Kintan Pty Ltd

VENTURE CAPITAL INVESTMENT IN TRANSFORMATIVE SCIENCE

The investment philosophy of Kintan Pty Ltd

N D Birrell

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1. Introduction

To succeed in investment it is essential to have an investment philosophy, namely a belief as to why investors can achieve their objective by investing in a particular way. This is especially important when the investment approach involves taking a risk that the investment objective will not be met.

For example, if the investor's objective is to achieve a rate of return of at least 2% per annum over inflation over a 10-year period, then one investment approach to achieving this objective is to invest in 10-year inflation indexed government bonds at a yield to maturity of say 2.5%. Then, the only investment philosophy required is to believe that the government will not default on meeting its obligations on the bonds over a 10-year period. If, however, the investment approach is to invest in listed shares, then the investor should have an investment philosophy that rationalises why this approach justifies the risk that shares are not guaranteed to meet the return objective.

In the case of venture capital, one does not often see well stated and rationalised investment philosophies. Of the 28 Australian Venture Capital Association[1] (AVCAL) members who, at the time of writing, are listed as having an interest in early-stage venture investing, only a handful have a well formed statement of investment philosophy on their web site. This, of course, does not mean that the others do not have one, but they do not publish on their site what their objective is and why they believe that they can achieve it doing what they do.

This document sets out the investment philosophy of Kintan Pty Limited. A simple statement of the philosophy is as follows:

Investment in a diversified portfolio of transformative science based companies with strong intellectual property protection and experienced, high quality management will deliver high risk-adjusted returns to investors.

In the following sections, after making some general observations about venture capital investment objectives, the above investment philosophy is explained in detail.

2. Venture Capital Investment Objectives

Investors in venture capital typically invest with the expectation of "making money" from their investment, but what does that mean? One of the AVCAL members mentioned above states its objective as being to achieve a "capital gain". Would they claim success for their investors if an investment of $100 returned $101 in five years? It is likely that more clarity of goals would be required by most investors.

[1] http://www.avcal.com.au

An investment in venture capital is an investment in ownership of a company or portfolio of companies, in many ways like owning shares in companies that are listed on the stock exchange. Indeed, the main difference between venture capital investment and listed company investment is that venture capital investments do not have the liquidity provided by being traded on the stock market (nor the transparency of public reporting that is required for such liquidity). Seed and early-stage venture capital investments are also typically in companies at an earlier stage of development than stock exchange listed companies, but for venture capital (or private equity) in general this need not be the case.

The overall reason for investing in a venture capital portfolio should thus be similar to the reason for investing in listed companies and, generally, the investment rationale that applies to the inclusion of listed companies in an overall investment strategy should also apply to venture capital investments. For example, if listed companies are included in a pension fund investment strategy because over the medium to long term their returns are expected to exceed inflation by a margin, then this might also be the rationale for including venture capital investments.

Investment in venture capital however provides additional features not found in listed investments. Small size associated with an early stage of development and lack of liquidity have already been mentioned. Access to industry sectors and technologies not represented in companies listed on the stock market is another. These features of venture capital investment can also mean that the returns from a venture capital portfolio can behave differently over a given time period to returns from a portfolio of listed companies over the same period[2]. Statistically, this difference in behaviour is evidenced by relatively low correlations between returns from venture capital investment and investment in listed stocks, a characteristic which is beneficial for the diversification of risk in an overall investment strategy[3].

The correlation between venture capital investment and the listed equity market is so small that using the equity market as a benchmark for an objective for venture capital investment does not make a great deal of sense. For example, a benchmark of outperforming the S&P200 index of Australian shares by some margin over a three-year time period would not be a very useful objective.

In the following, only investment in early and mid-stage developed companies will be considered. Investment in such companies is "risky" by almost any reasonable measure of risk. The work by Cochrane[2], using volatility of returns as a measure of risk, shows that for venture investments the bulk of the risk comes from company specific, idiosyncratic risk, rather than market or systematic risk. Other research gives similar results.

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[2] For an excellent recent paper on empirical evidence on US venture capital risk and return, see "Risk and Return of Venture Capital", John H Cochrane, Journal of Financial Economics, Jan 2005 http://www-gsb.uchicago.edu/fac/john.cochrane/research/Papers/venture.pdf

[3] An optimal allocation to venture capital in an equity portfolio is estimated at between 2% and 9% in "Venture Capital and its Role in Strategic Asset Allocation", Chen, Baierl and Kaplan, Journal of Portfolio Management, Winter 2002

Given these findings, a reasonable objective for venture capital investment is to obtain an absolute return that is commensurate with the risk of such investment. An "absolute return" is considered to be one that is independent of the return on the market (e.g. the S&P200 index). Further, given that the risk is high, the absolute return level is also expected to be high. For example, Cochrane[2], in his sample of venture investments in individual companies, finds an arithmetic average return of 59%/annum with a standard deviation of 107%/annum, while Chen et al.[3], in their sample of venture capital funds, find similar results of 45%/annum average and 116%/annum standard deviation.

A point of importance to note in the figures just quoted is that they are arithmetic returns. In many applications the distinction between arithmetic and geometric average returns can be considered an esoteric topic, of interest to only dedicated financial analysts. In the case of venture capital returns, the very high volatility levels result in large differences between the two types of averages and it is worth being clear on how to interpret each type of average. A good explanation of the difference is given in a New Zealand Treasury working paper[4]. Quoting from the Conclusion of that paper,"…the geometric average [return] provides a measure of the annualised proportional change in wealth that actually occurred over a past time series, as if there had been no volatility in return. However, for applications that involve future projections or other prospective analyses, expected geometric return has limited value and often the expected annual arithmetic return is a more relevant statistic for modelling and analysis."

Returning to the historical venture capital returns of the two papers just quoted, the geometric returns are 15%/annum and 13%/annum respectively, which in both cases is close to the return on the US S&P500 large stock market index over the same periods. Thus, an investor would have received roughly the same amount of accumulated wealth from investments in US venture capital or the large stock index over these time periods.

Cochrane[2] explains his results by pointing out that "venture capital investments are like options; they have a small chance of a huge payoff." In this respect they are also like highly geared, more mature companies. Of course, the risk-return numbers quoted above are for large samples of varied types of venture capital investments. There are large variations in returns dependent on investment stage and from one venture capital firm to another[5]. Indeed, venture capital investing produces probably the highest dispersion between top quartile and bottom quartile managers of any asset management discipline[6]. The point is also made in Table 1 below, which extracts some data from Lerner's[5] data on funds formed pre-1999:

[4] "Geometric Return and Portfolio Analysis", Brian McCulloch, New Zealand Treasury Working Paper 03/28, http://www.treasury.govt.nz/workingpapers/2003/twp03-28.pdf

[5] See, for example, "Smart Institutions, Foolish Choices? The Limited Partner Performance Puzzle", J Lerner et al., http://www.people.hbs.edu/jlerner/SmartInstitutions.pdf especially Table 1

[6] See Pioneering Portfolio Management: An Unconventional Approach to Institutional Investment by David F Swensen. Table 4.4 shows a top quartile to third quartile dispersion of 21.2% compared with 2.5% for US Equity.

Funds Type	Number	Mean IRR %	S. Dev. %	Min. IRR %	Med. IRR %	Max. IRR %
All	341	23.9	59.1	-94.2	10.5	513
Early Stage VC	71	60.5	99.6	-66.8	27.9	513
Later Stage VC	134	25.6	45.2	-38.8	14.4	268.4
Buyout	136	3.1	21.8	-94.2	3.1	57.9

Table 1. Fund Performance

3. Kintan's Objective

Kintan's investment philosophy involves providing high risk-adjusted returns to investors. This does not mean providing high returns simply resulting from the risk associated with venture capital investment being high, but rather providing a return that is high after allowing for risk. The distinction is important.

In a very interesting research paper[7] Jones and Rhodes-Kropf show that investors in venture capital and buy-out funds are on average compensated for risk but that is all. To quote from the paper, dealing with returns net of fees: "…in our large sample we find that fund investors do not earn positive alphas on average. Buyout funds have a value-weighted IRR of 4.57%, and venture capital funds have a value-weighted IRR of 19.31%, but these are commensurate with the factor risks that these investors bear (i.e., the alphas are insignificantly different from zero)."

Of course, in the universe of venture capital managers there will be those who provide positive alpha (or value add for risk taken) and those who provide negative alpha. It is Kintan's intent to be a manager which provides a positive alpha to investors after fees. Having said that, it is difficult with one manager over even moderate time periods to determine if they are adding statistically significant positive alpha. This is the case even for listed share fund managers and it is particularly the case for venture capital managers given the large intrinsic risk and illiquidity in their portfolios.

Nevertheless, it is possible to put in place an investment philosophy and process which, if implemented with appropriate skills, is designed to achieve the objective of obtaining a high risk adjusted return. Before turning in subsequent sections to describe this investment philosophy, it is worth considering by way of contrast, an approach which might lead to the appearance of success but which is really not adding value for clients.

Suppose that a venture capital manager has the skill necessary to raise a fund with a reasonable amount of money in it. Suppose further that he sets a few criteria for selecting investments, such as early-stage biotechnology, must have a patent and must have a company manager with some industry experience. Not a great deal of skill is required to apply these criteria but it may require some skill to convince entrepreneurs to decide to accept an investment from the venture capitalist. Assume that he has this skill and that he puts together a portfolio with a number of investments meeting his criteria. In a theoretical sense he has constructed a

[7] "The Price of Diversifiable Risk in Venture Capital and Private Equity", Charles M Jones & Matthew Rhodes-Kropf, http://www0.gsb.columbia.edu/faculty/mrhodeskropf/papers/VCRiskReturnRFS.pdf.

portfolio with a range of risk factors that will typically generate a high level of idiosyncratic risk. Now, being unkind to our venture capitalist, given that we have assumed that he has not exhibited a great deal of skill in selecting investments, what he has in effect created is a casino. Depending on which way the dice rolls, it may produce a large return, commensurate with the risk being taken. Alternatively, it could fail.

One characteristic of a successful outcome might be that a large proportion of the portfolio investments fail and one or two strike it lucky with big returns. This is in keeping with the quote from Cochrane[2] above that "venture capital investments are like options; they have a small chance of a huge payoff." Indeed, it is almost folklore that a venture capital portfolio will have quite a large percentage of failures, a large proportion of "living dead" and modest successes and a small number of great successes. On average, this is borne out by data. The following table is an extract from Table I of Hochberg et al.[8] covering venture capital funds formed in the USA between 1980 and 1999:

	No.	Mean	Std. dev.	Min.	Median	Max
Exit rate (% of portfolio companies exited)	3469	34.2	29.2	0	33.3	100
Dollar exit rate (% of invested $ exited)	3411	35.8	32.3	0	30.6	100

Table 2. Fund exit rates

While the mean figures support the folklore, there is clearly enormous dispersion between funds, just as there was in Table 1 for fund IRR, with some funds having very high exit rates[9]. There is thus no reason to aspire to performance in line with the folklore.

Kintan's objective is to invest in a portfolio of companies that perform with a higher degree of consistency than the outcomes just discussed. All of the investments in the portfolio are expected to provide returns at least commensurate with the risk that is an intrinsic part of investing in relatively early-stage development. The objective is to avoid failures and "living dead". There will inevitably be some failures but they are not taken for granted. There may be some "blockbuster" outcomes but that will be as much a result of luck as of skill. We would expect that returns at least commensurate with risk in the order of 20-50%/annum will be achieved at a fund level, depending on the detailed characteristics of the composition of the fund and point of the economic/market cycle[10].

[8] Hochberg, Yael, Ljungqvist, Alexander and Lu, Yang, "Whom You Know Matters: Venture Capital Networks and Investment Performance",(September 2005. http://ssrn.com/abstract=631941

[9] Note that an exit can be made at an undesirably low IRR, so exit rates probably over-estimate success.

[10] There are clearly time related variations in returns from venture capital. See for example Table 1 Panel E of Lerner et al. (footnote 5).

4. Diversification

Part of Kintan's investment philosophy statement involves "investment in a diversified portfolio…". This section elaborates on the reasons for diversifying.

The general reason for seeking diversity in venture capital investment should be clear. The idiosyncratic risk in a given investment is very high and diversification reduces this risk at a portfolio level[11]. Another way of looking at this, is if the folklore outcome of the previous section is stylised as[12] 40% total losses, 30% "living dead" and 30% good returns on investment, then the portfolio needs to be sufficiently large to ensure that there is a high probability of receiving the good returns from 30% of the portfolio.

Of course, it can be argued that an institutional investor can achieve such diversification by investing in a number of funds of different venture capitalists or by investing in a fund-of-funds. This is indeed the case, however, there are also reasons for an individual venture capitalist to diversify. These reasons relate to a range of factors, that are well covered by research, including the venture capitalist having more information on the nature of risk than his/her client and agency issues between client, venture capitalist and entrepreneur (see Jones and Rhodes-Kropf[13]) and optimal use of the venture capitalist's resources (see, for example, Kanniainen and Keuschnigg[14]).

Agency issues between investor, venture capitalist and entrepreneur are extremely important and the work of Jones and Rhodes-Kropf sheds light on many critical issues in the relationships between the three parties. One interesting corollary of their work relates to the option-like "carried interest" arrangements which form an important part of the reward of venture capitalists. Jones and Rhodes-Kropf show why the typical United States approach of the venture capitalist receiving a carried interest once the investor has received back their initial investment makes sense from an agency theory point of view. They also explain how having a higher hurdle before the carried interest cuts in will tend to lead the venture capitalist to take more risk (for example, by lower diversification) that is not necessarily in the best interests of the investor. Such a higher hurdle rate is the norm that has developed in Australia. Whether it is leading to sub-optimal risk profiles does not yet appear to have been researched.

In the previous section, it was stated that Kintan's objective is to invest in companies that perform with a higher degree of consistency than the stylised results presented above. Why then do we still aim for a diversified portfolio? Part of the reason relates to optimal allocation of resources. There is only so much

[11] For a report on recommendations on using venture capital in an institutional (e.g. pension fund) setting, including the need for diversification, see "UK Venture Capital and Private Equity as an Asset Class for Institutional Investors", O Burgel, London Business School, 2000, http://www.bvca.co.uk/publications/assetclass/assetclassfull.pdf.
[12] See, for example, "Venture Capital Overview", http://www.jbv.com/lessons/lesson20.htm.
[13] Op. cit. see footnote 7.
[14] "The optimal portfolio of start-up firms in venture capital finance", V Kanniainen and C Keuschnigg, Journal of Corporate Finance, 9, 2003, http://www.iff.unisg.ch/org/iff/iffweb.nsf/SysWebRessources/IFFDP0105/$FILE/IFFDP0105.pdf.

assistance that can be provided by a venture capitalist to one company without a diminishing return. A more subtle reason relates to an aspect of venture capital investment that has only been touched on thus far, namely that having the opportunity to finance attractive deals can be a highly competitive process.

Although one can get the impression from the financial media that it is depressingly difficult for an entrepreneur to attract venture capital[15], for really exciting and attractive deals, quite the opposite can be true, with the entrepreneur getting to pick and chose between venture capital firms. There are many factors that can affect the entrepreneur's choice but clearly relative cost of funds is a very important one. Thus, a venture capitalist who can offer a relatively low cost of funds will be at a competitive advantage in winning attractive deals, every thing else being equal. One way in which this can be done without compromise is by having diversified away more idiosyncratic risk than competitors, who will have to charge more for the extra risk that they bare. This is well explained in the paper by Jones and Rhodes-Kropfs .

Kintan's investment philosophy involves thinking carefully about an optimal portfolio structure to make best use of resources available to assist portfolio entrepreneurs and to reduce avoidable idiosyncratic risk. For example, no matter how much skill and due diligence is devoted to making an investment in a company founded on stem cell research (see section 9), there is a risk that international government regulatory action could severely damage the prospects for the investment. It makes sense to limit this risk by limiting the number of portfolio companies involved in such research.

In practice, the extent of diversification, as measured by number of portfolio investments, results from some fairly simple arithmetic based on the productivity of the venture capitalist and the desirable time period over which a fund should be fully committed. For early stage investment, an individual venture capitalist might be able to handle 2-4 new companies per year, recognising that there will likely be multiple investment rounds for each company requiring attention for a number of years. If the desired time frame for committing the fund's assets (allowing provision for multiple rounds) is 3-4 years, then the number of portfolio investments for one venture capitalists will end up being in the range 6-16. Multiply this by the number of individuals working on the fund and one has the total number of portfolio investments. Assuming 1-2 full time equivalent venture capitalists per fund, one obtains the number of portfolio investments in the range 6-32, which is consistent with observed data[16].

[15] See, for example, "Global Ambitions", The Age, February 14, 2005, http://www.theage.com.au/news/Management-Focus/Global-ambitions/2005/02/14/1108229910082.html

[16] See, for example, "Determinants of Venture Capital Performance: Europe and the United States", U Hege and F Palimino, LSE Working Paper 2003, http://lse.ac.uk/collections/RICAFE/pdf/RICAFE-WP01-Hege.pdf and "The Determinants of Venture Capital Portfolio Size: Empirical Evidence", D Cumming, Journal of Business (forthcoming), http://www1.fee.uva.nl/fm/people/bachmann/seminar/020123Cumming.pdf.

5. Structural change as a source of risk adjusted return

The previous sections set out Kintan's objective in venture capital investment. In this section a key concept of the investment philosophy related to achieving the objective is explained. This is the concept of structural change as a source of high risk adjusted returns.

It is obvious that if all investors could foretell the future, there would be no risk in investing and all investments would receive the risk free bond rate. In a very important body of work[17], Mordecai Kurz takes this a step further. If investors are not able to foretell the future with perfect accuracy but from past information they are able to deduce the statistical characteristics of the process driving asset price returns, then their expected excess return from investment is zero. This is not what we want. Our investment philosophy would not be compatible with such an outcome.

Fortunately Kurz's great contribution is a theory of asset prices, known as the Theory of Rational Beliefs, which allows excess returns to occur. The theory also provides a number of other significant contributions, such as explaining the size of the equity risk premium[18]. The essence of Kurz's theory is that structural changes occur in the system that is driving asset prices. Thus relying on the statistical characteristics of past asset price movements does not guarantee that the future price movements will be determined by a process with similar characteristics. A rational investor will develop a model of the future that is compatible with the past but there are many such models and this diversity of beliefs about the future is what drives asset prices in a way that allows excess returns to be achieved.

By not correctly forecasting or detecting structural change, investors can make "mistakes" in asset pricing for long periods of time. Kurz[17] uses a fascinating example to illustrate this point and to explain one of the strangest periods of US market history. In 1966, the Dow Jones Industrial Index of US shares reached the 1000 level but did not close above it. For the next 17 years, the index fluctuated in a band from 600 to 1000 but did not close above 1000 until 1983. In the same period, the general level of prices in the US, as measured by the Consumer Price Index, rose by a factor of 3. The result of this was that over the 17 year period, the stock market, as measured by the Dow, declined by 71% in real terms, a devastating effect for people saving for retirement over that period. Kurz explains in detail the structural changes that occurred in the US economy and society to result in such a market pricing mistake.

Forecasting or detecting structural change is consequently an important part of investing generally. It is also a way to set about adding value in an investment process. Indeed, it has been at the heart of the author's investment philosophy for

[17] See for example, "Asset Prices with Rational Beliefs," Chapter 9 in a monograph entitled "Endogenous Economic Fluctuations: Studies in the Theory of Rational Belief", Mordecai Kurz (ed.) Springer series in Economic Theory, No.6, August 1997. http://www.stanford.edu/~mordecai/

[18] "The Equity Premium is No Puzzle " (with A Beltratti). Chapter 11 in "Endogenous Economic Fluctuations: Studies in the Theory of Rational Belief", *op. cit.*

many years[19]. It is not, however, an easy matter to detect or to forecast correctly structural change at an economy or society wide level and then take advantage of it in the capital markets. Even if a structural change is correctly forecast, working out the implications for an individual market or company and the extent to which the change is reflected in prices is difficult. In particular, one needs to form a view on the extent to which the remainder of the market has correctly forecast the structural change.

The situation with venture capital is rather more favourable due to three very significant factors:

i. The market consists of the Entrepreneur and a usually small group of other venture capital investors;
ii. The fortunes of the investment can be related to structural change very specifically, given the normally very narrow domain of interest of the investee company;
iii. It is possible for venture capital investee companies to be the cause of structural change in their domain.

The first of these allows for excess returns to result because, even if he/she correctly foresees a relevant structural change, the Entrepreneur may only be able to find a very limited number of investors with a similar view and prepared to back the company.

The second point means that it is easier to find a linkage between a forecast structural change and the economic impact that it will have on the fortunes of the company.

The final point, which will be explained further in the next section, means that the difficult job of forecasting structural change at a broad level is replaced by the task of determining whether what is being done by the investee company is a potential source of structural change in its domain.

Of course, even allowing for these factors, extracting excess returns from venture capital investment is not an easy business. As in so many fields, specialisation can help greatly in the development and application of effective skills and this is especially the case in investment. Kintan's investment philosophy is based on forecasting or detecting a particular type of structural change, namely that caused by transformative science. That is the topic of the next section.

6. Transformative science

A generally very useful article entitled "Keys to Successful Venture Capital Investing: Due Diligence"[20] states:

[19] See, for example, "Investment Philosophy", N Birrell & C Macek, County NatWest Investment Management Limited, January 1995.
[20] A sample chapter http://www.phptr.com/articles/article.asp?p=102237&rl=1 from "Venture Capital Investing: The Complete Handbook for Investing in Private Businesses for Outstanding Profits", D Gladstone & L Gladstone, Financial Times Prentice Hall 2003.

"The product or service should not be revolutionary; rather, it should be evolutionary. We suspect that most VCs would not have backed Edison's new invention, the electric light bulb, because it was too revolutionary. Revolutionary products change the way human beings live on Earth. As a result, they take many years to gain public acceptance, and the return on investment is stretched out over such a long period of time that the annualized return on investment is too low for most investors. VCs don't want to wait 20–25 years."

This statement is somewhat misleading. Edison's invention of the electric light was revolutionary but it was also the evolution of previous work by others that had failed to create a practical electric light. Further, Edison was funded by venture capital and indeed by one of the greatest venture capitalists of all times, J P Morgan, who made a large amount of money out of his investment in a time frame that would be quite acceptable to modern venture capitalists. A debunking of myths such as the above about Edison is given in an excellent IEEE article[21]. A good account of J P Morgan's involvement with Edison is given in the outstanding biography of Morgan by Jean Strouse[22].

Edison's invention of a practical electric light is an example of transformative science. In this case, the invention changed society and the global economy in myriad ways[23]. The invention caused a structural change of mammoth proportions with consequent opportunities for excess returns on investment, for J P Morgan and others, and losses, for example, for investors in gaslight companies.

The Edison case is an example of an inventor working on an invention and taking it to venture capitalists who recognised its transformative nature and backed it. Investment in transformative science also provides an avenue for venture capitalists to be proactive in seeking out investments as a result of researching the state of science versus the needs of society. One of the greatest examples of this approach involves venture capitalist Robert Swanson, dubbed "The Father of Biotechnology". The following is an extract from an interesting tribute to Swanson on the Spirit of American Innovation website[24]:

"In 1976, Swanson worked for a venture capital company, which helped start new, high-risk electronics businesses. Swanson read about gene splicing and thought it could be used to make much-needed medical products. He convinced one of the developers of the technique, Herbert Boyer of the University of California–San Francisco, to join him in founding a company. Boyer and Swanson invested $500 each to start Genentech. Within two years, company scientists figured out how to produce human insulin inside bacteria cells using the new technology. They went on to make human growth hormone and become a model for other companies."

Both of the companies created as a result of these venture capital investment examples continue to prosper. General Electric, one of the world's largest and most successful companies, is a direct descendent of the company founded by Edison and backed by Morgan, and Genentech now has a market capitalisation of over $US100 billion.

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[21] "Underrated Entrepreneur – Thomas Edison's overlooked business story", *"IEEE Power & Energy Magazine" Vol. 3, No.1, January/February 2005*, reproduced at http://ieee.cincinnati.fuse.net/reiman/03_2005.htm

[22] "Morgan – American Financier", Jean Strouse, Random House 1999.

[23] See, for example, "Lighting a Revolution – Consequences of Edison's Lamp" http://americanhistory.si.edu/lighting/19thcent/consq19.htm

[24] http://www.thetech.org/nmot/detail.cfm?id=98&st=awardDate&qt=1999&kiosk=Off See also Business Week, The Great Innovators series, October 18 2004, "Robert Swanson and Herbert Boyer: Giving Birth to Biotechnology", http://www.businessweek.com/magazine/content/04_42/b3904017_mz072.htm

GE and Genentech are two companies founded from transformative science. We define transformative science as science that can result in a structural change in society, the economy, an industry sector or even the competitive position of a number of companies. Science involves the observation of nature, forming hypotheses on those observations, carrying out experiments to test the hypotheses and forming theories based on the results that allow predictions to be made and tested. Science is transformative when it is clearly differentiated from science that has come before and the new knowledge results in technologies that change what we do or how we do things. Some examples of the types of change that can result are the following:

- Creation of a new activity or market (e.g. the provision of electricity for lighting)
- Creation of a new process or service for existing activities (e.g. drug manufacture using gene splicing)
- Improved quality of life (e.g. bionic ear)
- Improved productivity (e.g. catalytic cracking in petroleum manufacture)
- Changing human behaviour (e.g. oral contraceptives)

A range of further major examples of transformative science is given in Table 3 below.

➢ *Electric Lamp* ➢ **Optically Pumped Laser Amplifiers; Light Amplifiers Employing Collisions to Produce a Population Inversion –** *Laser* ➢ **Process for Producing Biologically Functional Molecular Chimeras –** *Genetic Engineering* ➢ **Semiconductor Amplifier; Three-Electrode Circuit Element Utilizing Semiconductive Materials –** *Transistor* ➢ **Estradiene Compounds -** *Oral Contraceptives* ➢ **Method of and Apparatus for Contacting Solids and Gases -** *Catalytic Cracking* ➢ **Noise Reduction Systems -** *Dolby Noise Reduction* ➢ **Extract Obtainable from the Mammalian Pancreas or from the Related Glands in Fishes, Useful in the Treatment of Diabetes Mellitus, and a Method of Preparing It -** *Isolated Purified Insulin* ➢ **Display Devices Utilizing Liquid Crystal Light Modulation -** *Liquid Crystal Display* ➢ **Apparatus for examining objects by means of penetrating radiation –** *CAT scanning*	➢ **Acetyl Salicylic Acid –** *Asprin* ➢ **Photographic Product Comprising a Rupturable Container Carrying a Photographic Processing Liquid -** *Photography* ➢ **Process for Making Polymeric Products and for Modifying Polymeric Products –** *Polyurethane* ➢ **Fused Silica Optical Waveguide; Method of Producing Optical Waveguide Fibers -** *Optical Fibers* ➢ **Aryloxyphenylpropylamines –** *Prozac* ➢ **Process for Amplifying Nucleic Acid Sequences -** *Polymerase Chain Reaction (Biotechnology)* ➢ **Miniaturized Electronic Circuits -** *Integrated Circuit* ➢ **Cochlear Implant -** *Bionic Ear* ➢ **Alcohol-Catalyzed Cyanoacrylate Adhesive Compositions –** *Superglue* ➢ **Production of pluripotent granulocyte colony-stimulating factor –** *Cancer treatment* ➢ **Optically Anisotropic Aromatic Polyamide Dopes and Oriented Fibers Therefrom -** *Kevlar*

Table 3. Some Transformative Science (Source: Primarily www.invent.org)

It is helpful also to think about examples of what investment in transformative science does not cover. Much of the venture capital investment that took place during the Internet or "dot.com" bubble would not have qualified as transformative science. Even the successful Internet retailers eBay Inc. and Amazon.com Inc. do not qualify as being based on transformative science. The

tremendously successful[25] venture capital funded Google Inc. is a more difficult matter. The question of whether Google's success rests, at least partly, on transformative science, can be abstracted up to the question of whether computer science is science. This is not merely an academic question when it comes to successful investment within the framework of the investment philosophy espoused here. The question is explored in a good article by Denning[26]. From a practical point of view, the question will probably be answered by the next part of the investment philosophy, namely that the company has "strong intellectual property protection". Google holds some key patents[27] related to the technology that it uses and would probably qualify (although hindsight is a wonderful thing!).

Transformative science is inherently amenable to protection by patent, which is the next component of the investment philosophy, as discussed in the next section.

7. Strong intellectual property protection

In order to enjoy excess returns from investment in transformative science, it is not enough to have an invention that satisfies the criteria established in the previous section. It is also necessary to have a monopoly right to exploit the invention. This is the purpose of the patent system, in which in exchange for disclosing the invention, the inventor will receive a monopoly to exploit the invention for a period of time (generally 20 years).

In the language of US patent law[28], any person who "invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent." It should be clear that much of what has been defined as transformative science in the previous section will have the potential to be patentable. In fact, part of the definition of transformative science, namely,

Science is transformative when it is clearly differentiated from science that has come before and the new knowledge results in technologies that change what we do or how we do things,

is almost a subset of the definition of what is patentable.

There is ample academic evidence that there is a connection between strongly protected proprietary intellectual property and market value. A good recent paper containing many relevant references is by Hall et al. [29], who looked at how the number of citations of a patent in other patents is correlated with the value of the

[25] See, for example, "The IPO Afterglow in Googleland", Business Week, August 20, 2004, http://www.businessweek.com/technology/content/aug2004/tc20040820_6742_tc024.htm
[26] "Is Computer Science Science?, Communications of the ACM, April 2005, http://www.cs.mtu.edu/~john/jenning.pdf
[27] For example, US Patent 6,526,440: "Ranking search results by reranking the results based on local inter-connectivity"
[28] See, for example, http://www.uspto.gov/web/offices/pac/doc/general/index.html#patent
[29] "Market value and patent citations", B H Hall, A Jaffe, M Trajtenberg, Rand Journal of Economics, 36,1 Spring 2005 http://elsa.berkeley.edu/users/bhhall/papers/HallJaffeTrajtenberg_RJEjan04.pdf.

company holding the cited patent. A paper by Thomas Hall[30] looks at a range of factors affecting the value of technology companies in both the USA and Europe and finds that while the number of patents held by a firm is not correlated with value, the number of useful patents (defined as providing competitive barriers to entry) is correlated. A further very interesting paper by Lerner[31], looks explicitly at venture capital funded biotechnology companies and shows a correlation between value and the scope of their patents.

There is, however, a long way to go from having transformative science to having exploitable intellectual property with strong protection. The process of obtaining strong intellectual property protection is more appropriately dealt with in a paper on venture capital investment process rather than philosophy, however, some key points are the following:

- The invention must not have been disclosed prior to patent application.
- The patent must make clear the differentiation of the invention from that which has previously been disclosed, either by way of patent or other publication.
- An intellectual property management strategy must be devised to continue to strengthen the protection and value of the overall intellectual property portfolio.

Understanding of the intellectual property protection environment of the invention, in particular versus competitors, is a major part of the due diligence associated with investment in transformative science early-stage companies. Having a strongly defensible intellectual property position can be the difference between making an excess return on investment and losing the investment. Providing input on ongoing intellectual property management is also a way in which the venture capitalist can assist the entrepreneur in protecting and strengthening their asset base.

This brings us to the final component of the investment philosophy, namely management.

8. Management

For a company to create value from strongly protected, transformative science, it additionally requires experienced, high quality management. This final part of

[30] "Law Finance and Venture Capital: The Cost of Capital for High-Tech Firms", Thomas W Hall http://cas.uah.edu/halltw/LawFinVC.pdf

[31] "The importance of patent scope: An empirical analysis", J Lerner, Rand Journal of Economics, Volume 25, No. 2, 1994, http://www.rje.org/abstracts/abstracts/1994/Summer_1994._pp._319_333.html. As an aside, this paper contains an interesting piece of data relevant to the history of Australian biotechnology. Based on an expert survey, the paper lists the 13 most important biotechnology patents from 1973 to 1992. Using Lerner's measure, the second most important of these is an Amgen patent for Human Granulocyte Colony Stimulating Factor (which also appears in Table 3 above). This is a discovery that could be considered to be the blockbuster that got away from Australia (see, for example, the AAS interview with Sir Gustav Nossal, under "A steep commercial learning curve"), http://www.science.org.au/scientists/gn.htm

Kintan's investment philosophy may appear obvious, but there is more nuance to the statement than may at first appear to be the case.

Once an inventor has come up with the transformative science and strong patent protection has been put in place with the help of a clever patent attorney, the task of creating value from the invention rests with the management team. As with many aspects of the business world, previous experience in commercialising technology is highly beneficial in obtaining the best outcome, as is the general quality of the management team.

Since management quality is such a subjective measure, there does not appear to be a great deal of empirical research supporting the (perhaps seemingly obvious) hypothesis that the quality of management is connected with valuation of venture capital funded companies. One recent piece of research, which also references previous papers, is that by Thomas Hall[32].

The reason that the requirement for high quality, experienced management is nuanced, is that once the asset base of transformative science patents and technology has been accumulated, that tends to be the core or heart of the company. This finding has been empirically verified in some very interesting research on the evolution of venture capital funded firms by Kaplan et al[33]. Quoting from the paper's abstract:

"We describe financial performance, the business idea, point(s) of differentiation, non-human capital assets, growth strategy, customers, competitors, alliances, top management, ownership structure, and the board of directors. Our analysis focuses on the nature and stability of these firm attributes. Firm business lines remain remarkably stable from business plan through public company. Within those business lines, non-human capital aspects of the businesses appear more stable than the human capital aspects. In the cross-section, firms with more alienable assets have substantially more human capital turnover."

By "alienable assets", the authors mean assets that can be pledged or sold, including patents. After the initial formative period, companies based on transformative science will tend to have a relatively large portfolio of alienable assets. These assets over the long term will be more important than the maintenance of a particular management team over any period of time.

None of this diminishes the importance of high quality management, but it does show that such management may change and making such changes is a typical role of venture capital companies (see, for example, Kaplan et al. and references therein). Indeed, the selection of high quality management appropriate for the stage of development of the company is a critical skill of a venture capitalist. An excellent study of the different approaches to this task and the success of each has been undertaken by G H Smart[34]. Although this is more a matter for a paper on venture capital investment process, in summary Kintan's approach tends most

[32] Op. cit. footnote 30.
[33] "What are Firms: Evolution from Birth to Public Company", S N Kaplan, B A Sensoy and P Stromberg, NBER Working Paper 11581 http://www.nber.org/~confer/2005/ents05/kaplan.pdf
[34] "The Art and Science of Human Capital Evaluation", G H Smart, 1998, http://www.ghsmart.com/PressPDFs/Human_Capital.pdf.

towards what Smart labels the "Airline Captain" method of human capital evaluation.

9. Case Study

An investment philosophy such as the one espoused here has the tendency to appear quite theoretical in nature, as a result of it being a statement of belief with supporting evidence. For a complete, successful investment operation, the investment philosophy must be implemented in an investment process, namely a practical manifestation of the investment philosophy.

It is not the purpose of this paper to set out Kintan's investment process but it may be helpful to give an example of the application of the investment philosophy by way of a case study. This case study involves Stem Cell Sciences Limited (SCS)[35] in which the principals of Kintan first invested in March 2000, when the company changed from being essentially a "virtual" company, with no employees, as it had been since 1994, to being a fully fledged operating biotechnology company. A second investment was made in 2003. In July 2005 the company listed on the AIM market of the London Stock Exchange at a price giving a return on investment of 18%/annum. Given that the company had been in existence for 6 years at the time of first investment and had generated around $A7 million of revenue, it was not really a start-up in the usual meaning of the term and the return achieved is considered a satisfactory outcome for risk taken, in keeping with the objectives set out in Section 3. The return is also highly satisfactory when compared with returns on Australian Private Equity funds over the 5 years to 30 June 2005 as reported in the AVCAL Yearbook[36]. Funds classified as "Early Stage/Seed/Startup" recorded a -3.6%/annum IRR over the 5 year period, while "Expansion" funds returned +1.2%/annum.

The investment was made on the basis of SCS's holdings of key patents in the field of stem cell technology derived from research carried out at the University of Edinburgh between 1991 and 1993 by the founding scientists, Peter Mountford and Austin Smith. SCS's technology relates to embryonic stem cells, a very special type of cell as described in the following quotation from a US National Institutes of Health introduction to the subject[37]:

> "Stem cells differ from other kinds of cells in the body. All stem cells—regardless of their source—have three general properties: they are capable of dividing and renewing themselves for long periods; they are unspecialized; and they can give rise to specialized cell types."

Harnessing of these properties gives rise to a vast range of potential transformative science in the areas of drug discovery and therapeutics. In the case of drug screening, good practical progress has been made with the use of stem cells. In the case of therapeutics, there is still quite a long way to go but the prize is enormous, with potential to cure a wide range of currently incurable ailments.

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[35] The Stem Cell Sciences web site is at http://www.stemcellscienceslt d.com/

[36] "Australian Venture Capital Limited Yearbook 2005", http://www.avcal.com.au/ftp/yearbook/AVCAL_Yearbook_2005.pdf.

[37] "Stem Cell Basics" at the Official National Institutes of Health resource for stem cell research web site: http://stemcells.nih.gov/info/basics/

In progressing both of these applications, there are two key technological goals[38]:

a) control of stem cell growth (propagating the stem cells without differentiation),

and

b) control of stem cell "differentiation" (transforming non-specialised stem cells into specialised cells, such as brain cells).

These are the keys to the transformative science of stem cell technology. At the time of first investing in the company, SCS held a strong patent portfolio of nine patents related to these goals, which it has subsequently added to and strengthened. One of the patents in place in 2000 is considered to be a critical patent of the sort that were discussed in Section 7 as adding large amounts of value to a company. The patent "Isolation, Selection and Propagation of Animal Transgenic Stem Cells"[39], has seven forward references to its US patent (see footnote 29) and was the subject of a landmark hearing before the European Patent Office (EPO) in 2003, in which SCS successfully defended its patent. This is the largest such hearing in the history of the EPO[40].

At the time of investing, it was clear that SCS had strongly protected intellectual property related to transformative science. The next component of the investment philosophy required ensuring that the company had high quality management experienced in commercialization.

Given that the CEO of SCS at the time of investment had been running the company for a number of years, had successfully negotiated access to key stem cell intellectual property and concluded deals leading to millions of dollars of revenue, the assessment of management was made easier. The company also illustrates the hypothesis on human capital turnover discussed in Section 8 (see footnote 33) in that Peter Mountford, the CEO at the time of investing, was not the founding CEO, even though he was one of the two founding scientists and remains CEO today.

As well as the successful AIM listing in 2005, SCS was acclaimed by Scientific American magazine as a Business Leader in the 2005 Scientific American 50, the magazine's prestigious annual list recognizing outstanding acts of leadership in science and technology from the past year.

SCS is an excellent exemplar of all of the aspects of Kintan's investment philosophy.

[38] Stem Cell Holdings Limited Information Memorandum, March 2005 (unpublished).
[39] Based on WO 94/24274, including US patent 6146888 and EPO patent 695351
[40] See note 38. Also, for example, "Patenting stem cells in Europe", Boult, Wade, Tennant, August 2004, http://www.boult.com/information/BulletinPrint.cfm?BulletinID=64.

IMPORTANT INFORMATION

This document has been produced by Kintan Pty Ltd (Kintan) ABN 85 003 783 257 which can be contacted at 3 Tivoli Place, South Yarra, Victoria 3141, by calling 0419347588 or emailing kintan@kintan.com.

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