

# ‘The Management of New Product Development’

## ‘The Design Brief’



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## 1. Introduction

This report looks at the requirements for developing a 'design brief' for a new type of breathalyser. The considerations are from the perspective of the 'New Product Development (NPD) and Innovation' manager of a small to medium sized enterprise (SME) based in Carmarthenshire.

The traditional breathalyser (Figure 1) manufactured by the company detects levels of alcohol in breath (a chemical breath analyser). A proposed new product, building upon the capability of the chemical breath analyser, can identify volatile organic compound markers in breath, which can indicate the presence of viruses including Covid-19. This product innovation was identified through a Knowledge Transfer Partnership (KTP) with a local University. The new componentry that is required for virus detection negates the suitability of all of the parts that are used in the traditional alcohol breathalyser product.

A prototype of the new breathalyser for virus detection has been successfully trialled (with certification awarded by the regulatory body) and a patent application has been made. A consultancy firm in London has been tasked with:

- Detailed product design.
- Sourcing manufacturers for the mechanical and electrical parts. The electrical element will be a single circuit board - preliminarily it is envisaged that they will be sourced from China. The mechanical elements will be injection moulded – it is envisaged that these parts will be sourced in the UK or Europe.

The final product will be assembled, tested, packed and dispatched at the factory of the Welsh SME. Indicative quantities are 750,000 in year 1, and 3 million per year thereafter.

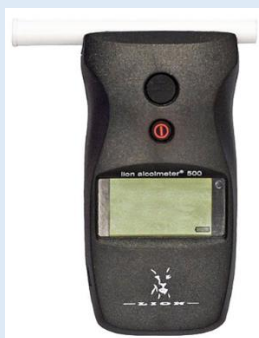


*Figure 1 – Breathalyser for Alcohol Detection*

The starting point for any NPD project should be the development of a 'design brief' that comprehensively considers the requirements of many stakeholders (Pugh, 1997). One might argue that the design brief should have been started by the Carmarthenshire based company before a prototype was made, before a patent application was submitted and before consultants had been approached to start detailed product design and sourcing component manufacturers. Sadly, this is not an untypical approach by businesses. The next chapter discusses how design briefs should take a holistic form – aligning well with business strategy/goals and involving multiple levels within the organisation. environmental sustainability considerations are discussed in Chapter 2, followed by market needs in Chapter 3 and a plethora of other considerations in Chapter 4.

## 2. Considerations for the development of a Design Brief

### 2.1 Strategy Alignment

There is broad agreement that NPD and Innovation are important factors for driving business growth and improving market competitiveness (Kavadias & Chao, 2007). However, there is weak statistical association between the technical product specifications and business performance in terms of profitability (see Figure 2).

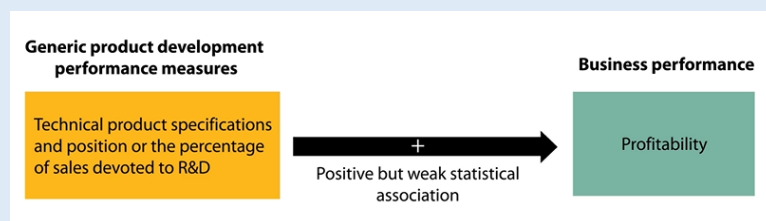


Figure 2 – Product development measures versus business performance {Source Terwiesch, Loch & Niederkofler 1998}

Organisations spend over \$2 trillion dollars annually across the globe on research and development and yet the volume of new sales generated from NPD is disappointing – only 1 in 4 NPD projects lead to commercially successful products (Cooper & Edgett, 2003). This suggests that design briefs are either not an effective tool or that businesses are not using them correctly, since the product design specification (PDS) evolves from the design brief.

Innovation and NPD are multi-dimensional and complex processes. A given set of inputs that result in the development of a commercially successful new product, will certainly not guarantee a successful outcome when used by different businesses, nor indeed by the same business on different products. Furthermore, outputs that are predicted through the use of financial tools (Return on Investment, Net Present Value (NPV) and Internal Rate of Return (IRR)) invite manipulation that can cause mistrust throughout the organisation. They encourage short-term thinking and incremental behaviours (Cooper & Edgett, 2003).

Lock et-al (Loch, Kavadias, & Si, 2023) propose that the key to enabling more successful NPD projects lies in the development of the process of innovation, moving away from the common practice of selecting innovation projects through financial measures alone. They argue that more effort should be deployed into the development of more effective NPD and innovation project portfolios that are well aligned with the business strategy – see Figure 3.

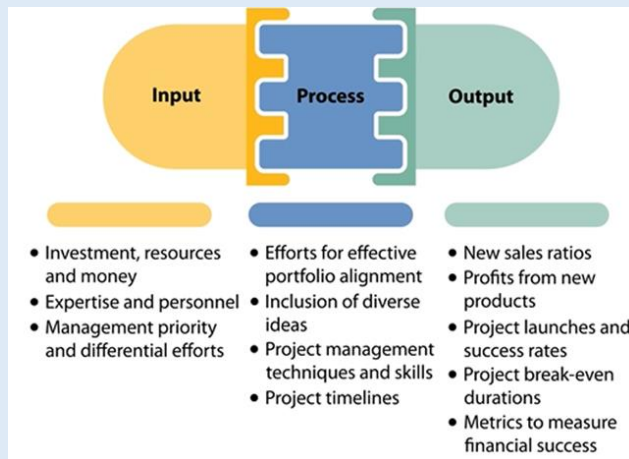


Figure 3 – Product development measures versus business performance {Source Terwiesch, Loch & Niederkofter 1998}

Businesses develop innovation (or new product) portfolios to have a mix of projects in the hope of improving the competitive position of the company (Cooper, Edgett, & Kleinschmidt, 2004). Typically, the senior management prioritise the projects and allocate budgets and resources accordingly. The difficulties in creating and managing these portfolios are acknowledged and understood by practitioners and academics:

- New product portfolios do not often align well with the business strategy.
- There is a need for a balanced portfolio that includes projects across a spectrum, from incremental developments through to ‘new to market (radical)’ innovations.
- There are new product development projects should often be ‘killed off’ much earlier in the development cycle, but businesses seem reluctant to do so.
- Businesses often overfill the ‘innovation portfolio bucket’ with projects that then compete with each other for scarce resources.
- Ensuring that senior management don’t by-pass the process and push their own pet-projects.
- Poorly defined and executed portfolio governance.

Since the turn of the century, there has been significant research into the NPD portfolio challenges. Some of the popular developed methods are shown in Table 1

| Item\ Stream | Knapsack Problem (KP)                                                                                                                                                                                                                                                                                                                                    | Dynamic Pro-gramming (DP)                                                                                                                                                                                                                                                                                    | Decision Analysis (DA)                                                                                                                                                                                                                                            | Organization & Team (OT)                                                                                                                                                                                    | Psychology & Behaviour (PB)                                                                                                                                                                                                                                                                                                | Qualitative Portfolios (QPA)                                                                                                                                                                                                                   |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Perspec-tive | Project collection                                                                                                                                                                                                                                                                                                                                       | Project collection                                                                                                                                                                                                                                                                                           | Decision                                                                                                                                                                                                                                                          | Organization                                                                                                                                                                                                | Behaviour                                                                                                                                                                                                                                                                                                                  | Practice                                                                                                                                                                                                                                       |
| Purpose      | Optimization by creating algorithms.                                                                                                                                                                                                                                                                                                                     | Preprogrammed policies about project treatment as a function of changing project status and interactions.                                                                                                                                                                                                    | Assist decision makers in selecting decision by providing tools and framework                                                                                                                                                                                     | Identify successful organizational elements that can support portfolio management.                                                                                                                          | People use (subconscious) heuristics to simplify complex decisions                                                                                                                                                                                                                                                         | Rather than optimization with tools that are too complicated, seek balance of strategic criteria.                                                                                                                                              |
| Key insights | Packing the most valuable items into knapsack of limited volume. With fractional items allowed, it is optimal to rank the items by "value/volume", but when items are included 0/1, "unused" capacity needs to be taken into account: to use capacity, one may need to include lower priority items. Therefore, combinatorial optimization methods used. | As long as stages capture relevant project status, state-dependent policies can identify: project prioritization on waiting time/ waiting cost, on value or quality/ scarce resource demand, with threshold policies for when to progress a project. Thresholds can depend on scarcity of the resource used. | Portfolios address multiple goals of the organization; Prerequisite of KP and DP because DA provides "aggregated criteria" for optimization, inclusion or optimization.<br><br>Also, DA tools should facilitate communication and collective problem structuring. | Successful day-to-day IPM requires frequent project reviews, assigned responsibility for IPM, sufficient slack capacity, stable core teams on projects and a mentality to increase resources into projects. | Individual biases may merit procedure modifications (e.g., present projects in different orders, discuss long-term effects);<br><br>Group composition and decision procedures must anticipate possible status competition, cronyism or group-think in order to ensure decisions in the interest of the whole organization. | Diagrams enable discussion of "reasonable-ness". Thus the emphasis is on discussion among the decision maker team.<br><br>Less dependence on complex and manipulation prone data, as the inputs to the diagrams can be "plausibility checked." |

Table 1 – NPD Portfolio Management Tools [source (Loch, Kavadias, & Si, 2023)]

These conceptual tools each bring clarity to pieces of the puzzle. There is evidence to suggest that combining these frameworks improves results and that a hybrid approach has been adopted by some leading companies – with a reduced emphasis on financial measures and a stronger emphasis on the buy-in to a rigorous process for NPD portfolio management across all levels within the organisation (Nadar, Debo, & et al., 2015).

Loch et-al (Loch, Kavadias, & Si, 2023) encourage further development of this hybrid approach, that focuses on the spirit, and the order of combined use of these conceptual NPD portfolio development tools. They propose two separate but intertwined phases - the creative phase and the analytical phase (see Figure 4).

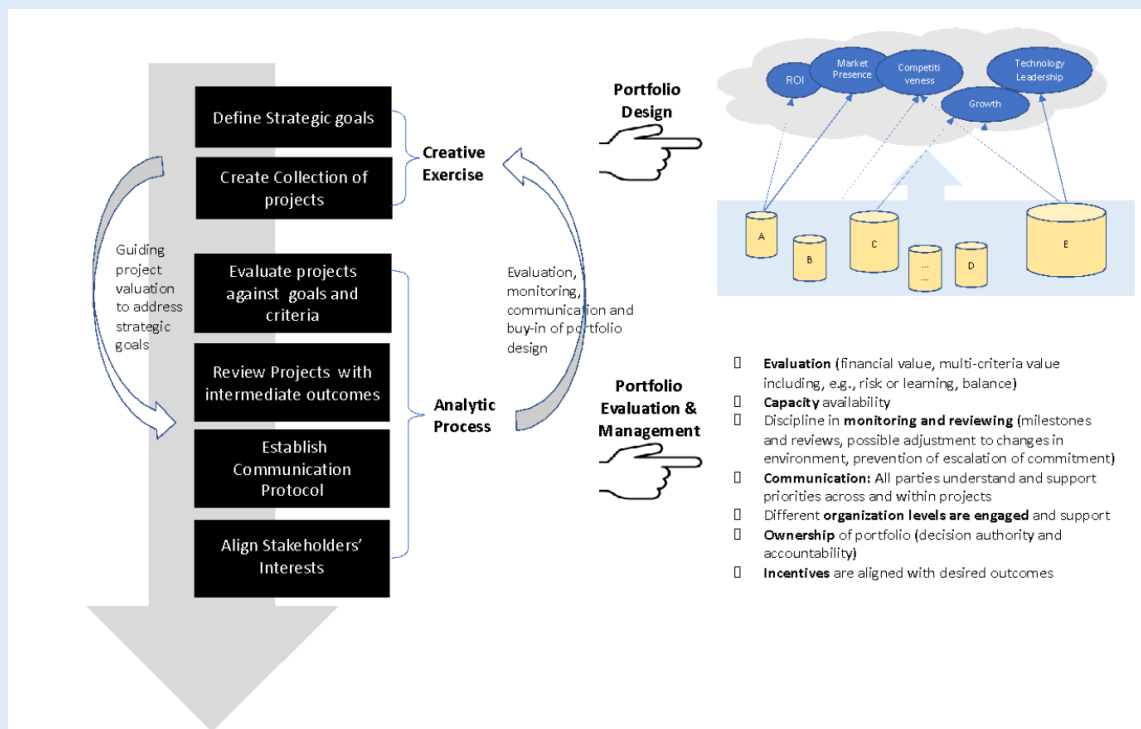


Figure 4 – A better approach to NPD [source (Kavadias & Chao, 2007)]

## The Creative Phase

Whilst the definition of the strategic goals (which is a creative process) falls outside of the process of creating the NPD portfolio, alignment of the two is critical to a positive outcome for project (Sinfield, Gustafson, & Hindo, 2014). The creation of the NPD portfolio is also a creative process where qualitative considerations play an important part in the evaluation of potential projects. Indeed it is also partially an intuitive process where opportunities and their appeal blend with how the projects fit with the strategic goals (Meifort, 2016). The discussion that leads to the creation of the portfolio can take place through workshops that involve different organisational layers - tools such as the DIBB (Data, Insight, Belief, Bet – argument framework) can be helpful during these workshops – see Figure 5.



Figure 5 – The DIBBS Argument Framework.

A very important consideration for all NPD work is 'the need' (Killen, Hunt, & Kleinschmidt, 2008) and how the product will create new markets or improve positioning within an existing market (see also chapter 3). Mene Pangalos (Executive Vice President, Biopharmaceuticals, R&D) turned around R&D productivity at Astra Zenica from 2010 onwards using a '5R' framework (right target, right tissue, right safety, right patient, right commercial opportunity). For the NPD portfolio of projects developed

through this framework, Pangalos advocated quality over quantity, and he believed that satisfying ‘unmet needs’ was the best test of potential project value (Morgan & et al., 2018). This chimes with the writing of Peter Drucker – one of the greatest thinkers on innovation – who wrote that:

*‘Successful innovating organizations, measure innovations not by their scientific or technological importance but by what they contribute [in terms of value] to market and customer’.*

The analytic process can then commence when the collection of potential NPD projects for the portfolio has been identified. The analytic phase helps narrow down the list and allows resources and budgets to be committed.

### **The Analytic Phase**

- Evaluate projects against goals and criteria.
  - *Using Knapsack, Decision Analysis and Qualitative Portfolios when considering value alignment (balancing project value against resource and budget requirements) with company strategy.*
  - *Using Dynamic Programming and ‘agile (stage-gate) approach’ (frequent iterations and validation demonstrations) when considering goal compliance.*
- Review projects with intermediate outcomes - Accommodating change as the environment changes, the innovation portfolio must flex and adapt to significant and business relevant change.
  - *Using Dynamic Programming and ‘agile (stage-gate) approach’.*
- Establish communication protocol - good communication across the business layers to motivate alignment that facilitates the execution of the portfolio analysis.
  - *Use Organisation & Team and Psychological Behaviours*
- Align stakeholder interests - working with and convincing the internal and external stakeholders who support the strategy.
  - *Use Organisation & Team and Psychological Behaviours*

The design brief for the new breath analyser must consider the alignment of the project with the strategic goals of the business through the process outlined above. It must detail how the NPD project sits within the NPD and Innovation Portfolios of the business – competing for resources and money. It must also identify the ‘need’ that product will satisfy for the market/user (Mital, 2014).

Whilst it is true that NPD commands the greatest volume of innovation effort across the four innovation categories (Business Model, Process, Offering and Deliver), the cumulative value creation from the effort spent on developing the offering (which includes NPD) is the weakest – see Figure 6.

## Returns on innovation

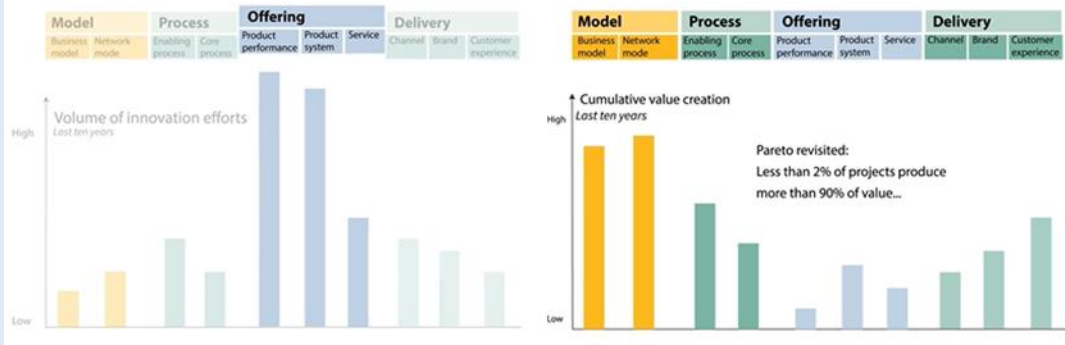


Figure 6 – Return on the different typologies of innovation [source Doblin]

The website for the Carmarthenshire based business identifies the business as a fully vertical integrated company that performs all of its own research, engineering product development, and manufacturing. There will no doubt be many other innovation projects around model, process, offering and delivery that compete with the NPD (breath detection of viruses) project. The design brief needs a holistic view and must clearly identify the potential rewards and risks and how the project contributes to the wider business goals.

This strategic part of the design brief is certainly not frozen in time – it needs a constant cycle of review and adaption as new information becomes available.

## 2.2 Environmental and Social Governance

The UK industrial sector is highly emitting and produces 16% (72MtCO<sub>2e</sub> annually) of all UK emissions. These emissions contribute to global warming and 8 of the 10 warmest years on record have occurred since 2014 - resulting in more frequent and severe weather, rising sea levels, more acidic oceans, higher death rates and higher wildlife extinction rates. The latest report from the United Nation's Intergovernmental Panel on Climate Change (IPCC) is damning and it pulls no punches when describing the destructive influence of global warmings on the earth's biosphere (Intergovernmental Panel on Climate Change, 2022). The IPCC is unambiguous in its position that global warming is the largely the result of human made greenhouse gas emissions (75% of which are from energy consumption).

The transition to net zero CO<sub>2e</sub> emissions by 2050 is essential to keep the average global temperature increase to less than 1.5°C of the pre-industrial (1880) value. It is estimated that the global temperature has increased by 1.1°C since 1880 and it is growing at a rate of up to 0.2°C per decade (NASA, 2023) – see Figure 7.

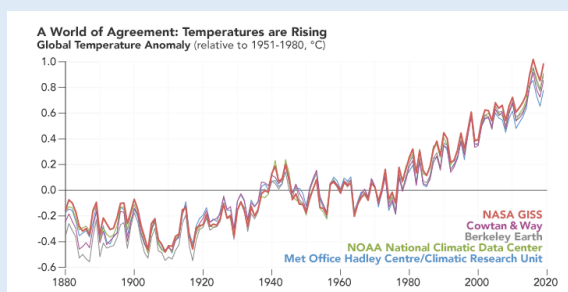


Figure 7 – Global Temperature Rise

The difference between the impact of a 1.5°C and 2°C average global temperature increase is startling (see Figure 8) – A 2°C rise will cause considerably more devastation for all life on earth.



Figure 8 – The Difference Between 1.5°C and 2°C average global temperature rise ( (Climate Change, 2021)

In 2022, the UK Government released its Decarbonisation strategy (UK Government, 2021). This strategic document highlights several innovation priorities, one of which is the investment in industrial digital technologies to maximise efficiency improvements. It is estimated that 13% of all UK industrial

CO2e emissions can be eliminated through efficiency improvements. A commitment is given to support the development of disruptive digital technologies such as Artificial Intelligence / Machine Learning, Additive Layer Manufacturing (ALM) and Digital Twins. The design brief must consider the way in which the breathalyser will be manufactured. Is shipping-in injection moulded plastic from China really the right answer? Regardless of the shipping emissions, are there advantages in locally produced parts from companies who are competing on productivity and sustainability through technology? Additive Layer Manufacturing for example allows new design complexity and therefore potential efficiency, that cannot be accommodated by injection moulding – facilitating lightweighting yet with increased strength (material can be more efficiently shaped). Whilst today, ALM competes with Injection Moulding only on production runs of up to 10,000 parts (3D printing an alternative to injection moulding, 2021), there is growing popularity in 3D Print farms where banks of machines print parts to compete with injection moulding.

There are other environmental concerns facing manufacturing businesses. Plastic pollution is one of the greatest global environmental challenges (almost 360 million tonnes of plastic is produced annually (Essentra, 2020)) and the UK is a major contributor – see Figure 9. It is estimated that almost 12 million tonnes of plastic enter the oceans every year.



Figure 9 – Plastic Pollution

The NPD breathalyser must be designed with circular economy thinking in mind. The design brief must identify how the product will be designed for longevity, how easy it will be to maintain. The next consideration is how easy it will be to refurbish and at the end of useable life, can some parts be stripped out for re-use or recycling – how easy can dissimilar plastic parts be identified (for material type) and then separated for recycling?

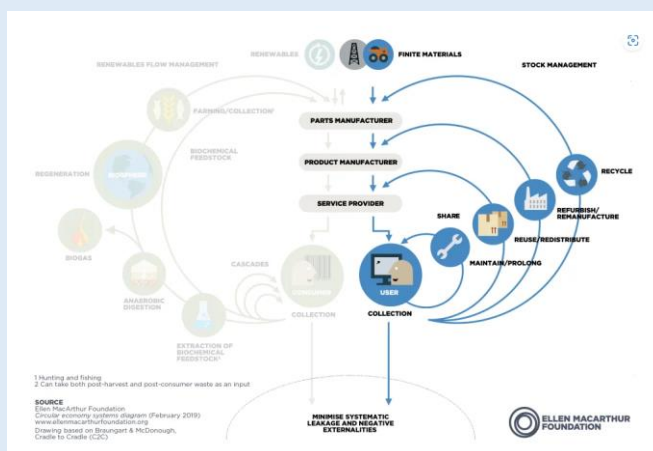


Figure 10 – Circular Economy for manufactured parts [source Ellen MacArthur Foundation]

### 3. Satisfying the user/market needs

Although this topic is discussed in Chapter 1, this chapter looks in more detail at the methods that can be detailed within the design brief about how 'value' has been determined by the products ability to satisfy a market need (the value increases significantly if it is an unmet market need).

The processes for defining, creating and delivering value are shown in Figure 11. In the very simplest of terms, it is about the knowledge and insight that can be acquired and how it is then used to create a competitive edge and stay ahead (Piercy, 2016).

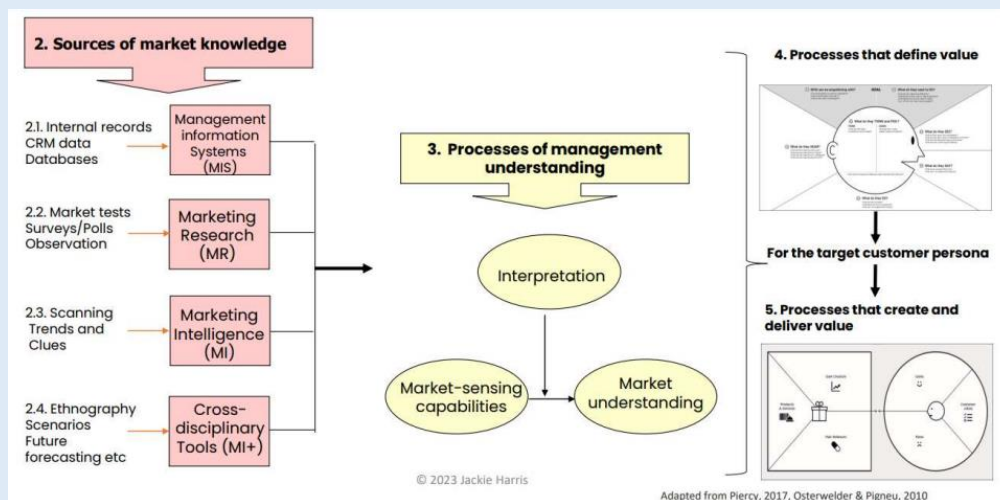


Figure 11 – Defining, creating and delivering value [Source: Jackie Harris]

The sources of market knowledge take an emic (inside) perspective (2.1 and 2.4 in Figure 11) and an etic (outside) perspective (2.2 and 2.3 in Figure 11).

A significant difference between emic and etic perspectives in consumer research is that:

- Emic perspective - the hidden meaning of consumption behaviours is revealed by the observer (what insight can be garnered from current technologies deployed, supply chain strengths and weaknesses, skill gaps, market positioning, competition etc..) (Piercy, 2016).
- Etic perspective – consumption meaning is determined by the observer (how do the medical practice view the need for this device, competing products (technical and price reviews and reputation), potential size of the market, product standards (national and international) etc..) (Piercy, 2016). Examples of tools include parametric analysis, needs analysis and matrix analysis.

These different perspectives must be captured in the design brief with clear interpretations and a descriptive picture of market understanding.

## 4. Other Considerations

The design brief should be a comprehensive document that involves input from many internal and external stakeholders. The 'Total Design' concept (Pugh, 1997) provides a brilliant block flow diagram about what should be included in the design brief – see Figure 12 – as a reference document that helps with the formulation of the NPD specification.

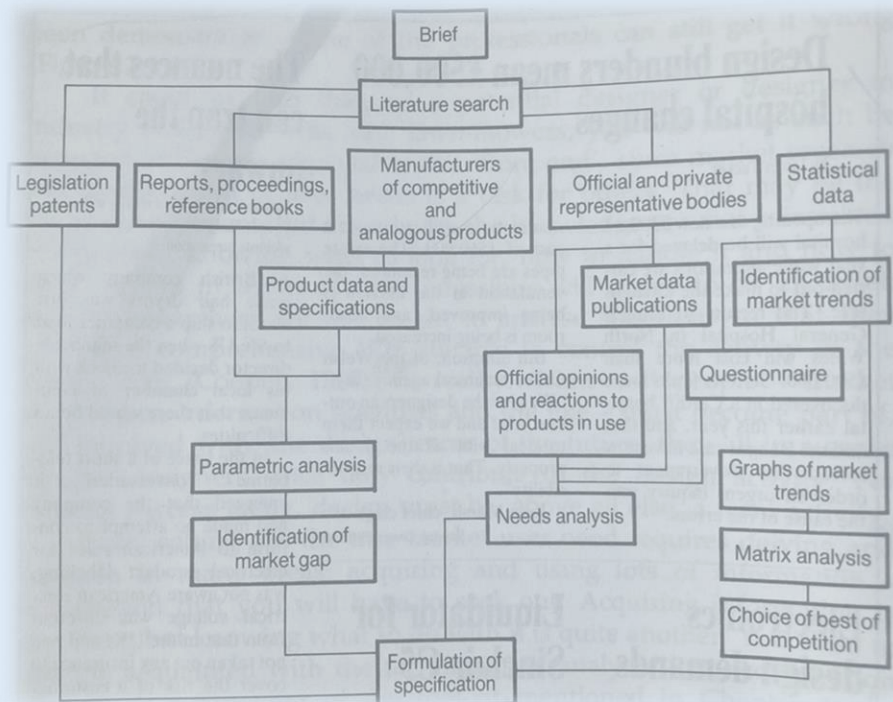


Figure 12 – Design brief for the 'Total Design' concept.

There are other important aspects that should be touched upon in the design brief without duplicating the purpose of the design specification but to support with its development. These are broken down thus:

### 4.1 Product Attributes

#### 4.1.1 Functionality

- How long will a patient need to breath into the apparatus?
- Is the product battery and/or mains operated? If battery, is it re-chargeable or disposable types?
- How will the result of the test be displayed?
- What is the required accuracy of the product?
- Has the medical profession been consulted about the technology used to detect a virus – do they have confidence in the proposal?

#### 4.1.2 Aesthetics

- What are the colour scheme, texture and shape requirements?
- Will consultants be engaged to support this activity or does the business consider that the required expertise lies within.
- What is the type and design of product packaging?

#### 4.1.3 Ergonomics

- How will the device be held?
- What are the different demographics of use – are there different ergonomic requirements across these groups? i.e., for older groups, what is the weight of the product, how long will they need to hold it for before getting a result?
- Can the product be moved, held in the hand and operated within the safe limits for human limbs?

#### 4.1.4 Health & Safety

- Do any of the components have the potential to become toxic – i.e., if set alight.
- If dropped, can the product cause harm to a patient?
- Is a COSHH data sheet required for any componentry?
- How will the device be cleaned after use to prevent virus transfer from one patient to another?

#### 4.1.5 Working Envelope & Mass

- What is the ideal space envelope for the product?
- What is the target mass of the product?

### 4.2 Operational Environment

- Does the product need to be water resistant? If so, what is the required IP rating?
- What are the temperature ranges within which the equipment might be stored?
- Can the product be damaged by prolonged exposure to sunlight, or subzero temperatures?

#### 4.2.1 Applied Forces & Life expectancy.

- What are the forces that will be imposed on the product during intended (and indeed non intended) operation i.e., grip force by operators' hand, shock loads due to impact from dropping the device?
- Are there any parts that may fail due to fatigue or are there any part that might wear prematurely?

#### 4.2.1 Life Expectancy

- How many operating cycles must the equipment be designed for?
- Are there any parts that may fail due to fatigue or are there any part that might wear prematurely?
- What is the 'mean time to failure' criteria for the electronic parts?

#### 4.3 Design for manufacture

##### 4.3.1 Quality

- What are the requirements for part tolerancing so that the assembly process is unhindered?
- For parts that are injection moulded, what are the design requirements to ensure that molds are not unnecessarily expensive?
- How will the product be calibrated? What is the recalibration period?

##### 4.3.2 Technology

- What are the new types of technology that will be considered for the manufacturing of component parts i.e., ALM.
- Will there be a smart element to capturing data from the product, sending it to the cloud and using software to look at data analytics – information that would be most useful to local and national health centres and governments?
- What product assembly technology will be deployed? Will there be an investment in robot assembly and packing.

#### 4.4 Financial Considerations

- What is the NPD budget?
- What are the financial measures telling us ROI, NPV, IRR etc.
- What is the target selling price?
- What is the marketing budget?
- What are the anticipated costs for document translation?

#### 4.5 Standards for Compliance

- Is there a quality standard for medical component manufacture (might not be relevant)?
- Are there any product design standards?
- Does the product require certification by an independent certification authority for this type of device?
- What are the standards for the design of the electronic components?
- What about the Machinery Directive (Is CE Marking a requirement)?

## 4.6 Documentation

- Does a technical file need to be created under the machinery directive requirements?
- What are the outline requirements for the Installation, Operation and Maintenance manuals?
- What are the required languages for documentation?

## 4.7 Risks

- Detailing the typical format of a risk register and identifying some of the risks that need to be considered.
- Typical details of any Failure Mode & Effect Analysis that will be undertaken.

## 4.8 Project Management

- Define whether Waterfall or Agile project management techniques will be employed.
- Define the stage gates with distinct 'go/kill' criteria for the project at each gate.

# 5. Conclusion

A design brief is a comprehensive document that involves input from many internal and external stakeholders. If constructed well, the design brief can guide the users through a process that captures both the creative and analytical needs of any NPD project. The design brief is always a live document that should be continuously referenced by the many different business levels and external contributors / stakeholders. The management of the project should follow a stage gate process that has clear 'kill' criteria should the project not be delivering against forecasts and expectations.

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## 6. References

- 3D printing an alternative to injection moulding. (2021, November 12). Retrieved from 3DPrintUK: [https://www.3dprint-uk.co.uk/3d-printing-an-alternative-to-injection-moulding/?gclid=CjwKCAjwitShBhA6EiwAq3RqA0XAdS2mMLsn7rsNS9uLvCThKMHK5HdNsa4b1K1g2\\_BfLLj7p-zmwXoCi9oQAvD\\_BwE](https://www.3dprint-uk.co.uk/3d-printing-an-alternative-to-injection-moulding/?gclid=CjwKCAjwitShBhA6EiwAq3RqA0XAdS2mMLsn7rsNS9uLvCThKMHK5HdNsa4b1K1g2_BfLLj7p-zmwXoCi9oQAvD_BwE)
- BEIS. (2021). *UK Innovation Strategy 'Leading the future by creating it'*. London: UK GOV.
- Climate Change. (2021, July 28). *What's the difference between 1.5 and 2 degrees of global warming*. Retrieved from World Economic Forum: <https://www.weforum.org/agenda/2021/07/2c-global-warming-difference-explained/>
- Cooper, R. G., & Edgett, S. J. (2003). *Benchmarking best practices performance results and the role of senior management*. Product Development institute.
- Cooper, R. G., Edgett, S. J., & Kleinschmidt, E. J. (2004). Benchmarking best NPD Practices. *Research Technology Management*, 31.
- Essentra. (2020, October). *Essentra Components*. Retrieved from Sustainable Manufacturing : <https://www.essentracomponents.com/en-gb/news/manufacturing/sustainability/sustainable-manufacturing-a-beginner-s-guide>
- HM\_Government. (2017). *Industrial Strategy 'Building a Britain fit for the future'*. London: UK GOV.
- Intergovernmental Panel on Climate Change. (2022). *Climate Change 2022 'Impacts, Adaption and Vulnerability*. IPCC.
- Kavadias, S., & Chao, O. (2007). Resource allocation and new product development portfolio management. In *Handbook of new product development management* (pp. 135-163).
- Killen, C., Hunt, E., & Kleinschmidt. (2008). *Project portfolio management for product innovation*. London: Cambridge Press.
- Loch, C., Kavadias, S., & Si, H. (2023). *Managing Innovation Portfolios: From Project Selection to Portfolio Design*. London: Production and Operations Management.
- Meifort, A. (2016). *Innovation portfolio management*. McMillan.
- Mital, A. (2014). *Product Development - A structured approach to consumer product development, design and manufacture*. Boston: Elsevier.
- Morgan, P., & et al. (2018). *Impact of a five-dimensional framework on R&D productivity at Astra Zenica*. Cambridge: Springer Nature.
- Nadar, E., Debo, L., & et al. (2015). *Optimal Portfolio Strategies for New Product Development*. London: SSRN.
- NASA. (2023). *Earth Observatory*. Retrieved from NASA: <https://earthobservatory.nasa.gov/world-of-change/global-temperatures>
- Piercy, N. (2016). *Market-Led Strategic Change*. R.
- Pugh, S. (1997). *Total Design - Integrated methods for successful product engineering*. Edinburgh: Addison-Wesley.
- Sinfield, J. V., Gustafson, T., & Hindo, B. (2014). *The discipline of creativity*. Boston: MIT.
- UK Government. (2021). *Industrial Decarbonisation Strategy*. London: UK GOV.

PROJECT  
TRAINER SUPPORT ARCHITECT  
CUSTOMER HELP  
TEST WRITER  
VISION PRODUCT DESIGN  
ADVOCATE SALES  
EXECUTION  
STRATEGY  
LEAD EVENT  
MANAGER  
BLOGGER  
SUCCESS  
TESTER  
VALIDATE  
CHEERLEADER  
ITERATE  
MANAGE