



Student Name: **Jessica Berger**

Student ID Number: **2012885**

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Lecturer: Alan Mumby

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Creating resilience to Black
Swan events in SME
manufacturing businesses:
Markes international case
study and the novel use of a
Product Managers toolbox.

Abstract

This study explores the concept of Black Swan events, those incidences that are unpredictable and have extreme impacts on businesses and their employees. It focuses on the recent Black Swan event of the Covid-19 pandemic, examining the challenges faced by an SME manufacturing business in South Wales, comparing their experience to other manufacturing businesses.

Upon identifying key themes from the challenges, the study investigates practical tools often used within Product Management that a business can utilise to create resilience.

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Research Aims

The aim of this study is to answer the question: can an SME manufacturing business create resilience to a Black Swan event, protecting them from closure.

If yes, what aspects should they focus on and what practical tool can they use to develop this resilience.

The research will seek to explore the challenges faced by SME manufacturing businesses, if there were any positive outcomes, and what businesses can do to improve ahead of the next Black Swan event.

The context of this research will focus on Markes international, a scientific manufacturing business located in Bridgend, South Wales, to establish a case study on how this SME manufacturer was affected by Covid-19.

This will be compared to a limited selection of other manufacturing businesses, where first hand account from former employees will be used.

Research Methodology

Two main types of research methodology will be undertaken in this study, both of which will be qualitative.

The first will be semi-structured interviews with employees from multiple departments throughout Markes international about their thoughts and experience through the Covid-19 pandemic.

Following this, tools and processes that have been used or are known to the product management team at Markes will be reviewed and assessed for their effectiveness at addressing any themes identified as potentially creating resilience.

What are Black Swan events?

Black Swan events are those incidents that arise seemingly out of the blue and cause large scale disruption.

It is a term created by Nassim Nicholas Taleb (Taleb, 2007) who used the analogy of the first sighting of a black swan by Willem de Vlamingh, a 17th century explorer, in Australia. Previously all, or at least most, people throughout the western world believed that all swans were white as that was all they had ever seen. Therefore, it was accepted that all swans *must* be white, and no-one questioned this or made a conscious effort to disprove it.

He explains that the “single observation can invalidate a general statement derived from millennia of confirmatory sightings of millions of white swans” which “illustrates a severe limitation to our learning from observations or experience and the fragility of our knowledge.”

What Taleb can be taken to mean with these statements, is that people too often rely on their experiences, a general consensus, and what they are able to see (what they know) when making decisions or interpretations, whether that be in life or business. They do not seek out the unknown, so when these Black Swan events occur, they are blindsided.

For an event to be designated a Black Swan, Taleb breaks it down into having three attributes:

1: **Rarity:** They are outliers. Nothing in the past can point to its possibility and so it is “outside the realm of our regular expectations.” Therefore, they cannot be predicted which should mean they are extremely difficult to prepare for.

2: **Extreme Impacts:** They create large disruptions and the potential to exhibit long lasting consequences and paradigm shifts. This can be on a global scale, like some of the examples listed below, but in SME businesses the event can be localised and just as impactful.

3: **Retrospective predictability:** Contrary to the first attribute, although the event is an outlier, Taleb states “human nature makes us concoct explanations for its occurrence *after* the fact, making it explainable and predictable.” Therefore, with hindsight people will try to make sense of the event and look for the clues that led to it occurring.

Examples over the past several years include:

- Covid-19 pandemic,
- Energy crisis,
- Cost-of-living crisis,
- Russian invasion of Ukraine,
- 2008 financial crisis,
- September 11 attack on World Trade centres.

Why are Black Swan events important?

As the first two attributes laid out by Taleb explain, these events are important due to the severe impacts they have on businesses and people. They can result in mass unemployment and closure of well-established businesses.

Focusing on the Covid-19 pandemic, data from the Office for National Statistics shows that from the beginning of 2020 through to the end of Q3 2021, over 650,000 businesses within the UK ceased trading (Office for National Statistics, 2021). This has caused a substantial number of people to be either out of work or having to find alternative occupations.

The Financial Times (Romei & Thomas, 2020) reported in early 2020, when lockdowns in the UK had not long been implemented, that one quarter of UK businesses had temporarily closed and “half a million companies reported to be in significant distress.” It is worth noting that the businesses reported to be in distress were mostly SMES with less than 250 employees, emphasizing the exposure of small to medium size businesses to economic impacts.

Of the businesses that were still operating, Financial Times stated, using ONS data, 38% were reporting “substantially lower” turnover. Not only were people being forced out of the workplace, but businesses were struggling to keep the levels of cash flow that they were used to operating with. Lower turnover and cash flow means restrictions on staffing head counts and reduced investments to help a business grow.

Jumping ahead 12 months to April 2021, Business Leader (Ballard, 2021), reported on several of the biggest businesses that failed due to Covid-19. This included names such as:

- Debenhams, the department store which closed all of its stores after 242-years of operating,
- Arcadia Group, who owned several retail clothing brands. Some of which have since moved to online selling only.
- Bertram Books, a book wholesaler in Norwich which had been established in 1968 in a chicken shed.
- Mothercare, retailer for maternity and baby items, this company was already in decline, but Covid-19 saw it completely close after 59 years of trading.

Black Swan events are important not just because they have consequences to businesses, which can be in the form of total closure, but they also have considerable impacts on the people who work for the businesses and the people who rely on their services.

When is a Black Swan event not a Black Swan?

During the interviews for the case study with Markes international, several people mentioned Brexit – the exiting of Britain from the European Union – as a type of Black Swan event. It certainly fits as a rarity, as it has only happened once in the UK. However, some will argue that Brexit was predictable (counter to attribute one but fits into attribute 3 in terms of hindsight) due to the media coverage and political lead up to the referendum where the UK general public voted to leave the European single market. Prior to the results of the vote, no-one knew what the outcome would be.

On the other hand, Brexit has caused substantial impact (second attribute) to businesses due to the lack of clear information from local authorities, UK government, and European governments. This particular event has caused operational disruptions over a longer period compared to Covid-19. So, perhaps it is a type of Black Swan.

Head of operations at Markes international (Appendix A) provided a fascinating definition for the types of Black Swan events that they have experienced. She separates them into two categories using an analogy from the medical field:

- **Acute** – those that require immediate and urgent action. They truly come out of the blue with no warning and have maximum impact in terms of disruption. Covid-19 is in this category.
- **Chronic** – those that have longer lasting disruptions. These events have an element of foresight in that they are coming. However, these are challenged with little to no information on how to deal with them. She places Brexit and the upcoming environmental policies on achieving Net Zero in this category.

She then explained that it was the lack of information that left Markes scrambling to figure out what the correct actions should be following Brexit. Whereas, with Covid-19 they were able to acquire concise and trustworthy information from their external partners, GAMBICA and Effective HRM.

The disruptions felt from Brexit included increased costs and a significantly more paperwork – with many people not knowing or understanding what paperwork they required. The Supply Chain Manager (Appendix C) elaborated on this by explaining their suppliers and customers in Europe had not been provided with relevant accurate documentation from their governments or local authorities, in the same way UK businesses were also not provided with clear instructions. As such, there was a consistent disconnect, which in some instances lead to delays over several months whilst both entities tried to confirm what was required for export/import.

The further effect from this was that invoices did not get paid in the timeframe expected, which reduced cash flow (another challenge to SME businesses) and has contributed to increased cost of components as businesses tried to “claw back” the expenses of the extra paperwork and the cost of working with consultants to help get them back to being able to sell and ship.

Deficiency of understandable information is one of the biggest challenges to businesses, made worse in an SME where there is a smaller team, or possibly only 1 person, who are responsible for juggling multiple tasks. These people become less productive as they are trying to figure out the best course of action when responding to a Black Swan event with little to no instructions on what to do.

Markes international dealt with the acute Black Swan of Covid-19 better than the chronic Brexit because they had received and where able to action the clear, concise instructions on what they had to do. This provides evidence that if a business has a credible source for the information, they can react with haste and create a level of resilience to the event.

Businesses must react differently to the specific Black Swan event that is happening to them. Black Swans events do not have to happen on a global scale, they can occur locally to a business. As asserted by (Taleb, 2007) where he states:

“we can easily trigger Black Swans thanks to aggressive ignorance.”

Therefore, provided that the event has not happened to the business before and it causes significant distributions, an event like Brexit can be classified as a Black Swan.

How did the Covid-19 pandemic impact manufacturing businesses?

Continuing with the focus on Covid-19 pandemic, media coverage and the reports discussed previously, set the impression that all businesses were at risk of failure. In this case it is easy to assume the same was happening in the manufacturing industry. However, studies, interviews, and the case study on Markes international present a different story.

Some manufacturing businesses were able to adapt what they were producing to create products that were used in the fight against Covid-19.

Perkin Elmer – analytical instruments manufacturing

As an example, the Commercial Marketing Manager at Markes (Appendix D) describes how, in his previous company Perkin Elmer, they were able to diversify and create a product and service that was in high demand for the PCR testing. Perkin Elmer created “lighthouse labs” in hospitals and even hotels, across the UK to perform the testing. This was an opportunity that created jobs for people to operate the analytical instruments.

Perkin Elmer decided to do this after a senior member of staff saw a report in the news that a competitor of theirs was unable to keep up with demand for testing. This information led to an urgent internal discussion to investigate as to whether they would be able to offer a suitable solution. They knew that with their internal skills and knowledge that this could be achieved.

The Commercial Marketing Manager, who had been placed on furlough for six weeks, was quickly re-trained on how to train others to use the analytical instruments required for this analysis, this adaptation demonstrates Perkin Elmer's agility to react to the situation.

The advantage that Perkin Elmer had compared to other manufacturing businesses is that they are a large enterprise with thousands of employees. This meant they had the resources in both money and manpower to be agile.

The success of the life science and diagnostics business unit has since led to a rebranding of that unit, now known as Revvity, and the sale of the analytical instrumentation, food safety and enterprise services businesses to New Mountain Capital, (Prete, 2022).

Food manufacturing

The Supply Chain Manager (Appendix C) was able to provide additional information and different perspective. She had been working in a food factory at the beginning of the Covid-19 pandemic, where their biggest challenges were to keep up with the demand for packaged rice and the safety requirements brought on by the illness.

As people were forced to stay home due to the lockdowns, home cooking became essential. People were able to purchase groceries that were delivered direct to their homes (another industry that flourished due to Covid-19). The demand for prepackaged rice in supermarkets witnessed a spike, which the factory initially struggled to keep up with.

To fulfil the demand more staff were hired to enable the company to achieve the required targets. This additional labour also provided cover for the employees who had to take sick leave. They were fortunate to be able to hire the people from the service industry, such as hospitality, catering, and hotels, who had been made unemployed from the shut-down of that sector. Due to the number of employees made unemployed or furloughed from other sectors during this period, hiring was not a challenge.

However, ensuring employee safety and following the social distancing were a challenge. In this business many employees typically worked in close proximity to each other, so the 2-meter rule forced them to reduce capacity. This was carefully managed by introducing new shift patterns.

This business was able to be agile and adapt to the new requirements and is another example of a business that was able to flourish.

IQE – semiconductor manufacturing

In contract, when the Supply Chain Manager moved to work for IQE, a semiconductor manufacturer, during the Covid-19 pandemic, they had a different experience.

Among their products, IQE create silicon chips which require raw materials from Asia. The supply of the materials that were required were diminished as they were competing with larger industries, such as the automotive industry, for the same items. This was an issue seen later at Markes international, as mentioned by Head of Applied Engineering (Appendix G).

Not only did IQE struggle to get the materials they needed to manufacture their products, they also could not purchase the required personal protective equipment (PPE) for their staff. The products they make have a requirement to be manufactured in a clean room environment. This also necessitates the use of face masks. However, the supply of masks were, understandably, being prioritized to the NHS and hospitals. Therefore, IQE had to reduce the staff they had on site to try to manage their dwindling stock of PPE.

From this, IQE were forced to divert resources to explore different contingency plans to maintain business continuity and investigate alternative materials, something they had not been prepared for. Although best efforts were made, they could not be as agile as other manufacturers because they couldn't get the materials they needed to remain fully operational, and they were not able to diversify, as seen with Perkin Elmer. It should be noted that IQE has not failed and are operational today.

This illustrates some of the challenges faced by SMEs who are competing on a global market.

How has the Covid-19 pandemic affected Markes International?

How do these experiences compare to Markes international? To answer this question interviews took place with employees covering different functions within their business:

- Operations
- Finance
- Supply Chain
- Commercial
- Marketing
- Production
- Engineering
- Purchasing

Who are Markes international?

Markes International are a manufacturer and supplier of analytical instrumentation, accessories, and consumables that are used by laboratories globally in the analysis of volatile organic compounds (VOC) from air, gases, solids, and liquids **Invalid source specified**.

They were established in 1997 at a site in Llantrisant, and in 2020 they relocated their entire manufacturing facility and headquarters to a 52,800 square foot site in Bridgend **Invalid source specified**.

The overall consensus at Markes was that they performed okay throughout this acute Black Swan event, as described by the Head of Operations (Appendix A). They didn't have to let anyone go, they didn't permanently close any of their sites, they operated throughout the entirety of the lockdowns, and the business is still going strong today.

Markes did have some foresight due to their colleagues in China. They had firsthand accounts of what was progressing there, which allowed them to react faster than the guidance from the UK government. Backed up by the clear information and support they received from their external partners GAMBICA and Effective HR (Appendix A), who were also providing their recommendations ahead of the governmental advice. Head of Operations stated that their partners "provided clear, high quality information that could be trusted". This gave Markes a slight advantage and improved their ability to be agile.

Therefore, a lesson that can be taken from this is that SMEs should partner with external entities that can provide the information that is unknown internally and an added level of support.

Actions taken at Markes international.

To enable themselves to remain operational Markes took several actions.

Protecting the vulnerable

Early in 2020, ahead of the UK government implementing lockdowns, Markes made the decision to send home staff that they were aware of having health issues on fully paid sick leave. They are an ethical company and recognise the importance of looking after their employees. Without whom they would not be able to function (Appendix A).

Working from home

Quickly following those that were given sick leave Markes provided all office staff with the hardware required to work from home, which included their office chairs and not just their laptops or PCs.

The IT infrastructure to support more remote workers was swiftly upgraded, with additional licences for platforms such as NetExtender and Parallels being purchased – an unexpected but necessary expense. These permit the remote workers to access the shared drives and files that they need to be able to perform their job functions.

Markes' ability to react quickly to these new requirements demonstrates agility.

Social distancing

For the staff who were unable to complete their job function from home, which covered factory operators and laboratory staff, Markes followed the UK government rules on distancing by 2 meters. This did not have an impact on the capacity of who could be on site, as seen with the food factory, due to their recent move to a larger facility.

The new factory floor is laid out in such a way that each operator has their own workstation which is already separated by the required distance. This is to provide each person with enough space to manually hand build the instrument that they are working on (Appendix F). Therefore, Markes didn't need to put extra controls in place within that area.

For the laboratories, the employees worked on a rota ensuring there was at least two people on site, as required by health and safety, but not working on the same instruments.

Supply chain audit and increased stock holding

Markes started looking at the supply chain very early on by reviewing their contracts, and what they had on scheduled and bulk orders (Appendix H). As part of their assessment, they performed a SWOT analysis which found that stock levels were a potential weakness. They evaluated the levels of the most commonly used parts with the help of their targeted movement records. From this they asked themselves which parts were potentially at risk (Appendix G). Those identified as being at risk were signed off to have increased stock holding.

One such material was their sheet metal, which prior to Covid-19 had already been flagged up as at risk due to some volatility with the local company they had been working with for many years.

The action of increasing the levels of stock they held protected them from the ups and downs of most suppliers, although with hindsight the Production Manager (Appendix F) commented on the team not getting all of these increased levels correct. Some items purchased in 2020 are still on the shelves in 2024. But they also recognised where it has worked well for Markes.

However, increased stock levels for any business means more money on the shelf and higher insurance costs. For an SME this becomes a challenge as they need to balance how much inventory they have vs the cash flow coming in. Due to this the Supply Chain Manager (Appendix C) stated that as the business has been getting back to normal, they are under pressure to return some of the over stock.

Markes, as an SME, are a small player compared to some of the other companies that their suppliers also partner with. Therefore, it is imperative that SMEs maintain a close working relationship with suppliers to ensure they obtain the fastest lead times and lowest costs. The act of returning over ordered items can be damaging to this relationship. An alternative approach that an SME can take would be to explore what else they can use those items for – a new product for example, or set their salespeople an incentive to sell the products that those parts are used in.

Cash flow management

Cash flow management was approached in a couple of different ways.

Finance Controller (Appendix B) described how Markes made a conscious effort to ship as many products as possible in Q1 of 2020, before the lockdowns were imposed. This was to improve the cash flow at the beginning and to provide support for the rest of the year.

In addition to this, Head of Operations and Finance Controller (Appendix A and B) spoke of an optional deferment of bonuses request. With this, they asked if the highest earners would be willing to delay the payment of their bonuses until later in the financial year, with the aim to guarantee 100% retention of staff and to keep the business operating without any debt finance. Not only would this protect staff, but by remaining debt free they were protecting themselves from the rise in interest rates which can cause some businesses to go bankrupt.

The deferment request was entirely optional and not everyone agreed, of which Markes were understanding and accepting given peoples personal situations.

Government support

Markes took full advantage of the financial support offered by the Welsh and UK governments. From the Welsh government there was a grant of £1,000 per employee that was retained – which for Markes equated to £120,000. From the UK government they signed up for the furlough scheme which allowed Markes to claim 80% of the wages of the staff that were placed on temporary leave.

These were an essential lifeline for many SMEs and demonstrates the importance of working with authorities to ensure they are getting all of the support available to them.

Challenges faced at Markes international:

No matter how many actions are put in place to react to a Black Swan event, businesses will be faced with multiple challenges due to the extreme impact (attribute 2) of these types of events.

Seven key challenges from the Covid-19 pandemic came to light throughout the interviews.

1. Stress and loss of culture

With the Covid-19 pandemic extending over a couple of years, rather than the weeks that people initially expected, there was a negative effect on the morale and culture within Markes.

Production Manager (Appendix F) was the only senior manager onsite everyday throughout the entire period and saw firsthand the growing disgruntlement of the factory workers.

There became a feeling of an us vs them between those having to go to the factory and those having to work from home. Markes has historically had a family like culture, where discussion between employees in different departments was very open and easy going. During the pandemic this broke down, and there is a feeling amongst some staff that it has not yet fully recovered.

Head of Operations (Appendix A) also recognised this and suggested that a rota of senior managers being on site may have helped to alleviate some of the tensions. It would have shown support to the staff that had no choice but to be on site that they were not alone.

However, the stresses were not just felt by those travelling into work. For the people placed on furlough there was a worry that their position wasn't valued, which is why the business could function without them, and so they had a fear of redundancy. And for those who were working from home, many have expressed some levels of bitterness to not being offered furlough. Some felt they missed out on what seemed to them as a fully paid vacation to spend time with their children during the particularly sunny weather of summer 2020.

For an SME to maintain a positive company culture and reduce stress during an event like this, increased communication could have helped. Senior managers have a responsibility for the wellbeing of their staff. Open discussions with them on their thoughts and feelings could have brought the issues to the forefront sooner. Through understanding what their staff were going through they could have taken action to increase the levels of communication between the different groups.

2. Supporting international employees

Markes have an international presence, with additional offices located in Canada, USA, Germany, and China. Markes needed to adapt their actions depending on the localised rules put in place by that country. China for example, took a much harder stance on the lockdowns with no-one being allowed out of their homes. This meant that both the office and laboratory had to shut down for several months.

How Markes responded in each region was reliant on the teams working there to provide the information on what their governments were saying. Therefore, communication was key.

3. Cost of relocating

Although the move to the new, larger facility meant that Markes could now continue to expand, and when the pandemic hit social distancing was not an issue, the Financial Controller (Appendix B) argued that the move happened at the wrong time. With the office staff transferring to work from home, this would have allowed the factory to expand into the office space. As previously mentioned, each analytical instrument is hand built to order using manual tools. It would have been very easy for Markes to set up factory workstations, including social distancing, within the now vacant offices.

The rental costs to Markes for the Bridgend location are double that of the Llantrisant site. This money would have been better spent on further investment into innovation, and the future planned projects.

Counter to this argument, had they not secured the building when they did there was no guarantee that it would still be available post-pandemic. Restricting their ability to expand once the staff who were working from home returned. The Bridgend location provides Markes with future proofing too; they can expand their own brand, diversify their products, or offer contract manufacturing in the space that is currently left fallow. The latter could provide support to local start-ups who do not have access to their own manufacturing facility, which will help to grow the local economy.

In addition, the Bridgend facility has all departments under a single roof whereas Llantrisant was spread over 3 buildings. The lack of physical walls, roads, and car parks between staff should support the regeneration of the family like culture.

4. Forecasting inaccuracy

Production Manager (Appendix F) highlighted a concern specific to the forecasting and production planning. As lockdowns rolled out at different times around the world, it became difficult for them to predict what needed to be scheduled to build. Some customers were requesting their orders to be held whilst they couldn't take receipt, meanwhile others were requesting expedition to try and have everything on site when they were in their laboratories. The constant shifting of order book priorities meant that resources were sometimes spent on building products that sat on the shelf for several weeks or months, preventing the invoicing and negatively affecting cash flow.

Forecasting improved over time as more information was provided from the salespeople about what was occurring in their location. However, increased direct communication with their channel partners and customers, not just the salespeople, would have enhanced this further. Markes could have set realistic expectations on delivery dates, and better understood the pain points for their customers.

This is another example of where consistent and clear information is required to be fully agile and ensure the SME business is focusing their resources on the correct actions.

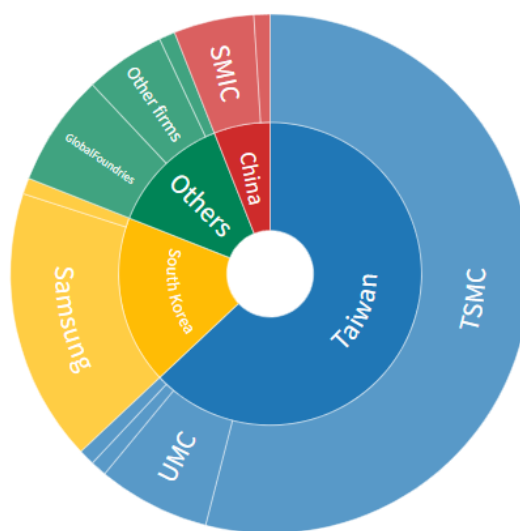
5. Supply chain disruption

Even though Markes performed a supply chain audit and increased stock holding for the identified components at risk, they didn't get it completely right. The biggest disruption they encountered was from the electronic chips their suppliers use to create the boards that Markes purchase. Head of Applied Engineering (Appendix G) spoke of how Markes didn't consider looking ahead at these components.

Taiwan is the global leader in the production of semiconductor parts, with the company Taiwan Semiconductor Manufacturing Co (TSMC) being reported as accounting for 54% of the global market share, (Lee, 2021)

Semiconductor contract manufacturers by market share

Total foundry revenue stood at \$85.13 billion in 2020



The lockdowns in Taiwan caused reduced output to an industry that had been running at full capacity. Head of Engineering explained that not only were there less components being manufactured but the automotive industry bought up most of the excess stock to try to catch up with their demand once their factories reopened yet have still suffered from the chip shortages.

As an SME, Markes and their local suppliers had far less buying power to purchase the chips required to make the electronic boards that are used in all of the analytical instruments. For a short period, Markes were unable to complete builds and deliver product – illustrating another challenge that negatively affected their cash flow.

Markes quickly fixed this issue by utilising the relationships the procurement team have built over the years, to source alternative chips. Markes then purchased thousands of control chips from a new source in China to supply to their partner TenStep, who are their supplier of electronic boards.

The source from China was at a higher cost than Markes usually pay, however, the cost of not shipping final products to their customers would have been far more damaging to the brand than the few extra pounds per component.

SME businesses should use this collaborative approach to support the struggles of all those in their supply chain, enabling solutions to be found faster. They should also embark on an exercise in mapping out who their suppliers are, who supplies their suppliers, following the chain back to raw material to identify further risks.

SMEs like Markes can struggle to perform this task as it would be a manual job, taking up significant resources. As well as requiring suppliers to provide details that they may not be willing to share. A possible fix to this would be to digitalise the entire supply chain, starting at the raw material, and create a digital chain of custody. Something to consider for future study.

6. Increased lead times

Almost all the interviewees mentioned the substantial increase to lead times. Markes procure 90% of their components from UK businesses, which is why it was surprising to discover that items that normally would be delivered weekly or monthly, were pushed out by several months. The worst case seen were some components from a single supplier being quoted with over 36-month lead times. In this situation the procurement team once again used their relationships with suppliers to find alternatives, which meant some items had to be imported at higher costs, but as mentioned above, Markes prioritise shipping complete products to customers on time over the short term increased expenses.

7. Cost inflation

With the supply chain issues, reduced supplier output creating higher demand, energy crisis costs, and some of the aftereffects of Brexit still being felt, there has been significant inflation to component costs. As an SME, Markes cannot afford to absorb these into their margins, and so in 2022 and 2023 were forced to pass some of this cost onto their customers through pricelist increases.

It is a careful balancing act for any business to ensure they are getting the most profit from their products, whilst not pricing themselves out of the market. Thorough assessment of the competitors pricing assisted Markes in setting the limit of how high they should increase their pricing. This is another manual process that required input from the regional salespeople, taking considerable time, effort and resources.

Positive outcomes at Markes international

Covid-19 pandemic was not all doom and gloom at Markes international. The consensus was that they performed okay throughout this event, with 7 themes for positive outcomes highlighted.

1. Adoption of digital platforms

Working from home necessitated the increased use of digital platforms for communication, collaboration, and generally to get work complete. Markes moved from a paid-for service with StarLeaf, whom they were about to purchase multiple licences for their remote workers, to the vastly easier to use Microsoft Teams. A short learning curve was required to get everyone using the software effectively, but the result has been long lasting use and far more collaborations with both internal staff and external partners.

The service department at Markes have found the increased use of Teams and other platforms like TeamViewer especially beneficial when dealing with customers who have instruments out of action. The ability to video call and remote into the customers PC has allowed them to fix more instruments remotely than they had been able to before Covid-19. Historically they would have travelled to the customer to provide face-to-face help, at the expense of either Markes if there was a contract in place, or the customer if not. Lockdown removed this ability to travel, so forced the team to find alternatives to keeping their customers happy. This is providing monetary savings to all and accelerating repairs.

2. Increased training

Whilst many staff were forced to work from home, Markes and other companies like Perkin Elmer (Appendix D) took this opportunity to bring forward their training plans. Schedules that were spread over 2 years and included travel were reduced to a few months and moved to video calls. Sales teams (internal and external channel partners) were delivered with “upskilling training” to increase their confidence in portfolio selling.

Training took place within the factory too. With people needing to take time off to isolate it was identified that there were gaps in individuals’ knowledge of how to build certain products. Markes have been moving their build instructions to a digital platform, but this is currently a slow and manual process to set-up. In the meantime, the production team set-up training sessions on each product, with those attending in-person spread out by at least 2-meters across the seminar room. More work is required at Markes to eliminate this vulnerability, but they are actively implementing training programmes (Appendix C).

3. Increased output

To the joy of management, and many office staff, Markes found that people working from home were more productive rather than less, as was expected. An example provided by the Head of Applied Engineering (Appendix G) was from the software engineers who’s output increased as they had a lot less distractions. Eliminated chatting around the water cooler type interactions

meant they could get their heads down and code. Similar increased outputs were seen from other departments too.

On the other hand, it should be noted that this did not work for all. Head of Marketing and Communications (Appendix E) made the point that some people were not given clear targets with achievable deadlines, so some tasks were either delayed or not complete. Also, some members of staff struggled with the isolation of working from home, they have personalities that thrive in a face-to-face interactive environment. Suddenly this was taken away from them, and a few people have spoken up about their struggle with mental health.

Careful management and clear communication are required to overcome these objections. This is also where hybrid working comes to the forefront.

4. Hybrid working

Hybrid working is expected to be the new normal for many industries including Markes. Staff are now required to be onsite a few days per week enabling them to have those unscheduled interactions that can produce inspiration and new ideas, whilst also being able to work from home the other days.

Some believe that hybrid working was an inevitable progress for all businesses (Appendix E) and Covid-19 simply accelerated the implementation by several years as it proved to management that working from home can be effective.

Furthermore, offering job positions that are either fully working from home or hybrid will enable businesses to potentially hire better talent that live further away from the main facility.

5. Less travel

The quality of video conferencing since the beginning of 2020 has improved to the point that it is now used in the everyday operations for Markes staff. For salespeople, they no longer have to travel for hours between customer visits, and they are able to speak to more customers in a day using platforms like Teams (Appendix D). The same experience is felt in other departments, with the Product Manager working far more collaboratively with some of Markes' biggest clients to expedite the addition of products to their pricelists, providing short-notice training, and instant support.

Less travel has a positive impact on the businesses environmental goals by reducing their carbon footprint.

However, face-to-face interactions cannot be completely eliminated. Body language is just as important when communicating with people, and in-person interactions allow for more relaxed conversations where people are fully engaged. From these dealings it is often found that people can be more agreeable and new information can come to light.

Therefore, businesses should plan to include both types of communication in their operations. Video conferencing for short and concise meetings, update training, and for sharing quick information, whilst leaving the in-person meetings for those longer sessions which require engaged interactions or discussions.

6. Strengthened supplier relationships.

Markes' increased collaborations with their suppliers, in helping them find solutions to shared challenges, has strengthened the relationships that the purchasing team have with them (Appendix H).

A closer working relationship to understand the needs and challenges of both the purchasing team and suppliers, supported the creation of joint plans of actions. As an example, from the Senior Buyer (Appendix H), Markes had very large contracted monthly call off from several component parts. Their open discussions with suppliers enabled them to spread the deliveries out, so instead of receiving 5000 of one component they received 1000, with an agreement that the remaining call-off would be delivered later within the financial year. This approach was beneficial to both businesses, it put less pressure on the suppliers who were struggling with output to have all of the parts ready by the initial scheduled delivery date and is continuing to reduce the amount of stock that Markes have sat in storage.

The purchasing team are now able to negotiate flexible contracts that allow them to adjust the volumes being called off over a 6-month, rather than 12-month, period. The benefit to Markes is that they have improved stock control and will assist them in reducing money tied up in storage.

Businesses can only achieve this through being open to working collaboratively with their suppliers and viewing them as partners rather than just a company they make demands from.

7. Reduced supplier vulnerabilities

Following on from the supply chain audit, Markes recognised a weakness with some of their component parts being single source. These are typically critical components that are essential to making their instruments function. As such, and with the support from purchasing, the engineering team are now designing their latest range of products to accommodate components from multiple sources.

Head of Applied Engineering (Appendix G) provided the example of the mass flow controllers (MFCs) that Markes had been using. The supplier, Axetris, decided they were going to stop production of this component to focus their efforts on other parts of their business. At the time, the MFC was solely sourced from Axetris with all of the hardware, firmware, and software built around they use.

Markes have since designed their instruments to operate with three different suppliers of MFCs to ensure not only immediate use but longer term support after the main instruments are taken out of production. Markes provide customers with a guaranteed support of at least 7 to 10 years after the end of production, as all of their instruments come with a right to repair.

The same approach is being applied to other components to remove this vulnerability.

Businesses require this flexibility so that they can quickly react to supply chain shortages or disruptions. This will create agility and resilience.

What can Markes international do better for the next Black Swan event?

From the interviews, three actions stood out as ways in which Markes international could improve ahead of the next Black Swan.

Updated business continuity plan

Markes do have a business continuity plan however this is not widely known or shared, as mentioned by the Production Manager (Appendix F).

Their previous experience in developing the continuity plan involved input from all departments, which will help to capture all considerations. There is a feeling that the plan at Markes is not robust and would benefit from a comprehensive update that includes the reactions to pandemics. Had the plan been widely shared amongst the managers, the Production manager surmises that they could have been more agile.

Internal business continuity plans are important, as are those of the suppliers. Ensuring the supply chain has a plan of action for when the next big event happens will lend itself to reducing supplier vulnerabilities. Markes have recognised this and include a request to view this document as part of their annual audit of suppliers (Appendix C).

Product diversification

Resilience can be created in a business by expanding the types of products and services offered.

Markes have established themselves as a global leader in the field of analytical thermal desorption for over 25-years but have also branched out into other analytical techniques including Time-of-Flight GC/MS, sorbent extraction, data analysis software.

Nevertheless, further investments could be made into exploring additional options. The business could undergo an innovation audit which would illustrate the capabilities and knowledge already available internally. With this information they have the potential to discover what else they could be manufacturing, a radical new venture.

Similar to the example of Rolls Royce expanding from building engines to producing small modular nuclear reactors for clean energy, (Rolls Royce, n.d.)

Future innovation plan

Recently Markes have developed a new innovation plan that focuses on digitalising operations and products (Appendix B). They are creating new software products and developing a digital learning platform that will reduce their reliance on physical products for revenue generation. Which has the added advantage of protecting them from future supply chain volatility.

Summary of learnings from Markes International.

Although the feeling at Markes international was that they performed okay throughout, the evidence collected suggests that they did better than just okay.

Unlike other industries and some manufacturing businesses, they didn't need to resort to firing people and were able to carefully manage their cash flows to ensure that both the business and their employees were supported throughout Covid-19.

Markes were able to take quick and decisive action due in part to the trustworthy information they were able to obtain from their colleagues in China and through their partnerships with external companies, GAMBICA and Effective HRM. This demonstrates their ability to be agile, a key factor in being resilient to Black Swan events.

Their close working relationships with suppliers mitigated most of the supply chain disruptions, that have been felt globally since the start of the pandemic, especially for the electronic chips industry. By viewing their suppliers as partners and having effective communication, they were able to work together to find solutions.

The company's ethics and drive to care for their staff as well as the business was demonstrated in both how they managed their cash flows very early on and protected their most vulnerable employees.

Markes did encounter seven key challenges, which for most they were able to react positively to. The perceived loss of culture is one of the challenges that could be improved on through better understanding of their employees' emotional states and therefore improved communication could have allowed everyone to comprehend the issues each other faced – removing or reducing this new barrier.

However, Covid-19 also highlighted seven positive outcomes. The company swiftly adopted improved digital platforms that have made their working lives easier and more productive, demonstrating further agility. Increased training has provided staff with more confidence in performing their roles, again creating agility as less is required of specific people who previously were the only ones with the technical know-how. The implementation of hybrid working has improved the work-life balance whilst also inadvertently having a positive effect on their environmental impact. In addition, their communication skills were tested during the supply chain issues, to which Markes were able to demonstrate that through understanding and collaboration they could not only strengthen their relationships with suppliers but reduce vulnerabilities.

From this case study it has been identified that three aspects are required to create resilience to Black Swan events:

- clear, trustworthy, and usable information,
- excellent communication skills that speak to the demographic that they are targeting,
- agility, being able to make decisions and changes quickly and effectively as needs arise.

Creating resilience to Black Swans: theoretically

Given that many businesses survived not only Covid-19 but other Black Swan events, it can be a fair assumption that there are ways in which they can make themselves resilient and prevent their closure.

Anna Grandori provides an interesting take in the journal of Management and Organization Review, (Grandori, 2020). She describes how recovering from events as big as Covid-19 take more than simply “bouncing back” and returning to the previous normal, but instead bounce forward. This is due to the new paradigm created in the social system, where people are not going to be willing to returning to “normal”, such as working in the office full time.

She highlights that businesses should use these events as an opportunity for development, rather than a limitation that they have to struggle through. Which means they should allow themselves to imagine new responses to the challenges they are facing.

Anna agrees with the notion that all Black Swans are different, commenting on them being not equally black – somewhat similar to the categorising of them as Acute or Chronic. She separates how to approach them by two methods:

- “Being prepared to the improbable but imaginable”.
- “Being robust in the face of the unimaginable”.

The aspects that she has identified for businesses to focus on in generating resilience:

1. “PRECURSORS, PREPARATION, AND RATIONAL IMAGINATION” in other words Information – “making the unexpected less unexpected.”

This agrees with the first aspect identified from the case study. Anna elaborates by telling the reader that businesses need to pay attention to all precursors, which they can only know about if they are seeking out information. However, they must also be cautious of false alarms. Therefore, rather than trying to make a prediction on what the next Black Swan will be, businesses should prepare for as much as possible, including being willing to act “out of the book” – i.e. being agile and capable of adapting to the situation rather than following strict protocols that may now be included in the business continuity plan.

2. “RESOURCEFULNESS, REDUNDANCY, AND MULTIMODAL ORGANIZATIONS” – this section discusses material and organisational resources.

Businesses need to be agile enough to use the resources they have available to react to situations, including having plans in place for unexpected redundancy. If we take supply chain as the example here, what Anna is saying that businesses should be prepared for finding alternatives is a component becomes unavailable (redundant). The approach used could be to have an alternative source already planned or know that they can adapt a resource they already have to fit the function of the component no longer available. Here Anna is talking about a businesses ability to be agile, aspect 3 identified.

A separate article, in Wolters Kluwer, written in 2016 (pre-pandemic) highlights three ways in which they advise businesses to prepare for Black Swan Events, (Wolters Kluwer, 2016)

1. “Map the supply chain and supply chain risk”

This is exactly what Markes international did at the beginning of the pandemic. They identified most of their vulnerabilities and took quick actions to protect their component supplies by increasing stock holdings.

2. “Implement a Business Continuity Management Program”

As discussed, this has not been effectively performed at Markes and is an opportunity for them to improve. However, the plan did not include who to deal with a pandemic, so would have been somewhat useless for this Black Swan event. What this does agree with however, is that the business should be preparing for any eventuality.

3. “Develop a Communication Plan Aimed at Reducing Uncertainty.”

This third means of preparing for a Black Swan event agrees with the identified second aspect.

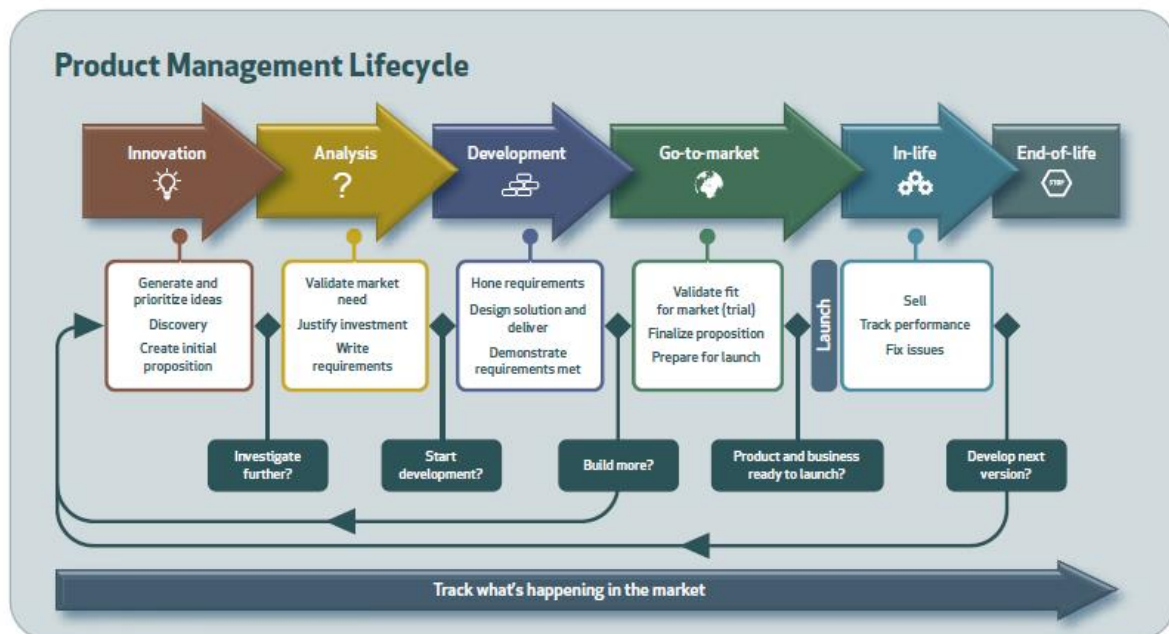
People and markets do not like uncertainty which can cause stress, and in the case of Markes a break down in culture. Therefore, businesses must have a robust communication plan that is tailored to the audience.

Kluwer finishes their article by also highlighting agility – which agrees with the third aspect identified.

Utilising product managers in creating resilience.

A novel and practical approach for businesses to create resilience to Black Swan events is to utilise the skills of a product manager.

Product managers have the unique position within a business to have input and insights of almost all functions. They are often described as Mini-CEOS (Product Focus, 2019) because they are required to have an overview of all aspects within the products lifecycle, from the initial innovation through to end-of-life:



(Product Focus, 2008)

They are able to get work done, such as product launches and improvements, by leading (project managing) multiple teams across the different departments. Therefore, they must have strong communication skills with finance, engineering, sales, marketing, and production. A product manager does not need to be subject matter experts as that is what each department is for, but still have enough knowledge to collaborate with each team.

Additionally, a working relationship with stakeholders and confidence in dealing with senior management is key to working effectively. They are required to have a voice of authority when decision making, which is made easier once they have the stakeholders backing.

As part of their job role, strategic planning is essential. They must carefully prioritise their time and resources between firefighting the tactical activities, which can require urgent responses, with the activities that are focused on “what’s next”. Product managers will therefore have developed strong time management skill when performing their role effectively.

It is these attributes that will enable a product manager to support the business in planning for the next Black Swan event.

To further support the approach of utilising the product manager, are the wide range of tools and processes that they have learned to assist them.

Collectively, these are described as their toolbox.

The Product Manager toolbox.

Varying tools, techniques, and processes are employed by a Product Manager to assist with:

- Market analysis,
- Portfolio analysis,
- Understanding customer values,
- Strategic development,
- Prioritisation,
- Pricing strategies,
- Communication

The analysis activities enable a business to gather information to confirm what they think they know, realise what they had wrong, identify gaps in knowledge, and discover information they didn't know. These increase a business's understanding which in turn allows them to make informed decisions.

The strategic and prioritisation tools ensure the business are focusing their resources on the correct activities. Preventing staff from wasting time and effort on actions that are either not required or can wait until later. An advantage to managing projects and resources should also prevent staff from being spread too thin.

Communication tools are used by business to confirm the language required for effective marketing to their target audience.

What has become apparent during this study is that there are three key aspects that Product Managers can help with in creating resilience to the next Black Swan event:

1. Information gathering
2. Communication
3. Establishing agility

Tools for information gathering.

High quality, usable information is essential in the decision-making process. Without these businesses are left scrambling to try and guess what they should be focusing their resources on – as described by the Head of Operations and their feeling towards dealing with Brexit (Appendix A)

Below is a selection of tools used in production management for gathering information.

SWOT analysis

Used extensively throughout Marks international, the SWOT analysis is a very simple tool for evaluating products and processes.

The analysis requires the participants to consider four key characteristics, and provide facts (information) that relate to each of the following:

- **Strengths** – These will be the positive aspects. Such as a product having many valuable unique selling points, or a business's strong collaborative relationship with an external partner.
- **Weaknesses** – Those aspects that are not so great. These could be properties like known gaps in internal knowledge, products that are difficult to support, lack of funding for a particular venture.
- **Opportunities** – typically this characteristic explores external factors, such as new or growing markets, new regulations that will require the use of the business's product or service, or advances in technology. However, it can also be used for creative thinking about internal improvements or new product designs.
- **Threats** – also generally a characteristic that examines external factors. This will look at competition, supply chain issues, and anything really that will disrupt the success of the product or process being analysed.



(Bruin, 2017)

A successful SWOT analysis will provide a company with accurate information covering all of the above. Therefore, it is best performed with a team of people covering different points of the product/process lifecycle.

Multiple departments in Marks International use this tool, although not always as effectively as it could be.

Annually, the finance team send out a SWOT template for each business unit leader to complete ahead of the budget review and business planning for the upcoming year. It is the opinion of some staff that the digital version sent out is not effective at getting all the information required as the files are filled out in isolation by a small selection of people. Working sessions for open discussions and agreement on the information being entered do not take place, which means the information only contains what those few people already know.

Whereas, when this tool has been used as part of a product review the Product Manager pulled in representatives from many parts of the business: production, final test, product development, purchasing, service, engineering, sales, and marketing. The exercise only took a couple of hours, but the conversations led to some revelations and better understanding of what are the real strengths and weaknesses of the product are (Appendix I).

Following the initial SWOT analysis, the business could take it a step further and continue the discussions to find potential strategic actions. Converting the SWOT analysis to a TOWS analysis:



(Bruin, 2017)

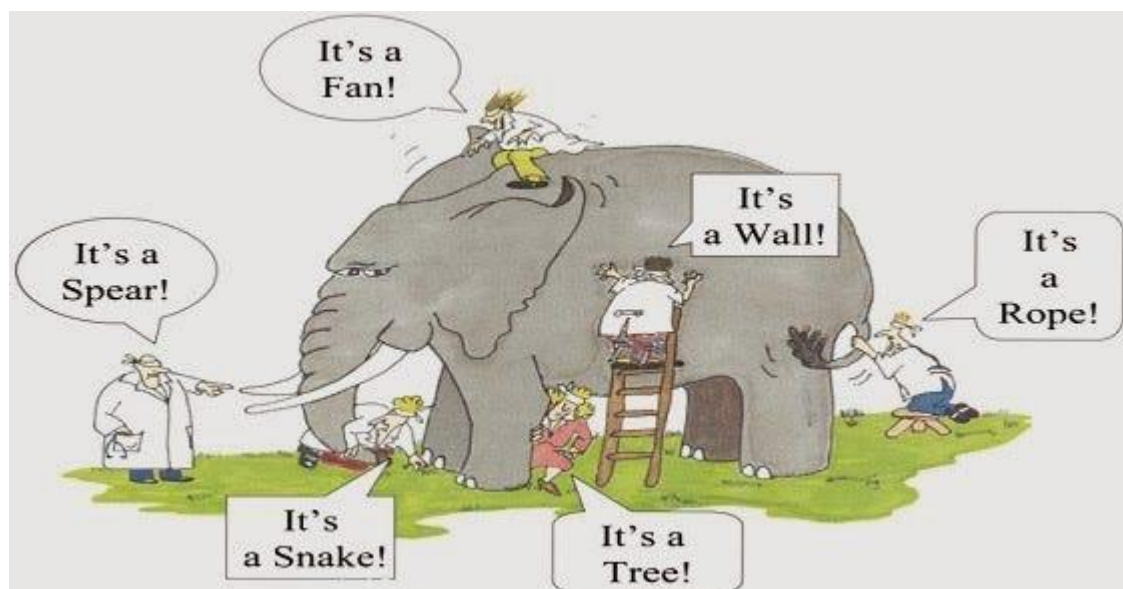
Here the team would answer four questions:

1. WT – What could the business do to prevent weaknesses being exploited by threats?
2. ST – How could the business use their strengths to combat their threats?
3. WO – What could the business do to prevent the weaknesses from damaging the opportunities?
4. SO – How could the business use their strengths to address the identified opportunities?

Whether the business just performs the SWOT analysis or extends it to a TOWS as well, these matrix are considered by some as being particularly good for looking at the granular details and heavily focused on internal views. Where it lacks is exploring the bigger picture.

An analogy that can be used to explain this in an interesting way is the parable of the blind men and an elephant. To paraphrase, in the story each man approaches this unknown object from a different angle and describes what it is they can feel – this becomes their interpretation of what it is in front of them, and they present their facts. Each observation is correct to the information they are presented with – very much like a SWOT analysis.

However, if they had been able to see and were provided with more external information, they would have been able to establish the bigger picture, that the object was actually an elephant. Some researchers suggest this is where a PEST analysis comes in.



(Tepe, 2019)

PEST analysis

PEST analysis is used by a business to evaluate the external factors that affect the product, service, or process being scrutinised. A comprehensive assessment can assist in creating a more effective strategic plan – this is far more resilient to Black Swan events.

This analysis focuses on four characteristics:

- **Political** – here the business would research government policies, laws, trade regulations, political stability/direction, or new regulations that are being implemented in the regions that they intend to offer their services. For Marks international, one essential topic is finding out what analytical methods are being developed and regulated that their products can be used for, or if they should develop something new to comply with the new regulation.

- **Economic** – This characteristic focuses on examining monetary type factors such as interest rates, economic growth, inflation, exchange rates, or recessions.
- **Social** – Businesses would research the humanistic factors, exploring elements like workplace and lifestyle attitudes, age demographics, population growth, and cultural differences. This enables the business to better understand a customer's/supplier's thought process when dealing with their business.
- **Technology** – Requires the business to explore the technology being used within the industry, identifying trends and any new changes. This research should help to identify what types of technology people are wanting to spend their money on, therefore the opportunities for major developments. Such as the rapid advancement of AI for automating many processes.

PEST is an effective and simple tool for discovering what is happening in the wider macro-markets that the business serves, avoiding tunnel vision due to lack of information. Typically, it will require researching information that is not already known to the business, broadening their understanding and enabling them to see the entire elephant.

Combining the use of both SWOT (and TOWS) and PEST will provide a business with robust facts that they can use to make informed decisions, whether that be to capitalise of a new opportunity or provide a warning for negative changes – an essential requirement for building resilience to Black Swan events.

Kano analysis

Manufacturing businesses must ensure that they are designing products and features their customers want. This will change over time as customers' needs develop and technology progresses. Black Swan events can have an influence on customers priorities – taking Covid-19 as an example, more people required products and services that allowed them to operate outside of the office or even laboratory.

Telling a product development team that customers want remote working could lead to them running off and starting to create all of the products and features they *think* the customer *might* want, simply because they have the knowledge of how to make them. However, just because a business can make something doesn't mean they should. This approach would waste resources, which in an SME is limited.

Businesses need to take an analytical approach to understanding exactly what a customer needs, one tool for doing this is a Kano analysis.

This was first published in 1984 by Dr Noriaki Kano, (MindTools, n.d.), and the model is used to get product teams thinking about the emotions of the customer, not just the functionality of the product/service.

The model splits the proposed features into three categories:

1. **The Basics / Must haves:** features that are critical to release but are simply expected by customers to be included. They may be indifferent about their presence however, if the features are not present the customer will be unhappy and unwilling to purchase.

2. **Valued requirements / Satisfiers / Should haves:** features that are not always essential to the operation of the product or service but with investment and implementation these will generate revenue as the customer will like them.
3. **Exciters / Delighters / Could haves:** these features are the differentiators, what makes the product or service stand out against the competition and will generate the most revenue, but they are not required for the general operation of the product. If the customer wasn't aware this could be a feature, they wouldn't miss it. However, when they are present the customers should feel like they absolutely need these features and so would be willing to pay a premium for them.

For a business to assign a feature to one of the three categories, they must communicate with their customers. This can be through direct conversations, surveys, or focus groups of a range of customer types. The business would ask the customer how satisfied or dissatisfied they are/could be about a current or potential new feature.

With this feedback the business can prioritise their time, effort and resources on the features that will provide their customers with satisfaction, ensuring they include exciters that will generate revenue, whilst also identifying the features that can have a negative impact on customer satisfaction. The latter can be avoided, and resources saved from wasting time developing or investing in them.

This tool can also therefore be used with prioritising time and producing agility – one of the three key aspects identified in this study to creating resilience to Black Swan events.

In addition to assessing the strengths and weaknesses, researching the external factors, and understanding what customers want, businesses should be constantly analysing their competitors. As mentioned previously, a business can create their own Black Swan event through their own ignorance.

Ignoring what the competition (direct or indirect) are doing can mean that a business is shocked when the competition release something new, that has the potential to remove the need for the business's product from the market. Think Apple killing off the Blackberry.

Porters 5 forces

An effective tool used by product managers to analyse the competitive landscape is Porters 5 forces. This framework helps a business to assess other external factors that could limit their success in a given market.

The five forces being:

1. **Rivalry amongst existing competitors:** this is regarded as the typical competitors that the business should already be aware of and therefore already have knowledge on how to compete with them. For Markes international this will be the other producers of analytical thermal desorption instruments. However, just because they know who they are, and should have information on how to beat the current product offerings, doesn't

mean that they should be ignored. As rivals, the competition will likely be developing new products and services that can undermine the businesses offerings. As such, they must obtain regular insights from speaking to customers or salespeople, attending the same tradeshow to view what is on offer, or monitoring the competitions website.

Given this force is seen as a rivalry, the business must be careful not to fall into the trap of price wars and “races for slight advances” (Gratton, 2024) which can reduce margins. However, healthy competition also has the benefit of stimulating the advancement for improved products.

- 2. Threat of new entrants:** For businesses that operate in industries where it is easy to set up a new company, such as hospitality, this is a significant threat to them. Whereas, for the manufacturing industry, this can be seen as a lower threat due to the perceived high-cost investments required to set-up and scale up. Although, manufacturing businesses should have in mind that companies working in the same or similar industry but currently with different product offerings could diversify and become a rival. One possible option to avoid this is to partner with the other companies, whereby they offer to resell each other’s products into different regions. This is an approach used a Markes with their OEM (original equipment manufacturer) partners who have offices in regions that Markes do not currently have a direct sales team.
- 3. Bargaining power of customers:** Customers can have the ability to disrupt planned developments by exerting pressure to create customised products specific to their wants, or they can drive down prices through expressing an interest in bulk purchases. Disruptions to the developments do not always have to been seen as negative, these can instead provide insights into what they and other customers currently need and are willing to spend their money on. Therefore, businesses should work with the customer to understand *why* they are making these requests. It could be the business already has a product or service available to fit these wants, otherwise it gives them first hand knowledge on potential improvements or new products. In regard to the bulk purchasing and driving down cost, a business simply needs to monitor their margin levels and set a limit on how much they are will to drop their selling price. Anything below this threshold, the business should explore alternative products or services. For example, at Markes they offer products with different levels of features, that are field upgradable later in the products lifetime. Therefore, is the customer doesn’t have the required budget now, they can purchase a lower specification product and upgrade later.
- 4. Bargaining power of suppliers:** Single source suppliers on key competent parts are a risk to businesses. They can easily increase their costs and make them vulnerable to any supply chain disruptions, as seen with the mass flow controllers for a short time at Markes. Businesses should design their products to be built using parts from multiple sources, enabling them to find more competitive pricing and safeguard against any shortages from a single supplier. Businesses should also have in mind if there is the possibility for their supplier to also diversify and enter into their direct market, becoming a rival. Partnering with suppliers and building trusting relationships can help to prevent this

from happening, so businesses should utilise their purchasing teams for this.

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- 5. Threat of substitute products or services:** this force is where a customer perceives that they can find alternative products that offer a similar service. Businesses should ensure they are clearly advertising the properties that make their product or service unique and focus on those that resonate with the customer (the excitors).

Regular use of the Porters 5 forces analysis framework will support a business in finding new information on potential competitive threats, allowing them to make adjustment and strategic plans before they become an issue, or worse a Black Swan event.

Tools for improving communication.

Another challenge that became apparent during this study, is that communication does not always happen effectively even though it is essential. People need to understand what it is they are being told, otherwise it creates a barrier to that person either being willing to accept what they are hearing/reading or a barrier to them agreeing to the proposed actions.

At Markes this was observed through the breakdown of culture and a feeling of them vs us between those who were on furlough, those working from home, and those having to work in the factory.

It was also present in the absence of sharing the business continuity plan. Markes could have shared the full plan with their managers, and created a filtered and customised version for the staff to demonstrate that they did have plans. This could have had the effect of alleviating some of the concerns and stresses felt throughout the business.

Personas and empathy maps

In product management personas and empathy maps are used to create a better understanding of their customers needs and what they value. They bring to life the target audience of a product or service by exploring what really matters to the customer – what that person finds interesting and valuable.

These tools are used by product managers, marketers, and development when they want to:

- Develop stories for the requirements – reasoning to why the requirement is listed,
- Confirm design decisions (or disprove them),
- Prioritise feature requirements and requests – those that the target personas value highest should be in the top priority list (the must-haves),
- Gain inspiration for new products or services,
- Critique what has been developed,
- **Understand the language required to market the product.**

It is this last point on language that makes this tool suitable for creating resilience to Black Swans events *within* a business. To be resilient they must be able to communicate the information they have gathered and the decisions they have made in such a way that all employees can fully comprehend them. This will require tailoring the messaging to the specific demographic within a department. For example, terms used in finance and to shareholders may not resonate with teams working in the laboratory or on the factory floor. As stated, through ensuring their staffs concerns are fully mitigated with effective communication, this could have prevented the loss of culture.

External to the business, using this framework will help them create marketing material that will bring in new customers, or encourage returning customers to purchase their products or services supporting cash flow and building resilience to the brand.

Personas and empathy maps are both user-centric methods that look at humanising and understanding the target audiences' motivations and pain points, but they do have distinctive differences.

(UserPilot, 2022), explains that personas tell a business who their different customers are (the different demographics), focusing on their needs, pain points and motivations. These are generally identified by internal people based on who they are used to selling their products to.

Whereas empathy maps are a visual tool for discovering customers attitudes based on their senses. To complete this framework efficiently the business should speak with the customers identified in the persona activity and confirm what they actually experience, rather than trying to guess.



(Business Model Toolbox, n.d.)

It can be argued that the empathy map is better suited to understanding the target audience as it provides greater detail on what matters to them, however, (Huff, 2023) at Forbes contends that these are complimentary tools. To paraphrase them "personas draw the portrait of people as buyers while empathy maps appreciate them as individuals" which means that businesses can "break through superficialities and gain the kind of rich, authentic insights that allow them to not only deliver but anticipate the experiences customers crave."

Therefore, these tools can be used in combination by a business to humanise internal and external demographics, and allow them understand how to improve their communication with everyone, preventing barriers being created.

Tools for establishing agility:

Agility, the proficiency to act quickly, has been mentioned multiple times throughout this study. If a business cannot act in response to a Black Swan event, or are too slow, they risk damaging their brand, losing customers, not being able to produce products or service, having to reduce headcount, or ultimately failing.

As exemplified by the Head of Marketing (Appendix E) with a chartered institute. They were unable to quickly adapt to working in a digital space when their face-to-face interactions with their members was taken away. This led to redundancies.

SMEs must carefully manage the time their employees spend on activities and projects to ensure they are getting the best efficiency. SMEs do not have the capacity of larger businesses to assign entire teams to a single activity. Therefore, many employees are required to wear multiple hats to cover all the obligations of running a business successfully.

However, there is the risk that the employees will become spread too thin. They are challenged with juggling far too many responsibilities that they cannot focus on the highest priority task that is required. They may also inadvertently be working on the same activity as a colleague without realising it. This overlapping can cause there to be no accountability for an activity. The result of which will lead to missed deadlines and reduced output. The business will not be efficient.

More seriously, when the next Black Swan event occurs, they will struggle to manage the reactive actions needed.

A product management tool that can be utilised to address this challenge is the Product Activities Framework from (Product Focus, n.d.)

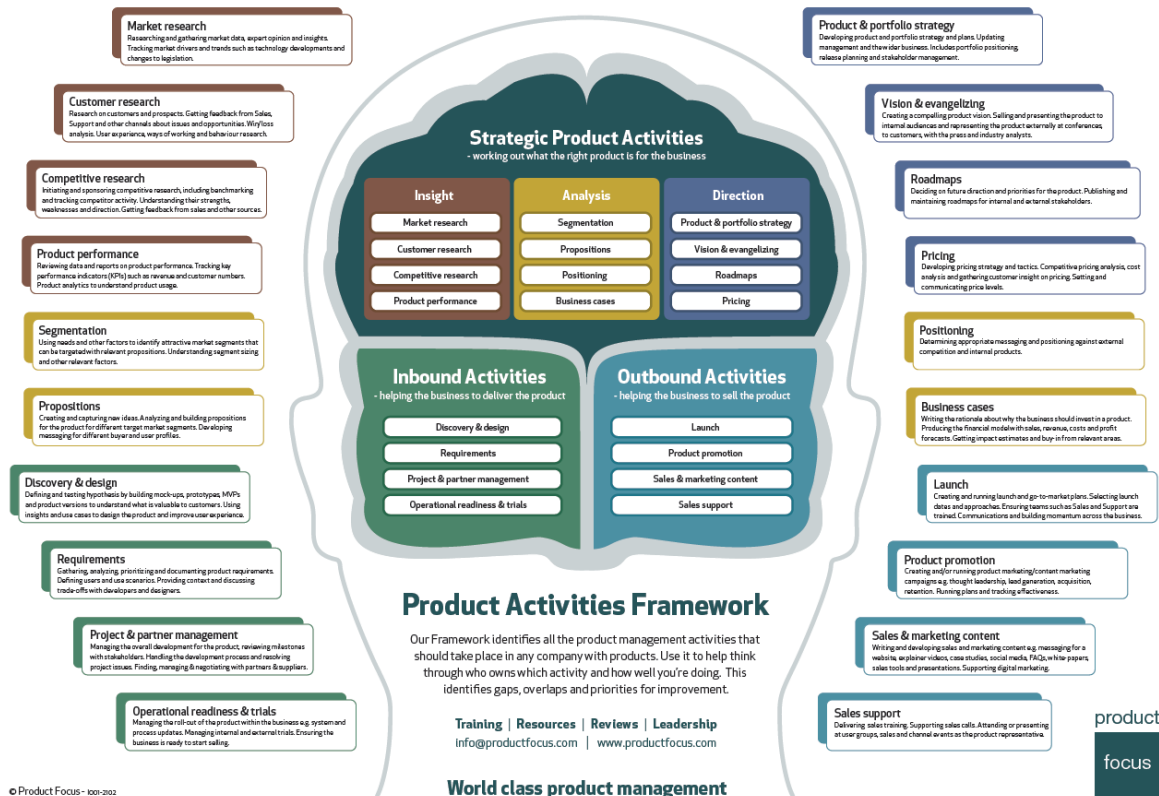
Product Activities Framework

The Framework maps out all of the activities that take place within a business to bring a product or service to market. As seen in the image below, Product focus separate it into five blocks:

1. Insight – information and data capture.
2. Analysis – understanding the insights and making the information useful.
3. Direction – deciding what actions need to happen, or don't need to happen, now or in the future.

These top three blocks enable a business to realize what are the best products or services they should be offering.

4. Inbound Activities – getting the product or service ready for launch.
5. Outbound Activities – launching and supporting the sale of the product or service.



(Product Focus, n.d.)

They then break each block into 4 activities. The product manager is not responsible for each activity shown, which are typically shared between different departments with the business.

An effective process for analysing and using the framework is to apply the RACI model:

- **Responsible** – The person or team who should be carrying out the activity.
- **Accountable** – The one person who has ownership and authority over the activity. They will make any final decisions and are accountable for the activity being complete on-time.
- **Consulted** – The people who need to be involved with the discussions before an activity takes place.
- **Informed** – The people who need to be told about the outcome from an activity.

The action of discussing, deciding, and agreeing who sits where on the RACI model allows a business to find the gaps where no-one is doing that activity, any overlaps, and if there are any issues.

An outcome of this will be to improve efficiency as multiple people should not be accountable for the same task, which will free up resources to be reactive when needed.

This framework can be adapted to analyse the activities of other sections within the business, such as supply chain management – a key area that was challenged throughout Covid-19. They could apply RACI to:

- Supplier sourcing
- Supplier information management
- Purchase order management
- Stock and warehouse management
- Logistics – goods in and goods out

At a more granular level, after employees know what activities they are responsible for, businesses also need to carefully manage the volume of work and projects they are assigning to each person/team.

How can a business decide on what projects should be their current focus, and therefore where they need to designate resources?

RVCE Prioritization Matrix

(Big Agile, 2023), provide a simple explanation of the RVCE (Risk-Value-Cost-Effort) prioritization matrix used by product managers when deciding what features or products should have resources assigned to them.

As the name suggests, projects are evaluated based on four categories:

1. **Risk** – potential to gain or lose something valuable to the business.
2. **Value** – how desirable the project is to the business.
3. **Cost** – how much will it cost to develop and implement the project.
4. **Effort** – how much resourcing and time will the project take? Is that resource available in-house?

This tool is not just for product managers, businesses can apply this to provide guidance on what projects they should be putting at the top of their priority list, what should be considered, what needs further investigation, and what could be avoided.

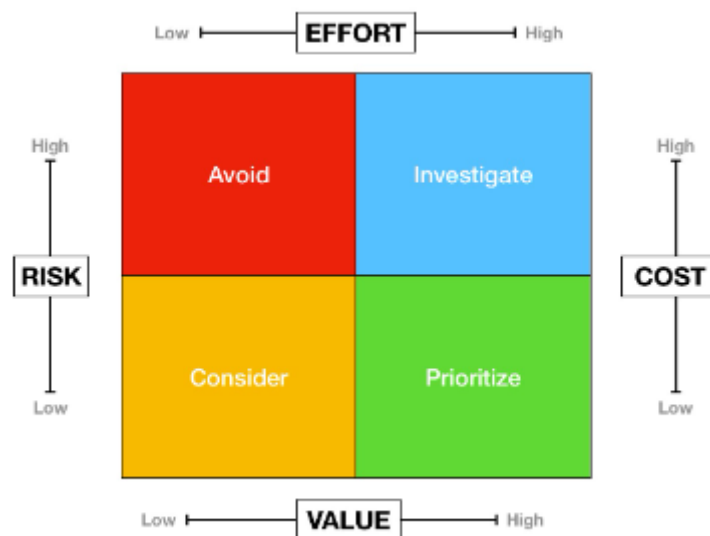
It requires input from senior management and stakeholders so that all insights and concerns can be openly discussed. They also need to decide together on where the projects should be placed on the matrix by agreeing and defining what the low to high criteria means for their business.

At Markes international, for example, low effort would mean that they already have the knowledge internally to perform the project whereas high effort would mean they need to outsource or find a collaborator. Low value to Markes is where they expect a lower return on investment compared to their normal margins.

This model is effective in how simple it is. Each project can only be placed in a single quadrant which then informs the team on what they should do, not what they must do.

- **Top left** = Avoid. Projects in this section should be avoided because they come with too high cost and risk, as well as low value.

- **Top right** = Investigate. Although assigned high to all criteria, these projects may offer significant payback in the future.
- **Bottom left** = Consider. The assignment of low to all criteria illustrates to the business that this project should be lower down on the priority list, but not disregarded. However, these can be the “low-hanging fruit” or “quick-wins” that lead to higher value projects being realised.
- **Bottom right** = Prioritise. These are the projects that the business should be allocating resources as they have low risk and cost whilst having high value.



(Big Agile, 2023)

In addition to being very simple to use, this model encourages communication between different teams and functions. It gives visibility and agreement on what actions the business should be performing now. They can appoint responsibility to the most appropriate team, which will reduce the amount of resource spent on the wrong thing.

In regard to how this model will help with Black Swan events, it should ensure that teams are not spread too thinly over too many projects; so, when an event occurs, they should still have some capacity left to be able to react as needed.

Conclusion

The first part of this study set out to explore how manufacturing SME businesses are affected by Black Swan events with a focus on the Covid-19 pandemic.

An interesting early observation when reviewing the concept of a Black Swan was that not all Black Swans need to be on a global scale. They can in fact be localised and inadvertently introduced due to lack of knowledge or ignorance.

There was an unconscious bias at the beginning that many manufacturing businesses struggled or failed due to the aggressive media coverage of high unemployment and seemingly stable brands going bust, such as Debenhams. However, the research into manufacturing businesses and the case study with Markes international illustrated a different story.

Although many faced struggles, some were able to thrive and instead grow as a result of the pandemic. Markes international sits somewhere in between, they faced several challenges which, as discussed, they were mostly able to overcome, as well as experiencing several positive outcomes.

The study brought light three keys aspects that are required to make a manufacturing business resilient to the next Black Swan event:

- Information gathering – researching to fill in gaps and find the bigger picture,
- Communication – humanising how businesses speak to people in different demographics both within their business and with external partners. Ensuring that the information they are sharing and decisions they have made are fully understood and accepted by all.
- Agility – resources are limited in any SME business, so ensure that time is not wasted on the wrong project or product is essential. Teams will be less likely to feel spread too thin and still have capacity to react to the next Black Swan event, which unfortunately is inevitable.

The next part of this study took a novel approach and analysed practical tools used within the role of Product Management to improve each of the above aspects.

Through the systematic use of the tools identified, which should be part of good practice, the business can take a step back from focusing on the granular and tunnel visions, allowing them to see the bigger picture and research the unknown. They will plug in some of their gaps in knowledge and become less ignorant – seeing not only the whole elephant but possibly the entire herd. These tools will also assist in prioritisation, creating enough space for a business to still be reactive when required.

The tools identified in this study were chosen because they are effective and simple to use. Most should not be worked through in isolation, but explored as a team with insights from internal and external sources which will prevent the information being gathered being biased and only of the opinion of one person (who has limited knowledge – they don't know what they don't know).

Therefore, to answer the question, can manufacturing SME business build resilience to Black Swan events. The answer is Yes.

Limitations and further research

This study has focused on a limited number of businesses and practical tools that require manual processes to gather, analyse and make decisions.

For a more detailed examination, the experiences of other types of manufacturing businesses could be compared and contrasted to see how they were affected by Covid-19 and if there were any similarities to Markes international.

Additionally, as artificial intelligence (AI) develops, the information gathering and analysis has the potential to be complete by computers, freeing up further resources and enabling the SME business leaders to simply make informed decisions. However, investigation would be required into how effective AI is at finding the information needed, and if it is able to analyse the data into usable insights for the decision making.

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Appendix

A – Interview with head of operations

[Pam - thoughts on black swan events-20240110_151214-Meeting Recording - Copy.mp4](#)

B- Interview with Finance Controller

[Simon - thoughts on black swan events-20240112_100303-Meeting Recording.mp4](#)

C- Interview with Supply Chain Manager

[Marie - Thoughts on black swan events-20240108_143725-Meeting Recording.mp4](#)

D- Interview with Commercial Marketing Manager

[Aaron - thoughts on black swan events-20240105_143709-Meeting Recording.mp4](#)

E- Interview with Head of Marketing and Communications

[Gavin - thoughts on black swan events-20240105_093352-Meeting Recording.mp4](#)

F- Interview with Production Manager

[Luke - thoughts on black swan events-20240104_150204-Meeting Recording.mp4](#)

G- Interview with Head of Applied Engineering

[Nap - thoughts on black swan events-20240108_130451-Meeting Recording.mp4](#)

H- Interview with Senior Buyer

[Tony - Thoughts on black swan events-20240111_103905-Meeting Recording.mp4](#)

I – SWOT analysis of a Markes international product

Internal feedback - The Strengths



Operation

- *Simple to use* – once set up and familiar with controls
- Simultaneous condition/dry-purge
- Off-line from TD, saves time
- Nitrogen, cheaper option than Helium
- Compatible with *TubeTAG (TAG only)*
- Cool down outside of oven – *cooling rack*
- Easy to remove manifold
- *Multiple manifolds (TAG only)*
- Dry-purge. Saves time from TD run and prevents water getting into system

Production / build / design

- Easy to build – TC-20
- Easy to test

Serviceability / maintenance

- *Easy to maintain*
- Customer installable – easy to do
- Filters are easy to change – 4 screws

Commercial / other

- Industry size tubes and 60 mm x 6 mm
- Price is not a barrier
- Reliable – 15 year old ones in production still being used
- Robust – can survive being bumped
- Small footprint, compact
- *Capacity is good*
- App note explaining savings is great.
- Transportable
- Easy to use in field

MARKES

Internal feedback - The Weaknesses



Operation

- Controls are not intuitive, they are difficult and "fiddly", and require time to learn
- No programming/ramp, 1 temp ramp only
- No flow readout, external flow meter
- External gas regulator has to be ordered separately
- No alerts for gas flow, temperature, end of cycle, other faults
- Gas doesn't stop at end of cycle – cannot be left to run over night as this will waste a lot of gas
- Gas flow through every port, even when less tubes inserted – High gas consumption.
- Timer starts straight away - is not delayed until temp reached – does not account for time at the setpoint
- Methods not stored in/on unit
- Only 1 manifold (TC-20 only)
- Tubes get stuck – requires tweezers to remove
- Manifold scratches off barcodes
- TAGs are not updated with thermal cycle info (TAG only)
- No USB port/connectivity
- Slow to heat

Production / build / design

- Difficult to build – TC-20 TAG
- 8 week lead time - parts becoming obsolete
- Live connection is not shielded
- Covers are not simple to remove
 - requires removal of bezels and undoing of earth wires.
- Poor design of front bezel where screws attach
- Voltage is not universal – set during build depending on order destination.

Serviceability / maintenance

- Return to factory for repair, almost impossible to service in field
- Changing of O-rings is difficult
- Inconsistent heating between models and within heating block

Commercial / other

- TC-20 TAG can only accommodate most 1 bed tubes –not all, depends on bed length
- Covers are outdated – looks like it was built in the 80s
- Only 20-tube capacity

MARKES

Internal feedback - Improvements

Operation

- Easier, more intuitive controls.
 - ❖ Touch screen control, similar to Agitator design
- 4 x temperatures ramps with settable times for each.
- Internal flow meter / flow readout
- Alarms for faults such as no gas and temp not reached.
- Alert for end of set conditioning/dry-purge cycle
- *Internal gas regulator – if cost allows*
- Overnight operation: Automated gas cut-off with way of sealing and protecting tubes
- Gas flow through port only when tube is inserted
- Timer delayed until each temperature is reached
- Saveable methods with easy recall
- Preloaded methods for named tubes
- Min 2 x manifolds – 1 cleaning & 1 cooling
- USB port for connection to PC and/or WIFI for remote operation
 - USB has been requested in USA
- TAG read/write built in
- High temp to 450C (LOS) (TD high is 425, recommended condition is 20C above desorption temp)
- Manifolds must not scratch tubes and remove barcodes
- Consistent heating across heater block, $\pm 3^{\circ}\text{C}$
- 'Reasonable' heating time, consistent across models – min 5 C/min & max 35 C/min (LO PE)
- Guide on unit/in software to explain what direction to insert tubes



MARKES
ANALYTICAL

Internal feedback - Improvements

Production / build / design

- o Easy to build for all models
- o Target lead time = 4 weeks
- o New design that is safe – no unshielded connections
- o Universal voltage
- o Filters need to be assessed for effectiveness and safety
- o Multiple manifold positions with individual control – multiple tube types conditioned on one unit with different methods.
- o On board tool holder for tweezers, CapLok tool
- o Tray for brass caps

Serviceability / maintenance

- o Field serviceable with easy access to part, specifically heater cartridges.
- o Easy access for user changeable parts – O-rings & filters
- o Method for cleaning the tube positions without turning the unit upside-down

Commercial / other

- o Compatible with DAAMs/CDS (4.5"), Gerstel 7" and Bruker tubes
- o Completely new aesthetics, in-line with -xr range but not powder coated panels
- o Increased tube capacity: 25-tubes (LOS) (2x batches dry-purged for TD-50 and 4 x batches dry-purged for TD-100)
- o Certificates & approvals – Met/Standards
- o Packaging to be reviewed
- o Handles to aid with transporting/moving in field
- o Bundle to include everything needed for set up, including tubing, unions and regulator (if not built-in)



MARKES
ANALYTICAL

The Competition

Competitor feature comparison

Product name: TC-20

Feature	Our performance vs the competition									
	TC-20	TC-20 TAG	SIM	PE / REDShift	GERSTEL	SIS 6-tube	SIS 24-tube	KnR	CDS 6-tube	CDS 1-tube
Tube capacity	3	2	2	2	1	1	3	1	1	1
High temp (400)	3	3	3	3	1	1	1	3	2	2
Temperature ramps (4)	0	0	2	3	1	2	2	3	0	0
Multiple methods simultaneously	0	0	0	2	0	1	1	0	3	0
Saved methods	0	0	3	0	2	1	1	0	2	0
Tube cooling	1	1	2	3	1	1	1	2	1	1
Integrated gas flow	0	0	2	2	1	2	2	2	2	2
Gas flow only if tube inserted	0	0	3	3	0	3	3	3	3	3
Multiple tube compatibility	2	1	0	0	3	1	1	1	3	3

Key		
Value entered	Colour bar displayed	Meaning
0	0	Feature not present
1	1	Very limited implementation
2	2	Pretty complete implementation
3	3	Market-leading functionality