Consolidation revisited

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Abstract In 1998, the author produced two papers that argued that consolidation was a necessary activity for biotechnology companies to pay greater attention to. Three years later a further consideration of the subject seems worthwhile. Examples of successful consolidators are reviewed.

Keywords: consolidation, mergers, acquisitions

Introduction

In the early/mid-1970s, the pharmaceutical industry consisted of more than 100 research-based businesses of some significant size, although none of them could convincingly claim a global presence. Typically, a leading company had a strong position in its local market (examples included Merck and Pfizer in the USA, Bayer in Germany, Beecham in the UK, Roussel-Uclaf in France and Fujisawa in Japan) and possibly some other neighbouring countries (US companies in Canada, German companies in France and UK companies in the Commonwealth), supported by a network of licensing arrangements with peers in the other major markets.

Since then, there has been a sustained agglomeration of the leading companies to create the behemoths that bestride the sector at the beginning of the 21st century. GlaxoSmithKline (GSK), which is the second largest pharmaceutical company as ranked by sales in 2000,[1] includes the operations and products of what were in 1970 at least four separate companies (Glaxo, Wellcome/Burroughs Wellcome, Beecham, SmithKline&French) and also some smaller ones. GSK's predecessor companies operated in ethical pharmaceuticals, over-the-counter (OTC) medicines, food and drink, vaccines and animal health but there is now greater focus on the highest profitability sector, human pharmaceuticals. At the time of writing, GSK is rumoured to be a possible purchaser of Bayer's pharmaceutical business, the future of which has been questioned after the withdrawal of cerivastatin.

Aventis, the eighth largest pharmaceutical company by sales in 2000,[1] includes the operations of 1970s companies such as Rhone-Poulenc, Rorer, Fisons, Hoechst, Marion, Richardson Merrell, and some smaller companies. Moreover, Aventis is currently spinning out its agrochemical interests, via a sale to Bayer, to focus on pharmaceuticals, and vaccines (as an aside we may note that Aventis's agrochemical part, accounting for about 25 per cent of revenue and 21 per cent of profit in 1999, encompasses the 1970 interests of at least nine companies: Aagrunol, Boots, Fisons, Hoechst, May & Baker, Roussel-Uclaf, Rhone-Poulenc, Schering and Union Carbide).

The consequence is that there are now only about 15 major pharmaceutical companies and they would all claim to have more-or-less global presences. Their number may decrease further, as a result of the Bayer situation and some resolution of the Novartis minority holding (a 20 per cent stake) in its neighbour Roche. It is, however,

noteworthy that few of them have a dominant position in the large Japanese market and that no Japanese company is represented among this 'elite'.

During the same period, say 1975–2000, there has been an extraordinary creation of new companies with considerable scientific capability. Biotechnology, essentially a new set of enabling tools discovered in the past 30 years, has been the source of some 4,000 companies[2] which are carrying out research in the life sciences and predominantly, but not exclusively, with the aim of developing drugs for human healthcare.

To date (mid-2001), few of these biotechnology companies have attained sufficient size and product density to be able to challenge the pharmaceutical majors in their sales and distribution activities although, arguably, many challenge them in research creativity and capability. Even the largest of the 'new' companies, Amgen, which has a market capitalisation in the order of US$70bn does not maintain a sales/distribution network which would enable it to reach the full GP market. In contrast, GSK boasts a US salesforce in the order of 8,000 and a worldwide sales operation of some 40,000; no biotechnology company comes even remotely close to this scale of operation. With a total revenue of some US$3.6b,[3] Amgen is dependent partly on fees/royalties from partners supplementing the efforts of its own relatively small sales and marketing operation of about 1,500 which is focused mostly on specialist units in major centres.

Partnering

There is no doubt that biotechnology companies, individually and as a set, have developed an astonishingly creative R&D capability. Protein engineering, combinatorial chemistry, high-throughput screening, chip diagnostics, antibody humanisation, genomics and proteomics (examples of companies in each area being Genentech, Affymax, Pharmacopeia, Affymetrix, Cambridge Antibody Technology, Millenium and OGS respectively) have all been developed by biotechnology companies without any notable scientific input by the leading pharmaceutical companies. Nevertheless, the latter have recognised the power of these new technologies, most of which appeared only in the last decade, and have bought into them (by acquisition or by licensing deals) and are in the process of reducing the platform technologies, especially CC and HTS, to commodity status that are obligatory requirements for all the major players. Specific platform acquisitions included Affymax (bought by Glaxo)[4] and Sphinx bought by Lilly. Examples of other biotechnology purchases by majors include Agouron by Warner-Lambert, Sugen by Pharmacia, Chiron by Ciba-Geigy (now Novartis) and Genentech by Roche, though in some of these cases the acquiring company has contented itself with a majority stake rather than 100 per cent ownership.

The rapid consolidation of the pharmaceutical sector (which is always explained by the management to be justified by significant cost savings) has not been observed to make a significant difference to the R&D capability of the larger pharmaceutical companies; indeed, it is possible that the increasing size and the regular (seemingly once every two or three years) uncertainty of incumbent employees about their job prospects have even reduced the productivity of the majors. Indeed, the motivation of the staff of American Home Products was unlikely to have increased as the management engaged in three successive attempted, but ultimately abortive, deals. Nevertheless, there can be no doubt that pharmaceutical consolidation has increased the marketing, sales and distribution power of the survivors, by force of numbers if for no other reason.

The dichotomy between relatively sclerotic R&D organisations in large pharmaceutical companies and the creative energy of small biotechnology companies has led to a perception of a natural symbiosis between the two groups with one side having money (large pharmaceutical companies are usually highly cash generative) but needing products to feed

into its sales operations and the other side having product candidates and, usually, not the wherewithal to develop them (a cash shortage and sometimes a clinical and regulatory skills shortage) or the marketing power to sell them.

Most biotechnology companies respond to questions about strategy by stating something like 'we aim to partner our products as soon as possible with a leading pharmaceutical company'. There is an irresistible analogy with the answer given by a bank robber as to why he kept robbing banks 'that's where the money is'. The validation by a scientifically knowledgeable unit can of course also support a further approach to the public markets.

Partnering arrangements (involving some or all of equity investment, up-front fees and potential royalty payments) have generally been characterised by large pharmaceutical companies offering to biotechnology companies what are to themselves small amounts of money (but, to the other side, large sums) to obtain rights to the latter's output. Deals of this type have certain characteristics:

- The initial payment is generally comparatively small, as a percentage of the potential payments (and it may include an equity investment which can deter other possible partners);
- milestone payments require demanding performance;
- They include some elements of an option, ie the pharmaceutical company has the right to progress but does not really have the obligation to do so (effectively, this reserves the right of the pharmaceutical company to consider other offers in the same therapeutic area including from its own R&D effort, when a greater share of the value chain will be retained in-house).

But there is a serious risk to a biotechnology company in adopting this partnering model, however superficially attractive the injection of funds is. The larger company can always discontinue a deal 'because the product did not perform to expectation' which can perhaps sometimes be interpreted as 'because a more satisfactory candidate is available' to devote its scarce clinical development resources to, possibly in a different therapeutic area but not always. Indeed, the current style of partnering renders this a significant risk to most deals. The large company always has the right to proceed *but not the obligation* and the logical thing for it to do is to take lots of relatively cheap options but to keep expenditure low until all the candidates have been thoroughly evaluated and have progressed satisfactorily for a year or two.

It is noteworthy that even a company as large as Alza felt exposed in its dealings with large pharmaceutical companies. In commenting on the deal under which Johnson & Johnson (J&J) acquired Alza for an announced price of US$12.2bn, Ernest Mario, Alza's CEO, said 'Alza was at the whim of its clients. If they developed another product which did not use Alza's technology, they could just stop marketing our technology. Alza was not the master of its own destiny'.[5]

Of course, pharmaceutical mergers are a classic reason for re-evaluating portfolios to avoid conflicts between internal and external product candidates (it is an easy guess which will be favoured) and between two or more external candidates. The on/off dance between GlaxoWellcome and SmithKlineBeecham was the background to the closure of the partnership arrangement between the latter and Vanguard Medica (now Vernalis) concerning that company's development of frovatriptan, because GlaxoWellcome's stable contained the competing, and more advanced, sumatriptan. In the end Vernalis managed to find another partner, Elan, for frovatriptan but not without experiencing a nasty hiccough in its share price. Given Bayer's present instability, the management of CuraGen, which entered a key partnership (with a headline value of US$1.3bn) with that company only in January 2001, must be acutely aware of the risk it faces. CuraGen's share price dropped rather more than the NASDAQ index in the month around Bayer's withdrawal of cerivastatin which might precipitate an acquisition of Bayer's

pharmaceutical business, though the fall was not heavy.

Since most big pharmaceutical companies have large product pipelines with 20 or more products in the clinic (eg at the end of 1999, AstraZeneca, not the largest pharmaceutical company, had a pipeline of more than 30 drugs in clinical development) and given that profit performance is based largely on the sales/profitability of extant products, the impact of dropping an external candidate is usually small. On the other hand such an action, given that the original agreement validated the biotechnology company's work, can have a devastating impact on its share price; indeed, partnership discontinuance can lead to share price falls in excess of 50 per cent in a single day. Just as a validation may justify a funding operation, a partnership break-up can signal a funding famine and even no effective independent future (and any remaining equity held by the departed partner may be even more of an embarrassment). Many acquisitions of biotechnology companies are preceded by a breakdown of a partnership with a leading pharmaceutical company.[6] Sometimes, even being acquired is not possible; arguably, Boehringer Ingelheim's decision in November 1998 to drop the cancer product Foscan was the starting point of Scotia's journey into receivership.

Thus, there is an asymmetry of risk in most biotechnology/pharmaceutical relationships. This is greater when the deal is on an early stage development rather than on a late one and when the biotechnology company has a narrow portfolio, as most of them do. In general, this risk asymmetry has tended to get worse between 1998 and 2001 as the ratio of biotechnology companies to leading pharmaceutical companies has moved from about 3,000 : 25 to 4,000 : 15. Despite this, partnering remains the predominant strategy because it is still one of the quickest ways of getting some funds into biotechnology companies. Considerable effort is expended in finding better partnering models. Moscho and Leiter[7] have written an article called 'Perfect partnering' which includes a section entitled 'Choose partners with care'; their article includes the story of J&J dropping Amylin's product pramlintide, despite having reputedly spent US$175m on its development (it is hard to know how Amylin could have found a more committed partner).

However, in a few isolated cases, biotechnology companies, which usually still need some help in marketing, sales and distribution, have been able to strike better deals or make alternative arrangements. They could be said to have managed their risk better; how they have done this is through consolidation.

Consolidation as a strategic response

In 1998, the author argued[8,9] that consolidation by biotechnology companies, with the aim of achieving a critical mass (to be defined later), would give them greater security and greater control over the outputs of their research creativity. Those papers also explored the factors that appeared to place limits on the adoption of merger and acquisition between biotechnology companies.

If two companies are 'sub-critical' and both are likely to stagger along (at best) but together they are above the 'critical' level there may be benefits for all parties in encouraging them to join together (the point behind the article by Parker[10]). The important riders to this are that both companies must have something of significant value and potential to bring to the party (as one major investor memorably said 'a dog, ie a failing company, buying a dog merely creates a bigger dog') and there has to be a coherent business case for the joint operation.

In practice, most acquisitions in the biotechnology sector seem to result from investors, especially venture capitalists, seeking to rescue some funds from the assets of a company which clearly could not sustain itself following one or more important setbacks:[11] in other words, when the management had thoroughly demonstrated that the company was sub-

critical. Yet, there have been examples where acquisition has led to much stronger companies with enhanced core capabilities and potentially very good positions in specific market sectors.

By examining selected examples of purposeful consolidation among biotechnology companies the present paper is aimed at demonstrating that consolidation can be a viable strategy that delivers notable benefits; but this is not so in every case and some cautionary notes are also sounded. Three main examples of consolidator companies are considered in some depth; these are Elan, Celltech and Shire. Reference is also made to other examples of apparent success, including some from the USA, though failures are not chronicled or even listed, partly because it would be invidious to make specific judgments and partly because, frankly, there are too many.

Elan Corporation

Elan was founded in Ireland in 1969. In its early years it developed technology, particularly for drug delivery, and manufactured and marketed selected active ingredients in improved formulations such as sustained release capsules. By 1992 it was a profitable public company with sales of Ir£62m (approximately US$100m) growing at a reasonable rate and a market capitalisation in the order of US$700m (stock splits and warrants complicate the calculation).

In 1996, Elan acquired Athena Neurosciences, the first big step in a major vitalisation of the company. The consideration of US$537m was settled entirely by the issue of 19.5 million shares. ATS was also acquired in that year for about US$141m. Things started to hot-up in 1998 when Elan acquired, in rapid succession, Sano, Carnrick, Neurex and Nanosystems as well as picking up two smaller companies. In 1999, Axogen was acquired and then in 2000 four more companies (Neuralab, Liposome, Dura and Quadrant) joined the group.

By the end of 2000, sales had increased to US$1.3bn with a profit of nearly US$500m and a market capitalisation in excess of US$16bn. Thus, over some eight years, Elan had turned in a compound growth rate in its market capitalisation in the order of 48 per cent per annum.

Of course, Elan has now developed very considerable financial power and the ability to make choices that it did not have some years ago; nevertheless, Elan is still not in the same league as the biggest pharmaceutical companies and is compelled to focus its energies on a series of market sectors where it can obtain a reasonably strong franchise without committing to the costs of a monster salesforce. Importantly, its strength in selected sectors means that Elan is now in a position to act in partnership mode towards smaller and more fragile companies offering them an alternative potential route to funds, clinical expertise and marketing. Arguably, Elan may be a more sympathetic partner (and one with fewer potential product conflicts) because of its own comparatively recent history of being a small company, an experience that has been forgotten in the corporate mind-sets of the major drug companies.

Celltech

This was the UK's first biotechnology company. Founded in 1980 to commercialise some technology arising from UK public sector research, it seems to have had many different faces over the years being, for a period, a specialist in the manufacture of monoclonal antibodies but has still not yet earned a profit.[12] Latterly, the company's focus has moved to drug development and marketing.

It was in 1999/2000 that Celltech made two very significant strategic moves. Firstly, it merged with Chiroscience and secondly, it purchased Medeva. The former had a portfolio of products, some in the clinic, complementary to those of Celltech; rather differently, Medeva had some minor but established products and a sales/marketing/distribution capability, albeit on a narrow territorial base. Later, Celltech also

purchased Cistron but this was a much smaller deal.

The impact of the two main deals, which followed each other closely, can be seen in the market capitalisations of the relevant companies. Before the merger (with Chiroscience) and the acquisition (Medeva) became public knowledge, ie in early 1999, the market value of each of the three companies lay in the range £250–500m with a total value a little in excess of £1.0bn. After completing the two deals Celltech's share price peaked at around £18, which corresponded with a market capitalisation in excess of £4.5bn. Subsequently, it traded for several months in the range of £12–14, indicating a market value of some £3.5bn. In other words, the financial consequence of the mergers was an increase in the total value of some 250 per cent; this is a clear vindication by investors of the 'synergy' achieved by the deals with, presumably, some benefit coming from lower risk and some from greater potential.

In addition there were operational consequences. By mid-2000, Celltech's status could be summarised as follows:

- It was profitable at the operating level (see note 12).
- It had several products on the market and its own sales operations in selected countries, including USA and UK.
- The pipeline included 12 products in clinical development and one just about to be launched in the USA.
- A strong financial position.

All of this meant that Celltech had greater flexibility in the timing and structure of the deals that it could do with other companies and would not be driven to seek a partner simply because it represented the best chance of a cash injection. This was demonstrated in March 2001 when Celltech made arrangements with Pharmacia in relation to the development and commercialisation of CDP 870. Not only is Pharmacia committed to up-front fees, milestone payments, royalties (in due course) and certain development expenditure but it has left some commercialisation rights with Celltech and granted the latter marketing rights to a few of Pharmacia's products in selected territories. It was reported[13] that Pharmacia was compelled to compete for this deal, structured around a product only in Phase II, against three other major pharmaceutical companies (Aventis, GlaxoSmithKline and Pfizer). In other words, Celltech's strong position gave it a chance to take control of the process. This is not the norm for less secure biotechnology companies and would have been almost unthinkable until quite recently.

Shire

Shire Pharmaceuticals is a very different company from either Elan or Celltech. Both of those companies have deliberately maintained a research base; in contrast, Shire has, at least until recently, generally seen its primary activity as being late stage development and marketing/sales.

The company was founded in 1986 and was floated (had its initial public offering, IPO) on the London Stock Exchange in 1996. At the end of that year total revenue amounted to £21m with a profit after tax of £2.7m. Neither figure would have been so impressive had there not been a licensing fee (from Janssen for galantamine) in the order of £11m. Shareholders' equity at the end of that year amounted to £25m with a market capitalisation of £114m.

By the end of the year 2000, Shire had acquired or merged with Pharmavene (1997), Richwood (1997), Fuisz (1999) and Roberts (1999) and had announced its intention to merge with Biochem Pharma. Revenues in the year had increased to US$517m with earnings, under UK GAAP (generally accepted accounting principles), of US$108m and shareholders' equity was stated as US$1.2bn. The market capitalisation at the year-end amounted to about £2.7bn having peaked a few weeks before at £3.8b.

The deal with Biochem Pharma, a company that tended to focus on preclinical and clinical development, surprised some parties because of Shire's previous strategy of staying at arm's length from research.

But, Biochem Pharma had high profitability owing to its previous successful development of 3TC, as a result of which it derived substantial royalties from GlaxoSmithKline, the licensee, a pipeline and no substantive sales operations itself. Shire presented the merger as the combination of two complementary companies. By mid-2001, the merger was complete although the senior management team was derived mainly from Shire; the market capitalisation of the combined company was in the order of £5.5bn.

Shire is now in a strong position. It does not have the financial firepower of a pharmaceutical major, or even of Elan, but its revenues appear to be growing rapidly and it is profitable on a pre-exceptionals[14] basis. The company now has a significant late stage (Phases II and III) clinical development portfolio and also Biochem's earlier stage capabilities; so, Shire is now in a position to choose additional projects that match the market sectors that it focuses upon.

Other examples of consolidation

The three examples reviewed above are all companies that have, it appears, carried out successful corporate development through aggressive mergers and acquisitions (M&A) activity and have achieved good returns for their shareholders. All three have their headquarters on the eastern side of the Atlantic Ocean but this is not to suggest that successful M&A activity does not occur in the USA.

Three examples of US companies that have been pro-active and, at least to date, successful in carrying out some consolidation are Valentis, Genzyme and J&J. These three examples (from many potential candidates) have been chosen because they are different types of company.

Valentis is still an early stage company without products, though its pipeline is strong. It was formed by two companies (Megabios and GeneMedicine) joining together and then purchasing Polymasc, a UK-listed company with complementary technology. This is a clear attempt to build core capabilities by M&A.

Genzyme is one of the longer established biotechnology companies. It has been distinctive in the financial mechanisms it has used to fund a wide range of technology developments and it has brought products to market. In addition, Genzyme has not hesitated to make acquisitions that strengthen its position; in 1997 it purchased Pharmagenics and in 2000 it bought Geltex. As this paper was going to press, Genzyme also acquired Novazyme.

J&J is a large diversified company with healthcare and other interests which has the financial strength to buy into new technologies. It has always had a significant position in OTC products and also an interest in ethical pharmaceuticals through its ownership of Janssen. More recently, it has purchased Centocor and Alza.

It should be noted that there has been considerable cross-border acquisition activity with US firms buying UK firms (Sequenom/Gemini, Incyte/Hexagen and Geron/Roslin Biomed for example) but this is not by any means a one-way traffic (viz. Chiroscience buying Darwin, CeNes with Cambridge Neuroscience and Celltech buying Cistron) and other countries are involved (eg Germany's Lion buying USA's Trega). In the CRO sector, Quintiles has been a busy acquiror, picking up at least 11 companies between mid-1997 and mid-2000.

But, there is no doubt that many companies have stepped into M&A activity and suffered problems as a result. Some entered into the activity for the wrong reasons and others made the wrong choices. Perhaps they were companies and managements that were doomed to fail anyway.

The general strategic context

In the early days of biotechnology (mid-/late 1980s) the aim of many managements was to develop a fully independent pharmaceutical company (FIPCO), something no company had really achieved since Syntex, which was founded in the late 1940s. Amgen can reasonably be assumed to

have reached that status but even Genentech and Chiron did not make it (both had to concede an effectively controlling equity stake to Roche and Ciba-Geigy (now Novartis) respectively. It was in the early 1990s that managers and analysts conceded that FIPCO status was not a realistic prospect for biotechnology companies growing organically and so increasing attention was paid to the partnering model.

But, as the number of pharmaceutical majors has decreased, through cost-saving mergers, and the number of biotechnology companies has increased the ratio has become even more unfavourable and the risks associated with partnering have become larger. Despite the view that pharmaceutical majors have potential product famines, the logjam they face is more in development and registration than in the number of available product candidates. They will continue to take options to new products but the chances are that they will also drop more of them when they have to focus on a small number of products for late stage development.

Fortunately for many smaller biotechnology companies, a second tier of candidate partners has been constructed through growth promoting and value adding mergers. (It is interesting to note that pharmaceutical/pharmaceutical mergers are always justified as cost saving while biotechnology/biotechnology mergers are stated to be growth oriented.) Elan, Celltech, Shire and Genzyme are clearly examples of companies that have stepped above the critical mass threshold.[15] Over the past few years, they have moved from relatively impoverished status, probably sub-critical and sometimes also suitors of the majors, to being natural ports-of-call for the smaller companies seeking both funds and development and marketing expertise. Indeed, there are now several companies that can perhaps be considered as nearly-FIPCOs. They have achieved this by M&A as much as, if not more than, by organic growth.

Rapid technology development, usually initially in universities, public sector research bodies (NIH in USA and MRC in UK) and major charities such as the Wellcome Foundation, predicates that many new companies will be formed (though it is interesting to note that Ernst & Young's regular reports suggest that the number of US biotechnology companies has remained constant at around 1,300 for several years; there, at least, the rate of new company formation is comparable to the combined rate of acquisition and various forms of demise).

Clearly, as the examples in this paper have shown (and it is recognised that the activities of three companies, plus some brief summaries, do not represent a statistically valid sample and can only be considered as exemplars), the financial markets are willing to recognise managements that deliver feasible development strategies making appropriate use of mergers and acquisitions and to mark up their share prices accordingly. But, on the other hand, the markets are quick to punish managements that promise more than they deliver or that cannot achieve viable strategies, whether by acquisition or otherwise.

The future

Looking forward, it is impossible to conceive that some 4,000 biotechnology companies can all have successful independent futures. Some degree of consolidation is inevitable. There are effectively two ways in which it can happen. Either, companies will enter distress situations, their managements will be dismissed and their investors will get what they can in a fire-sale of the assets, or, investors and managements will work together to secure companies with a realistic chance of long-term survival.

For the latter to happen rather than the former, the factors that may impede M&A activity have to be addressed. Two factors that appear to be particularly important are:

- venture capital investors always invest for capital gain; agreeing that an investee company should be taken over before that capital gain has emerged in the desired

amount is not necessarily an attractive option (and even less so if a book loss is crystallised); moreover, they are often in illiquid situations and do not have the option of running down their holdings in the way that investors in the public markets can;
- managements usually believe (understandably, but not necessarily realistically) that they are better than others and in a merger (or acquisition) one management team is likely to come out on top; moreover, sometimes the full range of share options may not be available.

There have been many reports that management is the single most obstructive factor to coherent M&A activity. It is accepted wisdom that the first GlaxoWellcome and SmithKlineBeecham deal failed because neither CEO was prepared to give way; two years later, one had retired and the other was willing to accept the post of non-executive Chairman (and also a prestigious university rectorship) leaving the top management post to an agreed candidate. Ben McGraw, the CEO of Valentis, was reported to have said at a conference of CEOs discussing M&A activity 'the problem is us' and the Celltech and Chiroscience merger is reputed to have become possible because the CEO of the latter wished to move to another company and a second director had expressed his intention to retire. (The author was present in an academic forum when a former director of Chiroscience explained the sequences of events in considerable detail, including confirmation of the summary indicated here.)

For consolidation to become more common, there has to be a general recognition that:

- it is essential if strong companies are to develop; organic growth is too slow, given the cash demands for development, and companies may remain sub-critical;
- the management of one of the two companies leaving after the merger is not a sign of failure; indeed, it should be seen as a sign of success that they have brought the company to the state at which it is attractive to others;
- there are managers who are fitted to run larger stronger companies and others who are better at the difficult task of starting a small company and energising it until it is an attractive prospect.

Consolidation activities would happen more frequently if investors, particularly venture capital firms but also major investors through the public markets, rewarded some managements by converting them into serial entrepreneurs able to earn their wealth from several short assignments rather than one long one. While there are some examples of this type they are relatively infrequent.

References and notes

1. Pilling, D. and Hall, W. (2001), *Financial Times*, 8th May.
2. The precise number is difficult to quantify, partly because it changes almost daily, but standard industry sources (eg Ernst & Young) suggest some 1,300 companies in the USA and approximately 1,600 companies in Europe. Allowing a mere 400 for Canada, 100 for Australia and 500 for the rest of the world leads to a conservative worldwide estimate in the order of 4,000. But, it should be noted that that the author has heard speakers at conferences suggest that the USA alone accounts for as many as 3,000 companies.
3. Amgen Annual Report 2000.
4. Interestingly, as this paper was being prepared, GSK announced the sale of Affymax to venture capital investors; Affymax's combinatorial chemistry techniques are now embedded throughout the larger company.
5. Abrahams, P. (2001), *Financial Times*, 21st June.
6. Xenova's merger with Cantab Pharmaceutical followed a major setback in the latter's relationship with GSK following a failure in a clinical trial of its lead product, a vaccine for genital warts. Ironically, just a few months earlier, Cantab had been attempting the acquisition of Peptide Therapeutics (now Acambis) which managed, at seemingly the eleventh hour, to secure a partnership deal with Baxter Healthcare. Also, some years before, Cantab's own partnership with Baxter, involving an antibody product for transplant rejection control, collapsed and triggered a catastrophic fall in Cantab's share price – indeed at one moment, its cash in the bank exceeded its market capitalisation.
7. Moscho, A. and Leiter, J. M. (2001), 'Perfect partnering', *Nature Biotechnol*, Suppl. to Vol. 19, p. BE21–22.

8. Williams, A. (1999), 'Is partnering an opportunity for a biotechnology company to grow or does it create risk?' *J. Commercial Biotechnol.*, Vol. 5, no 1, pp. 12–20.
9. Williams, A. (1999), 'Consolidation', *J. Commercial Biotechnol.*, Vol. 5, no 2, pp. 106–112.
10. Parker, S. (2000), 'Consolidation – The biotechnology prescription for success', *Europ. BioPharm. Rev.*, March, pp. 26–30.
11. Editorial (2001), *Nature BioTechnol.*, Vol. 19, no. 7, p. 597: 'only a matter of months ago . . . many biotechnology mergers appeared to be last-ditch acts of desperation'.
12. At the bottom line, Celltech made a substantial loss in the year to 31st December, 2000. However, it is fair to say that the main factor underlying the size of the loss was a write-off of goodwill following the Medeva acquisition. Annual amortisation of the remainder of the goodwill may prevent Celltech from reaching bottom line profitability for a year or two, even though it seems likely to earn a profit at the operating level.
13. See, for example, *Financial Times*, 6th March, 2001.
14. The pro-forma historical accounts issued by the company in July 2001 suggest that net income would have been ca US$210m on revenues of US$671m. In the year 2001, the year in which the merger was consummated, there may be exceptional expenses as indicated in the half year figures released in July 2001.
15. One may reasonably ask what critical mass is. In one sense, the answer is circuitous, 'big enough to survive'. However, it seems plausible to suggest that a more exact definition can be reached in terms of numbers of employees, numbers of pipeline products or some combination of metrics. A research project to define critical mass would be very interesting but is (regrettably) beyond the scope of this paper.