

Innovation Management
Assessment B – Written Report
Nest Thermostat

Submitted by:

Malvin Gonzales

2127191

Submitted to:

Alan Mumby

University of Wales Trinity Saint David

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1 Introduction

The design of the home thermostat can be traced back to the 1940's when Honeywell's president requested industrial designer Henry Dreyfuss to radically design a new thermostat (Lange, 2011). Dreyfuss went on to propose a circular design (Figure 1) which took more than 10 years to be released in the market due to the internal complications of the radical design (Lange, 2011). As years went by, the design of the thermostat evolved from the radical circular design to the rectangular devices commonly seen in household homes which provided limited features and looked unappealing (The Economist; London, 2013).



Figure 1 Henry Dreyfuss Thermostat Design (Dreyfuss, 1943)

The design of the Nest Learning Thermostat brought some similarities to the design approach of Henry Dreyfuss. Mirroring his early designs, the Nest Learning Thermostat is round, and consists of a brushed stainless-steel case and a circular black face (Lange, 2011). The centre circle is an LED screen which is controlled by turning the control wheel of the device which provides control of the current temperature as well as the ability to increase and decrease the current settings (Figure 2).



Figure 2 Nest Learning Thermostat (Fidell, 2012)

The innovation focus of this report is on the success of the Nest Learning Thermostat which provided an innovative take on the commonly disregarded home device. Disruptive innovation is stated as “a product that changes the basis of competition because it performs worse to traditional parameters, but better against new parameters that previously weren’t regarded as important” (Satell, 2017). The Nest Learning Thermostat’s radical innovation as well as technological innovation enabled the growth of a completely new market that did not previously exist (Kahn, 2018). The report also details the clear disruptive innovation outcome of the Nest Learning Thermostat, as well as how science and technology provided a clear path for the successful development of the device.

2 Nest Learning Thermostat

2.1 The principal drivers for the innovation

The Nest Learning Thermostat was developed with the aim of keeping up with the advancement of technology with the reinvention of the thermostat (Close-Up Media, Inc., 2011). A key driver for the innovation was how billions of thermostats are installed in US homes and only a small percentage of these thermostats are programmed to save energy (Gambino, 2013). The resulting product consisted of combining sensors, algorithms, machine learning, and cloud computing technologies to produce a thermostat which learns from the user's behaviours, as well as the environment of the home (Close-Up Media, Inc., 2011). It also enables the user to create scheduled heating and cooling intervals which enables better energy conservation when the home is empty (Close-Up Media, Inc., 2011).

Another driver for the innovation was the emergence of IoT 'Internet of Things' which during the development of the Nest Learning Thermostat was a key emerging technological innovation. The smart home category was a sector of IoT which the Nest Thermostat helped pave the way in advancing. This category of smart home devices has become one of the fastest growing consumer electronic categories, as illustrated in Figure 3 there is an evident increase in smart home devices shipped worldwide in 2020 and 2021 with 4.5 million Thermostat devices being sold (Statista Research Department, 2022). The Nest Learning Thermostat cemented itself as one of the key products that have adopted the IoT technology through its innovative solution which provided human to device interaction via the internet, allowing the product to be connected and used by the user without needing to be in close proximity to the device (Rao, 2019).

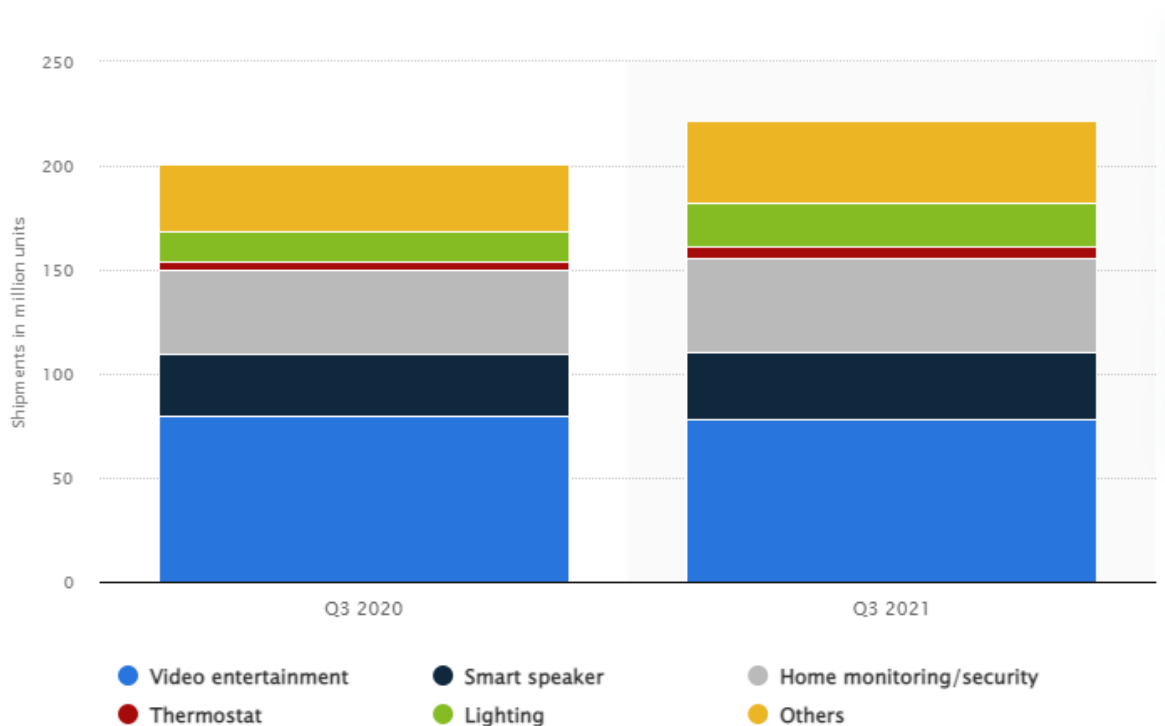


Figure 3 Smart home device shipments worldwide 2020 and 2021 (Statista 2022)

2.2 The barriers and risks faced by the company in developing the innovation

Tony Fidell and Matt Rogers, founders of Nest Lab needed to ensure that their vision for the product was clearly defined. A barrier encountered by Nest Labs during the development of the Nest Learning Thermostat was ensuring that the company and its team of engineers and designers had a shared vision of reinventing and redesigning the thermostat. Additionally, another barrier faced by Nest Lab was understanding that the market was accepting of such a premium and advanced thermostat device (The Economist; London, 2013). However, new-to-the-world products such as the Nest Learning Thermostat enables for the growth of new markets that previously did not exist (Kahn, 2018) i.e. the smart home device market.

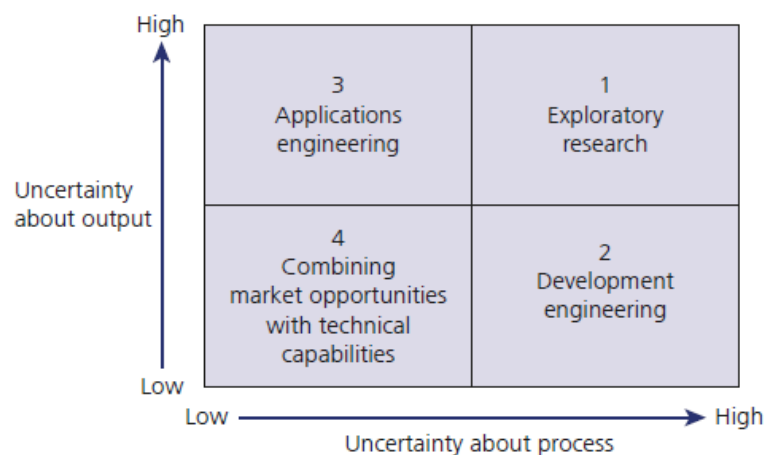


Figure 4 Pearson's Uncertainty Map (Trott, 2021)

Considering Pearson's uncertainty map when reviewing the uncertainties that were faced by Nest Labs during the development of the Nest Learning Thermostat (Trott, 2021), their approach was to combine market opportunities with their current technical knowledge and technological advancements. This in turn provided low uncertainty outputs and processes during the development phase of the product. Additionally, their approach in the development of applications engineering, as well as exploratory research within current capabilities of sensors and components provided high uncertainty consideration due to the need to further understand current technologies as well as having the right resources which can prove that such components could work simultaneously to provide the required performance from the device.

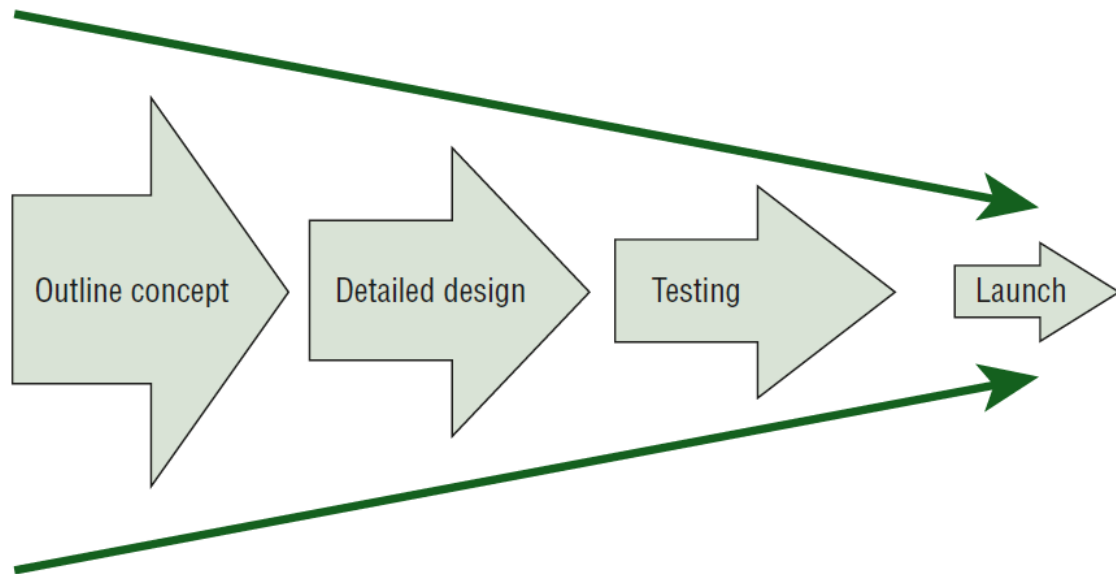


Figure 5 The Innovation Funnel (Tidd & Bessant, 2009)

The team at Nest Labs did not just decide to commit to the initial idea for the development of a smart thermostat - instead, the process was considered carefully and can be linked to the Innovation Funnel (Figure 5). Nest Labs's aim of reinventing the thermostat required concise decision making at each stage of the funnel prior to moving on to the next steps (Tidd & Bessant, 2009). Commitment to resources during the product development process provides difficulty in diverting to different directions, which provides risks to the project on further understanding its acceptance and success when launched to the market.

2.3 The key determinants in the process of committing to develop the innovation

Designing a product integrating human to machine interaction as well as a system that learns from the inputs of the users was a key requirement that Nest Labs has set as an integral feature for the Nest Learning Thermostat. Although the concept of reinventing the thermostat was largely clearly defined, and both Tony Fidell and Matt Rogers, founders of Nest Lab, already had the expertise in developing such product design focus concepts, the 'Learning' part of the thermostat required key determinants around the need for an experienced lead capable of integrating interaction human learning and machine learning to drive the device (Pransky, 2014).

Nest Lab brought in Dr. Yoky Matsuoka during the development stage of the product to lead the development of the learning and control technology for the Nest Learning Thermostat (Pransky, 2014). Dr. Matsuoka was a key determinant which provided important input during the development stage of the product innovation. Her expertise ensured that the product was able to provide the required machine learning capabilities that enabled the device to understand commonalities in the way the user has interacted with the device. She also ensured that the user and the device can work in cohesion to empower users to become more energy efficient when using the Nest Learning Thermostat (Pransky, 2014).

2.4 The process and technologies the company used to carry the development forward

Nest Labs focused their technological approach on the Nest Learning Thermostat to ensure intractability using the IoT approach and thus developing a smart device that could be controlled without the need for the user to be close to the device. Since IoT was an internet centric / driven principle, Nest Labs ensured that a strong understanding of the key sensors, connectivity, data processing, and user interface requirements were well considered as part of the development of the device. Utilising sensors to gather key datasets as well as learning from the environment, combined with well-developed software which can break down distinctive information led to an effective system that has enabled key automations within household homes (Rao, 2019).



Figure 6 Nest Thermostat Features Introduce Over the Years (roboauthority, 2015)

Existing thermostats have relied on users to manually set their desired temperatures within their homes (Crawford & Johnson, 2021). Nest Learning Thermostat on the other hand, programs itself by learning behavioural patterns as well as gathering data from previously set temperatures by taking into account the days and time within a week (Crawford & Johnson, 2021). The integration of IoT as well as the combination of hardware tucked inside the device propelled the development of the product forward, attracting household owners to consider the device. It has also made household owners aware of how much energy savings they could make by ensuring that their home thermostat was controlled depending on their presence at home. The Nest Learning Thermostat has evolved its key features from its initial product release in October of 2011 (Figure 6), such updates within the device features were all aimed at giving the user a good understanding of their energy saving analytics and giving them the peace of mind that the device is working autonomously as intended from its initial development and design.

The outcome of combining all the key components and technologies is what enables the Nest Learning Thermostat to transform a home into a smart home environment and follows the principle that smart devices are complex and transform how people live their day to day lives (Twiste, 2022). Smart devices such as the Nest Learning Thermostat allow systems to communicate with each other and allow for control using smart phones making life easier and convenient (Twiste, 2022).

2.5 The extent to which the development relied on resources external to the company and the ways in which the deployment of these resources was managed

Although designed and developed in Silicon Valley, Nest Labs relied on external collaboration with manufacturers in China for the fabrication of the Nest Labs. Collaboration arrangements such as the process taken by Nest Labs are driven by technology-based objectives i.e. reliance for the manufacturer to identify suitable integration advance sensors and components (Schilling, 2017). Such innovations such as smart home devices all fall within the technological innovation sector. (Bessant & Tidd, 2011) details that the import of foreign technology can provide positive impacts on innovation, with such influences also leading to the enhancement of innovation capabilities. This goes on to drive the understanding of how the device is to be manufactured, highlighting DFM or 'design for manufacture' at the earliest stage of the process.

The Nest Learning Thermostat's internal components such as Wi-Fi interface, internal batteries, USB ports, internal storage, and memory as well as its external casing and housing can all be traced back to their manufacturers in China. Since Nest Labs founder Tony Fidell's experience working at Apple, his knowledge and expertise in ensuring collaboration agreements with key sensor and circuit board manufacturers are well established (Schilling, 2017). This insight also ensured that specific manufacturers with close ties with Apple were considered to ensure that the Nest Learning Thermostat is as close to the technological advancement of the Apple iPhone as possible.

In 2019, Google, who purchased Nest Labs in 2014, took a proactive measure with moving the fabrication of the Nest Learning Thermostat from China to Taiwan (Li, 2019), in a bid to counter the potential impacts of the trade wars with the U.S. and China (Li, 2019). The repercussions of shifting geographical manufacturers meant that prices of such devices have increased (Ricker, 2019) but despite the increase in costs, Google has already established themselves in Taiwan during their acquisition of HTC in 2017, giving them the presence required to ensure high quality production capabilities.

2.6 How management overview of the development was maintained

(Kahn, 2018) defined that product innovation pertains to market offerings which range from incremental to radical innovations. Nest Labs has ensured a clear focus on the product entries they introduced in the market which paved the way to the trend of smart home devices as a means to make people's lives easier. This philosophy introduced by the company has evolved to ensure that any product development considered was fitting to their long-term goal of "Connecting Everything at Home to the Internet" (Kovach, 2014). With this in mind, they were able to ensure clear management of the development of the Nest Learning Thermostat, but also a clear goal in new product development projects they plan to introduce in the future.

What was evident with the successful management on the development of the Nest Learning Thermostat was that they were able to make a home appliance which was previously disregarded, to have an appeal as well as urging the user to have the need to interact with the device. This was also a foundation for Nest Labs to build on as the second product they released in the market, the Nest Protect Smoke and Carbon Monoxide (CO) Alarm, took the same innovation approach with the Nest Learning Thermostat during its development.

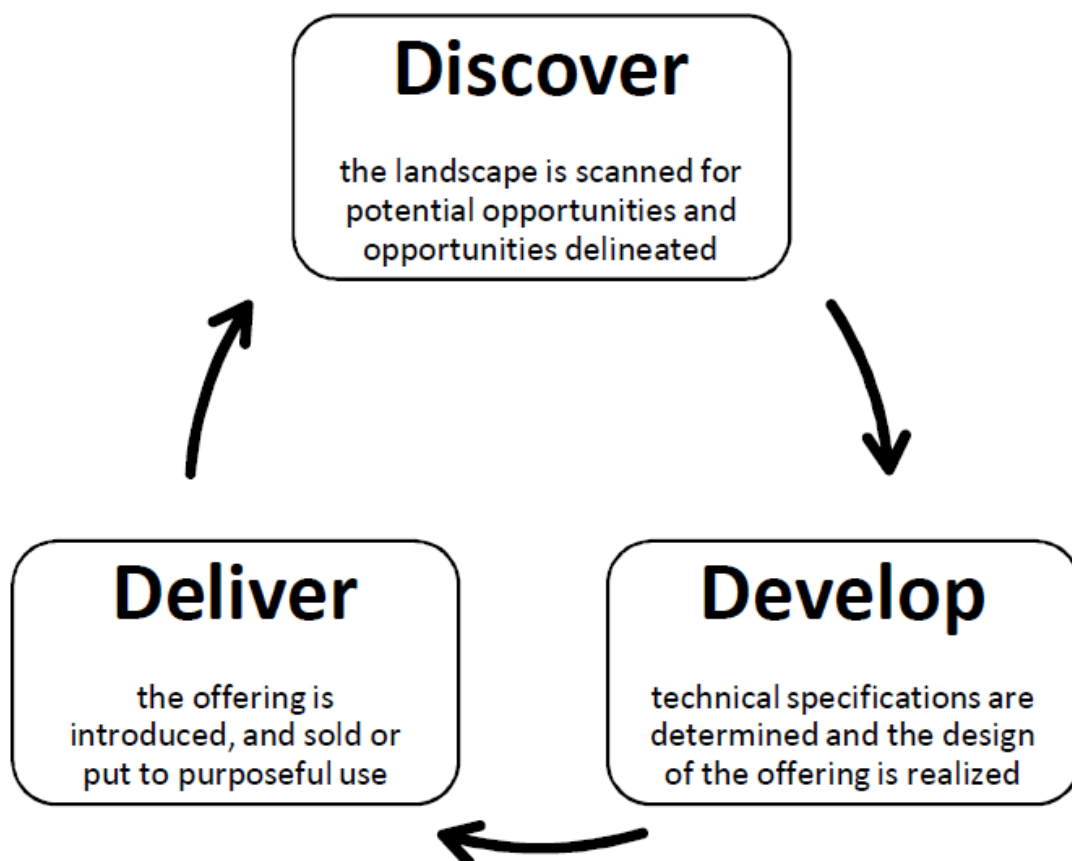


Figure 7 The Innovation Cycle (Khan, 2018)

Another point of consideration is Nest Lab's approach to innovation as a process which clearly considers the innovation cycle (Figure 7) and can be broken down into three phases:

- **Discovery** phase was conducted to identify potential opportunities in regards to the commonly neglected home devices which has the potential to be developed for the smart home device market (i.e. thermostat, smoke detectors, and door bells) as well as market opportunities that can either be new product categories or new-to-the-world products (Kahn, 2018).
- **Develop** phase was where technical requirements and specifications are defined on what is needed to make the device function as intended. This is also a phase to which external collaborators are brought into the process to support new technologies which can be considered as part of the device in development (Kahn, 2018).
- **Deliver** phase can be interpreted in two ways. First, is how Nest Labs was able to deliver a solution / improvement to a common home device which considers new technologies and pushes new ways of interacting with such devices. Second is how the device was delivered to the market and how it was executed to attract consumers and encourage them to become accepting of such a radical approach in the design and development of the product.

2.7 The extent to which you feel this innovation process represents best practice

Considering the effective approach of best practices of innovation management during the development of the Nest Learning Thermostat, it is clear that Nest Labs has been able to follow and consider such best practices of managing innovation leading to the success of their products. Figure 8 illustrates how Nest Labs' process fits within 'the cyclic model of innovation with interconnected cycle' 'CIM' as the process is an approach which considers multidisciplinary approaches – a major factor in the development of the Nest Learning Thermostat (Trott, 2021).

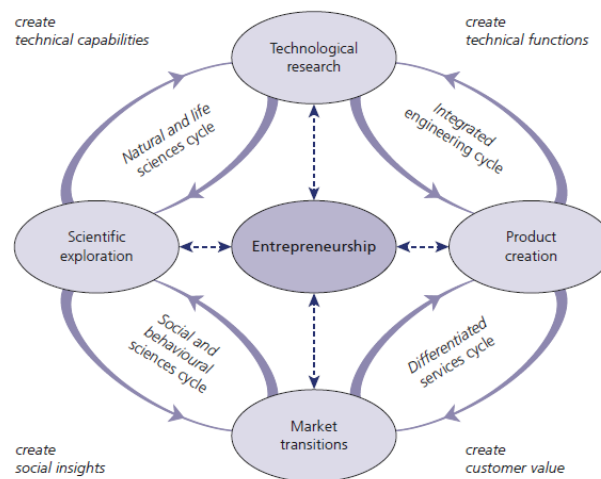


Figure 8 The Cyclic Model of Innovation with Interconnected Cycle (Trott, 2021)

Applying the principle of the CIM to the Nest Learning Thermostat, the idea can be linked to entrepreneurship since thermostat devices prior to the Nest Learning Thermostat were all manually controlled and commonly disregarded. The idea then moved through both scientific exploration and technological research which are both multidisciplinary activities of the CIM (Berkhout & Duin, 2007). A scientific exploration activity by Nest can also be linked to the employment of Dr Yoku Matsuoka as mentioned in section 2.3 which provided expertise in necrobiotic and the knowledge required within mechanics and informatics to drive optimal product performance (Pransky, 2014).

With the aim of Nest Labs of "Connecting Everything at Home to the Internet" as mentioned in section 2.6, technological research was another activity that focused on understanding different technological areas to provide superior solutions, advanced performance and unique features while considering efficient manufacturing methods. With both the scientific and technological research activities being the focus of the innovation model approached by Nest, alongside this, the existing design and manufacturing knowledge of the team, both product development and market transitions were activities that did not particularly have a lot of resources put on to them as the main bulk of the innovation is traced more on the scientific and technological activities of the CIM.

Furthermore, innovation can start anywhere and anytime, but when followed using the CIM, each activity is able to influence each other in a cyclical manner which provides a thorough research and development process. This goes on to give rise to a breakthrough product showcasing disruptive innovation, and in turn, disruption in the market.

3 Success of Nest Learning Thermostat

The success of the Nest Learning Thermostat has enabled Nest as a company to further expand their product portfolio as well as establishing themselves as a major company within the smart home device market. Google in January of 2014 bought Nest Labs for \$3.2 billion (James, 2014) and the acquisition was part of Google's strategy to break into the growing smart home devices business which helped Nest Labs establish (James, 2014). The acquisition of Nest Labs by Google has also enabled other new technologies to be acquired by Nest Labs to further sustain their innovation within the Nest Learning Thermostat, as well as acquiring other companies with innovative technologies to further grow Nest's smart home device portfolio. Such successful acquisition provided a new opportunity to develop products for home security and therefore further disrupting new markets (Crunchbase, 2022).

The success of Nest Learning Thermostat as an innovation can be associated with the aims of Google in terms of how to ensure the same innovation management process followed by Nest Labs prior to their acquisition of the company. (Tidd & Bessant, 2009) remarks that a company with focused strategic goals, capabilities of supporting technological developments, and clear project management processes which is well supported by its senior management has a better chance of success with innovation management.

An example of such a scale might be:

- 1 = Innovation not even thought about, rarely happens.
- 2 = Some awareness but random and occasional responses, informal systems.
- 3 = Awareness and formal systems in place – but could still be improved.
- 4 = Highly developed and effective systems including provision for improvement and development.

Figure 9 Measurement of Innovation: Innovation Scale Example (Tidd & Bessant, 2009)

The innovation of the Nest Learning Thermostat can be graded using the scale cited by (Tidd & Bessant, 2009) (Figure 9). When measuring the success of the Nest Learning Thermostat as a whole, a scale of 3 can be graded to the innovation approaches undertaken as part of the development of the device. Nest Labs success can be attributed to their effective innovation management considerations. Through their processes, factors such as understanding new technologies to disrupt new markets, they were able to acquire the required awareness for the successful implementation and integration of such technologies. They also managed to implement such formal innovation processes which provided significant knowledge which can be accounted for when developing new products. Their effective management for innovation can be seen when reference the use of the CIM processes as the cyclical processes of the CIM enables for different innovations to sprout at different stages, directly feeding into the growth of a new solutions, consideration for new technologies which leads to an innovative product to materialise and disrupt new markets (Tidd & Bessant, 2009).

4 References

Berkhout, A. & Duin, P. A. v. d., 2007. New ways of innovation: an application of the cyclic innovation model to the mobile telecom industry. *Int. J. Technology Management*, 40(4), pp. 294-309.

Bessant, J. & Tidd, J., 2011. *Innovation, Globalization and Development*. 3rd ed. Chichester, West Sussex: John Wiley & Sons Ltd..

Close-Up Media, Inc., 2011. *Professional Services Close - Up: Nest Labs Introduces Learning Thermostat*, Jacksonville: Close-Up Media, Inc..

Crawford, S. & Johnson, B., 2021. *How the Nest Learning Thermostat Works*. [Online]
Available at: <https://home.howstuffworks.com/nest-learning-thermostat.htm#pt1>
[Accessed 06 May 2022].

Crunchbase, 2022. *Nest Labs Company Financials*. [Online]
Available at: <https://www.crunchbase.com/organization/nest-labs>
[Accessed 15 May 2022].

Dreyfuss, H., 1943. *FOR ACRATHERM W/CLEAR PLASTIC CAP*. [Art] (Honeywell Inc.).

Fidell, T., 2012. *Nest Learning Thermostats*. [Art] (Nest Labs Inc.).

Gambino, M., 2013. *A Smart, Sleek, Money-Saving Thermostat*. [Online]
Available at: <https://www.smithsonianmag.com/innovation/a-smart-sleek-money-saving-thermostat-3060849/>
[Accessed 03 May 2022].

James, O., 2014. *Google buys Nest Labs for \$3.2 billion*. [Online]
Available at: <https://money.cnn.com/2014/01/13/technology/google-nest/index.html>
[Accessed 15 May 2022].

Kahn, K. B., 2018. Understanding Innovation. *Business Horizon*, Volume 61, pp. 453-460.

Kovach, S., 2014. *Ex-Apple Employee Tony Fadell Explains Why He Sold His Company To Google For \$3.2 Billion*. [Online]
Available at: <https://www.businessinsider.com/tony-fadell-explains-why-nest-sold-to-google-2014-1?r=US&IR=T>
[Accessed 10 May 2022].

Lange, A., 2011. *Reinventing the Thermostat*. [Online]
Available at: <https://designobserver.com/feature/reinventing-the-thermostat/31838>
[Accessed 15 May 2022].

Li, A., 2019. *Google shifting Nest, other hardware manufacturing out of China*. [Online]
Available at: <https://9to5google.com/2019/06/11/google-shift-nest-china/>
[Accessed 09 May 2022].

Pransky, J., 2014. The Pransky Interview: Dr Yoky Matsuoka, Vice President Technology, Nest Labs. *Industrial Robot*, 41(6), pp. 481-486.

Rao, V. B., 2019. *Internet of Things*, Ames, Iowa: Iowa State University.

Ricker, T., 2019. *Google is moving US-bound Nest production out of China, reports Bloomberg*. [Online]

Available at: <https://www.theverge.com/2019/6/12/18662448/nest-manufacturing-leaves-china-trade-war>
[Accessed 09 May 2022].

roboauthority, 2015. *How Nest Thermostat Work*. [Online]
Available at: <https://www.roboauthority.com/how-nest-learning-thermostat-work/>
[Accessed 06 May 2022].

Satell, G., 2017. *Mapping Innovation A Plabook for Navigating a Disruptive Age*. New York: McGraw-Hill Education.

Schilling, M. A., 2017. *Strategic Management of Technological Innovation*. 5th ed. New York: McGraw-Hill Education.

Statista Research Department, 2022. *Smart home device shipments worldwide in the 3rd quarter of 2020 and the 3rd quarter of 2021 (in millions), by category*. [Online]
Available at: <https://www.statista.com/statistics/822488/smart-home-device-revenue-worldwide-by-category/>
[Accessed 04 May 2022].

The Economist; London, 2013. The podfather, part III. *The Economist*, 406(8826), pp. S.21-S.22.

Tidd, J. & Bessant, J., 2009. *Managing Innovation Integrating Technological, Market and Organizational Change*. 4th ed. Chichester, West Sussex: John Wiley & Sons Ltd..

Trott, P., 2016. *Innovation Management and New Product Development*. Harlow, United Kingdom: Pearson Education Limited.

Trott, P., 2021. *Innovation Management and New Product Development*. 7th ed. Harlow United Kingdom: Pearson Education Limited.

Twiste, L. G., 2022. Smarter products for high-tech homes. *Hardware + Building Supply Dealer*, 48(1), pp. 28-29.