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Intellectual Property Strategy Trajectory: A New Visualisation Approach

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Intellectual Property Strategy Trajectory: A New Visualisation Approach

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Abstract:

Although data visualisation approaches have been extensively discussed in the literature, most visualisation tools are associated with quantitative data and lack the compound ability to collect data. The author's PhD research needs a data collection tool that has the ability to present qualitative data on how and why companies change their intellectual property (IP) strategies and to allow visualisation of the companies' IP strategy trajectories. Hence, in this paper, the authors created a bespoke set of tools, consisting of the IP strategy trajectory framework and the IP strategy trajectory map. With exercising this new approach with the data of a case study, the authors show that the framework offers a clear presentation of the path that a company takes with regards to its IP strategy openness, whereas the map help explain how and why a company change its IP strategy during three key transitions. The paper contributes theoretically by offering a definition for intellectual property strategy trajectory and contributes practically by creating a new visualisation approach which consists of the IP strategy trajectory framework and the IP strategy trajectory map.

Keywords: intellectual property strategy change, intellectual property openness, intellectual property trajectory, data visualisation, roadmapping

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1. Background Introduction

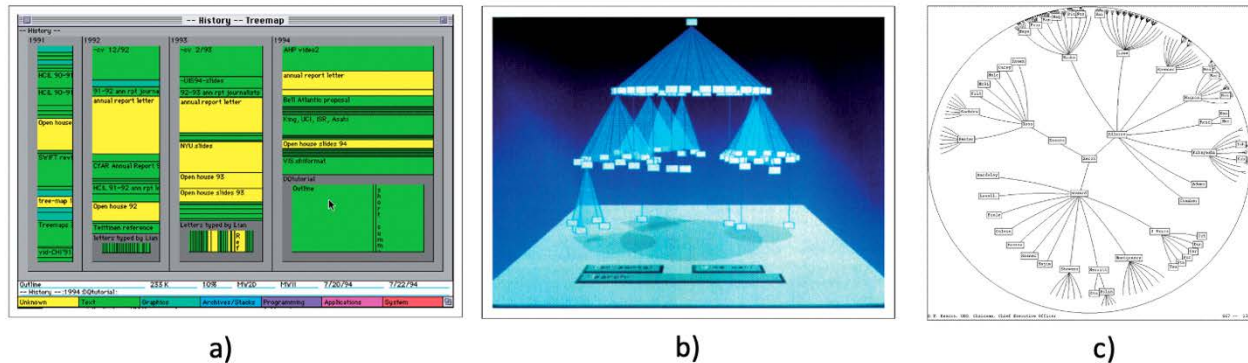
This paper introduces a new visualisation approach which assists the users to track and analyse the intellectual property strategy trajectory of a company. This tool is developed for the author's PhD project, which investigates the impact of intellectual property strategy changes on key transitions of emerging technology companies.

The literature on intellectual property strategy has developed strongly since seminal contributions from the early 2000s (eg Pitkethly 2001, Davis 2004, Gollin 2008)(Pitkethly, 2001)(Davis, 2004)(Gollin, 2008). In more recent years, the roll of intellectual property strategy in open innovation and innovation ecosystem has been discussed in the literature (Wen et al, 2016, Bogers et al, 2011, Holgersson et al, 2018)(Wen, Ceccagnoli and Forman, 2016)(Bogers, Bekkers and Granstrand, 2011)(Holgersson, Granstrand and Bogers, 2018). IP strategy changes during various levels of transitions has been discussed in literature since late 1990s (Ganguli 1998, Smarzynska Javorcik 2004)(Ganguli, 1998)(Smarzynska Javorcik, 2004). That literature has focused a lot on the IP strategy changes during regional transitions (Kochhar 2008, Balsmeier and Delanote 2015, Bayar et al 2020)(Kochhar, 2008)(Balsmeier and Delanote, 2015)(Bayar, Remeikienė and Gasparėnienė, 2020) and sectoral transitions in biotechnology (Daizadeh, 2006)(Daizadeh, 2006), pharmaceutical (Chaves et al, 2007) (Chaves et al., 2007)and healthcare (Dixit, 2018)(Dixit et al., 2018). Synthetic biology is currently one of the most anticipated emerging technology and its IP landscape has been discussed in recent literature (Bera 2015, Minssen et al 2015, Carbonell et al 2016)(Bera, 2015)(Minssen, Rutz and van Zimmeren, 2015)(Carbonell et al., 2016). While various studies investigate IP strategy changes during sectoral transitions (Dixit, 2018) and regional transitions (Bayer et al, 2020), however, very few studies report insights into how and why IP strategy is changed on the firm level for emerging technology fields. Therefore, the author's PhD research aims to investigate the trajectory of emerging technology companies changing their IP strategies during transitions. And the authors' definition for IP strategy trajectory is the representation of the path that the company takes, along with organisational changes, with regards to changing its inbound and outbound IP openness.

In order to answer these questions, a set of data collection and trajectory data visualisation tool is required. This tool should capture the data for answering the key questions, including how IP strategies were changed during transitions; why IP strategy changes were made during transitions; and, most importantly, what the IP strategy trajectory of the company is. Moreover, this tool should also provide clear visualisation of the data set to allow iterations of the tool itself and discussions over the data.

Since early 1980s, a noticeable number of studies have studied and discussed various types of trajectory visualisation processes. With personal computers being popularized, the studies on visualization processed really started to blossom in 1990s (He et al., 2019). Small Project Observatory was proposed to support the analysis of various ecosystems through interactive visualization and exploration (Lungu et al., 2010). Tree maps, proposed by Johnson and Shneiderman (1999), used nested rectangles to represent tree structure. It produces both a space-limiting and a screen-filling algorithm (Figure 1). The different attributes on the tree map determine the size of each leaf rectangle, while the sum of the attribute values of the subtrees determine the size and colour of interior rectangles. Cone

tree models require a three-dimensional layout to display the root node. It forms a cone shape with nodes dropping down in a circular fashion, linking the root node to the next level root nodes (Robertson, Card and Mackinlay, 1993). This process is illustrated in Figure 1. Another model, called the hyperbolic tree browser, improves on the basis of the cone tree model. It retains the node-link visual relations but places the root node in the centre



surrounded by the next-level nodes in an oval shape (Lamping and Rao, 1994), as shown in Figure 1.

Figure 1. Early version of a) tree map (Shneiderman *et al.*, 2012) b) Cone Tree (Robertson, Mackinlay and Card, 1991) and c) Hyperbolic tree browser (Lamping and Rao, 1994)

Apart from the four quantitative methods mentioned above, a few qualitative trajectory visualisation methods existed in literature as well. Purchase, Kum and Olaru (2017) aims to investigate the innovation trajectory of a university spin-off organisation and how it is affected by a series of sequencing events. It uses a flow-chart like model to track and represent the innovation paths of the case company. Another study illustrates the supply chain innovation trajectory by mapping events, value and stakeholder interactions on a visual canvas (Pagano and Neubert, 2015). This map offers a clear history of the path but lacks the macroscopical view of the entire trajectory. Nemanich, Keller and Vera (2007) used a combination of a flowchart and a two-dimensional time chart to illustrate firms' innovation trajectories, shown in Figure 2. The model successfully showcases the relationship between executives' decisions and the company's management architecture in terms of roles, rules and resources. Although this method does not fit perfectly with the needs of the author's PhD study, it offers an inspiration of using a combination of two diagrams to form a balanced visualisation tool.

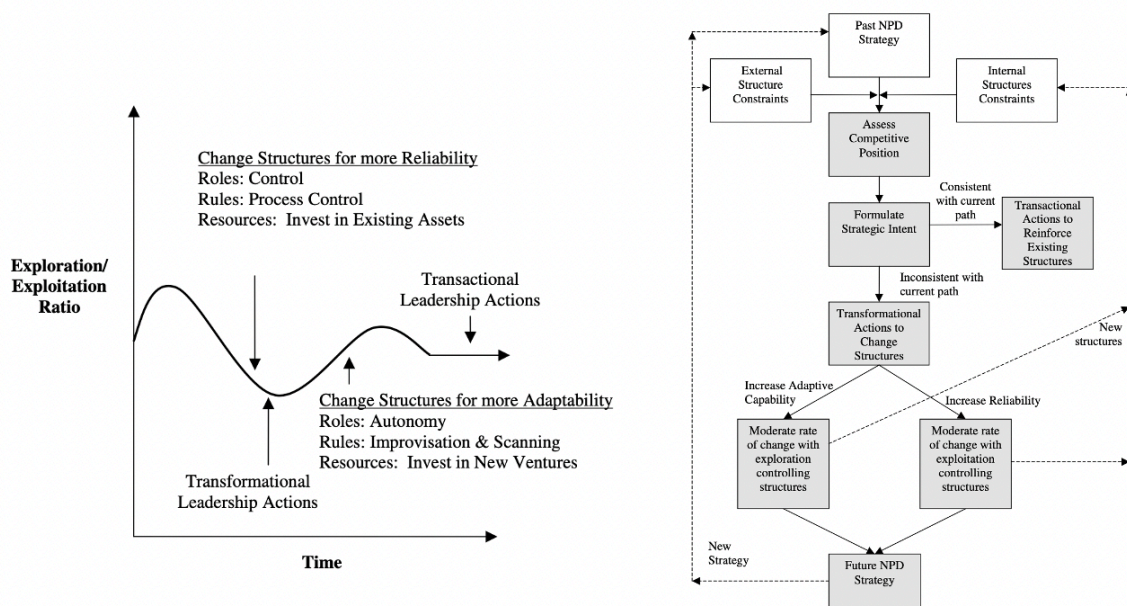


Figure 2. Nemanich, Keller and Vera's (2007) two-part model to demonstrate a company's innovation trajectory

The author's PhD study needs a tool that has the ability to present qualitative data on how and why companies change their IP strategies and to allow visualisation of the companies' IP strategy trajectories. However, none of the visualisation tools or processes proposed in previous literature can provide both of these qualities. Therefore, the authors decided to develop and create a new set of tools to meet the needs of the master research study.

This paper will first explain the methodology behind how this set of tools is developed. Our method was based on an adaptation of the Nominal Group Technique. After a few iterations, we reached the current edition of the tool, which is fully explained and presented in the results section. Finally, this paper is concluded with the directions of how this tool can be used in the future, alongside the practical and theoretical contributions of this paper.

2. Methodology

The authors used an adaptation of the Nominal Group Technique as the basic research methodology to develop the IP strategy change trajectory visualization approach. Additionally, a unique iteration cycle is created for this study as well.

Along with the Delphi survey (Hutchings and Raine, 2006), the Nominal Group Technique (NGT) is one of the most widely used formal consensus development methods (Delbecq, Van de Ven and Gustafson, 1975)(Freeman, 2006). Both seek expert opinions on a given topic and achieve group consensus, however unlike the Delphi methodology, NGT emphasizes scheduled face-to-face sessions. NGT was created in the 1960s as a method to aid effective group decision-making in social psychological research (Van De and Delbecq, 1971), and it has since been used in a variety of disciplines, including education and health. Within a focus group context, NGT provides an organized approach for getting meaningful and trustworthy qualitative input from a group of experts (Van De and Delbecq, 1971). NGT can be utilized in a focus group to elicit replies from all members of the group to planned and structured questions (Jamieson, Griffiths and Jayasuriya, 1998). Some authors suggest that this increases the value of focus groups as information sources by generating data on a specific topic or question and prioritizing problems and issues through group debate (Langford, Schoenfeld and Izzo, 2002). It enables divergent opinions on a shared topic to be presented and compiled with the goal of identifying areas of agreement and setting change priorities (Harvey and Holmes, 2012). Due to the collaborative character of NGT, stakeholders are more likely to take ownership of the resulting research, which raises the likelihood of transforming clinical practice and policy (Vella *et al.*, 2000).

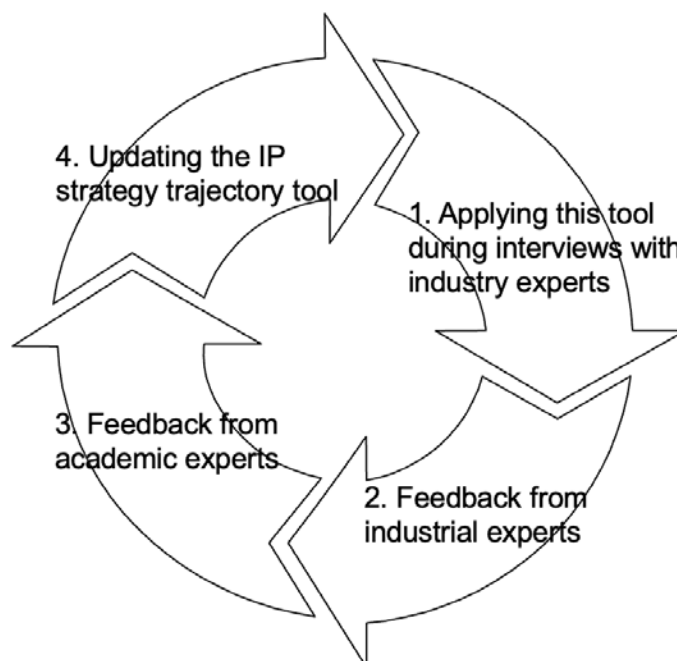


Figure 3. The method cycle for developing the trajectory visualisation tool

For this study, we adapted the NGT method as our basic methodology and created a solution iteration cycle upon on it to suit the need for this study. The cycle is illustrated in

Figure 3. After the first version of the data collection tool is created, it is used in a few pilot case studies. After each interview with industrial experts, feedback on the data collection tool is collected. These expert opinions are then shared with a group of academic experts for further comments. The tool is then updated according to this round of industrial and academic expert feedbacks. After the method is iterated, it is put back to use in interviewees with industrial experts again. This 4-step cycle, based on NGT, provides an effective and time-efficient solution to developing the IP strategy trajectory visualisation tool.

3. The IP Strategy Trajectory Visualisation Tools

In this section, the IP strategy trajectory visualisation tool will be introduced. The tool consists of an IP openness trajectory framework and an IP strategy trajectory map. The framework will be explained first, followed by the details of the IP strategy trajectory map. The procedure and the effectiveness of the tool will be illustrated with the results of one of the case studies of the author's PhD research. The case study company is a UK-based life sciences R&D company that specialises in biopharmaceutical discovery and development with the technology of synthetic biology.

3.1 IP Strategy Openness Trajectory Framework

The first part of the trajectory visualisation tool requires a two-dimensional matrix that tracks how the openness of IP strategy changes. The authors proposed a IP openness conceptual framework in 2019 (Tang, Tietze and Molloy, 2019), the original framework is shown in Figure 4. The horizontal axis ranks five common out-bound IP strategies from closed to open, whereas the vertical axis displays the in-bound IP strategies in the order as indicated. Trade secret is the most closed form of IP because there is no information flowing between the owner and the outside world. Patenting, on its own, is also fairly closed. However, since the patent description is disclosed, at least some level of information is shared. Moreover, collective licensing, such as patent pools, give more individuals and organisations the opportunity to access and share information than exclusive licensing. And open strategies, such as patent pledges, are at the far open end of the spectrum. This framework was used to analyse the openness of IP strategies for a group of synthetic biology companies.

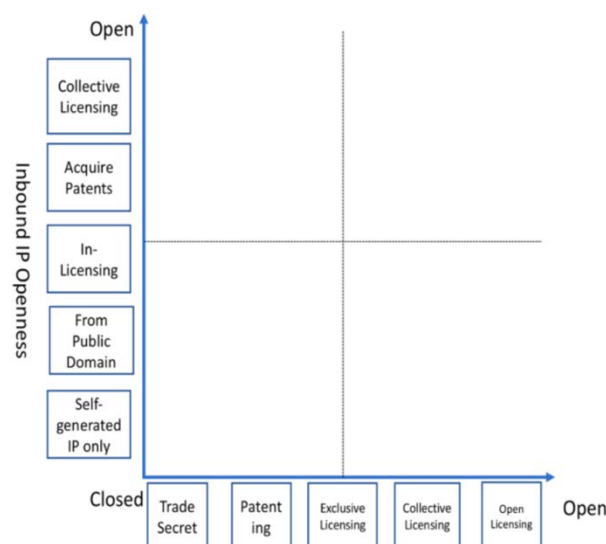


Figure 4. The conceptual framework of measuring openness of IP strategies

In order to show the path of IP strategy trajectory with regards to changing the inbound and outbound IP openness, this study has created an evolved version of the IP openness conceptual framework. Figure 5 shows how the new version is used to present the IP strategy openness of four phases of a company. The new version has five numerical settings

for both the vertical axis and horizontal axis. Number 1 to 5 on the vertical axis represents the inbound IP openness levels:

1. No information coming in
2. Know-how or other informal IP
3. Acquiring IP
4. Licensing in IP
5. Collective Licensing or Co-own IP

Number 1 to 5 on the horizontal axis represents the outbound IP openness levels:

1. Secrecy only
2. Patenting
3. Exclusive Licensing
4. Collective Licensing or Co-own IP
5. Open Patent Pledge

The four different shades formed on the framework in Figure 5 represent the IP strategy for four critical phases of emerging technology companies, which are the science phase, the technology phase, the application phase and the market phase (Phaal *et al.*, 2011).



Figure 5. IP strategy openness for four critical phases

For each phase, the block(s) represents the company's IP strategy used at the time. The circle is the centre of gravity of the blocks. Figure 6 shows the summary IP openness framework for the case study company. Details of IP strategies of the four phases are put together on this framework. The circles are linked to demonstrate the IP openness trajectory of the company. It is clear that the company opened up its IP strategy from the science phase to the technology phase and from the technology phase to the application phase. However, during the transition from the application phase to the more matured market phase, the company, interestingly, chose to close up its IP strategy. This trajectory offers an easy understanding of the path that the company has taken with regards to its IP strategy openness. And the U-shape formed on the framework is used to categorise this type of company in the author's PhD research.

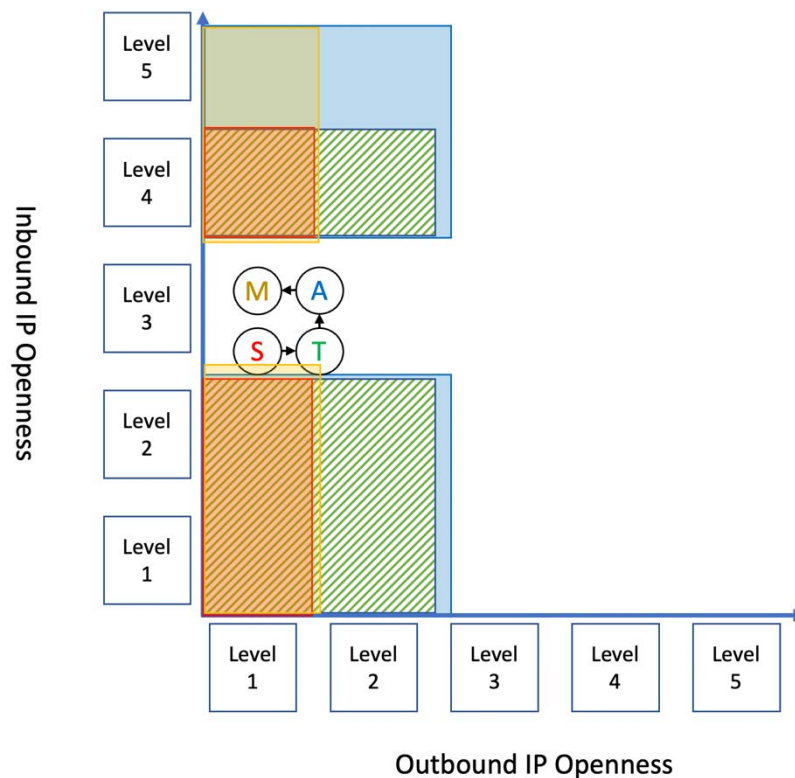
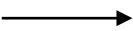







Figure 6. The summary IP openness framework for the case study company








3.3 IP strategy trajectory map

There are four steps for developing an IP strategy trajectory map for a case study. The maps consist of a large number of symbols, shades and lines, which help demonstrate the antecedents of the company's IP strategy path and its corresponding impacts. As shown in Table 1, the solid and dashed arrows represent the short-term and long-term decision flows linking antecedents to IP strategy changes and then to the impacts correspondingly. If the flow is long-term and spans over two transition periods, then the dashed line would have two colours that represent the corresponding transition periods. The four critical phases for emerging technology companies mentioned above form three key transition periods between them (Phaal *et al.*, 2011). These three periods are coded with three colours. The time periods are shown as shaded areas on the map, as shown in Figure 7, because the timeline for these transition periods is often quite vague.

Table 1. Details of the IP strategy trajectory map

Decision Flow of Intellectual Property Strategy Change		
Short-Term ^a	Long-Term ^b	Cross-Transition ^c
		

Color Coding for Transition Periods ^d		
Science to Technology	Technology to Product	Product to Market
		

Symbol Representation	Nomenclature ^e	Description
	Antecedent of IP ^f Strategy Change	The cause, driver, or enabler which lead to a change of the company's IP strategy
	Impact of IP Strategy Change	The impact of the company's IP strategy change
	Cross-Transition Linkage	This element represents an event that is both the result of a previous IP strategy change and an antecedent of an incoming IP strategy change, hence linking one transition to another
	IP strategy Change	This represents a change of the company's IP strategy, the graphic in the center hints the nature of the change ^g
	Technology Milestone	The moment when a piece of the company's core technology is established ^h
	Product Milestone	The moment when a core product is launched
	IP Milestone	The moment when the first of each type of IP is obtained by the company

Notes:

^a The decision flow ends within one transition period

^b The decision flow goes beyond one transition period but ends before the start of the next transition period

^c The decision flow spans across two or more transition periods

^d The transition periods are represented as shaded areas with these designated colours

^e List of critical nodes for the roadmap

^f IP stands for intellectual property

^g This graphic is a simplified version of the IP Openness model, it indicates whether the change is opened/closed for in-bound IP strategy only; or opened/closed for out-bound IP strategy only; or opened/closed for both in-bound and out-bound IP strategies

^h Internally recognized or published through granted patent, academic paper or press release

There are seven types of symbols used for the IP strategy trajectory map. They represent the most important elements of the company's IP strategy path. An antecedent, shown as a flash symbol, could be a cause, driver, or enabler that leads to a change of the company's IP strategy. The impact of IP strategy changes is represented as the tick symbol. The third symbol is a cross-transition linkage. This linkage element represents an event that is both the impact result of a previous IP strategy change and an antecedent of an incoming IP strategy change, hence linking one transition to another. We created an original symbol for the IP strategy change. The symbol consists of a simplified version of the IP strategy trajectory framework and two surrounding lines that represent change. The arrow in the middle of the symbol shows the openness nature of the change. There are six types of changes, as shown in the figure below. The technology and product symbols represent the R&D and product launching milestones. The last symbol is the IP milestone, which represents the moment when the first of each type of IP is obtained by the company.

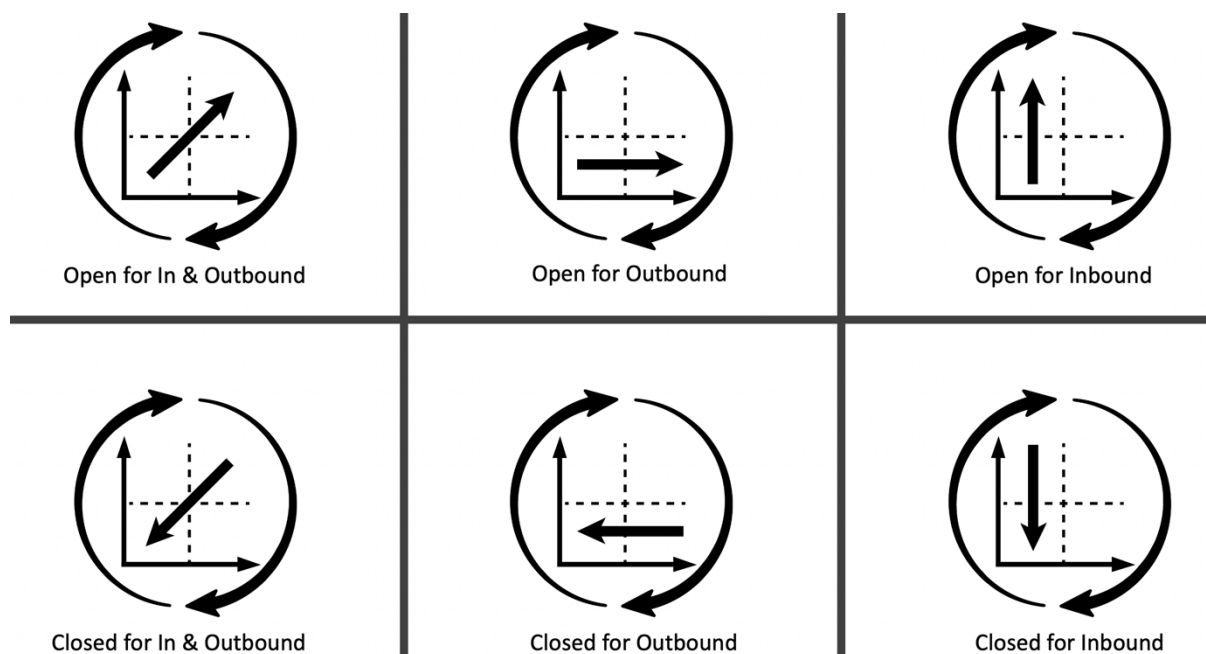


Figure 7. Six types of symbols for IP change

The symbols are used in three of the four stages of the IP strategy trajectory mapping tool. The first version of the map is prepared before the first round of interviews with the company. The information recorded on the map is mainly the available secondary data. An example of this stage. The second stage of the map is created during the first round of the interview, by the author and the interviewee. Due to the restrictions caused by the global pandemic, we used an online whiteboard software called Miro to recreate the face-to-face post-it notes interactive sessions. At the end of the session, a second version of the map, full of post-it notes and decision flow arrows, is created. The third version of the map is created after the authors analyse the results from the second-stage map. All the shades, symbols and arrows in Table 1 are used for this version. The case study company's maps of these three stages are shown in the appendix.

After the third version of the map is finalised, the authors would have a second round of interviews with the case study company to verify the details and initiate more discussion around the IP strategy trajectory. The last version of the map summarises the results from these interviews. The map for the case study company is shown in Figure 8. The map is divided into three sections, which represent the science to technology, technology to application, and application to market transitions. In the author's PhD study, the IP strategy change for each transition is analysed individually and compared to the same transition of the other companies. In this case, the first IP transition change was straightforward with one antecedent and one impact event. The second IP transition change becomes more complex by adding an extra impact event, which turns out to be the antecedent for the changes in the third transition. This is represented by a cross-transition linkage symbol. The case company experienced a relatively long third transition period, where the interviewees identified two noticeable changes with multiple antecedents and impact events. It is clear that this IP strategy trajectory map is advantages in displaying the details of organisational changes and events that surround the IP strategy changes during these transitions. Combining the information in this map and that in the IP strategy trajectory framework, the authors are able to obtain sufficient data for further analysis.

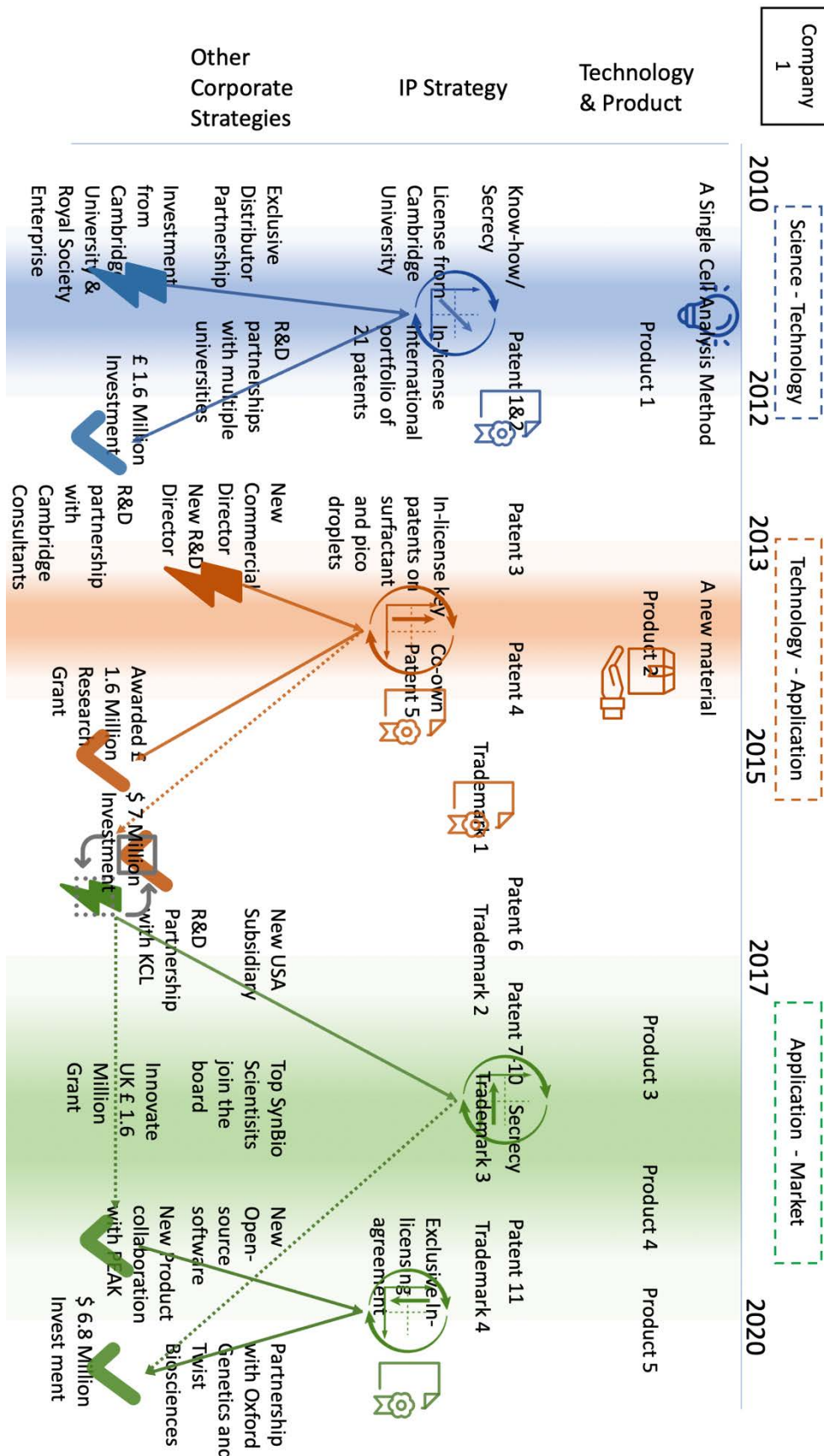


Figure 8. The fourth version of the case study company’s IP strategy trajectory map

4. Conclusion

The visualisation tools in literature are mostly associated with quantitative data and lack the compound ability to collect data on multiple matters, hence they cannot fulfil the needs of the author's PhD research project. In this paper, the authors created a bespoke set of tools, consisting of the IP strategy trajectory framework and the IP strategy trajectory map. The framework collects data and form a trajectory which offers an easy understanding of the path that the company has taken with regards to its IP strategy openness. The map displays the details of organisational changes and events that surround the IP strategy changes during these transitions.

This paper contributes practically by proposing the combination of these two tools which forms a new approach to visualise the data regarding IP strategy trajectory. Additionally, we also gave our definitions for the term 'intellectual property strategy trajectory' and the key elements of mapping a company's IP trajectory listed in Table 1.

The author's PhD study consists of data collected with over ten highly innovative companies in the field of synthetic biology, which is a fast-emerging technology. The IP strategy trajectory visualisation approach will be tested and further optimised with these data.

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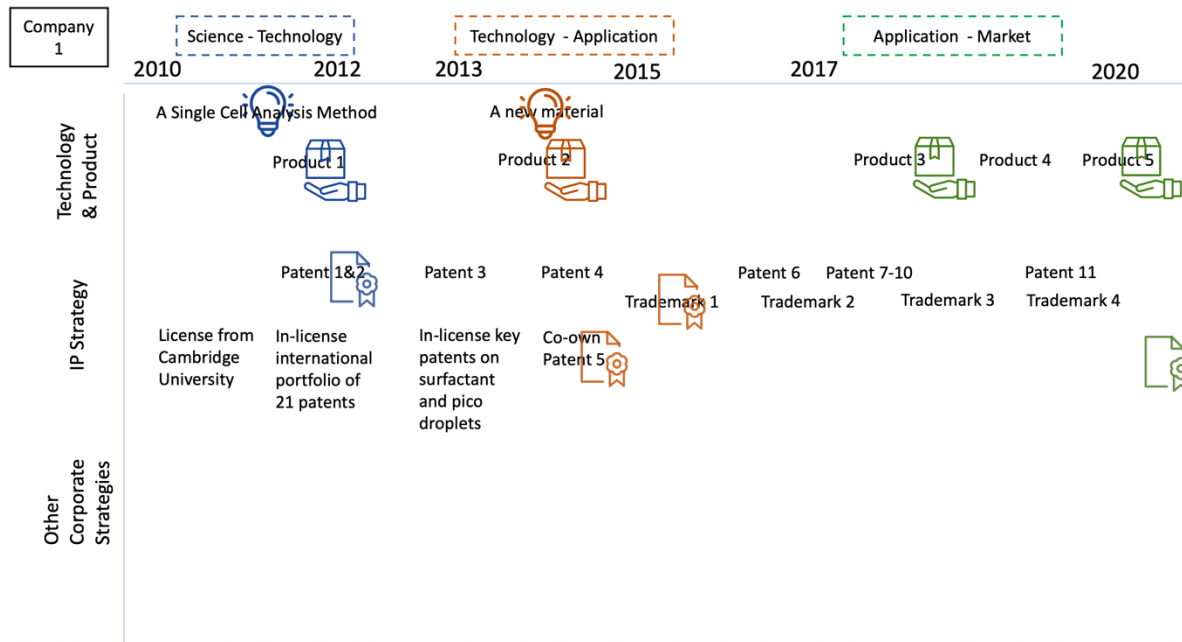
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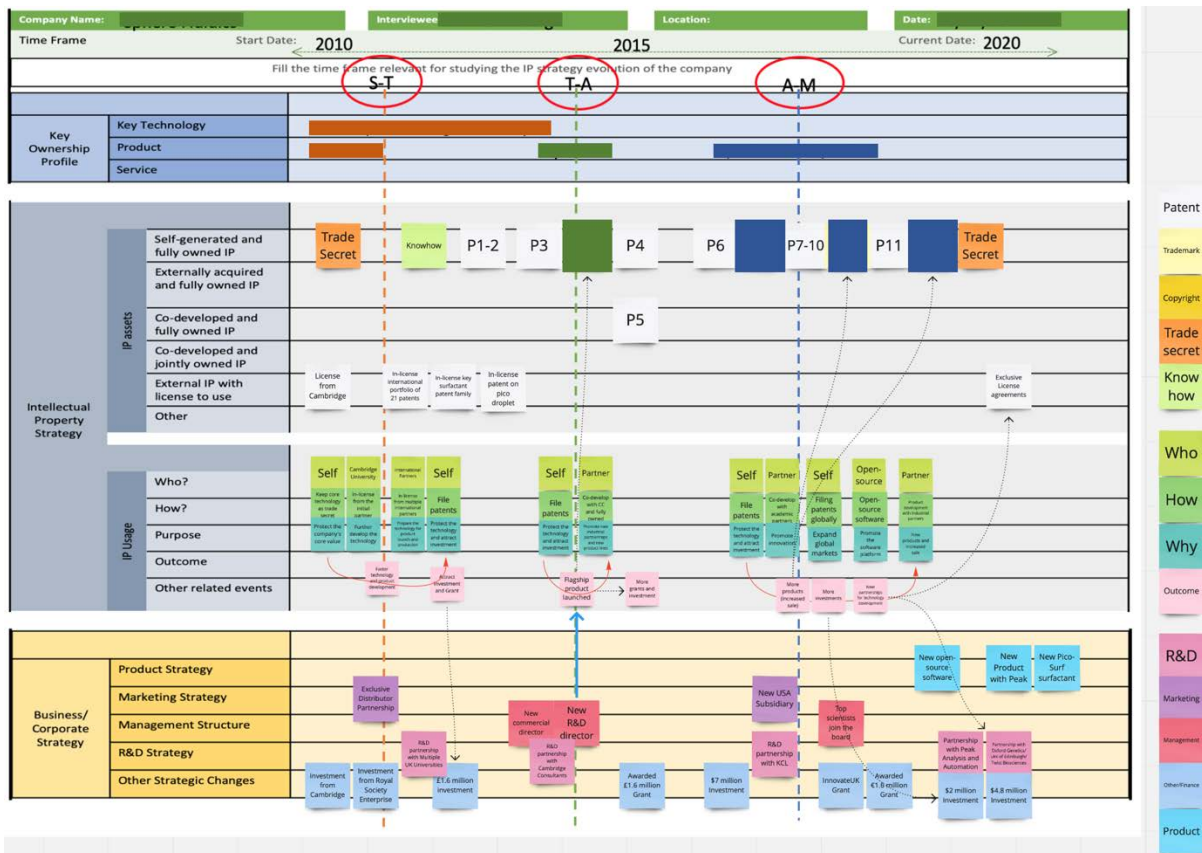
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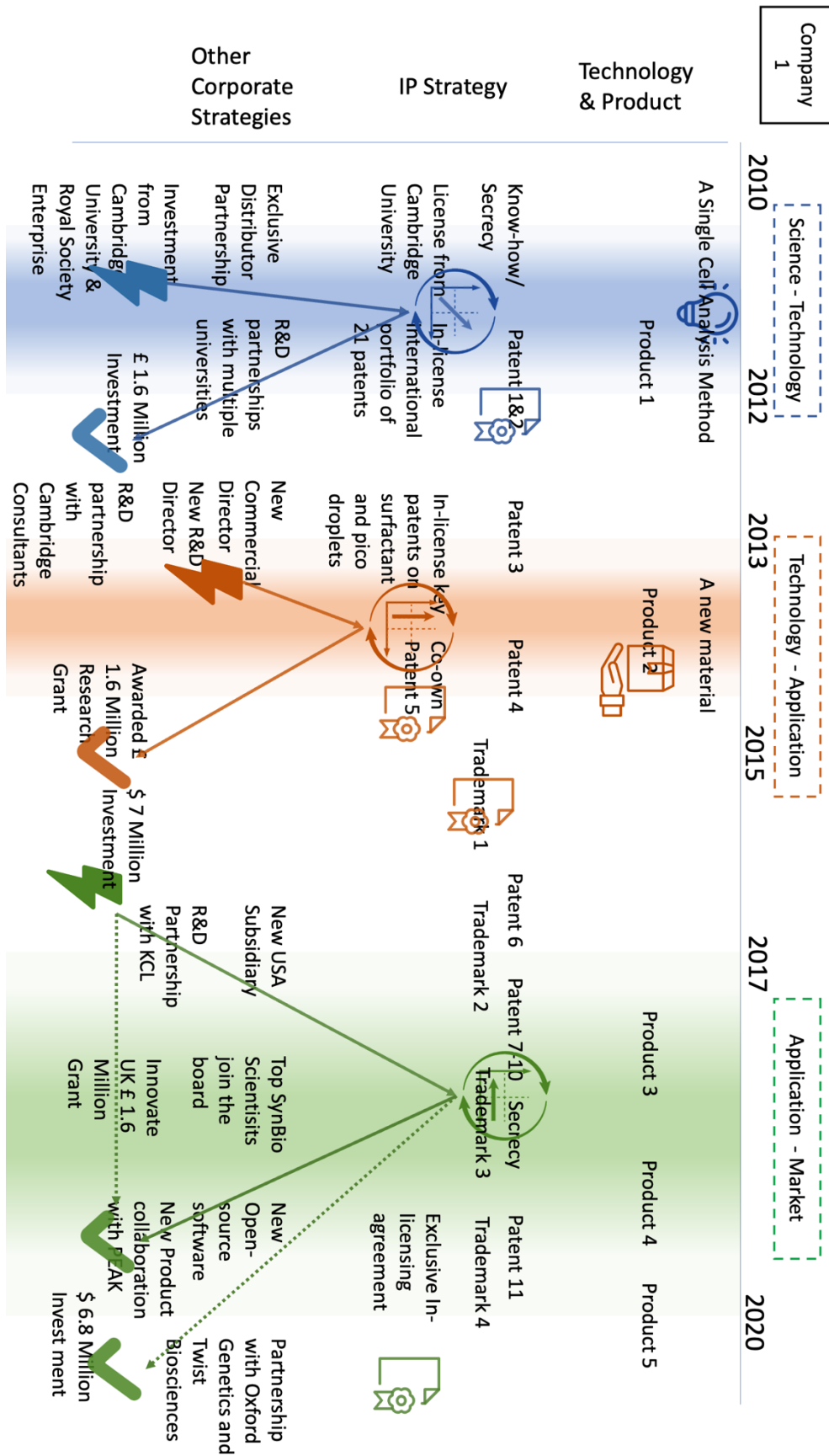
Appendix



The first version of the case study company's IP strategy trajectory map



The second version of the case study company's IP strategy trajectory map



The third version of the case study company's IP strategy trajectory map