Internal Invention, External Development

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The success of GlaxoSmithKline's (GSK's) business relies on the continual identification of differentiated and innovative drugs that can be protected under patent for twenty years. Advances that can increase the number of new drugs successfully introduced to the marketplace or that can reduce the amount of time spent in the product pipeline (between identifying a potential new drug and releasing it in the marketplace) will be of great value to GSK. One way to increase the throughput of successful drugs is to increase the number of potential target compounds that enter the product pipeline. GSK has achieved this by developing a 'high-throughput chemistry facility', which uses advanced automation systems to perform tasks that would previously have been performed manually by chemists; this facility now plays a key role in the drug discovery process.

During a three-year research project, and with a primary focus on this new facility, University College London has investigated GSK's relationship with its suppliers of automation instrumentation. We have discovered that GSK often provides the ideas for new systems to its suppliers, who then develop the products commercially and sell them in the marketplace. Interestingly, so as to encourage continuity of the supply chain, GSK generally allows its suppliers to sell instrumentation produced from GSK ideas to GSK's competitors. This paper is a case study investigating how GSK works with suppliers of equipment essential for its Research and Development process, and why this structure proves mutually beneficial.

1. Introduction

"*The current increase in R&D expenditure together with the reduction in successful drug candidates is leading the pharmaceutical industry towards extinction. The solution must be in new technologies*"

– Dr Brian Warrington, Vice President Technology Development, GSK (Warrington, 2004)

GlaxoSmithKline (GSK) is the world's second largest pharmaceutical company with a turnover in 2004 of over £20 billion. Expenditure on pharmaceuticals R&D was £2.8 billion (GlaxoSmithKline, 2004a). In fact, pharmaceutical companies generally spend a greater proportion of their revenue on R&D than companies in any other industry (Long, Wilkinson and Zurer, 2002). The success of GSK's business relies on the continual identification of differentiated and innovative drugs that can be protected under patent for twenty years; 85% of GSK's turnover comes from patent-protected therapeutic drugs. Anything that can increase the number of new drugs successfully introduced to the marketplace or that can reduce the amount of time spent in the product pipeline will be of great value to GSK. At present, it typically takes ten to twelve years between identifying (and patenting) a potential new drug and releasing it in the marketplace. It is estimated that for every million potential medicines tested, only ten advance to clinical trials, and just one is approved for patient use (GlaxoSmithKline, 2004a). One way of finding leads for new drugs is to screen an existing collection of compounds against a target of interest. Whilst chemists are constantly synthesising new compounds to add to the collection, GSK's store of compounds represents only a tiny fraction of the 10^{40} conceivable types of therapeutic compound. GSK's vision is to increase the throughput of new compound preparation by a factor of a thousand.

To achieve the increase in throughput required, GSK has developed a high-throughput chemistry (HTC) facility as part of its 'Discovery Research' activity (Figure 1). This facility uses advanced automation systems to perform tasks that would previously have been performed manually by chemists (GlaxoSmithKline, 2003).

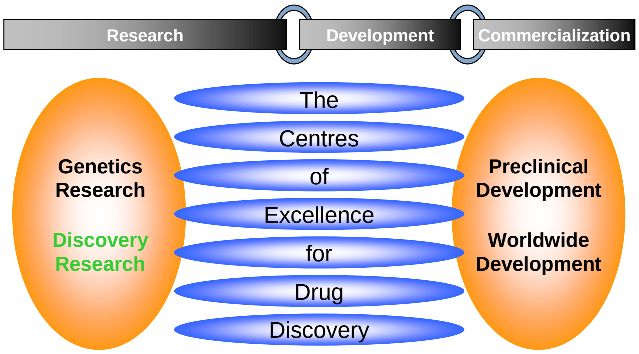


Figure 1. GSK's R&D processes

"*This facility is one more important milestone in GSK's strategy to become the most productive company in the industry. Our systematic high-throughput approach will improve productivity and quality at the start of drug discovery, reduce attrition in the later stages of development and allow us to reduce the time it takes to bring a drug to market by as much as 2 years.*"

– Dr Tadataka Yamada, Chairman, R&D, GSK (GlaxoSmithKline, 2003)

GSK's collection of diverse compounds is screened against targets in the 'Centres of Excellence for Drug Discovery' (CEDDs) to develop leads for new drugs. There are seven CEDDs, each seeking to develop useful medicines in a specific disease category (GlaxoSmithKline, 2004a). The new HTC facility is also used to produce smaller arrays of compounds for more target-focused lead generation. A key goal of the HTC process is the continual enrichment of the collection with compounds likely to provide leads.

The new HTC facility therefore now plays a key role in drug discovery. Developing the facility required a fundamental shift in the way that GSK performed its chemistry, though, with repetitive manual tasks replaced by sophisticated robotic instruments. In fact, the approach to automating chemistry R&D at GSK is leading to a shift in roles (Figure 2). Traditionally, there has been a flexible approach to creating compounds, with chemists taking responsibility for the whole process, from design, through synthesis, purification and registration of new compounds. Now chemists are much more able to focus on the creative and problem solving (value-adding) steps, working with equipment and technical specialists to increase productivity and throughput. This greater specialization of work is consistent with Taylorism and Ford's approach to running efficient production lines (Taylor, 1911; Brown, 1954; Hughes, 1989), and is manifested by a shift from horizontal lines to diagonal lines in the role matrix shown in Figure 2.

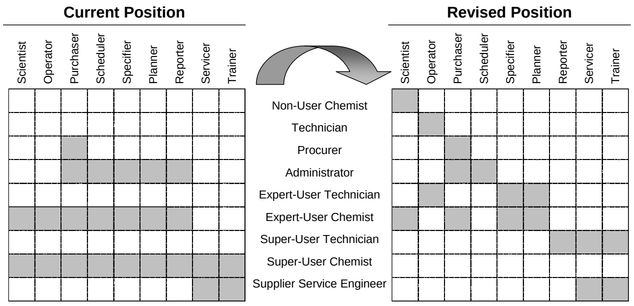


Figure 2. Anticipated evolution of roles in High Throughput Chemistry

Furthermore, installation was not simply a question of plugging together existing technologies; several key production techniques had to be adapted to the high-throughput chemical environment. Whilst GSK knew well what it needed from the facility and its component technologies, and had the capability in house to modify and manufacture one-off instruments, it lacked the resources to manufacture all of the new technologies on the scale required. Whilst R&D was clearly a core competence of GSK, developing robotic instrumentation to replace the manual tasks of chemists was not.

Whether to produce or provide a technology internally 'insourcing' or to purchase that technology from an outside supplier 'outsourcing' is one of the most important business decisions facing technology-intensive organizations today. The impact of sourcing decisions can be felt for many years. When US electronics firms outsourced radio transmitter components in the early 1950s to Japanese suppliers, for example, they helped to establish the electronics industry in Japan and Hong Kong. With the transfer of technology that took place, these same suppliers eventually became major competitors in US markets (Handfield, 1999).

Company	Sales, 2003 ($m)
Agilent[1]	6000
Mettler Toledo[2]	1300
Tecan[3]	231
TTP[4]	168
Hamilton[5]	100
Genevac[6]	25

Sources: [1]Agilent 2004 Annual Report, www.agilent.com; [2]Mettler Toledo 2003 Annual Report, www.mt.com; [3]Tecan 2003 Annual Report; [4]http://www.ttplabtech.com/news/news04_USoffice.htm; [5]Estimate from Tecan Corporate Presentation (October 2004), www.tecan.com and http://www.comstocksbusiness.com/cnn-story-spring.htm; [6]Estimate from http://www.realbusiness.co.uk/

Table 1. Selection of major GSK suppliers for R&D automation equipment

GSK faced a critical decision in developing its HTC facility – how much of the technology development to outsource, and whether and how to exploit the intellectual property rights associated with the novel technologies that it had identified.

GSK had good relationships with its major equipment suppliers (Table 1), who considered GSK to be a technological leader in the pharmaceutical industry. In this situation, how should GSK develop the chemistry production process that it desired?

2. GSK's zeal for R&D

GSK's annual report begins as follows (GlaxoSmithKline, 2004b, p.0):

Mission	To improve the quality of human life by enabling people to do more, feel better and live longer.
Our Spirit	"We undertake our quest with the enthusiasm of **entrepreneurs**, excited by the constant search for **innovation**. We value **performance** achieved with **integrity**. We will attain success as a world class global leader with each and every one of our people contributing with **passion** and an unmatched **sense of urgency**."
Strategic Goal	To become the indisputable leader in the industry.

The annual report then outlines the three challenges that GSK must meet to achieve these goals:

1. improving productivity in research and development
2. ensuring patients have access to new medicines
3. reaching consumers beyond the traditional healthcare professional

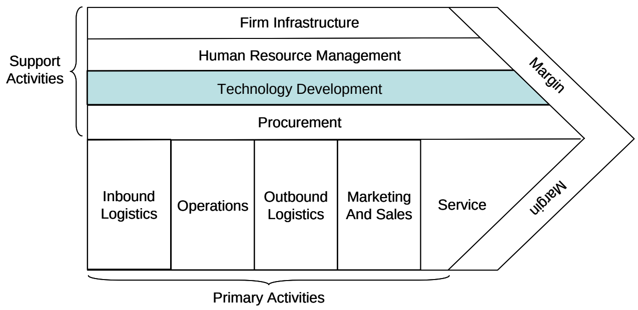
It is clear from this that GSK considers R&D to be of critical strategic importance, as innovation is the basis of its business. Although R&D and technology development are traditionally seen as supporting activities in the value chain, the R&D process is GSK's life-blood. The mantra 'innovate or die' can be overstressed for many industries (Getz and Robinson, 2003), but for GSK it is hard to overstate the importance of innovation. GSK would therefore not take the decision lightly of whether to outsource aspects of R&D activity.

3. The Theory

Two popular and related themes in business strategy over the last decade or so have been 'core competencies' and 'outsourcing'. The general maxim has been for companies to focus on and internalize those things the organization does well – its core competencies, and to get rid of or outsource the activities it does less well or that add little value (Prahalad and Hamel, 1990; Munsch, 2004; Baxter, 1999).

What do we mean by activities that add little value? Porter distinguishes between primary and supporting activities in the value-chain, placing technology development in the latter category (Figure 3). Primary activities are "involved in the physical creation of the product and its sale and transfer to the buyer as well as after-sale assistance … Support activities support the primary activities and each other by providing purchased inputs, technology, human resources, and various firmwide functions" (Porter, 1985, p.38). As a supporting activity, then, the development of new technology at GSK might legitimately be outsourced.

Porter goes on to say that technological change by a firm can lead to sustainable competitive advantage if "the technological change itself lowers cost or enhances differentiation and the firm's technological lead is sustainable" (Porter, 1985, p.171). For GSK, then, technology development may be too important to outsource.



Source: Porter (1985)

Figure 3. Role of technology development in the value chain

Perhaps the most important advantage of outsourcing is the increase in flexibility that it allows for the buying firm: "As market demand levels change, the firm can more easily make changes in its product or service offerings in response. Because there are lower levels of investment in specific assets, it is easier for the firm to make unexpected changes in its own production resources … also, outsourcing allows for improved cash flow because there is less up-front investment in plant and equipment" (Handfield, 1999: 17.33). In times of rapidly changing technology, outsourcing technology development to a supplier can reduce risk. Unfortunately, GSK could not afford for its suppliers to fail, so is unlikely in practice to be able to benefit from this apparent reduction in risk.

Prahalad and Hamel suggest that companies should view themselves as portfolios of competencies rather than portfolios of businesses, defining core competencies as "the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technology" (Prahalad and Hamel, 1990, p. 81). They underline some of the dangers of outsourcing: "The embedded skills that give rise to the next generation of competitive products cannot be 'rented in' by outsourcing and OEM-supply relationships. In our view, too many companies have unwittingly surrendered core competencies when they cut internal investment in what they mistakenly thought were just 'cost centers' in favor of outside suppliers" (Prahalad and Hamel, 1990, p.84). They further point out that when fundamental technologies change or when a supplier decides to enter a market as a competitor, a company dependent on this supplier might become vulnerable.

Verkatesan identifies a key distinction – between producing a technology entirely in-house, and controlling the design and manufacture of a technology by retaining expert ‘architectural knowledge’ of it. Architectural knowledge is “the intimately detailed and specialized power of translation required to capture customer requirements and reproduce them in the language of subsystem performance specifications” (Verkatesan, 1992, p.6). It is based on detailed understanding of the linkages between user requirements, system parameters, and component specifications, and is unique to each company. He cautions that “carelessly executed, the outsourcing of subsystems can result in the destruction of architectural knowledge within a single product generation. Lost architectural knowledge has always been difficult to get back. Today it is virtually impossible” (Venkatesan, 1992, p.7). This is because with suppliers becoming increasing specialized and components becoming increasingly complex, very large investments are required by more generalist systems integrators to make up lost ground on world class suppliers.

A balance between outsourcing technology development and retaining the degree of expertise necessary to remain a knowledgeable customer for technology is therefore desirable. Boston Consulting Group’s report into the pharmaceutical industry refers to the large, non-specialized pharmaceutical companies as ‘orchestrators’ due to the large number of partnerships they rely upon, noting that “at each step of the value chain, orchestrators need to assess the tradeoffs between improving internal skills and accessing superior external capabilities”. They further warn that “unsophisticated partnering will erode margins … as the number of partners increases” (Goldsbrough et al, 1999, p.16). They suggest that a key question when choosing what to obtain externally is how much of an activity can be outsourced before the company loses functional expertise critical to linking activities across the value chain (Goldsbrough et al, 1999, p.22), noting that “pharma companies that rely too heavily on the outside world may fail to fully capture the lessons from it. Most companies have recognized this risk and have maintained some functional expertise in-house, as well as simultaneously building new in-house capabilities when technologies look promising” (Goldsbrough et al, 1999, p. 24).

4. Research Findings – GSK’s approach to developing new R&D technologies

University College London has conducted a three-year research project investigating the supply-chain issues associated with new technology introduction in the pharmaceutical industry. In particular, we have investigated GSK’s relationship with its suppliers of automation instrumentation used for research and development. The study focused primarily on instrumentation within the HTC facility, so the findings do not necessarily reflect the situation throughout all parts of the GSK organisation. Forty-five interviews have been conducted with representatives of ten different companies in GSK’s supply chain for instrumentation. We discovered in the course of this research that GSK often makes the inventive step in creating new technologies, and provides the ideas for new systems to its external suppliers. These suppliers then develop the products commercially and sell them in the marketplace. Interestingly, so as to promote viability and continuity of the supply chain, GSK demands little in return from its suppliers, perhaps a six month exclusivity period or a modest reduction in purchase price. GSK generally allows its suppliers to sell instrumentation produced from GSK ideas to GSK’s competitors. This approach is consistent with GSK’s objectives for corporate responsibility (GlaxoSmithKline, 2004b, p.6). In particular, in the area of ‘leadership and advocacy’, GSK aims to: “share best practice and seek to influence others, while remaining competitive in order to sustain our business” (GlaxoSmithKline, 2004c, p.60).

GSK’s technology development groups generally provide the specifications for new technologies, since they are closest to the end users. Occasionally, suppliers innovate and develop new products themselves, but this is less common as the suppliers tend to take a market-driven approach to technology development. They minimize risk by remaining responsive to large customers’ needs rather than investing in developing new technologies that may be unattractive in the marketplace. Suppliers use GSK as a ‘lead user’ to help them identify new market opportunities (Herstatt, 2004; Deszca et al, 1999). In fact, GSK has achieved a “magnet status, with potential partners seeking it out as a partner of choice” (Goldsbrough et al, 1999, p.28).

Whilst GSK has the internal capabilities to develop and manufacture instrumentation on a small scale, it doesn’t have the resources to manufacture the number of instruments required for the high-throughput production capabilities it needs on a global scale. Acquiring these resources, either by hiring more staff with the relevant experience or by acquiring a supplier with manufacturing capability, would be inefficient to serve GSK’s relatively limited instrumentation demands. Instead, GSK has learnt that the most efficient development process is for specialist suppliers to develop and manufacture the instrumentation for GSK, to GSK’s specifications. Since GSK provides most of the ideas for new technologies, one might argue that it should retain the intellectual property rights for the technologies. However, serving GSK’s needs alone would not provide a large enough market to allow suppliers to survive without charging excessive amounts for the development of new instrumentation. By selling similar technologies to a range of different companies, including GSK’s competitors, these specialist suppliers can achieve significant economies of scale, sharing some of the development costs across quite a wide customer base. This is particularly true given that GSK, despite being the second largest player, has only around 7% of the worldwide market share for pharmaceuticals (Table 2).

Company	**Market Share, 2001 (%)**
Pfizer	7.0
GlaxoSmithKline	6.9
Merck & Co	5.0
AstraZeneca	4.4
BMS	4.1
Novartis	3.9
J&J	3.8
Aventis	3.7
AHP	3.2
Pharmacia	3.1

Source: IMS, 2001, www.ims-global.com/insight/news_story/0101/news_story_010104.htm

Table 2. Pharmaceutical company market shares of worldwide sales

Furthermore, products that are made commercially available are likely to be better supported by their manufacturers in the future than one-off specials designed exclusively for GSK. The cost for GSK of doing this, however, is to lose the strategic benefit of having exclusive access to the technology. This is a price that GSK feels is worth paying in general, since it can still derive competitive advantage from the combination of technologies that it employs, even if each individual technology is commercially available to its competitors. Treating other parts of the supply chain as partners in this way, and adopting a strategy that doesn't necessarily maximize GSK's own short run profit but promises greater mutual long run benefit, is consistent with a shift from an 'intracompany' view of the supply chain to an 'intercompany' view of the supply chain as shown in Figure 4 (Chopra and Meindl, 2001). Such a shift ultimately requires a greater degree of trust and sharing of information between the supplier and buyer of technology, though.

"*While the experience of High-Throughput Chemistry lies in-house, the engineering of new instrumentation is done by suppliers and consultants. A robust relationship is needed between the two organisations. Suppliers have to understand the issues. This understanding takes time to build up. Collaborations with other drug manufacturers are good for GSK, since they provide the suppliers with a wider market, and GSK with cost mitigation and assured support.*"

– Dr Brian Warrington, Vice President Technology Development, GSK (Warrington, 2002)

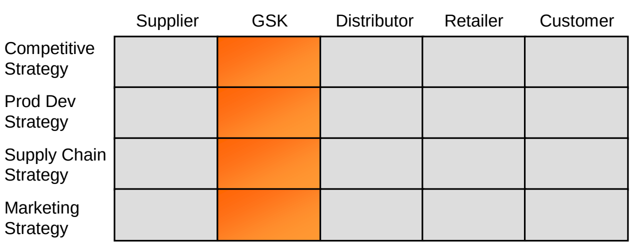


Figure 4. Taking a broader view of the supply chain

GSK has the expertise necessary to integrate the HTC technologies, and therefore may be able to derive a competitive advantage from the combination of technologies that it uses. In future, GSK might want to consider whether it could benefit from empowering its suppliers to take a more proactive role in proposing new technologies. Even under these circumstances, though, GSK should retain its competence in systems integration. Otherwise, it would be unable to remain a knowledgeable customer for technology. Furthermore, if it had to rely on a third party to perform the integration, it is probable that the same combination of technologies would be used for GSK and other competing pharmaceutical companies. As a technological leader, GSK would be disadvantaged under such an arrangement. The 'systems integration' role that is required to combine successfully different technologies is not part of a typical chemist's skill set. Whilst initially key individuals performed the role more through default than through design (Cowper, Emes and Smith, 2004), they have since developed into experts in the planning and integration of technology. They were helped in this respect by the culture established within GSK, in particular through the support of higher management (Metz, 1996) who recognized the importance of technology, creating a Technology Development Department, and putting in place the infrastructure necessary to nurture the technology management skills of its chemists.

5. Conclusions

Whilst GSK's approach to inventing new technologies internally and allowing external suppliers to exploit them commercially may seem counter-intuitive, it proves an effective way of ensuring that it gets the technologies it needs in a timely manner, whilst nurturing key supplier relationships. Of course, if GSK had an invention that it could realistically expect to lead to a sustained competitive advantage in its core business, then it would be more circumspect about its approach to developing this technology externally.

According to investment analysts, GSK's R&D programme already seems to be bearing fruit:

"*GlaxoSmithKline is head and shoulders above its European and US peers in terms of R&D productivity*"

– Smith Barney (GlaxoSmithKline, 2005)

"*GSK's pipeline appears to have strengthened numerically – [the] quality [is] yet to be validated by clinical data*"

– Goldman Sachs (GlaxoSmithKline, 2005)

Of course, whilst the stock market may already welcome this increased productivity, with new drugs spending ten to twelve years in the product development pipeline, it will be a few more years before GSK begins to see real economic benefit.

6. Acknowledgements

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