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Section 1: Introduction

1.1 Create, deliver, and capture value - Industry 4.0 technologies present many opportunities to change the manufacturing production environment. In a world moving rapidly towards mass customisation, away from traditional mass production, systems need to be more flexible and intelligent (Yi Wang, 2017). Innovation is required in both mindset and methodologies to ensure that a business remains competitive. Innovation can be defined as “the process of creating value from ideas” (Tidd, 2014). A business model describes the rationale of how an organisation intends to create, deliver, and capture value (Ibarra, 2018). A business model underpins value proposition, market segments, structure of value chain, value capture mechanisms and how these elements link together (Weking, 2020) (Appendices 1.1).

1.2 Introduction to Bisley - When it comes to creating work environments, Bisley is the name people turn to for quality they can trust. For over eighty years, the company has been creating innovative products that meet the evolving needs of our working world (Bisley, 2023). The core values of the business are integrity, pioneering, sustainability, creativity, and connected (Appendices 1.2). Bisley is a leading manufacturer, traditionally of steel office storage but more recently diversified to manufacture wood products too. The company has just one manufacturing site – although the company sells and distributes products all over the world including the UK, Ireland, North America, and Dubai, as well as France, Germany, and the Netherlands. There are various sales channels including a dealer and resellers network, sales directly to corporate clients, direct to end users through the Bisley web shop and recently Bisley has launched onto the JohnLewis.com website.

1.3 Business context - Over the past few years, the world has been through unprecedented times. This has impacted the availability of raw materials, increased lead times and resulted in astronomical price increases (Marketline, 2022) (Make UK - The Manufacturers' Organisation, 2022) (Appendices 1.3). There have been various factors which have caused this including the COVID-19 pandemic, Brexit, and the Ukrainian conflict. During these times, the businesses' agility, and ability to react to these external factors are increasingly important – as consumer habits and needs change rapidly. To create, deliver and capture value at maximum efficiency and effectiveness, industry 4.0 technologies need to be embedded in product and process development capabilities. As well as the economic benefits, these practices provide potential opportunities for societal, environmental, and industrial improvement as well.

Section 2: Current Design Practices

2.1 Design for market - One fundamental aspect of industry 4.0 is big data analysis – whilst the concept of data collection to monitor the efficiencies of a manufacturing system is not new – companies are being increasingly adept at using data analysis to monitor changes in their operational landscape. For example, data analysis can be used to understand the full life cycle of their products, identify changes in customer requirements and more closely align supply with demand (Elias Ribeiro da Silva, 2020).

2.2 WSGN platform - Bisley have recently become members of the platform, WSGN, the global authority on change. They use expert trend forecasting combined with data science, to intelligently advise on emerging trends within the sector. It is hoped that Bisley can align themselves with the right trends at the right time to maximize sales and exposure. It will enable Bisley to *create products, experiences, and services* that consumers will want to be a part of in the future (Bisley Communications Team, 2022).

WSGN are the world's leading global forecasters - they identify, verify, and forecast trends across multiple industries. They track the past and extrapolate the data into the future to actively forecast what is coming next. For over twenty years, they have been forecasting trends for hundreds of brands, in the fastest and most unpredictable of industries. They believe that the trends that have resonance and build real momentum are born from many disparate factors coming together.

2.3 Methodology - Their STEPIC methodology is used as a foundation for all trend forecasting and is based on the PEST analysis (political, economic, social, and technological) which is a management method whereby an organization can assess major external factors that influence its operation to become more competitive in the market (Kenton, 2022). As described by the acronym, those four areas are central to this model. WGSN track and unpack the drivers of change in society and technology, and they understand the environmental, economic, and political challenges on a global scale.

The methodology relies heavily on high quality research and data analysis, and particularly understanding all of the global nuances. WGSN is unique because it adds a deep industry context. Experts apply their domain knowledge and insights to ensure the forecasts appreciate industry specific context, history, and dynamics. Culture and creativity can be the most volatile and sensitive inputs to appreciate. Increasing amounts of data; behavioral, social, e-commerce and search allows even more specific trend forecasting (WGSN, 2021).

2.4 Market trends - Three fundamental trends identified are:

1. Designing comfort: our physical surroundings have a direct correlation with the way we feel – this has a direct impact on both our emotional and physical wellbeing (Dickinson, 2022) (Appendices 2.1).
2. Product priorities: home storage solutions: Clever and efficient storage options have become a key priority in the home as a result of living spaces becoming smaller. Versatile solutions that are decorative and adaptable can ensure flexibility in interior layouts (Klabuhn, 2022) (Appendices 2.2).
3. Post-pandemic co-working spaces: Remote workers are looking for an alternative to their home offices, and employers are looking for a low-cost, low-commitment solution to hybrid work. New co-working spaces are adapting and catering to the shifting lifestyle of workers, from inspiring accountability and productivity, to creating a sense of community and inclusivity, to offering exclusive experiences (WGSN Insight Team, 2022) (Appendices 2.3).

2.5 Design for sustainability - The term sustainability can be defined as development that meets the needs of the present, without compromising the ability of future generations (United Nations Brundtland Commission, 1987). We want furniture that lasts a lifetime for our customers; made from the highest quality materials, using the latest innovative technologies and processes with minimum impact on our environment (Costin, 2022).

2.6 Sustainable Development Goals - To ensure that the activities and progression of Bisley are aligned to internationally recognised targets, its sustainability strategy has been created around the requirements of the UN Sustainable Development Goals (SDGs) (Bisley, 2022).



The initial focus is on four of these goals:

1. Climate action – Take urgent action to combat climate change and its impact - A pledge to achieve carbon neutrality by 2030 through reduction activities and accredited offsets.
2. Decent work and economic growth – Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all - To provide stable, fair, and equally paid work to all of our employees.
3. Reduced inequalities – Reduce inequality within and among countries - To promote a culture of inclusion, irrespective of age, sex, disability, race, ethnicity, origin, religion, or economic status.
4. Responsible consumption and production – Ensure sustainable consumption and production patterns - Achievement of zero waste to landfill by 2030 (United Nations, 2015).

2.7 Action on sustainability - Net zero - Bisley are committed to achieving carbon neutrality by 2030 through reduction and offset of emissions of carbon dioxide and other Kyoto gases that are attributed to our activities. Bisley aims to achieve Net Zero emissions by 2050 in line with current UK legislation and targets set forth by the Paris Agreement (UK Government, 2019).

Circular economy and waste management – In the past 12 months, 98% of manufacturing waste was recycled or diverted from landfill. Bisley aims to become zero to landfill by 2030. Nearly 300 bales of cardboard and plastic waste returned to packaging suppliers, and 1000 tonnes of process steel waste reintegrated into steel manufacturing process (Bisley, 2022) (Appendices 2.4).

Manufacturing – 100% of the electricity used in the manufacture of Bisley steel and wood products is derived from renewable sources. Waste elimination in all forms is achieved primarily through lean manufacturing and Training Within Industry (TWI) (Soltero, 2011). There is a strong emphasis placed on “Right First Time” and moving to “Flow”, reducing energy and material waste of remanufacture.

Logistics and supply chain - Much of Bisley’s primary raw materials are manufactured in the UK, as is its packaging, and many internal components. A localised supply chain ensures that we reduce the carbon footprint, while generating economic and social value at a local level. Wood used in manufacturing is FSC™ compliant from sources which support responsible forestry management (Forest Stewardship Council, 2023).

Product and design - The products are manufactured with full life cycle environmental impacts considered, calculated through complex life cycle analysis, from material extraction, through raw material processing, manufacturing processes and each following stage until end of useful life. This process is otherwise known as ‘cradle to grave’ (Huthwaite, 2007). The key design principles in sustainable product development are sustainable material selection, quality and durability, design for re-use, recycling, and end of life plus packaging and transportation.

Section 3: Future Design Practices

3.1 Continuous improvement to innovation - Inherent with any innovation-based activities are uncertainties and technical / business risks. Individuals, teams, and corporate behaviour can both facilitate or stifle innovation. Companies often rely on continuous improvement to make small, incremental changes with regards to producing things better, faster, cheaper and being more agile.

However, this must go beyond the products and services themselves. It is necessary to improve the materials and basic processes intrinsic to them.

Intuitively, there must be a limit to continuous improvements – whilst small incremental improvements over time lead to substantial improvements, at some point that improvement will slow. Regardless of effort, there is only so much that can be done economically to improve something. Once the limit is reached, improvement is only achieved by adopting something fundamentally different and innovative (Appendices 3.1). This is called innovation or breakthrough improvement (Nicholas, 2018).

The innovation matrix from (Satell G. , 2017) (Appendices 3.2) refers to four different types of innovation, sustaining, breakthrough, disruptive and basic research – categorized depending on the problem definition and skill domain. (Satell G. , 2021) suggests implementation of the 70/20/10% rule whereby the majority of the focus is on investment into the core business. The remaining innovation capacity involves exploration into adjacent markets and capabilities.

3.2 Business model innovation - According to (Muller, 2018), business model innovation represents the designed, novel, and non-trivial changes to key elements of a business' model and the architecture linking these elements together. To create new value propositions, innovation needs to consider both technical and managerial elements simultaneously. Managerial elements may include cyber physical systems, sustainable development, outsourcing and value chains. Whereas technical elements include for example, IoT, machine learning, services, and modularity. The business model reflects the implementation of the strategy in terms of economic effects. Current and future revenues are generated by products offered and a competitive approach to market. This results in revenue stream, return on investment, combination of profit and appropriate cost structure (Grabowska, 2022).

The business model canvas is a shared language for describing, visualizing, assessing and challenging business models. (Osterwalder, 2010) suggests that the nine building blocks are:

1. Customer segments: An organization serves one or several customer segments
2. Value propositions: It seeks to solve customer problems and satisfy customer needs with value propositions.
3. Channels: Value propositions are delivered to customers through communication, distribution, and sales channels.
4. Customer relationships: These are established and maintained with each customer segment.
5. Revenue streams: Result from value propositions successfully offered to customers.
6. Key resources: The assets required to offer and deliver the previously described elements....
7. Key activities: ...by performing a number of key activities.
8. Key partnerships: Some activities are outsourced, and some resources are acquired outside the enterprise.
9. Cost structure: The business model elements result in the cost structure.

3.3 Potential of industry 4.0 - Industry 4.0 technologies aim to provide businesses with the ability to create production networking through digitalised connectivity between suppliers and customers across the complete value chain. Three key elements to this are high grade digitalisation, smart manufacturing through cyber-physical systems and inter-connectivity.

High grade digitalisation has the potential to totally transform eco-systems and value chains within manufacturing companies. An eco-system is a web of mutually beneficial relationships brokered by a digital platform that enhances economic value for all (Deloitte, 2021). This changes how companies

interact across firm boundaries upstream and downstream. Improvements can be made with regards to supplier and customer interactions, enhancing data acquisition.

Smartness is the ability to communicate and co-operate in real-time (Weking, 2020). It refers to autonomous decision making based on information obtained. Cyber-physical systems are composed of physical hardware, software, and human intervention. Each of these elements are integrated closely and networked to deliver some global behaviour.

Interoperability is the ability to communicate, share digital assets and data (Grabowska, 2022). It refers to working together more effectively within a range of operational technologies. An ambidextrous approach is needed to optimise the existing core market to ensure they are being served efficiently, whilst also developing a digital vision that focuses specifically on the needs of a new market segment (Kohtamaki, 2020).

3.4 Design for industry 4.0 business model –

3.4.1 - Product service systems (servitization) - can be described as a transition where a company moves from providing stand-alone products and add-on services, to maintenance contracts and finally to an outcome, solution, or platform-based offering (Kohtamaki, 2020). The value proposition from the company is the function of the product, not the product itself. This changes not only the value proposition to the customer, but also the revenue stream and cost structure of the business. The purpose is to serve the real needs of the customer, who do not necessarily want or need to own products but benefit from using them. Economically, this is beneficial for the business as revenue stream is more consistent. This would give investors and other stakeholders confidence in the business. Additionally, this approach could help address environmental issues; it reduces the demand on raw material and energy consumption needed for manufacturing. In addition to this, consumers have an alternative option to the conventional take, make, waste – linear economy.

3.4.2 - Networked eco-systems (expertization) – this type of business model utilises big data, IoT and artificial intelligence to share information and data through a trusted networked eco-system. It allows businesses to be more transparent with all stakeholders in the value chain (Ibarra, 2018). Key activities which may be outside of the expertise of the company can be outsourced, and key partnerships can be formed to serve customer needs. Companies with complementary capabilities can use the expertise of others to monetize value from new market segments outside of their own capabilities and experience. As globalization increases competition worldwide, it is important for local companies to support each other. Optimization of the value chain can benefit in terms of economies of scale and can provide opportunities for companies to reach new customer segments through new channels. Essentially, companies use their internally built expertise in products or processes, and make more of it, and offers it as a new consulting service or a new platform-based product. SMEs in particular can benefit from joining such networks.

3.4.3 – Customer driven (integration) – In this type of business model, new product development is driven by crowdsourcing or an open innovation strategy. A community of potential or existing customers present ideas directly to the company. Enabling industry 4.0 technologies like additive manufacturing, digital twins and AI allow quick production and on-demand feedback from customers (Platform Industrie 4.0, 2019). Iterations can be made before time and money is wasted developing over-engineered solutions, that do not add customer perceived value. In the wider manufacturing context, this approach can help to encourage companies to innovative with frugality, as they truly understand what is important to the customer. It has environmental benefits too, if a local company is able to serve its community's needs, the carbon footprint through reduction in transportation and delivery.

Section 4: Conclusion

3.1 Summary of findings – The manufacturing production environment is continuously evolving and therefore both the methodology and mindset towards production operations need to keep pace. Creating value for the customer must be at the forefront of designing both product and processes. Bisley is a well-established business but understands that this does not exclude it from the pressing global challenges of today's market. The current design practices demonstrate its willingness to implement change. There is an understanding of necessity to take some business / technical risks in order to drive improvement for the future. The company is using data analysis in order to explore new market segments through non-traditional channels. This has the potential to not only increase revenue for the business, but also looks to align its supply with customer demand – ensuring minimised waste through over-production and over-processing. Three key market trends have been identified: designing comfort, product priorities and post-pandemic co-working spaces. This ensures that product development resources can be utilised effectively to focus on a clear vision. Likewise, the company has recognised its responsibility to ensure sustainable development for the future. Considerations are being made towards climate action, decent work, and economic growth, reducing inequalities and responsible consumption and production.

Nevertheless, future design practices should look further than continuous improvement to innovation. In order to retain competitive advantage within the industry, the company needs to manufacture better, faster, cheaper and with more agility. The batch size of 1 is a very real opportunity for manufacturers, but this needs to be achieved with efficiency and effectiveness to be sustainable. Innovation is creating value from ideas, but in order to be innovative you need to do something fundamentally different. It is suggested that the 70%, 20%, 10% rule is implemented, as this ensures that the majority of the focus is invested on the core business. Whilst the remaining capacity involves exploration into adjacent markets and capabilities. In addition to product innovation, and exploration of new market segments and channels, there are opportunities to implement industry 4.0 business models for servitization and expertization.

Financial opportunities are often the highest priority for stakeholders of the business. Of course, this is understandable because the profitability, liquidity, efficiency, and leverage of the business are important. Resources need to be available to pursue innovation, and commitment and clear communication is critical to unify the company towards a common vision. Industry 4.0 business models can develop more consistent revenue streams, via service-based models and increase revenue by using open innovation strategies. In addition to this, there are opportunities to provide environmental benefits by enhancing local networked eco-systems to outsource expertise and improve the carbon footprint by reducing transportation. Integration can ensure that innovation is frugal, and solutions are not over-engineered with limited added value for customers. Alternative value propositions can provide a solution to the current take, make, waste – linear economy.

In conclusion, it is recommended that the company uses the business model canvas (Osterwalder, 2010) to visualise, assess and challenge the current business model. Key stakeholders from various departments within the business should consider opportunities to innovate the business model with respect to industry 4.0. The paper has demonstrated that there are various opportunities to realise financial, environmental, societal and industry benefits.

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5.2 List of appendices –

Components of business models.

Foss and Saebi (2017), Saebi et al. (2017)	Teece (2010)	Osterwalder and Pigneur (2010)	Gassmann et al. (2014)
Market segments	Customers	Customer segments	Who is the target customer?
Value proposition	Value	Value proposition	What does the customer value?
Structure of the value chain	Value creation, Value delivery	Key partners, Key activities, Key resources, Customer relationships, Channels	How is the value proposition built and distributed?
Value capture mechanisms	Value capture mechanisms	Revenue streams, Cost structure	Why is the BM financially viable?

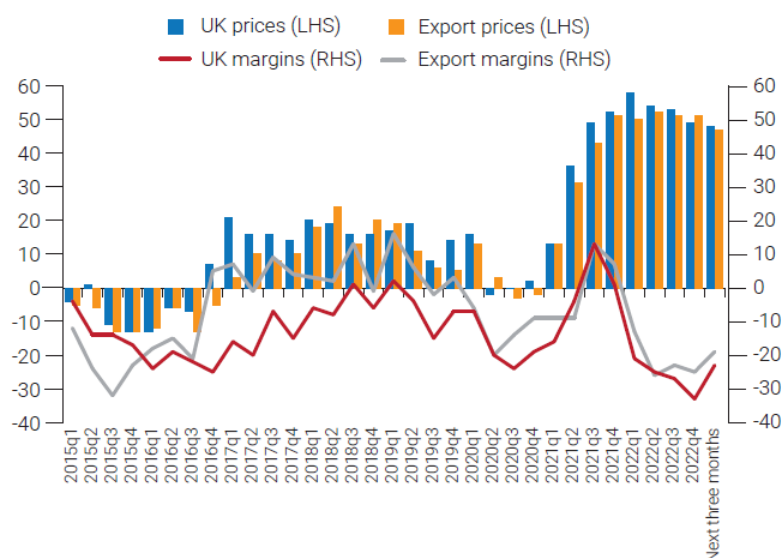
Appendices 1.1 - (Weking, 2020)

Bisley core values	What is means
Integrity	We do not sacrifice our long-term reputation for short-term gain.
Pioneering	We will continually seek to improve our products and designs to ensure we lead the market.
Sustainability	We will continue to act responsibly concerning our environmental impact and care of our employees.
Creativity	Our agility means that we can respond creatively to challenges in the internal and external environment without losing momentum or vision.
Connected	Our brand relies on the loyalty and connection that we have with our customers, our suppliers and importantly, one another.

Appendices 1.2 - (Bisley, 2022)

Prices growth remains historically high but hints at a pace reduction

% balance of change



Appendices 1.3 - (Make UK - The Manufacturers' Organisation, 2022)

Designing Comfort: Key theme	Meaning
The new soft	Surrounding ourselves with softness – from both visual and tactile perspective – is a powerful emotive way to counterbalance the difficult and uncertain times we are living in.
The resurgence of feng shui	The ancient Chinese practice of feng shui, which was popularized in the Western world in the 1990s, is experiencing another revival.
Comfort as a feeling	Comforting design features, spatial illusions and sensorial layering can create a sense of grounding or feel like a warm embrace.
Counterintuitive comfort	Counterintuitive concepts include configurations that encourage the user to be more active, and cluster-positive trends which eschew conventional notions of comfort.
Comfort everywhere	Consumers expect comfort everywhere they go; in increasingly mobile lifestyles as well as the online spaces they inhabit as they spend more time in the metaverse.

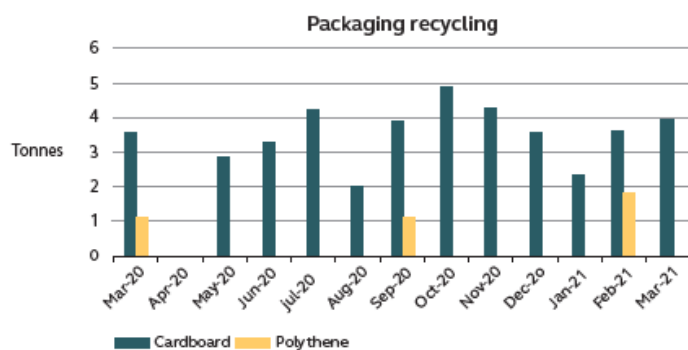
Appendices 2.1 - (Dickinson, 2022)

Product Priorities: Key theme	Meaning
Flexible and versatile	Control interior spaces and their layouts with adaptable product installations
Multifunctional measures	Support everyday practicality with furniture and accessories that tackle more than one need
Space-saving	Small living spaces call for uncomplicated yet well-designed optimization opportunities
Small and clever	Small-sized appliances and utensils simplify consumers' daily actions
Stacked solutions	Explore the additional dimension of height with several cases or boxes arranged on top of each other
Hide and seek	Declutter spaces with camouflaged storage facilities
On display	Use displays to stow and arrange contents in an appealing way
Soft storage	Textile shells and flexible material containers bring softness to interiors
Personalized and customized	Allow for consumers to customize their storage, supporting them in curating their interiors
Luxury-look	Sophisticated materials and finishes bring a glamorous look to functional products
DIY hacks	Self-made storage installations help use the available space in consumers' homes most efficiently

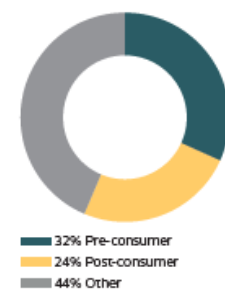
Appendices 2.2 - (Klabuhn, 2022)

Co-working Spaces: Key themes	Meaning
Retail partnerships	As the world embraces hybrid work models and lifestyles become more digital, a symbiotic relationship is emerging between retail and co-working.
Co-working and hospitality	With the growth of digital nomad lifestyles and flexible visas in global destinations from Bali to Barcelona, hospitality brands and co-working companies are coming together to service this work-anywhere cohort.
Fostering inclusive community	The extended amount of time spent in isolation during the pandemic has resulted in a stronger focus on creative and inclusive ways for professional people to interact IRL.
Productivity boosters	According to Statista, the global collaboration software industry will reach \$17.9b by 2025, boosted by the employee need for collaboration. This has created an opportunity for growth in online and IRL platforms promising accountability for workers who struggle with setting work/life boundaries.
Co-working for care-givers	The pandemic and resulting school closures both highlighted and exacerbated the childcare crisis in the US, and new co-working formats are servicing the need for flexible workspaces that double as day-cares.

Appendices 2.3 - (WGSN Insight Team, 2022)



Recycled steel content: 56%



Appendices 2.4 - (Bisley, 2022).

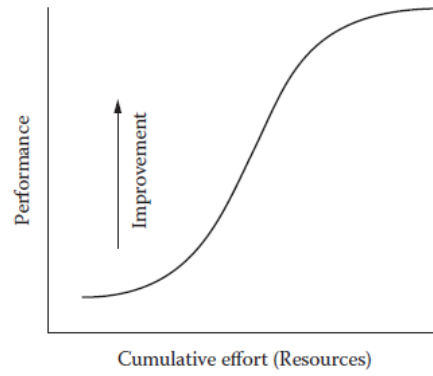


Figure 2.1 The S-curve of incremental improvement.

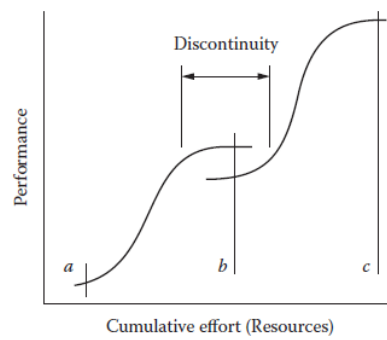


Figure 2.2 Each curve shows incremental improvement; jump from lower curve to higher curve represents innovation improvement.

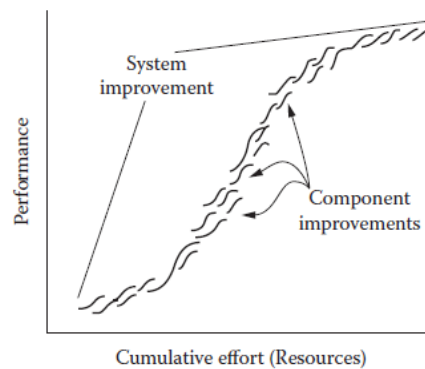
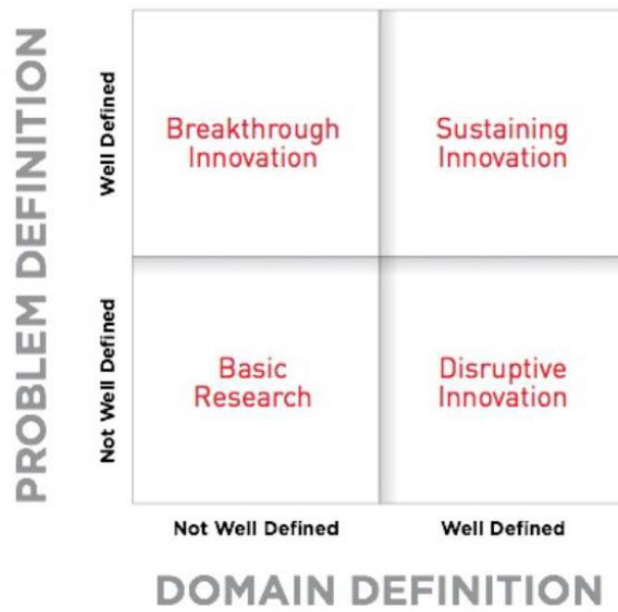


Figure 2.3 System-wide improvement through improvements in components.

Appendices 3.1 - (Nicholas, 2018)

Innovation Matrix



Appendices 3.2 - (Satell G. , 2017)