResMed can make in terms of equipment, people and processes in order to serve these new customer types more effectively. It also puts forward a communications framework to help make such decisions in a faster and more agile manner going forward.

1.3 Project motivation

Historically ResMed sold their devices exclusively through HMEs who would take delivery of respiratory care devices, like CPAP machines and then invite patients to come into physical stores and have a trained sleep therapist help set them up in person on the machine – this process will be elaborated on later in the document. HMEs are operationally easier to serve than the current mix, which includes growing retail and direct-to-consumer customers, for a number of reasons.

First, the HME business has stable and consistent demand, which makes it simpler to coordinate with the 7-8 week shipping times from Singapore and Sydney where the products were manufactured. Second, HMEs tend to order products in bulk and have them shipped to their own warehouses or facilities where they keep their own inventories. This simplifies ResMed's own warehouse operations where they can optimize for shipping mostly in cases and pallets – any small volume HME orders were usually making up a portion of a larger order, where the HME was receiving sufficient

inventory anyway in a different shipment. Third, there is little need for ResMed to spend time on the customer's setup experience as this is almost wholly controlled by the HME – the products can ship in nondescript cartons with little in the way of guidance because the sleep therapist will train the patient. Finally, there is no need to create HME-specific SKUs. As HMEs are effectively distributors, the packaging, literature, and case sizes can be identical across them all - the HME unpacks each pallet and the end patient never sees the box the product came in. While HMEs of course are able to provide feedback to ResMed which can be incorporated in product lifecycle updates, these changes could be done on ResMed's timeline.

Customer preferences began to change even pre-pandemic however. ResMed were looking to expand their market reach by expanding into new sales channels, namely retail (in-store shopping at pharmacies and health outlets), e-tail (third party sales online) and direct to consumer (DTC). Retail started with CVS who continue to be ResMed's largest retail customer – currently the business is entirely cash pay but insurance reimbursements are expected to come online in the next 12mo which will dramatically increase the volume of CVS business. E-tail refers to online resellers of medical equipment such as CPAP.com – they purchase devices from ResMed which get sent to their warehouses. DTC is currently restricted to the AirMini travel CPAP product line, and the business is entirely cash pay. All of these channels are growing significantly faster than the HME business year-on-year: retail in particular is on a steep trajectory. From a revenue perspective this is beneficial but operationally several gaps have emerged as internal systems and processes previously designed for HME customers have been ineffective in serving these new channels. In particular this is felt at the fulfilment level. At first with small order quantities, stop-gap measures at the factories and distribution centers were acceptable but as those channels began to grow, and then supply constraints set in, service levels dropped (orders shipped on time, orders with correct contents) and the goal of helping customers start therapy in a timely manner became more difficult to achieve.

This project came about as a direct result of the proliferation of these new sales channels, where ResMed is shipping products directly to consumers and dealing with

retail customers who have different needs and ways of working compared to HMEs. Given the importance of success in these channels to ResMed's growth, they must find solutions that can help scale sales in a meaningful way looking forward over the next five to ten years, and carry over the excellence seen on the HME side. Finally, these solutions need to produce a positive impact on the core HME sales business also, working in a synergistic manner with the mainstay of ResMed's customers.

1.4 Problem statement

Following conversations with teams across the ResMed org to understand the nature of their issues, a guiding question precipitated – how should a traditionally B2B medical device organization adapt their mindset, systems and processes to also sell products through more consumer-facing channels while maximizing the value generated for the organization as a whole?

1.5 Project goals and hypothesis

Two overarching company goals guide ResMed's operational work:

1. Help patients start therapy in a quickly and timely manner
2. Ensure patients adhere to their prescribed therapy

These two goals stem from the company's well-socialised mission to help people live healthier lives by providing treatment for those who suffer from sleep apnea.

They remained lodestars throughout the internship, and helped shape specific initiatives with various teams across the organization. This will be explored in more detail in the approach ideation section. ResMed's sales are concentrated in North America with manufacturing in Sydney and Singapore, leading to significant shipping lead times. The internship began with a working hypothesis based on conversations within the Supply Chain and Operations teams that ResMed was not able to satisfy US-based customer demand for certain popular or high-volatility SKUs as a result of

the 7 week lead time for shipping completed products from the Asian manufacturing facilities to the US.

Through the ideation and approach process however, it became clear that while focusing on manufacturing would help serve both existing and emerging channel customers who had more variable demand, this alone was not sufficient to give ResMed the agility it needed.

The research goals for this thesis can be contextualised in the setting of a B2B company with a single type of customer transitioning to a mixed B2B / B2C model. Items 1 and 2 will be explored the most thoroughly, with a deep dive into postponement as a supply chain technique to bring down cost when dealing with volatile demand, and an examination of the home setup experience.

1. To help ResMed understand how to better meet unpredictable demand for popular products in the face of supply constraints

2. To identify what would have most impact in improving the at-home setup experience from packaging to fulfilment, with the aim of therapy adherence in mind

3. To find better methods for facilitating communications within the organization, allowing for smoother processing of product changes requested by customers and elevating the customer experience

Chapter 2

Strategic Review

2.1 Current mindset and processes

ResMed's current mindset as it pertains to operations strategy is to work forwards from the supplier to the customer - this has only been exacerbated by supply constraints through the pandemic. This has held ResMed in good stead given their wide product assortment requires strong supply relationships to maintain, but with new channels like retail and DTC, customers have more input in the design of the products and packaging they receive as well as all associated timelines. CVS, for example, has the ability to dictate custom packaging requirements for all masks and cushions, and they are contractually only required to give ResMed a 6 month lead time. With product requirements changing on short timelines, ResMed may have to re-think putting their suppliers first especially when those suppliers are largely over 10 weeks ship time away from their largest market - the US. Adding flexibility with their supply relationships and manufacturing locations would be helpful to meet changeable customer demands.

ResMed's current processes, as mentioned before, can be described as supplier-forward, but also as reactive. Manufacturing and fulfilment are currently optimized for stable supply inputs – when certain parts are out of stock it causes a huge bullwhip in markets like North America. Shortages result in CPAP units not shipping to the US distribution centers and customers experiencing backorders. Changes to manufacturing locations are usually made as a result of prolonged difficulties meeting

customer product demands. This was the case with the N30i mask, a new mask model in ResMed's product line which quickly gained popularity with US customers. This is the only current example of shifting manufacturing closer to the customer to meet demand more quickly. Relatively small sales volumes made implementation simpler for N30i, but when the problem is scaled up to all CPAP units for example, it is difficult for ResMed to respond quickly. ResMed could adopt a more proactive mindset here – one where the operational needs from customer demands are analysed more predictively with changes made to supply and manufacturing processes as a result.

2.2 Case study - Boeing 787 - over-reliance on suppliers and rigid manufacturing processes

2.2.1 Introduction

Boeing pitched the 787 as a revolutionary aircraft that would shake up the midsize widebody passenger airliner segment. It promised greater passenger comfort, fuel economy and range than competitors. The promise of large aircraft performance and range from a smaller, lighter aircraft was a huge selling point to airlines and once order books opened the 787 quickly became the fastest selling airliner in history. It achieved this reputation through a combination of new composite materials and a modular design that allowed it to accept two different engine models with limited changes needed to the wing. Tang et al explore the supply relationships that were meant to make this aircraft's existence possible, and the consequences of their breakdown. [15]

2.2.2 Supply-forward focus

Boeing cultivated relationships with 50 Tier-1 suppliers, for whom Boeing was the largest customer by far. There was significant dependence placed on these suppliers - they were single-source partners for Boeing (no redundancy) and were tasked with integrating components to deliver built subassemblies to Boeing.

2.2.3 Failure point

Boeing had overestimated the ability of some of these suppliers to cope with the integration complexity of many of the subassemblies they were contracted to build. Suppliers were unable to deliver parts on time and with the demand being faced, customer delays started to pile up. Customers who then wanted different fuselage variants of the same aircraft (more or less passenger capacity) faced further delays or even were told they'd have to accept a variant they did not initially order thanks to these supply chain and production issues.

2.2.4 Consequences

Boeing faced a rapid drop in demand as customers grew unhappy with delays. Airlines switched their orders to leases rather than outright purchases, and some even took their business to Airbus who were offering the A-350 XWB, a competitive composite aircraft which would be available in a few years. In many cases Boeing was also paying fines as a result of the delays.

2.2.5 Reaction

Boeing's risk mitigation strategy was reactive, slow and in general not sufficient to plug much of the customer attrition. Given their size and market power, Boeing was able to acquire the key problematic suppliers and send Boeing personnel to the rest to mitigate ongoing supply risks. This is not a luxury all companies have available however.

2.2.6 Key learnings

Boeing made the mistake of placing heavy reliance on the supply of complex assemblies from suppliers who could not be substituted easily, and production of those assemblies could not be quickly moved in house. The lack of manufacturing agility cost Boeing customers and revenue – the fact there was no mitigation plan in place for supplier

difficulties to begin with caused most of the problems as the end solution was reactive and expensive, and ultimately diminished their customers' trust.

2.3 Case study - BestBuy - Rapid response to changing customer preferences

2.3.1 Introduction

Best Buy has long been renowned for pushing high volumes of products from factories, to its warehouses and ultimately to its mega-stores which can be found in cities and suburban retail parks across the US. Given the proliferation of online ordering however, Best Buy has had to adapt its sales and operations strategy to maintain its edge as a price-leading retailer where products that customers want are readily available to walk in and buy on the shop floor. The immediate availability of products at competitive prices is the only edge Best Buy can hope to have over Amazon, or even WalMart's online ordering operation. Cotrill explores the nature of their transformation in a Harvard Business School case study.[2]

2.3.2 Customer focus

To maintain this edge, Best Buy has to make sure the floor is always stocked with sufficient products that customers in that specific location are looking for. This means using sales data, they have to change floor layouts, product assortments and even pricing on-the-fly. Being able to do this requires a responsive supply chain with deep customer focus at its core.

2.3.3 Success factors

Best Buy uses three key levers: first moving nonsales activities higher up the supply chain, so delivering shipments preconfigured to the store layout they are going to – this reduces time spent rearranging floorspace. Second, allowing employees to

more autonomously push changes in products being delivered as they see customer preferences change in real time. Finally, linking the stores electronically back to the distribution centers where orders are shipped out from – this information flow ensures all parties required to fulfil a changed assortment for example are kept appraised of shipment and inventory information. On the fulfilment side, better on-time, in-full (OTIF) performance (packages shipped when they said they would be, without missing items or substitutions) in distribution centers and improved forecasting enables this level of store-level agility.

2.3.4 Results

BestBuy stores that adapted this new model booked sales growth double that of traditional stores, and since the time of the case study this model has been applied to all Best Buy locations across the country. It has enabled them to continue thriving as an in-person retail outlet during a time when many of their competitors have fallen in the face of competition from Amazon.

2.3.5 Key learnings

Best Buy has managed to remain competitive as it centered its focus on capturing as much customer demand as possible rather than focusing on cost and its suppliers. This perspective is facilitated by looking through a lens where cost is equivalent to missed customer opportunity. By letting employees close to the end customers in different regions influence the supply chain, which itself has agility thanks to reliable fulfilment and strong communications processes, Best Buy can make sure no customer need goes unmet.

2.3.6 Strategic implications for ResMed stakeholders

From the Boeing case, the key parallel to ResMed is a focus on existing supply-manufacturing paradigms. Boeing had no alternative but to delay production and pay the price with its customers when its suppliers were not able to deliver. In

their case, the nature of the good being manufactured prevented them from shifting manufacturing but with more supply chain flexibility, they could have avoided this extent of problems. Similarly, ResMed could benefit from being more flexible with location and scope of manufacturing, suppliers or both in order to further improve the customer experience when customer needs change or parts supply begins to constrict.

From the BestBuy case, ResMed can benefit from being closer to customer needs and wants. Right now, their operations are not set up to quickly process these new inputs such as retailers asking for different packaging, or DTC customers asking for specialised starter kits for at-home setups. Better information flow from customer request to operational change is one that ResMed could incorporate.

2.4 B2B to B2C transition - key enablers

2.4.1 Customer service and communication

In her blog, Lee brings up the importance of strong customer service and open channels of communications with the customer for a successful B2C business [6]. Retail and direct customers are less resilient to order disruptions and poor sales or setup experiences than bulk-order HME customers as their switching costs are lower. Moreover, as Bohnick mentions, users are now also buyers which is not the case in a B2B business [3]. The end user is likely to make a quicker judgment about ResMed's product and service than a business buyer would and can be impacted more significantly by problems like stockouts and order delays. ResMed needs to be able to keep customer service levels high in a cost-effective manner. and build customer facing communications capabilities.

2.4.2 Product choice

In his LinkedIn blog post, Jason Greenwood articulates the importance of helping guide customers to the right products while still offering enough selection that they don't feel pigeonholed [17]. Starting CPAP therapy can be confusing, even more

so without an in-person therapist at a physical HME location showing you how to use your device and what to buy. ResMed currently offers an enormous assortment of masks and cushions which HMEs help patients understand - there needs to be a convenient way for patients to understand how to setup and use their device, and buy the right masks / cushions without the help of an HME.

2.4.3 Fulfilment and unboxing

Greenwood also elaborates on the challenges of going from shipping cartons / pallets to small boxes of single or a few items. He links this to the importance of the 'unboxing' experience to keeping a customer satisfied and engaged, where the customer needs to be delivered a complete order in a timely fashion. Both of these are capabilities ResMed needs to build and he highlights the usefulness of a 3PL / 4PL solution in helping achieve that. [17]

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Chapter 3

Approach Ideation

3.1 Current mindset and processes

The takeaways from the case studies were helpful grounding for conversations with stakeholder groups at ResMed. It was important to understand which operational processes were resistant to change today, and what stakeholders saw as their greatest barriers to meeting evolving customer needs. This required meeting a broad range of stakeholders to ensure all groups with influence on operational processes at ResMed were being captured, not just the operations-focused teams.

3.2 Team Interviews

3.2.1 Commercial Operations

Team overview

Commercial operations run ResMed's distribution centres and warehouses. They are responsible for the fulfilment stage across all customers in the US, and also house some small-scale assembly / manufacturing activities in their facilities.

Pain points

The warehouses are largely set up for pallet and case sized orders that go out to

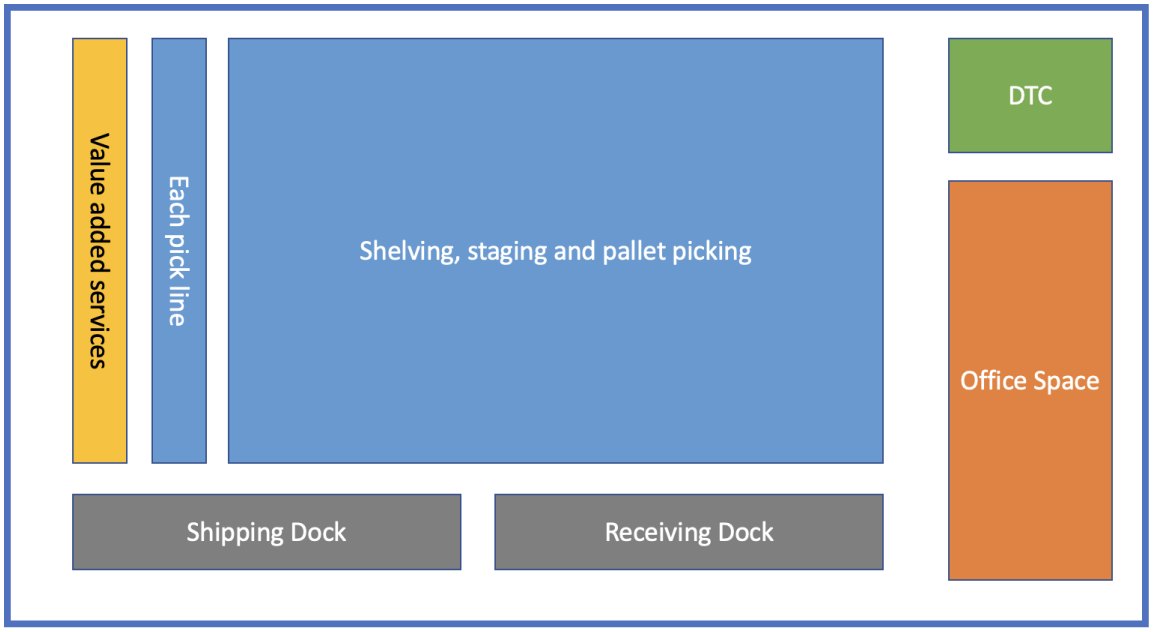

Figure 3-1: ResMed Atlanta warehouse Layout

HMEs. There has been difficulty catering for the increasing volume of small orders being shipped directly to patients as the each-pick line is small (see Figure 3-1) and not optimised for high-throughput. Similarly, new retail customers have specific demands for product packaging and case sizes which require dedicated packing areas to serve. Product teams can request space to be dedicated to processes like late-stage manufacturing but space is at a premium and there is no standardized method of comparing proposals to see what might yield the highest savings for the org. Currently the yellow value added services area has been earmarked for 'one off' requests. A second area of concern falls around the tracking of direct-to-customer orders that HMEs place with ResMed. These go through a different system to the usual order database and some of these orders get lost in the interchange with the warehouse management system.

Previous / current solutions

There is a single line set up for 'each picked' orders right now - it has limited validation steps to ensure that products going in boxes are correct. In the past, Commercial Operations has experimented with some validation based on weight or pick-to-light systems but problems with warehouse management system integration and stock

replenishment processes has led to those being phased out.

Changes requested

The Commercial Operations team were keen to bring the efficiency seen in HME orders to these new customer categories. They hoped to be able to create proposals with more autonomy – including late stage manufacturing or delayed differentiation, and changes to the warehouse equipment / systems.

3.2.2 Supply chain

Team overview

Supply Chain works closely with manufacturing, the commercial sales teams and Global Supplier Alliances (GSA) to ensure sufficient supply of manufactured products to customers. They also maintain demand forecasts and inventory levels with Commercial Operations.

Pain points

Parts and product supply have been pain points through the COVID-19 pandemic. For example, high demand parts that patients replace on an annual basis like the air tube or the humidifier tank, were on rolling backorders over a year in 2020. GSA has not been quick to find local-source options for high demand parts citing stringent regulatory concerns, leading to continued stockouts. Forecasting specific SKU requirements between certain high demand products has been difficult, leading to product substitutions for customers and then margin erosion when the correct product has to be shipped in the future. This will be explored more in Chapter 5.

Data hygiene and process standardisation for backorders could also be improved - for example, when a given product is out of stock, the sales rep managing that particular account can either record that stockout, or discount products on a per-customer basis and send a replacement. In the second case, it makes it hard to see when a stockout actually occurred, and similarly hard to judge the financial cost.

Previous / current solutions

Air freight has been heavily relied upon to reduce the 10-12 week shipping time and get products to DCs more quickly but this is not viable long term due to cost. The actual cost varies significantly depending on demand, but on average it is 7-10x that of sea freight. This can be equated to an incremental margin drop of at least 10% depending on the product. There has been some limited use of in-region manufacturing - scope to expand this exists.

Changes requested

Supply chain's problems could be alleviated by two key changes which work hand in hand. The first is a shift to more dynamic sourcing, with optionality to find local source suppliers that can facilitate more in-region manufacturing. This would be a concerted effort with the GSA team. The second change would be to set up US distribution facilities to spool up late-stage manufacturing or delayed differentiation activities more quickly, in order to solve for short-term stock issues related to volatile demand.

3.2.3 Manufacturing

Team overview

Manufacturing is based in Sydney and Singapore, running factories which produce all of ResMed's masks, devices and replenishment parts like nose cushions and mask seals.

Pain points

Manufacturing proposals outside of the Sydney / Singapore facilities can be difficult to operationalise because new part numbers and bills of material (BOMs) are required for half-assembled devices, but do not have an easy way of being created in the inventory system. Finally, given stringent regulatory guidelines, it is not trivial to set up manufacturing in-region due to the engineering burden of certifying a distribution centre as a manufacturing site.

Previous / current solutions

For the N30i mask late-stage manufacturing project that currently exists, manufacturing engineers were sent out from Sydney to ensure the Atlanta facility could reliably create products that meet regulatory standards.

Ideal future state

Ideally, manufacturing engineers would be present at all of the distribution center sites to conduct the requisite assessments, allowing any kind of in-region manufacturing activity to happen. Due to high costs however, it seems more likely that understanding how to assess the financial upside of a proposed activities would be helpful. This will be explored further in the analysis of a delayed differentiation proposal in Chapter 5.

3.2.4 Commercial Team – Sales, Product Marketing and Product Development

Team overview

Sales, marketing and product development all come under the 'commercial' umbrella; they work closely with in-house research teams and customers alike to understand what product changes to make between device lifecycles, and make sure the products are meeting business needs across the board.

Pain points

ResMed could benefit from a standardised communication channel between the commercial teams and the operations side who are executing on proposals to deliver products that have been promised to customers. There is no single dashboard where both ops and commercial teams can see which products have stockouts alongside customer-driven change requests, or indeed what mitigation steps are in progress to fix the issue.

Retailers like CVS have started requesting customised packaging and artwork

redesigns on short timelines. This happens via the sales teams, who pass the requests to Product Lifecycle Engineering (PLE) who are part of the Product Development organisation. Unfortunately, the 6 month timelines mean that the changes usually need to be implemented quickly – and fall to the Commercial Ops teams within the US distribution centers. This is problematic because Commercial Ops also need lead time to set up custom packaging areas etc within the distribution center, but are only be notified once the request has made it to the front of the often lengthy PLE product change queue.

Finally, ResMed has started to experiment with at-home setups for customers, bypassing the traditional in-person HME appointment, but fulfilment processes tailored more for larger orders and expensive virtual setup costs have made this program difficult to scale. Order fulfilment will be explored in more detail in Chapter 6, but in summary, small each-picked orders have 8% lower OTIF rates than larger pallet or case sized orders.

Previous / current solutions

Supply Chain is used as the conduit between Operations and Commercial teams today, but given the wide mandate of Supply Chain's existing work, this can eat away at the supply chain team's bandwidth. Supply Chain also are tasked with coordinating shipments from suppliers along with GSA; they maintain and refine the demand forecast for manufacturing; they manage inventory in the distribution centers along with Commercial Operations and also coordinate expedited logistics when required – this has been an increasing focus for them as supply disruptions increased through the pandemic.

Changes requested

A unified communications platform would help keep all teams appraised of changes, driven by customers or by the operations side and allow supply chain to focus more singularly on their forecasting and inventory management duties. This will be explored further in Chapter 7.

3.2.5 Finance, Regulatory and Tax

Team overview

In this capacity, the finance team spends time evaluating proposals by ops and manufacturing for the impact to ResMed's top / bottom line. They also liaise with tax and regulatory teams to ensure that none of the proposed changes would incur additional duties or taxes that could undermine the primary financial goals of the initiative or change.

Pain points

There could be more awareness among teams assembling proposals to change manufacturing or assembly processes about what tax or duty implications would be, e.g., when looking at delayed differentiation of a product with local sourcing of a part. This is because ofthen there are benefits rather than penalties, which should be added to a business case. A second issue is cost data availability – many of the ad-hoc operational changes being made (e.g., air freight) are not being tracked in a central location on a cost basis so it is difficult to quantify the benefits of a new solution. Teams tend to work more on relative costs e.g., of air freight vs sea freight.

Previous / current solutions

Finance and duty teams tends to intervene towards the end of a proposal's build-out when their input is required, for example on apportioning budgets.

Changes requested

Having access to a platform which documents upcoming product change or operations proposals would allow Finance, and Duty / Tax teams in particular, to be involved and have more visibility and input on designing Operations projects for cost advantages. For example, when I spoke to the Corporate Tax group about making distribution centers locations with significant manufacturing activity, they informed me that in the US this would actually result in a tax advantage rather than penalty. This was a

fact that the Atlanta Manufacturing and Commercial Operations teams could benefit from knowing given they have some amount of manufacturing work going on already (CVS repackaging, N30i assembly).

3.3 Key themes / shortcomings identified in team interviews

3.3.1 Data collection, data systems and hygiene

Most teams spoke about a lack of high-quality data for them to create and evaluate proposals to serve a new customer segment. In particular, the stop-gap measures being employed have no directly attributable cost – teams are just aware the spend is increased.

Similarly, the warehouse management system and order management systems do not always work smoothly with each other leading to some orders, particularly for new customers, slipping through the cracks.

3.3.2 Customer experience - Fulfilment and setup

In particular, the OTIF performance for each-picked orders was called out as these are the orders ResMed is seeing increasing volumes of, with products being shipped directly to patients. An 8% difference in OTIF rates exists today between each picked and pallet picked shipments.

Once these orders are shipped out, the patient either goes for an in-person setup at their local HME or they have a virtual setup at-home which is increasing in popularity. ResMed has seen limited success with virtual setups because of delayed shipments to patients, high cost to implement and lack of a standardized experience across patients. This is problematic as those patients end up with delayed starts to their therapy, or poor adherence. At today's scale this is not significant but given it is an area which will see growth it would benefit ResMed to dive deeper here.

3.3.3 Communication between teams

Teams have varied norms for communication, but with challenges like product changes being specified by new retail customers, there is a need for a platform which enables more teams across the value chain than before to have visibility and input into proposed or in-progress initiatives.

3.3.4 Cost / benefit analysis for operational changes

Internal organisational structure dictates that operational changes must be approved by a centralised team in Sydney even if they are to be enacted in region, and the regions themselves have limited ability to make operational changes of their own without Sydney's approval. Supply chain, finance and commercial ops would all benefit from being able to create a more financial, data-driven case for an operational change like delayed differentiation of a product to bring to Sydney's attention.

3.4 Resultant strategies and initiatives for the internship

Following this set of interviews, it became clear that to serve these new customer and order types more effectively, more would need to be done than just helping Operations evaluate delayed differentiation projects on a cost basis. While that would remain a part of the solution, it would no longer be the focus. Instead, three key areas emerged with a redesigned communications platform underpinning them.

1. At-home setup 'kit' design and experience

    - Examining the existing setup experience and understanding how to improve it while bringing down overall cost
    - Finding examples of good customer-packaging experiences and trying to integrate those success factors into a next-generation 'at home setup kit'

2. Evaluation of a delayed differentiation project

    - Analysis of postponement strategy for a frequently-backordered product line affecting ResMed today
    - Goal of maintaining customer service levels while reducing reliance on forecast accuracy and not incurring additional costs

3. Analysis to improve fulfilment performance of each-picked orders

    - Understanding why each-picked orders have lower OTIF rates today
    - Overview of solutions, including additional automation, in order to improve the experience of all customer groups, both traditional HMEs and newer Retail / DTC channels

4. Cross-team communication platform

    - Design a platform with decision logic that helps teams create and collaborate on product change proposals, as well as share details of product backorders and help coordinate mitigation steps
    - Combination of a familiar front-end interface with tools teams already use e.g., Sharepoint, but with additional features to help with cross-team visibility and collaboration

3.5 KPIs for new strategic goals

The following KPIs are defined with a 6-12 month timeframe in mind from the end of the internship being completed, to understand how well teams have been able to implement and benefit from change programs designed during my time at ResMed. They were designed with the stakeholders interviewed earlier, as indicators for them to get a fast read on the impact of improvements they are making. The intention was for teams to use these after the internship ended, given there was not scope for implementation during the internship itself. The Operations team was more focused

on using the internship to gather information for understanding where the problems were today with serving an evolving customer set, and thinking about what solutions could look like going forward.

Communication

1. Time for an ops proposal to be reviewed by all necessary teams and signed off for pilot implementation
2. Number of customer deadlines met for product changes

In-region manufacturing and fulfilment

1. Change in OTIF rates across pallet pick and each picked items
2. Percentage of orders 'missed' in the transition between ordering system and warehouse management system
3. Cost savings from implementation of proposals

Product and setup design

1. Number of customers adhering to therapy 1mo /6mo/1yr after setup performed virtually
2. Number of virtual setups possible to be carried out in a given timeframe

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Chapter 4

Product and setup design

4.1 Masks and replacement parts

Figure 4-1 shows the way a user would position the mask on their face. The tube goes directly to the CPAP unit which usually sits 2-3 feet away on a nightstand. ResMed offers three main types of mask: full-face (pictured), whole nose and nasal pillows (pictured). These come in three sizes, and each size has further customisation possible in different sizes of silicone cushions that form the seal with the user's skin. This level of customisation helps with optimising fit for different facial sizes and breathing preferences (nose only vs nose and mouth). Skin oils degrade the silicone over time, and roughly every month the user needs to replace the cushions. In addition to this, masks come in top-exit tube or conventional bottom-exit tube variants, which may be more comfortable depending on the user's sleeping position.

4.2 Typical CPAP setup and use

ResMed traditionally designs products to be set up with medical professionals employed by an HME (e.g., Lincare) guiding the patient through the process in person. This has a few key implications – first, the products and packaging do not need to be attractive or intuitive given the patient will see the product out of the box first and be taught how to use it. Second, the consumer has an in-person point of contact, the HME,

Figure 4-1: ResMed Masks - Full Face LHS; Nasal pillows only RHS
Adapted from ResMed website [7]

to resolve any ongoing issues with their setup including replacing masks which may not fit them correctly. Finally, the patient's journey with sleep apnea treatment is tracked by the HME and corrective action is taken when needed. When the HME is largely removed from the picture, and consumers are setting up their own devices, the paradigm governing these implications changes. As such there need to be changes made to the product and packaging to maintain a strong patient experience and help achieve the goal of long-term adherence to therapy.

4.3 Current HME-driven setup experience

4.3.1 Description

1. The patient is diagnosed overnight, either at a sleep lab or with an at-home sleep test and sees their doctor for a CPAP prescription

2. The doctor sends the prescription to a local HME, along with a recommendation for the CPAP device brand and mask type (the sleep therapist at the HME can change this however, depending on fit)

3. The patient visits the sleep lab and spends 1-2 hours with a sleep therapist,

who helps them try different types of masks (full face, nasal only, mouth and nose), cushion sizes and tube configurations (bottom exit, top exit) to find one which produces the best combination of a tight seal and comfort. While facial measurements guide the mask sizing, the correct mask type and cushion combination is usually found by trial and error

4. The sleep therapist also can adjust the prescription set by the doctor and have the doctor confirm the new prescription should it work better for the patient

5. The patient leaves and is monitored remotely by the sleep therapist via their CPAP device

6. The patient receives replenishment parts (masks, cushions) from the HME periodically as laid out by their medical insurance

4.3.2 Shortcomings

In-person HME setups are great for the face-to-face contact they afford patients, but pose many inconveniences. Patients have to make an appointment and find the time to travel to the HME location to be setup. Usually this delays the start of therapy by at least a week or two - even large cities tend not to have many HMEs for CPAP equipment (the Greater Boston area only has 5). Moreover, most insurance plans split the cost of CPAP therapy with the patient (very few have full coverage) so the patient shoulders some additional cost that the HME charges to the insurer for an in-person setup.

4.4 Current remote setup experience

4.4.1 Description

1. Steps 1 and 2 are as above, but now the device and recommended mask / pillow combination that the doctor initially sent with the prescription are sent directly

to the patient. No other components are sent e.g., different types / sizes of mask and cushions

2. The patient receives all of the components (device, mask, pillows, tubing) and has to assemble them with the help of a sleep therapist over a 1 hour video chat, as well as learn how to use the machine going through its various settings and features

3. The patient's setup is completed over video chat and the patient self-reports to the therapist if they feel the setup is comfortable and airtight

4. If the initial mask / pillow / tube combination is problematic, the patient then has to return the originally shipped parts to the HME via mail and wait for replacements to be shipped to them

4.4.2 Shortcomings

First, there is usually a delay between the diagnosis being made and the CPAP equipment being shipped out correctly to the customer thanks to ResMed's relative inexperience in each-picking orders (this will be explored in Chapter 6). Second, the setup process can be confusing especially for older patients, and usually requires more of the sleep therapist's time than an in-person setup – this is more to do with learning to use the machine and navigating its features / menus than physically connecting the parts together. Third, the mask / tube / cushion combinations are rarely correct the first time and the patient does not have other products at home to sample from. Thus, there is usually a delay in starting therapy while the HME and patient exchange masks, cushions etc until the right combination is found. Finally, the therapist has to check multiple factors - are there air leaks, is the silicone sealed continuously with the skin, does the mask move when the patient lies down, does the air tube placement conflict with the patient's sleep position. These are all much harder to evaluate over video, especially with older patients who may not be as able to show all of these to the therapist over a video chat.

4.5 Retail experience and sales associate interviews

Visits to two CVS and two HME locations as a patient looking to start CPAP therapy, and also as a patient who needed to change their existing mask type revealed shortcomings of the in-store experience. Interviews with the CPAP specialists in the store pointed to them not being the primary line of contact for the patient; instead they could answer high level questions but then would direct the patient to make an appointment with a visiting sleep therapist who would come in once every week at the HMEs or once a month at CVS for in-person setups.

This inevitably led to a delay in starting therapy for many patients. In addition, the in-store HME product assortments tended to the side of confusing (see LHS Figure 4-2) especially for elderly patients, who need guidance when picking out a new mask or finding the right mask to buy for replenishment. The LHS photo is at an HME location - the packaging is less user-friendly and doesn't always explain what is in the bag. The in-store assistants knew very little about choosing a mask so patients have to time their visits to coincide with the visiting therapist unless they already know exactly what they need. The RHS is at a CVS - this is a better experience as the mannequin heads show how the different masks types look worn, and the product packaging is colour coded for sizing. This said, there was no advice on what mask type to choose depending on sleep style - just a sizing guide. Again, the patient is reliant on an in-store therapist who visits infrequently.

Finally, the CVS CPAP specialists also said they would appreciate having in-store starter packs on the shelves for patients to buy and take home which included everything they needed to start therapy. They mentioned it would be a great way to get products into the hands of patients who were buying the product out of pocket anyway, and potentially help them start therapy quicker given the frequent shipping delays ordering online, and often long wait to find an appointment with a sleep therapist.

Figure 4-2: ResMed products on display: HME - LHS, CVS - RHS
Primary research

4.6 Customer survey - HME locations

I visited two local CPAP supply HMEs in Boston over the course of three days and asked 10 patients who were stopping to pick up replenishment supplies for their CPAPs about their experience. All 10 patients used ResMed CPAP products. They all had in-person setups (pre-COVID) and had been on therapy for over two years. They were all between 40 and 80 years old. Three were female and the rest male. I asked them the following questions and they gave me responses from 1-10; 1 being strongly disagree and 10 being strongly agree. Reported below are the means of their responses.

4.6.1 Survey responses

1. It was easy for me to start my CPAP therapy quickly (with in-person consultation) : **7.4**

2. It was simple to assemble and use my CPAP device once I received it, and did

not require any follow up sessions with the HME sleep therapist : **6.3**

3. I have not had issues with mask / cushion fit after my first setup was completed : **3.3**

4. I know exactly which masks / cushions I can / should use with my CPAP and they are easy to find : **7.8**

5. I would value the convenience using a mobile app or website to help guide me in choosing replenishment products (masks, cushions) or setting up my CPAP instead of coming into the HME location in person : **8.1**

The last question was an open response and I recorded the key reason being provided by each patient. What was the hardest or most frustrating part about the setup experience?

- I had many mask air leaks because the mask size and design wasn't right for me - I had to switch out 3-4 before I found the right one which took almost a month. I also had to pay for each new mask which was frustrating

- I was always calling the HME with questions – the menus are a little confusing to me on the device

- I didn't like having to come back to the store when I wanted to see what the latest mask options were – my brother-in-law had a new type of mask where the tube went out of the top, it looked much more comfy and I didn't know about it until I came back into the store for a cushion restock

- About 6 months in I needed a full warranty replacement on my CPAP. They (ResMed) were very nice about it; they sent me a new unit in the mail within a week. It came in a box with all the pieces but I didn't see the cushions in a little packet in the shipping box. I threw them away by accident so had to come in to pick up a new set

4.6.2 Survey takeaways

First, it is worth mentioning there will be sample bias present as the interviewees were all found in stores - this perhaps was due to them needing a replenishment item but could also be because they were unhappy with their fit. Given the time that had passed for them since starting therapy I would hope that they are not continuing to experience fit issues however.

It seems like while most patients were able to start therapy relatively quickly; most had to return to the HME location due to issues with mask fit and change out a few different masks until they found one that worked for them long term. This was despite an in-person mask fit session. This is problematic because non-adherence to therapy early in the process is a strong predictor of non-adherence later. Potentially this could be helped by some technological intervention in helping recommend one or two masks that are likely to fit well or be comfortable based on face / head measurements. This was confirmed by patients saying they would largely welcome some app-based guidance. Moreover, they were receptive to the idea of a companion app helping them with product awareness and not having to come to an HME location in person for replenishment or assistance with their device. Finally, one user highlighted the issues with the product shipping with constituent components in different packets – particularly with older users it increases the chances of small components like cushions being lost.

4.7 Industry benchmarks - packaging design

The following products are all available online (not via HMEs) and rely on a customer-led setup and use experience. They have been chosen for how they simplify the setup process and inform the customer to help them start use quickly.

Figure 4-3: Colgate Hum connected toothbrush
Colgate website, eBay [5]

4.7.1 Colgate Hum toothbrush

While simpler overall, Colgate's Hum smart toothbrush is a strong example of a product that is easy to setup at home and integrates with existing consumer technology to ameliorate the user experience. In summary it is an electric toothbrush with a replaceable head that connects to an app on the user's phone.

Packaging

The brush and associated accessories come in an attractive, recyclable cardboard tube. As soon as the box is opened, the components are clearly laid out (not stacked or in individual boxes). There is a quick start guide printed on paper as well as a QR code that takes the user to an app for detailed setup.

Assembly

The quick start guide shows the user how to snap together the components and install the battery or connect the power cord depending on the model.

App

The companion app is what makes the user experience stand out. It is easy to use and doesn't require the user to leave the app to connect the toothbrush via Bluetooth.

Figure 4-4: Withings connected blood pressure monitor
Withings website, eBay [18]

It integrates with Apple Health and gives the user alerts and reminders about their brushing performance, frequency and can even help connect them with a dental professional if needed.

Key takeaways

While a toothbrush is more self-explanatory to setup than a CPAP device, the product's colourful packaging and easy to understand layout with all components in one box make the process simple and stress-free. The companion app extends the functionality of the toothbrush and provides real-time guidance on how to make the product even more effective. The app is entirely optional in this case but provides functionality to those who wish to use it, serving a wider customer set.

4.7.2 Withings

Withings make a range of consumer focused health tech products for use at home. They range from blood pressure monitors, to smart weighing scales. This benchmarking analysis will focus on the blood pressure monitor (shown in Figure 4-4) as it is the most complex consumer device they make in terms of user operation.

Packaging

Again, the product comes in a durable and attractive box with a clear layout. The box itself has printed instructions on how to use the device; the difference here is there

is no option to use the product without the companion app.

App

The app itself makes it easy to setup the device by animating the setup process on the screen, right from the moment the box is opened. The steps between setup stages are small and easy to follow. There are options for troubleshooting along the way. The product only needs batteries for assembly, but the app is helpful for showing how to position your arm and attach the cuff for a correct reading. It can also self-diagnose when the cuff is not tight enough or at the wrong angle, and provide real time feedback on how the user can correct.

Key takeaways

The app experience is the focus here, in particular the way in which sensors built into the device provide the sort of feedback a medical professional could but at no incremental cost to Withings.

4.7.3 ResMed Air Mini

ResMed recently started selling a cash-pay only CPAP product that is miniaturized for convenience when travelling (but still requires a prescription to buy). This is unique in that it can be bought directly from ResMed's online store. The customer is entirely responsible for the setup process (there are no sleep therapists or HMEs involved). As a result, it has some elements of the design direction that would be helpful for ResMed to incorporate in their at-home CPAPs.

Packaging

The box is attractive and shelf-suitable; there is a single box with the device, power supply components and a travel case. The masks are still sold separately however and come in separate boxes.

Figure 4-5: ResMed AirMini travel CPAP
Adapted from ResMed website, eBay[7]

Assembly and setup

The device has a user guide included with it that shows how to connect the mask and tubing, and also how to configure the device. There is a device-specific app which helps the user select therapy modes, check for mask fit and provide sleep reports.

Key takeaways

ResMed has taken strides in the right direction with the app and packaging developed for the Air Mini. Customer response has been strong - online reviews are positive. The main complaint still seems to be around mask fit, just like with regular setups, as the device comes with a single mask when ordered. The philosophy around assembly and use needs to be applied to at-home setups for ResMed's main CPAP devices, to help give the patient more autonomy. This said, customers who travel frequently are likely to be younger and more tech-literate regardless compared to the customer set for the regular at-home device.

4.8 Packaging and companion app literature review

After seeing benchmark examples of user-friendly and setup-focused packaging, a next step is to examine what literature exists around design principles that ResMed can incorporate to help customers have a better virtual product setup experience.

Looking at the physical packaging design, Lorenzini and Olsson [4] discuss the tradeoffs traditionally made in patient-centered medical packaging, namely utility vs cost, and complexity of manufacturability vs complexity of use. In ResMed's case, cost

and complexity of manufacturability are likely to play significant parts in the final packaging design given constraints around what is feasible using existing packaging partners and still within a reasonable cost envelope (incremental $5-10 based on team interviews). Using existing packaging partners is vital as these are medical grade products and there is heavy scrutiny, as well as a lengthy approval process, around packaging materials and suppliers. Svanes et al [13] suggest a quantitative approach can be helpful in selecting key materials and a final design once some candidates have been established, focusing on environmental sustainability, distribution costs, product protection, market acceptance and user friendliness.

On the multichannel app side, ResMed already has a few apps that help users interface with their CPAPs. The team is planning to introduce features around air-leak detection and setup troubleshooting, but there is scope to further educate the user about the current range of mask / cushion products that are available. Also the ResMed app limits setup to basic videos - there is potential to follow a Withings model and have the setup be interactive with the device communicating with the app for real-time feedback. In terms of design, cues can be taken from apps optimised for elderly users like MediSafe and WebMD as well as the companion apps covered in the benchmarking section such as Withings.

4.9 Prototype design and testing

Using some of these basic principles, a packaging design can be tested with users to see how they respond - at least on the user-friendliness front. Given the confusion that customers experience when setting up the product and the frequency of fit problems, a potential solution is to offer a choice of masks and/or cushions in one 'starter kit' and guide them in connecting up everything correctly. An example is seen in Figure 4-6. Accompanying this can be an easy-to-follow quick start guide that has QR code links to an app or website with detailed video instructions, as in Figure 4-7.

This design was not tested physically with users due to lack of access to a ResMed device, but was sent to two current ResMed CPAP users for feedback and comparison

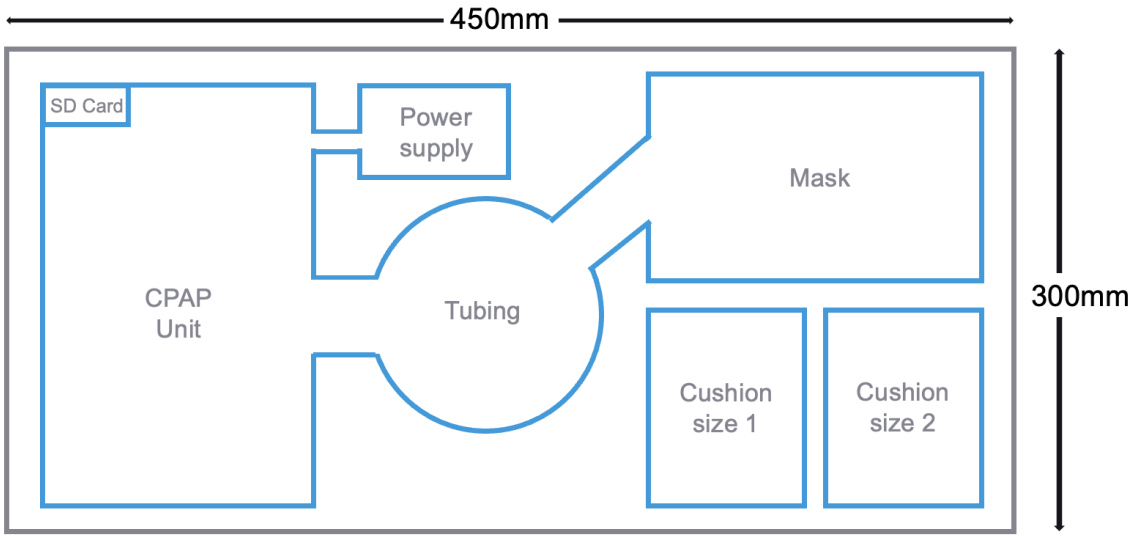

Figure 4-6: Starter kit design idea for remote setups or retail sales

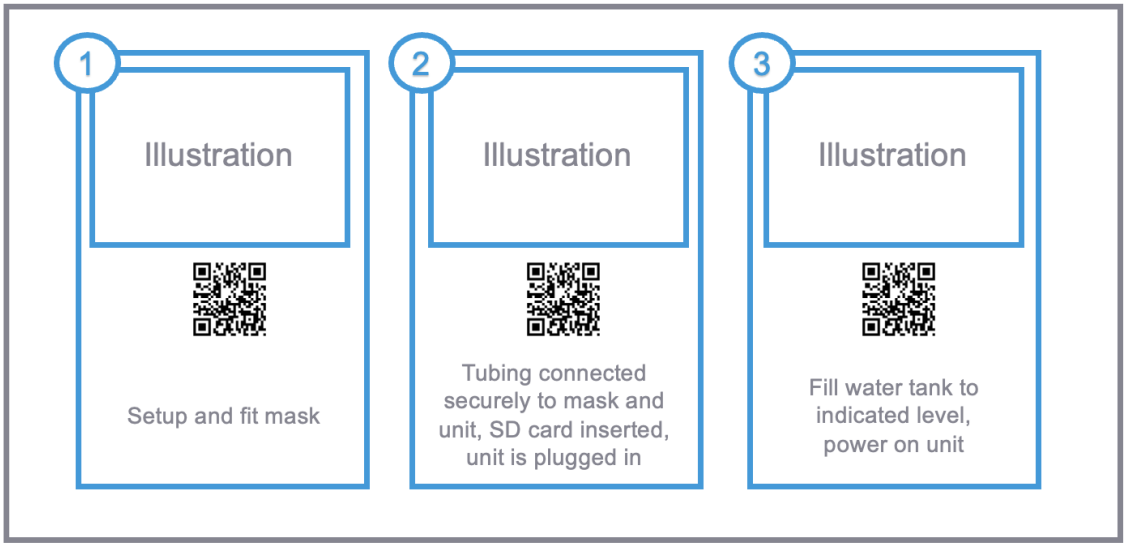

Figure 4-7: Quick start guide included with starter kit

to their setup / learning processes. Both of these users are female and over 60 years old. They have been ResMed patients for over three years. Their feedback was as follows:

Patient 1

"Guides in the box showing how the tubes are connected would certainly be helpful, when I watched the sleep therapist do it I wasn't sure which end of the tube went into the CPAP unit and which went into the mask. It would be nice to see a second mask available if needed in the box, I ended up with a totally different mask to the one the therapist set me up with."

Patient 2

"I am known to be forgetful - the quick start guide is definitely something I'd like to have had. I'm reasonably comfortable with using my phone and since the pandemic I'm used to seeing QR codes. It would be useful to have some way of referencing more detail however. Maybe a guide for navigating the device menus? I got a new doctor and she asked me what my prescription was for CPAP therapy. It's in the device but it took me forever to figure out how to get to it."

4.10 ResMed solution design

ResMed needs to have a simplified home setup experience across sales channels for its CPAP products, that is low cost and easy to scale to more patients. The current process is heavily reliant on expensive sleep coaches and could make more use of technology that ResMed has already developed for the Air Mini. The in-store experience is harder for ResMed to control, but could educate customers better to help them choose the right products to optimise their therapy.

Given the restrictions on packaging materials and design imposed by existing suppliers, ResMed should develop a few starter kit packaging options similar to the

design in Figure 4-6, and score them on a framework composed of the following elements as suggested by literature review. Manufacturability, material cost, environmental sustainability, distribution costs, product protection (for shipping) and user friendliness. Manufacturability can be assessed by the existing packaging suppliers. Sustainability can be rated according to existing criteria ResMed has in their ESG guidelines. Product engineering will be able to assess quality of product protection, and user friendliness will need to be put to the test with focus groups. In particular with those who are not familiar with how to set up the product; ideally there will be a reduction in time needed to get the device working with an effective packaging design.

The second component of the solution, to reduce the reliance on sleep coaches, therapists and in-store staff, will involve developing multichannel companion tools for the customer to use. These tools are likely to be websites or apps that can guide the patient when shopping online or visiting stores that would help the overall setup experience. ResMed already has a well-reviewed companion app for their CPAP devices with some of these features - the team is planning to introduce air-leak detection and setup troubleshooting, but there is potential for these tools to be better integrated into the setup process using QR codes and real-time setup feedback. Moreover, the existing app does not help navigate the range of products available or have a comprehensive 'how to' library. For elderly patients, simplified versions of these tech-centric tools can be made into booklets and packaged with the product, with colour coded images suggesting mask / cushion combinations based on some measurements that the customer has to hand. Patient feedback suggests this would be useful for both setup and as an ongoing reference. This said, there also exist apps designed specifically for the elderly and a design studio could be brought in to optimise any existing content ResMed has.

4.11 Business case

Right now, there is demand from HMEs to have more remote setups as some patients are reluctant to come into sleep clinics in person, but the costs involved make it

prohibitively expensive and potentially is costing ResMed incremental sales. The additional cost to the HME, which is not reimbursed, is over $100 per patient thanks to the video chat time with a sleep therapist. This does not take into account costs incurred when shipping replacement masks or cushions.

ResMed has the ability to reduce the amount of sleep therapist time required using smart packaging combined with an app that has a toolkit to aid setup and track therapy adherence. The cost of designing this packaging can be amortized across products sold in retail stores also. In an ideal situation, ResMed can allow the user to configure the mask / pillow combinations they think are most likely to be effective, then ship 2-3 sizes of cushions along with the product all in one starter kit, to help the patient start therapy as soon as possible.

Current costs:

- $100-150 – sleep therapist
- $20-30 – shipping and returns costs
- **Total: $120-180 per customer**

Future state:

- $5-10 – custom packaging
- $10 – extra cushions of different sizes
- **Total: $15-20 per customer**

Still to be considered are costs that incurred on the packing and fulfilment side to support this kit-to-order capability, but those costs can be shared across all channels as improving each-pick capabilities remains a central goal for ResMed's fulfilment and will be explored further in Chapter 6.

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Chapter 5

Delayed Differentiation - Meeting High and Unpredictable Demand

5.1 Problem breakdown

ResMed's manufacturing operations are highly centralized in Singapore and Sydney, with long lead times for shipping products to the US resulting in stock-outs and backorders on certain high-demand products when faced with variable demand from customers. Some of ResMed's newer customers in particular order in a less regular fashion than traditional HMEs, and the supply constraints on key parts mean that orders are often delayed to begin with, even before the shipping time comes into the picture.

5.1.1 Forecast accuracy

If the factory in Sydney knows about a spike in orders coming up, they can ramp up production of the correct SKUs and ship them out for the US distribution centres to keep in inventory. There are a few drawbacks here however.

First, forecast accuracy is a nebulous problem to tackle and is already being looked at by data science teams within ResMed – the forecast right now is usually correct within 15% of actual demand; the real issue being solved for here is enormous demand

swings caused by events that are in fact relatively difficult to predict, such as customer supply chain disruptions from COVID-19.

Second, producing more of a SKU pre-emptively means more working capital is being tied up in inventory which shareholders rarely want to see – increased inventory also carries increased storage costs incurred at the US distribution centres.

Finally, ResMed offers hundreds of SKUs across their product lines. This includes all the sizes and variants of masks, silicone cushions, tubes - including products launched over a decade ago due to ongoing demand from old customers for replenishment. It also includes versions of each CPAP device for different regions - while the device is the same, the software and literature in each box are subtly different. Simply getting better at predicting how uptake of these different options will change, especially with newer customers who don't have long order histories, is not trivial.

5.1.2 Agile manufacturing

Delayed differentiation, or late-stage / in-region manufacturing on the other hand, is an effective method of decentralizing manufacturing operations in order to satisfy customer demand closer to the source. This reduces total lead time for the customer, reduces ResMed's in-transit inventory costs and lets ResMed cope with order volume changes much faster than they are able to today. By being able to set up small-scale production lines to assemble specific products in the US, and working with local source suppliers for bottleneck parts, ResMed can make sure customers are more satisfied with the service they receive and reap financial benefits from not having to ship replacement products to these customers in the future.

5.2 Delayed differentiation and postponement

5.2.1 Literature Review

Delayed differentiation, or postponement, is an effective tool in manufacturing supply chains for pooling risk across product SKUs. This is done by holding inventory in an

undifferentiated state for longer [8]. The risk of a forecast being wrong is mitigated, as it is possible to change this undifferentiated piece of inventory to whichever SKU is in higher demand. In fact, forecasting becomes easier as it can be done at a pooled level across multiple SKUs, evening out some of the variability seen at the SKU level.

Lead times reduce overall as it takes less time to customise an intermediate SKU (which can also be done in-region) that has already been made, than to make and ship a new SKU. Inventory costs are reduced and lost sales are avoided as the new SKU can be customized based on demand. This in particular is what allows for fast response to changes in demand. [1].

Postponement has existed as a concept since the late 1970s, migrating from the world of marketing into logistics - Donald Bowersox was the first to predict the way in which postponement could play a role in reducing inventory costs, whereby warehouses would switch from a traditional storing role to one where small-scale manufacturing also occurs [19].

In the early 1990s, a case study about Hewlett-Packard helped bring together a lot of the concepts described, and introduce a design component whereby printers were designed specifically to be customized at a later stage. The case study focused on regional differentiation of the DeskJet consumer printer, where the in-box literature and power cord specific to the region the device was being sold in were added in-region, in distribution centers. The result of this choice was a meaningful reduction in inventory levels across the supply chain, saving HP several million dollars per year. [9]

Diving deeper into exactly where these savings come from, there are a few key cost drivers that need to be accounted for, as described by Lee and Tang [10]:

1. Total investment cost for redesigning the product such that there are now more common steps than before (delaying the differentiation point)

2. Total processing costs

3. Total inventory costs

They consider a case where there are two products being manufactured with N total steps in the supply chain and each operational step has an inventory buffer directly

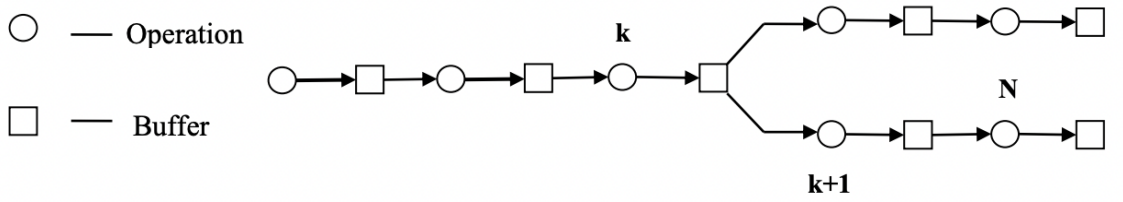

Figure 5-1: Delayed differentiation in a supply chain
Lee and Tang 1997 [10]

after it. Ordinarily, differentiation occurs at stage k but with delayed differentiation it is now happening at stage k+1. This is illustrated in the figure below.

There are several assumptions with this model. First, that demand *D(t)* is normally distributed across a time period t : $D_i(t) \sim N(\mu_i, \sigma_i^2)$. Second that the variation in demand of both products given they share operations is $\sigma_{12} = \sqrt{Var(D_1(t) + D_2(t))}$. Finally, Lee and Tang assume a constant target service level z across all buffers. This leaves an average buffer inventory at each stage of $\frac{\mu}{2} + z\sigma\sqrt{1+n}$ where n is the lead time at that stage

S_i represents the cost of redesigning the system at stage i to make this a common step for two products (i.e., the amortized cost of delaying differentiation). $n_i(k)$ is the lead time for task i, $p_i(k)$ is the processing cost per unit for task i and $h_i(k)$ is the per-unit holding cost. It is possible then to construct a total cost function from these pieces of information.

First, the investment cost is described by this term:

$$\sum_{i=1}^{k} S_i + \sum_{i=1}^{N} p_i(k)(\mu_1 + \mu_2)$$

Next, the processing cost is described by this term:

$$\sum_{i=1}^{N} h_i(k)[n_i(k)(\mu_1 + \mu_2)]$$

The inventory costs are broken down into two - the transit or work in progress (WIP) inventory cost moving between stages is described by this term:

$$\sum_{i=1}^{k} h_i(k)[\frac{\mu_1 + \mu_2}{2} + z\sigma_{12}\sqrt{n_i(k)+1}]$$

And finally the inventory being stored in in the buffers is represented by this term:

$$\sum_{i=1}^{N} h_i(k)[\frac{\mu_1 + \mu_2}{2} + z(\sigma_1 + \sigma_2)\sqrt{n_i(k)+1}]$$

Shortcomings of Lee and Tang

While Lee and Tang propose a logical model to identify the impact of delayed differentiation on major supply chain costs, there are two simplifications used here which are worth keeping in mind. First, is supply uncertainty - the model assumes identical service levels across the system in terms of inventory stock, which is not always the case. Second, there exists some level of process uncertainty, where technical faults or labour shortages can affect the ability to deliver products. These are reviewed in detail by Ngniatedema in his dissertation looking at ways to improve Lee and Tang's model [12]. For the purposes of this thesis however, those complications will be put aside.

Understanding how cost to serve is reduced from equations

There are a few ways, useful to the situation at ResMed, that delaying differentiation by a stage (going from k to $k+1$ can bring down costs, and they can be identified from these equations:

- In the first equation, S_i can actually be negative, e.g., if the process step being standardised across two SKUs reduces parts costs because they now come from the same supplier

- In the third equation, σ_{12} is be lower than $\sigma_1 + \sigma_2$ - there's an additional stage where the total amount of work-in-progress (WIP) or transit inventory to maintain a given service level can be brought down. This is the effect of pooling.

- In the second, third and fourth equations, the lead time for a given stage can be meaningfully reduced by bringing the parts supplier closer to the location of operations - this step is not directly tied to the equations shown, but the equations illustrate why reducing n_i is helpful

5.3 Test case - applying delayed differentiation to a problem at ResMed

A key goal of this internship and thesis is to help ResMed understand how to better meet unpredictable demand for popular products in the face of supply constraints This involved working closely with the stakeholder groups identified previously and understanding their needs throughout this process to make sure the end product was one they would use going forward.

5.3.1 Business problem

The project chosen was a proposal to help reduce lead time for supplying CPAP units to North American customers who ordered the devices with a certain type of tubing. There were two main tubing types available – heated and non heated. CPAPs sold with heated tubes were called 'TriPacks', and those sold with a standard tube were called 'CoPacks'. With an upcoming influx of orders from newer retail customers like CVS who were switching from cash-pay only to accepting insurance, this was a difficult SKU mix to forecast accurately.

The tubing was also proving to be a bottleneck part, with assembled CPAP units sitting in Australia waiting for tubing to arrive from a Chinese supplier. Once the tubing arrived, it was simply placed in the same box as the CPAP device, sealed and shipped. The solution would take the form of late-stage assembly in the US but it was important to spend time with each stakeholder understanding their concerns with the project.

5.3.2 Cost of maintaining the status quo

The first step was to understand the need for change by interviewing a few stakeholders. This was to help guide the teams I would need to work with and the analysis that would need to be done.

Internal factors

1. Financial cost of switching between SKUs - when CoPacks are backordered, TriPacks need to be sold to the customer at a discount and then the non-heated tube shipped separately when it is in stock later

2. The sales team has a time cost in orchestrating these swaps / discounts with customers

3. Consistent dependence on air freight to keep up with demand

External factors

1. Customers have a poor sales experience - they rarely can order a product with any certainty that they will receive it

2. Shipping times are variable, as is resultant discounting behaviour depending on the size and maturity of the customer

3. Customers have to be ranked and prioritized, which becomes messy and negatively impacts ResMed's reputation

5.3.3 Key concerns by team

In general, teams were in favour of the idea of reducing lead times, the driving force behind this project. It would help patients start therapy faster, increase customer satisfaction and also reduce the stress placed on supply chain teams who were using costly air freight to try and meet demand quickly.

Product marketing and Finance were strongly on board as this project would improve customer satisfaction while not incurring additional duties or taxes. Supply

Stakeholder	Reasons for support	Key concerns	Initial support
Product marketing / design	• Lower lead times help maintain relationships with customers	• Quality of finished product being at least equivalent to that from the factory • New product meeting regulatory and design specs	
Sourcing / supply chain	• Help even out demand on supplier • Reduce rush-order costs	• Suppliers being allowed legally to ship parts / subassemblies to new location • Parts being packed and sent correctly	
Manufacturing	• Helps them get inventory out faster	• Consolidated demand for new product still within reach of manufacturing capacity • Other parts should not now become limiting	
Distribution / logistics	• Reduced OTIF penalties and complaints from customers	• Inventory holding space in DC for new parts • Requirements for labour and machinery • Logistics routes not being too complex	
Finance	• Reduced overall cost to serve	• Duties and taxes are clear and make cost sense • No additional work required to set up entities in new territories etc	

Figure 5-2: Summary of stakeholder concerns with delayed differentiation

chain were concerned about packing and shipping of parts if they came from a new local supplier. The distribution team was happy to face fewer penalties as a result of delayed order shipments but were keen to understand exactly how the tube would be added in their DC, how many people and how long it would take. Finally, Manufacturing were concerned about an activity that usually falls under their purview being conducted outside of one of their facilities. They were used to owning all of the operational stages until the product was ready for sale, and this would move one of those stages out of their control. As a result, they had a concern about being able to product enough undifferentiated units given a potential demand increase if customers saw orders being fulfilled / not back ordered. They also were concerned about how this proposal could snowball if later a different part becoming limiting, e.g., the humidifier tub. They were worried that then this too would be moved out of their control and added in-region.

Addressing these concerns - product engineering teams would validate all new packaging and parts so this was not difficult to overcome. Time and layout studies helped understand the scope of the effort in the distribution center (presented later). For Manufacturing, it was important to reassure them that because tube addition was a final stage of the manufacturing process, it was being considered for in-region implementation. Particularly because of the potential cost savings from delayed differentiation. The intention was not to consider additional manufacturing scope

outside of the US more broadly.

5.3.4 Options for execution

After meeting with stakeholder groups, a few options emerged for potential solution types. These can be evaluated operationally, and financially with the aid of the delayed differentiation literature.

1. **Do nothing** - Understand the cost of leaving operations as-is, where units are sold for eroded profit margin and time is spent flipping backorders between
2. **SKU simplification**- Remove the 2-SKU model and have a single SKU that ships with the heated tubing – customers can choose to keep or discard
3. **Late stage customization – current suppliers** - Have the Chinese supplier ship the tubing to the US and add the bottleneck part locally
4. **Late stage customization – local suppliers** - Have a North American supplier ship the tubing to the US distribution center and add the bottleneck part locally
5. **De-link base product and tubing** - Have the tubing be a separate order item in a different box

5.3.5 Analysis of options

Figure 5-3 provides some commentary on the different options available to solve ResMed's long lead times for tubing. Leaving the situation as-is does not solve any problems as demand is likely to continue to outstrip supply for some time given the restricted global supply environment. The idea behind SKU simplificaton is to do away with one SKU altogether, and offer the other type of tubing as a separate extra if customers want it. The issue here is that the tubing supplier is already being stretched beyond their capacity, so doubling the order volume of one tube type is not going to be possible. The other argument against this idea also applies to the last option of

	Feasibility		Long term value	
Do nothing	High	Easy to continue	Low	Does not help address future demand fluctuations
SKU Simplification	Low	Supply of both types of tubing restricted currently, difficult to double quantity of just one	Medium	Lowers complexity but does not provide best value to the customer
Add tubing in ATL – current sourcing	Medium	Requires freight re-routing and the setup of a dedicated line in ATL	Medium	Strong stop-gap solution but long ship times for tubing will continue to keep lead times high
Add tubing in ATL – local sourcing	Medium / Low	Onboarding and setting up a new supplier for tubing in NA is time consuming	High	Ensures demand changes can be serviced rapidly in the future with no change needed to customer order habits
De-link CPAP unit / tubing as separate SKUs	Low	Ship time mismatch will ruin customer experience and delay therapy	Low	Does not build any capability for ResMed and puts the customer experience in the hands of a 3rd party

Figure 5-3: Analysis of different options for tubing case study

de-linking the CPAP device and tubing to sell them separately. Both of these options would ruin the customer experience as customers will have to wait for the right type of tube to begin therapy the way they wanted to - this is unlikely to help with adherence.

The other two options are both delayed differentiation ideas, where the appropriate tube is added to a CPAP box in Atlanta within the distribution center - the CPAP is customized to order in-region. Returning to the equations from earlier can help characterise this process.

5.3.6 Cost savings from delayed differentiation

Lee and Tang explore a case in their paper where a dishwasher is customised in-region: the approach they use is analogous to ResMed's case for customising a CPAP [10].

As a reminder, our total cost function is given by:

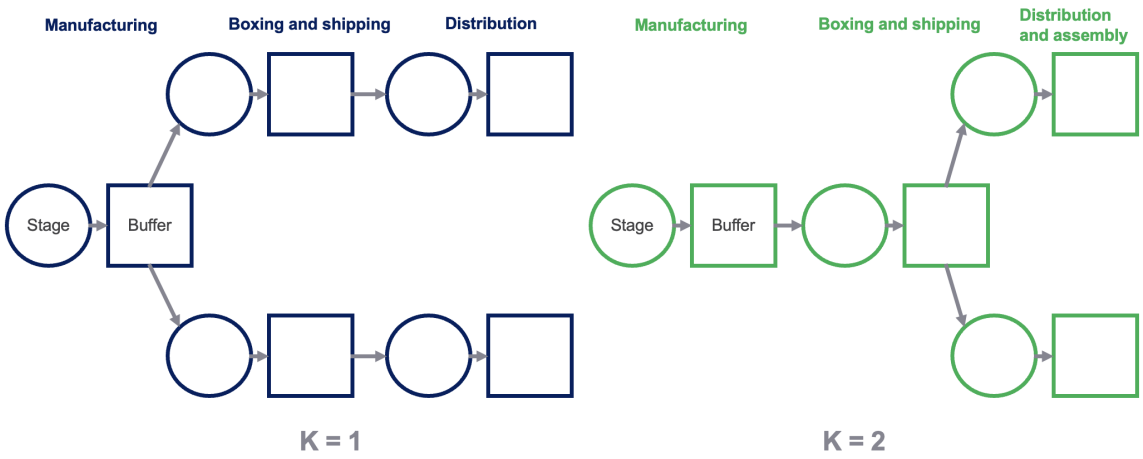

Figure 5-4: LHS: k=1 system today. RHS: k=2 proposed change

$$Z(k) = \sum_{i=1}^{k} S_i + \sum_{i=1}^{N} p_i(k)(\mu_1 + \mu_2) + \sum_{i=1}^{N} h_i(k)[n_i(k)(\mu_1 + \mu_2)] + \sum_{i=1}^{k} h_i(k)[\frac{\mu_1 + \mu_2}{2} + z\sigma_{12}\sqrt{n_i(k)+1}] + \sum_{i=1}^{N} h_i(k)[\frac{\mu_1 + \mu_2}{2} + z(\sigma_1 + \sigma_2)\sqrt{n_i(k)+1}]$$

The production and distribution process for a CPAP can be simplified into three key steps: manufacturing, boxing and shipping, and distribution. Using the equations above, that means there are N steps in the process and differentiation currently occurs at step k=1. Figure 5-4 shows the proposed change.

5.3.7 Analysis of options

The biggest change in cost occurs at the distribution stage, because there is an additional assembly step to contend with there where the boxes are opened and tubes inserted. Compared to doing this at the factory though, there is not a huge time penalty - the additional steps are the opening and sealing of the box. Given this is a discrete time model, this time penalty is negligible in a weekly period. Similarly, there

are no incremental materials costs as the tubes are already accounted for. It can be assumed that inventory space costs roughly the same at the factory as it does in a distribution center, and the investment costs are also negligible because there is no design change needed to the product to facilitate delayed differentiation. As a note, the investment cost S_i is not the same as the capex required to support this project - that will be addressed later.

With all of this in mind, the most significant per unit savings from this shift come from a reduction in transit inventory costs - given by:

$$Z(2) - Z(1) = zh_2[\sigma_{12} - (\sigma_1 + \sigma_2)\sqrt{n_2 + 1}$$

This equation, and the commentary above shows that delayed differentiation in this form is helpful in the following situations, all of which apply to ResMed:

- When n_2 the lead time of stage 2 is especially long - 7 weeks ship time from Australia to the US)

- When it is relatively inexpensive to redesign the product for this type of modular assembly i.e., S_2 is small - in this case S_2 is zero as no redesign is needed

- When there is little incremental process time, material cost or inventory cost difference in implementing the step in a different location - this was confirmed with the ResMed manufacturing team

Based on data from ResMed (partially blinded for IP reasons), the incremental inventory in transit savings can be analysed as a result of this model, using demand data from the last year. Product 1 is the TriPack and Product 2 is the CoPack.

$$z = service\,level = 90\%$$
$$h_2 = 10\%\,of\,unit\,value = \$80$$
$$n_2 = 2\,months$$
$$\mu_1 = XX$$
$$\mu_2 = XX$$
$$\sigma_1 = 1969$$
$$\sigma_2 = 727$$
$$\sigma_{12} = 1148$$

This produces savings of $\tilde{\$}$253,000 each month for ResMed, or around $3M per year. In large part this is driven by high shipping costs driving up h_2. Nonetheless this is a significant saving and points to delayed differentiation being the optimal strategy for this case. As for the sourcing location for the tubing, keeping it local to the US is a key enabler of low costs. As a reminder, the buffer stock required at the distribution center is given by $\frac{\mu}{2} + z\sigma\sqrt{1+n}$ - if the tubing were to come from China as today, the n = 8 weeks shipping time from China to the US. This would require significant safety stock, incurring substantial incremental cost, not to mention attracting additional China-specific duties levied on imported parts.

5.3.8 Business case

Note: Costs are estimated and provided for illustrative purposes only, impacted by COVID-19 pandemic

Savings

Implementing this option produces savings in two other key areas - order switching costs, and freight. Order switching entails ResMed shipping an additional correct tube when it returns to stock, in addition to the incorrect tube they had to ship originally as a substitution (e.g., the customer orders a TriPack which is backordered. They are

shipped a CoPack instead with the non-heated tube and then the heated tube has to be sent to them later). Eliminating this behavior could save ResMed an additional **$0.5-1M a year**. The range is due to variability in order switching rates. Illustrative math is shown below (with different numbers for IP purposes).

- Total CoPack + Tripack orders of 1M units per year
- 5% of orders are switched
- Cost of an additional heated tube is $20
- Cost of an additional non-heated tube is $16
- 0,000 orders * $18 average cost = $900k savings

For freight, there are incremental savings on total ship cost of the tubeless units thanks to a weight saving from not shipping the tube. This comes to around **$2-3M per year**. The ranging is due to variability in shipping costs. Again, illustrative math is shown below.

- $40 ship cost per unit at 4kg each
- Tubing unit weighs 300g, represents $4 ship cost per unit
- 1M orders * $4 average cost = $4M savings

Total estimated *actual* savings including transit inventory, freight and order switching **total $5-7M per year**.

Costs

On the cost side, there are two main categories: personnel and equipment. These are both governed by the processing capacity at the Atlanta warehouse. Figure 5-5 shows what cycle time would be based on proposed activity flow for packing the tubes. This can be used to arrive at a capacity figure.

Illustrative calculations are as follows: with a 1 minute cycle time, and a requirement of 1.2M orders per year. A single line can process 60 items per hour, a single shift is

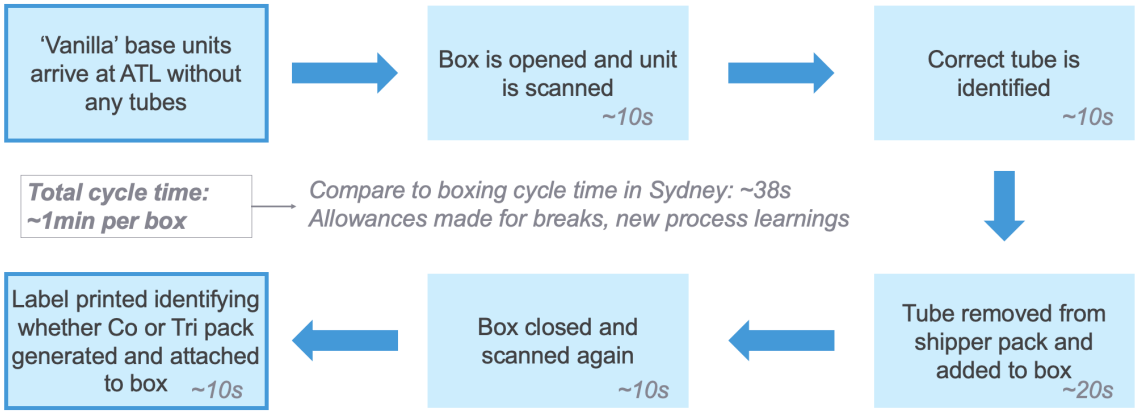

Figure 5-5: Proposed activity flow on manufacturing line

10 hours long, so 600 orders per day. A line is 'up' for an average of 300 days a year accounting for maintenance, vacations for work staff etc. So a single line processes 180,000 units a year. To meet the 1M unit requirement, 6 lines are required.

Each line requires 2 workers being paid $20-25 per hour each. This comes out to $720k-900k per year. There are also costs for a process supervisor at $100k a year and a test engineer for the line setup and maintenance at $200k a year. This gives total personnel costs of $1-1.2M a year.

Finally, there are capital costs for lines and test equipment. Each line costs $20-50k and the test equipment costs $100-200k. These are one off, not yearly costs. Total capex comes to $200-500k.

Actual costs using real ResMed data come out to **$1.8-2.5M in the first year and then $1.3-2M thereafter**

Net Impact: Looking across all savings and cost buckets, this project would net savings of **$2.5-5.2M in the first year, and then $3-5.7M thereafter.**

5.3.9 Analysis of team response

The stakeholders I engaged with overall were very engaged with this idea – in particular Manufacturing personnel at the Atlanta facility had built out versions of this analysis

in the past for proposals and were excited to provide input that would allow for some degree of formalization. The overall message and comments were that this supply chain model would remain helpful for that facility in evaluating delayed differentiation decisions going forward, and add financial gravitas to arguments put to Sydney for future regional Operations proposals.

The risks I observed were that in general, the case for change tended to be interpreted subjectively by different teams and the cost model highly assumption driven at this stage. There is also a degree of supply variability which the model does not incorporate, and the freight costs used are highly variable which eventually could push the needle a different direction. Mitigating actions for the future involve improving the model to take into account more variability potentially by working with data science teams who are currently attached to forecasting. Also, by more closely involving teams who may find additional financial benefits to add to these proposals like Duty / Tax.

Chapter 6

Fulfilment - adapting for new channels

6.1 Problem breakdown

There are an increasing number of packages being shipped directly to patients, either through ResMed's own DTC sales or shipping on behalf of HMEs doing remote setups. Currently, not all patients are able to start therapy in a timely fashion due to stockouts, errors or delays in the shipments they receive. To correct, this will require changes to the fulfilment infrastructure at distribution centres in order to serve this growing group of customers better.

Fulfilment that is traditionally set up for large volume orders, catering to B2B customers can be difficult to adapt to smaller order sizes where some, or most, of each order involves each-picking items into boxes.[14] This is where items are individually put into shipment boxes, versus shipping in cases or pallets (multiple cases). Each picking is not new to ResMed as there are no specific order quantities or multiples imposed on customers. As a result, most of an HME order, for example, is pallet or case picked and then the remainder is each picked.

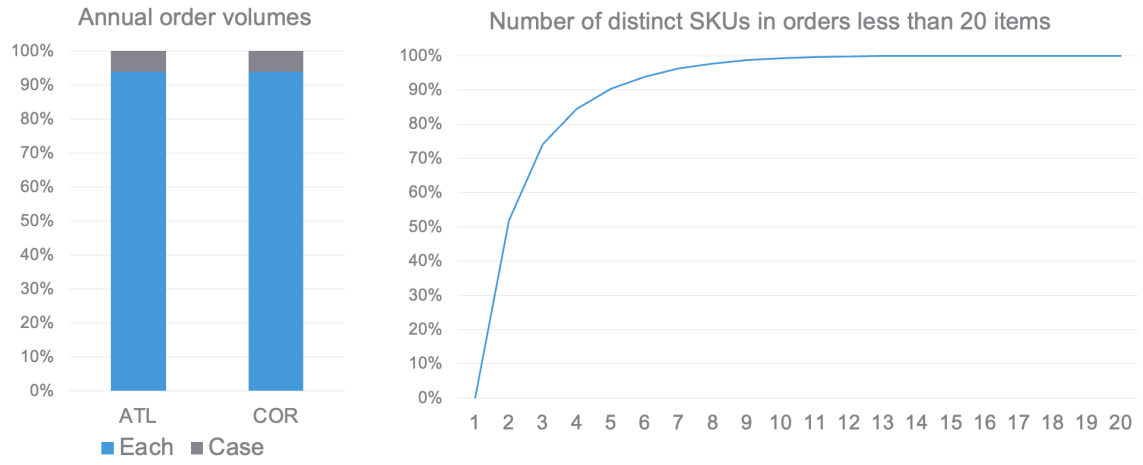

Figure 6-1: ResMed orders from July 2020 - July 2021

6.2 Why is drop shipping / each picking becoming more relevant?

Shipping directly to consumers provides them with more value as they can start therapy sooner. It also holds up a robust revenue stream from HMEs as they can keep buying CPAPs even when extenuating circumstances like COVID-19 prevent in-person setups from happening. Competitors are starting to offer drop shipping and it is important ResMed does not lag behind. Finally, it provides optionality to ResMed in the future to dis-intermediate HMEs should they choose to change their sales model.

Thanks to some of these factors, ResMed is seeing rising volumes of products being shipped directly to consumers at the request of the HME – with some HMEs also trying to reduce the inventory they carry this way. This places increasing importance on OTIF rates being high for each-picked orders.

6.3 Order demands and new customer characteristics

Figure 6-1 tells a compelling story. The LHS of Figure 6-1 shows that over 90% of orders involve at least one each picking stage at both the Atlanta (ATL) and LA (COR) distribution centers. This is especially problematic as OTIF rates are 8%

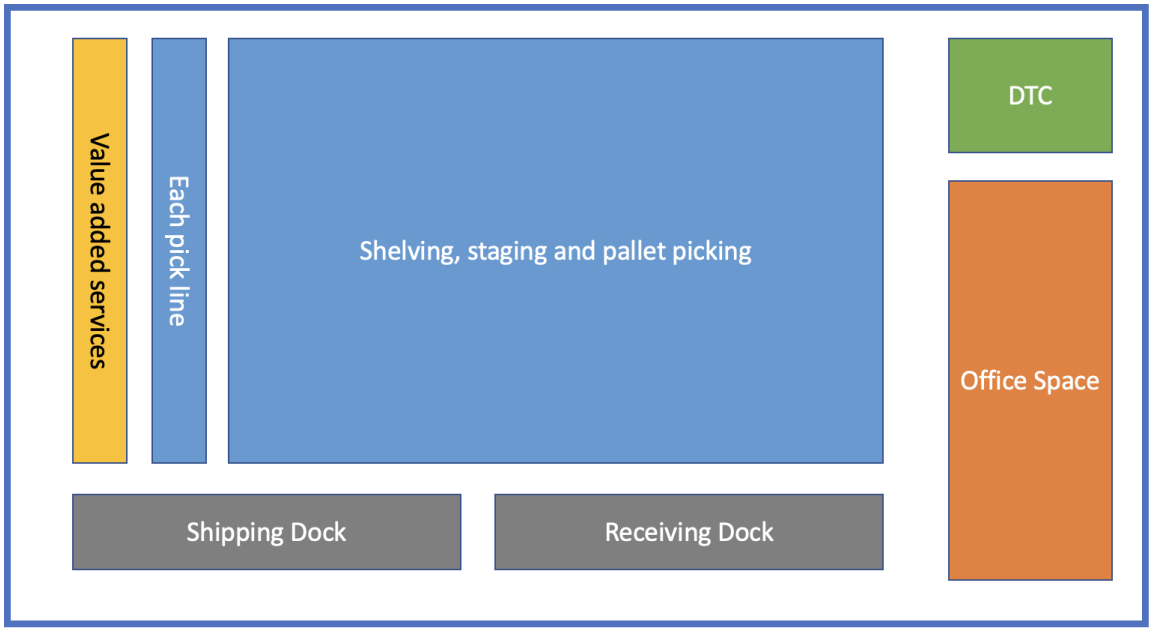

Figure 6-2: ResMed Atlanta warehouse Layout

higher for case picked than each picked orders. This implies there is a fulfilment issue that largely has to do with the each picking and drop shipping stage. The RHS of Figure 6-1 illustrates the concentrated nature of many each-picks, with only 9 distinct SKUs making up almost 100% of small orders (<20 items). 20 was chosen as it a typical size for a case.

6.3.1 Warehouse visit to Atlanta

On a visit to ResMed's Atlanta warehouse and distribution center, I was able to observe the each picking process in action (approximate floorplan in Figure 6-2). Each picking occurs in two streams today – in a separate area specifically for DTC sales of the Air Mini travel CPAP, and on a main picking line for the rest of the orders. This is a combination of HME and eTail today.

Observing the each pick line, as this is where over 95% of each picked order volume goes, errors frequently occur when counting the correct number of SKUs into each box. There are some weight-based validation steps later in the process but these are not sensitive enough to tell when light items like cushions are picked incorrectly. They are also more of a final check than any real-time pick assistance – this doesn't exist

apart from a barcode scanner. Boxes with similar inventory items are placed adjacent to each other often on shelves – this can lead to misplacement of products back on the shelf if the wrong quantity is picked initially and has to be put back. Finally, all each pick orders flow down the same line with the same level of checking / pick assistance regardless of size (43 items vs 2 items are picked in identical fashion). Human error starts to become problematic here as counting 43 items is much harder than counting 2.

6.3.2 Options for distribution center strategy

1. *Do nothing* - this would involve trying to understand the cost of leaving operations as they are, including potential customer attrition when scaling of this pick process is no longer possible

2. *Augment current pick system* - add additional picking assistance to the existing line such as pick to light or pick to voice

3. *Pick to tote system* - for orders that conform to specific characteristics (size, SKU assortment) there could be a divert set up that would take orders into a robotized picking system which would put products into totes, ready to be boxed

4. *3PL outsourcing* - partner with a 3rd party logistics provider to handle all each-pick operations

5. *Minimum / even order quantity* - force large orders to be in case or pallet multiples to eliminate the stress from HME overflow orders

6.3.3 Discussion

Next steps

Looking at Figure 6-3, in the near term it makes sense for ResMed to start augmenting their pick process with some assistance, and then automating a portion of each-picks

	Pros	Cons
Do nothing	• No major modifications required to current DC operations	• Labor will have to go up significantly as DTC / drop ship scale • Continued mis-picks and increased lead times
Augment current pick system	• Minimized disruption to existing line, much of the hardware exists already	• Reprogramming of existing pick-to-light system • Addition of validation checks augmenting current weight checks • Labor as scale increases
Pick to tote	• More reliable and scalable than existing solution • Little reliance on labor to scale up	• New line divert with specialized machinery and inventory holding • Potential opportunity cost for space in DC
3PL outsourcing	• Very scalable, closer to customers and easy to modulate capacity	• Significant incremental cost per order

Figure 6-3: Analysis of options for better each picking

using something like a pick-to-tote machine. This will help them gradually transition to a fully automated model, necessary with a sharp rise in direct-to-consumer order volumes predicted as soon as CVS begins accepting insurance payments and having product shipped directly to consumers at home.

Sticking to a largely human picking process only makes sense for incredibly large SKU variety. While ResMed does sell a very wide range of SKUs, the earlier figure shows this is not the case for smaller orders which make up a significant proportion of each picks – in particular these will be the orders that are drop shipped directly to customers. Those orders <20 items in size are in fact largely made up of only 9 distinct SKUs, which makes them prime targets for automated picking using a machine loaded with a limited selection of SKUs.

Risks and next steps

Having interviewed Commercial Operations team members, it seems like previous attempts at small-scale augmentation of the pick process with technology have run into issues with compatibility between the new technology and the existing Warehouse Management System and Order Management Systems.

Another risk is trying to overdevelop a capability that is not core to the business. ResMed has tried hard to expand their Commercial Operations team and build

excellence in fulfilment, hiring from Amazon and other industry experts, but once each-pick volumes get too large to serve from the Atlanta or LA warehouses they may have to move to a 3PL model. This is something that should be planned for today, by conducting small scale 3PL trials to outsource additional capacity that may be needed.

ResMed plan to bring in external consultants to conduct network analysis and feasibility review for some of these discussed options, including the potential to onboard a 3PL. There are some near-term steps that can be taken to ease the each-pick pressure on warehouse teams, including specifying an optimal order multiple / minimum order quantity for HME customers so each-picking capacity is mostly available for retail and DTC customers. This idea will be the foundation of next an LGO internship project next year.

Chapter 7

Communication

Underpinning the initiatives discussed so far is a robust communications plan. For any largely B2B company looking to shift their sales strategy and engage with customers more closely, internal stakeholder groups must be prepared to work together in ways they have not done so before. Cross-functional teams need to be formed quickly and be able to interact with speed when executing on decisions. There is often an added element of time pressure thanks to a constant flow of customer demands coming to the attention of the company, with execution required outside of traditional product lifecycle timelines.

Retail customers in particular present the greatest challenge to ResMed. Unlike HMEs, they have specific requirements for packaging and fulfilment which they dictate to all of their suppliers. They also tend to update these requirements annually and fine those suppliers who do not comply in a timely fashion. ResMed has faced fines from CVS for not being able to change the packaging of their products, or the case quantities in which they ship fast enough - this has happened already in a nascent (1 year old) relationship. The financial penalty represents several percentage points of margin hit on those products - but the erosion of trust in the relationship is even more problematic. CVS, like most current and future retail customers, stocks both ResMed and Phillips products - it is important to ResMed's retail expansion strategy that CVS continues to choose them as a preferred supplier.

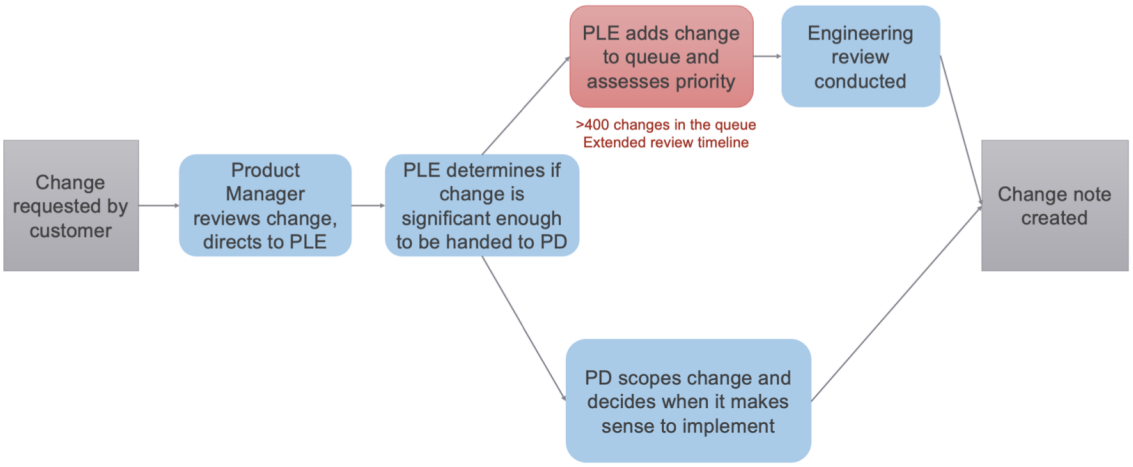

Figure 7-1: Current product change process

7.1 Creating an effective communication and collaboration platform

There are two key components to making an effective collaboration platform for product change initiatives. The first is a prioritization or logic flow for right types of changes to be reviewed by relevant teams in a timely manner. The second is a tech component – a platform for the change request to be generated and then reviewed, with access for all involved parties.

7.1.1 ResMed current state

Right now, as in Figure 7-1, any product change – whether it is to the packaging or the functionality – has to flow into a queue managed by Product Lifecycle Engineering (PLE) who are located in Sydney. In the past this was largely restricted to major product changes to the functionality – such as new control modules or communications features –the product development team would bundle smaller changes and then all of them would be implemented together when the next product lifecycle change happened. Now, smaller changes requested by customers – such as packaging design or case pack quantity – are being sent into the same queue which causes issues with the customer-specified timelines for changes to be made.

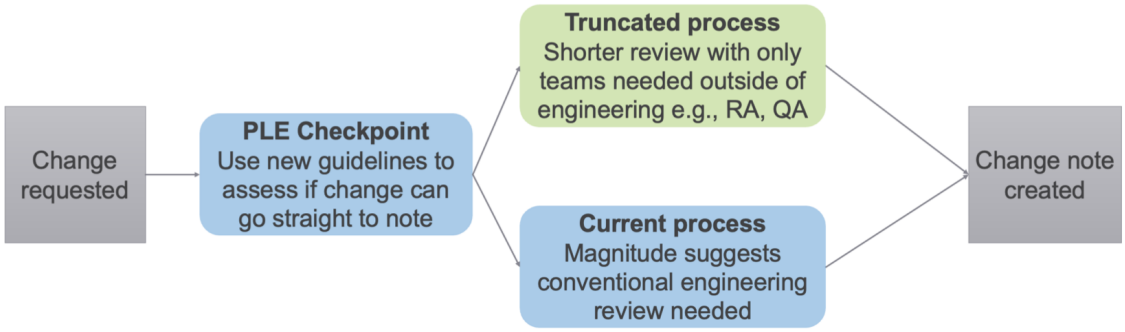

Figure 7-2: Proposed future state product change process

7.2 ResMed interviews - flow logic

Immediate solutions are either increasing the resourcing available to PLE for faster reviews, or redistributing the review responsibilities depending on the scope and time sensitivity of the proposed change in order to make better use of the existing resources. Increasing resourcing is not always an efficient solution unless done alongside operational changes. Interviews with major stakeholders in the product change process were key to understanding how best to modify the existing review process with the proposal in Figure 7-2 as a guideline.

7.2.1 Quality Assurance

QA are ultimately responsible for ensuring a product is fit to be manufactured and sold. As a result, they have had the most purview over product changes and usually work closely with PLE to ensure the changes are feasible and comply with engineering standards. They were clear that there are only certain types of changes that could be eligible for a truncated review process. The criteria they brought up were region specificity and lack of regulatory impact, with the remainder of the input to come from PLE.

7.2.2 PLE

PLE are responsible for conducting the technical review steps which are usually lengthy and involve re-specifying a product from scratch, and then conducting all of the requisite testing steps. This is their normal process for product changes, with all of this activity happening in Sydney, but given the region specific nature of some changes that US retailers asked for, and the pertinence to packaging but not the product itself, suggested there was potential for a specific US-based PLE team member to be assigned these truncated reviews.

7.3 Guidelines for truncated review

The overarching guidelines products to even enter this new review process are as follows:

- Products sold in North America only
- No form or function change to the product itself

The reason for the geographic restriction is that North America is the largest market with a significant retail presence today, with CVS. Retailers are currently the only types of customers who can demand these sort of changes on short deadlines - the paradigm is different in the HME space. The idea is this system should only be used when absolutely necessary, and this prevents other regional teams trying to get ahead of the usual product life cycle timelines when there is no valid business urgency.

The form / function restriction is because those changes automatically have to be pushed to PLE for integration in the next product life cycle refresh. That level of product change requires much deeper validation and testing due to the medically regulated nature of the products ResMed make.

Eligible change categories, with different logic regarding specific teams involved with reviews (but all requiring input from a regional PLE resource unless indicated) are:

1. Packaging - design
    - Artwork / colour / font change
    - Materials or form change
2. Labeling – no PLE input needed at all
    - New label placed on product packaging in addition to current label
    - Current label modified
3. Kitting - no PLE input needed provided original packaging is intact within a kit box
    - Customized packaging for home setup and drop ship customers
    - Custom kit creation with patient selection of device / mask / pillows
4. Case / packing
    - Different number of products per case from factory to distribution centre
    - Different number of products per case from distribution centre to customer
    - New type of shipper packaging used within cases

Based on working sessions with a cross-functional team including PLE, QA and Product Marketing stakeholders, these were the product changes that were identified as being most impactful for new sales channels to request easily. Being able to put through these changes more quickly will enhance the success of retail and HME direct to consumer sales relationships.

7.4 Software teams - agile collaboration

Part of the rationale for a truncated change review process is to enable ResMed to respond in an agile manner when customers need product changes made quickly. Software teams are intimately familiar with a constant flow of change requests coming

their way, and pioneered agile ways of working to cope with it. Specialized collaboration software packages help those teams maintain this efficiency. These packages do so by enabling collaboration among large groups of stakeholders, and cross-team communication of change needs and timelines. This approach has potential to also be applied across non-software teams at ResMed.

Though a software engineering approach has merit, this platform has to be usable by teams across multiple functional areas and cannot have an overtly technical interface, or only compatible with coding projects. Based on team interviews, there are three key aspects to optimize for: accessibility, customisability and cost.

Accessibility can be defined as how easy a particular piece of software is to use, or how many teams using the platform already have some familiarity with the tool. A bonus is existing integration into part of the review processes that PLE teams use. Customisability is important because it reflects how the tool can be adapted to non-software applications. In this case how well proposals for product changes could be created by various team members, and then sent into logic flow trees with specific reviewers notified as a result of input information. Finally, from a cost perspective it is important that ResMed either already has access to this tool or it is relatively inexpensive.

The option set that emerged from interviews with classmates and ResMed team members was as follows:

Slack

Already used by multiple teams to communicate, this tool was most familiar to teams in product development, management and marketing. While it facilitated easy collaboration, it was not useful for creating and moving a given initiative between teams.

Trello

Some, but not all software teams used Trello in addition to Jira. Trello is a dedicated Kanban board which visually allows users to create initiatives as 'cards' and move

these in a flow across the screen between parties. This is the essence of what I was trying to create but it lacked the customization to implement logic regarding who could create what types of cards.

Jira

Jira is used by ResMed's software teams to manage and track bugs; it also has a built in Kanban board feature like Trello. Some PLE teams use Jira already to facilitate review steps. It has a technical interface however and it is not easy to implement the logic flows mentioned earlier.

K2

This is a dedicated workflow creation tool that helps deploy processes – it is already used at ResMed by New Product Introduction teams. It has maximum customizability when it comes to creating new initiatives – teams can create specialized forms for starting a change initiative and this form can be integrated into a logic flow based on information the creating team provides. It also has the ability to interface with Jira so existing PLE teams do not experience disruption.

7.5 Final design choice

Working with the QA team in Sydney, K2 was the chosen platform for this collaboration tool – towards the end of the internship, QA were piloting the suggested guidelines for truncated review with PLE to help cut down the size of the review queue. Iterating on this approach and refining the K2 interface with the pilot team will be a key next step - there is scope to use this platform more broadly to socialise information about stock shortages and mitigation steps between Operations and Commercial teams. ResMed made it clear communication is a priority for them going forward and this scope of work was absorbed by the QA team.

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Chapter 8

Conclusion

ResMed is at an exciting crossroads as a company. As a leading provider of CPAP devices, changing millions of lives across the world, they now face the challenge of growing into sales channels less familiar to them and selling more products to patients, and in-store retailers. This challenge is only compounded by the supply chain disruptions caused by the COVID-19 pandemic.

8.1 Revisiting thesis goals

1. To help ResMed understand how to better meet unpredictable demand for popular products in the face of supply constraints

2. To identify what would have most impact in improving the at-home setup experience from packaging to fulfilment, with the aim of therapy adherence in mind

3. To find better methods for facilitating communications within the organization, allowing for smoother processing of product changes requested by customers and elevating the customer experience

This thesis aimed to address the goals listed above. Regarding unpredictable demand, ResMed needs to be equipped and willing to reevaluate its manufacturing and supply chain decisions in a dynamic fashion, drawing on delayed differentiation as a key

enabler of efficiency and cost savings. The at-home setup experience requires a combination of redesigned packaging, a companion app / documentation for setup and better fulfilment performance to get devices to patients in a more accurate and timely fashion. These changes, and other product level changes requested by customers, will need to be supported by quick and transparent communication within ResMed on an easily accessible software platform, that is inclusive of multiple stakeholder groups.

New customers in retail and direct-shipped HMEs are only going to grow in size and become more relevant to the core business, and supply issues are unlikely to abate in the near future. As a result, ResMed needs to be equipped to move quickly and make operational changes that will endure and improve on themselves as scale continues to grow.

8.2 Guiding goals and how to support them

ResMed has an overarching goal of helping people live healthier lives, and it does so via two guiding aims. The first is to help people start therapy in a timely manner, and the second is to ensure they adhere to that therapy long-term. These goals are broadly applicable to companies in the medical space selling products that patients use and interact with directly.

Supporting these goals requires a mindset shift to being patient and customer focused in more internal processes, adapting functional areas across sales, product development, operations, supply chain and manufacturing to be agile and receptive to changing customer needs.

Central to maintaining this focus and agility is strong internal communications between internal stakeholder groups, to enable fast communication between teams who each need to participate in order to reach a company goal.

When paired with a robust evaluation process for making value-accretive business decisions, medical businesses can quickly work to adapt key aspects of manufacturing and fulfilment in order to satisfy customer needs and maintain high service levels across the business even in the face of supply challenges and government regulation.

8.3 Next steps for ResMed

ResMed can start using some of these tools to measure and assess the ways in which they can be applied best in their organisation. They should spin up pilot programs where appropriate and learn fast lessons to enable lasting, resilient changes to their organization that will enable them to scale sales channels that deal more directly with consumers. The HME business will not be responsible for top line growth forever, and ResMed has a chance to invest in growth avenues early and stay ahead of their main competitor, Phillips, when they emerge from their current product recall situation.

The proposed pilot using the framework laid out here for delayed differentiation, with the K2-based pilot for the communications platform will be important in proving out how quickly decisions can be made when all stakeholders are open to new ways of working. After this, the same framework can be used to tackle issues in fulfilment, enabling the product design changes to make a difference to patients starting therapy at home. Given the focus on patient wellbeing I saw across the organisation I am confident ResMed will be able to adapt and transform their organization to replicate their remarkable success in the HME space with these evolving customer profiles.

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