

DECIPHERING TECHNOLOGY

TIME TO GET TANGIBLE ABOUT
INTANGIBLE ASSETS – PART 4

JUNE 2023



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The IVSC issues Perspectives Papers from time to time, which focus on pertinent valuation topics and emerging issues. Perspectives Papers serve a number of purposes: they initiate and foster debate on valuation topics as they relate to the International Valuation Standards (IVS); they provide contextual information on a topic from the perspective of the standard setter; and they support the valuation community in their application of IVS through guidance and case studies.

Perspectives Papers are complementary to the IVS and do not replace or supersede the standards. Valuers have a responsibility to read and follow the standards when carrying out valuations.





Background

The introduction of new technology often marks the beginning of a new era: railroads, electrification, and combustion engines produced momentous changes even before the advent of the “digital revolution”. The current wave of innovation is one of the factors behind the rise of intangible assets, which now account for a larger proportion of corporate assets than tangible ones.

This transformation towards more intangible assets has had profound effects on the valuation of assets and businesses. It is the object of the current series of Perspective Papers the IVSC has published. In Parts 1 and 2 of our series, we examined the “Case for Realigning Reporting Standards with Modern Value Creation” and focused on human capital. In Part 3, we examined brands and reputation. In this paper, the fourth of our series, we address the topic of technology valuation.

In this paper we will:

- Define technology as it pertains to valuation;
- Examine the lifecycle of technology and the difficulty of realising certain benefits as commercial profits;
- List the salient features of technology that are critical in a valuation;
- Use Apple’s launch of the iPhone to contrast firm value and value of technology;
- Gauge investor reactions to these developments in the valuation of technology;
- Outline the ways in which IVS can be deployed to better manage technology valuation risk.



Defining technology

In the context of this paper, we define technology as “the application of knowledge for achieving practical goals in a reproducible way.”¹ The word also encompasses the “products resulting from such efforts, including both tangible tools such as utensils or machines, and intangible ones such as software.”^{2 3} The result of a technological advance is to push out the frontier of the possible.

Technology encompasses several intangible assets that evolve over time. These range from fundamental R&D in the initial stages to mature production processes.⁴ The deployment of a technology requires investment to finalise an initial production run (e.g., automobiles), to build infrastructure (e.g., mobile telephony) and to commercialise a finished product.

The lifecycle of technology

Innovation is often less the result of grand plans than of gradual tinkering,⁵ and its final application can vary greatly from its original conceptualisation. For instance, algorithms used to interpret sonar data in oil exploration became the basis for the Autotunes software.⁶ More recently, Virtual Reality (VR) hardware and software have been adapted for use in operating theatres and military applications.

New technology eventually diffuses into the economy as products become available for purchase, improving the features of other products. Today, no one gives the electronics in an entry-level car or the GPS in their phone much thought.

1. Skolnikoff, E. B. (1993). The elusive transformation: Science, technology, and the evolution of international politics (p.13). Princeton University Press.

2. Salomon, J.-J. (1984). What is technology? The issue of its origins and definitions. History and Technology, 1(2), 113-156.

3. Mitcham, C. (1994). Thinking through technology: The path between engineering and philosophy. University of Chicago Press.

4. Many fields of current technological progress involve the accumulation and exploitation of data advances. The valuation of data will be considered separately in a subsequent paper.

5. Nassim Nicholas Taleb suggests constant tinkering to benefit from Black Swans, or rare events, because they are hard to predict. (Taleb, N. N. (2007). The black swan: the impact of the highly improbable. Random House)

6. Eckard, G. (2016, February 26). How an oil engineer created Auto-Tune and changed music forever. Vice.

<https://www.vice.com/en/article/bmaj4d/how-an-oil-engineer-created-auto-tune-and-changed-music-forever-interview-creator>

Technology also becomes cheaper with time: older semi-conductors remain useful but the product becomes structurally cheaper as newer generations are launched. In fact, a technology will eventually become commoditised, or even free, as it is replaced by something new.

Not all value can be realised commercially

Nobel prize-winner William Nordhaus⁷ has estimated that innovators, and their investors, only capture a sliver of the value their innovation creates for society. In fact, one interpretation of this analysis is that investors overestimate⁸ how much of the value they can “appropriate” for themselves.

Nonetheless, given the absolute amount of the potential rewards, it is rational for entrepreneurs and their backers to try to capitalise on an innovation, even if they know that most of the benefits accrue to others. This phenomenon was captured by Scott McNealy's (the CEO of Sun Microsystems) “what were you thinking?”⁹ diatribe as he reflected, after the fact, on his company's stock valuation during the bubble.



7. Nordhaus, W.D. (2004). Schumpeterian profits in the American economy: Theory and measurement. Cowles Foundation Discussion Papers 1733. <https://elischolar.library.yale.edu/cowles-discussion-paper-series/1733>

8. Nesvisky, M. (2004, October 10). Who gains from innovation? NBER Digest <https://www.nber.org/digest/oct04/who-gains-innovation>

9. “At 10 times revenues, to give you a 10-year payback, I have to pay you 100% of revenues for 10 straight years in dividends. That assumes I can get that by my shareholders. That assumes I have zero cost of goods sold, which is very hard for a computer company. That assumes zero expenses, which is really hard with 39,000 employees. That assumes I pay no taxes, which is very hard. And that assumes you pay no taxes on your dividends, which is kind of illegal. And that assumes with zero R&D for the next 10 years, I can maintain the current revenue run rate. Now, having done that, would any of you like to buy my stock at \$64? Do you realize how ridiculous those basic assumptions are? You don't need any transparency. You don't need any footnotes. What were you thinking?” <https://www.bloomberg.com/news/articles/2002-03-31/a-talk-with-scott-mcnealy>

Narrowing down to valuation

The large-scale economic and social transformations brought about by technology percolate down to the process of valuation that professionals conduct, whether in the context of a business valuation (eg, for M&A) or a narrower asset valuation (eg, Purchase Price Allocation).

Investment in technology has two salient characteristics:

- First, the investment itself influences the path of the technology's development and, to some extent, its success. Without enough investment, the technology might not reach the "tipping point" where it sustains a viable business.
- Second, an investment into technology generates highly dispersed returns. These range from a high probability of failure to extraordinary returns reflecting the "winner takes all (or most)" characteristics of successful innovations. Quantitatively, this is partly captured through the high degree of dispersion that technology investing entails, whereby the spread between the top and bottom quartile of stocks in the technology-heavy sectors is much larger than the same spread in other sectors.¹⁰

Both these traits are captured, as part of the valuation of a technology asset, in various adjustments to forecasts and discount rates. Uncertainty is especially high for technology in its initial phases, where changes in inputs can result in large shifts in expected value.

A technology that has achieved commercial success has already avoided failure at launch. However, its valuation is still contingent on several key variables, including:

- What remaining useful life (RUL) or rate of attrition does the technology have?
- What outlays, whether as ongoing capital expenditures or expenses, are required?
- What premium or differential pricing or cost savings will the technology allow? And how long might these persist?
- How does the technology integrate with and separate from other assets?

Overall, improved disclosure about unit economics and enhanced financial reporting, both matters that are important to investors, can help make technology valuations more reliable. This remains true even when the resulting values remain volatile.

10. Mauboussin, M. (2020, April 14). Dispersion and Alpha conversion. [Not all value can be realised commercially](#).

The technological continuum

The valuation of a specific technology is framed by two broad factors.

First, the delineation between and among the technology to be valued, its predecessors, and future iterations. A specific technology should be viewed as a discrete point on a continuum. New technology is seldom one dramatic discovery. Rather, it is built on earlier advances and is often a gateway to further changes, most of which cannot be foreseen. Therefore, one of the challenges of valuing a given technology is to separate it from the earlier technology it was built upon. An analysis of intellectual property may be required, allowing valuers to mark the contours of the technology.

Another, related, challenge is more subtle: a specific technology necessarily contains the seeds of its own evolution. Certain new applications and derivations might be foreseen. However, there are many examples where a new technology creates value by creating optionality and germinating future products that are yet to be invented, like the sonar algorithms that developed into Autotunes.

The second factor is the relationship between the technology and other intangible assets. Just as a specific technology should not be conflated with its predecessors, neither should it be confused with other intangible assets. In a business, technology works closely with other intangible assets such as brands or customer relationships. For example, the distinctive brands of large consumer technology companies routinely support the launch of new technologies. The trajectories of the new technology will depend on the strength of the other assets the firm can deploy.

The valuation community has progressed in developing techniques to evaluate and apportion value creation from various intangible assets. These techniques delve into the operations of companies' activities. However, executives are understandably hesitant to disclose competitive information for fear of losing competitive advantage.

This intermingling of technology with other assets leaves the valuer to identify the principal driver of value creation for the business, a task that requires in-depth analysis.



Firm value vs technology value: Apple's launch of the iPhone

Apple's unveiling of the iPhone on 9 January 2007 illustrates how the value of specific technologies relates to the value of a firm. The "technology" was, in fact, a bundle of assets. These assets included:

- Rights that Apple had acquired from various standard setters and national and international organisations;
- Data that Apple had acquired or collected from its customers' use of its software suite (iTunes, iPhoto etc) and iPod devices;
- Technology, including software, that Apple had licensed in from other firms such as chip manufacturers; and
- Proprietary technology, including software, that Apple created to run or integrate the various functionalities of the device. As Steve Jobs said of the "Multitouch" technology he revealed: "Boy, have we patented it!"

Until the commercial launch of the device six months later, analysts and investors had little hard data upon which to calibrate their expectations. A consensus eventually emerged about the size of the market, the trajectory of the iPhone's penetration, the level of sustainable margins, and likely competitors' responses.

These analysts and investors were also free to assign "future value" to opportunities and applications that required a significant leap of faith: health monitoring, video streaming, and others. This narrative, however, concerns the value of the firm. A valuer tasked with valuing Apple's technology necessarily had a narrower subject asset to tackle.

Part of the technology, as noted above, was not Apple's and could be licensed in. The integration of these available technologies and standards accrued to other intangible assets such as human capital.

Even if valuers used the emerging projections for the sales and financial performance of the iPhone, they would have had to assume a rate of decay for the specific technologies that were introduced on that day. They would have suspected that first version of "Multitouch" would be improved and eventually replaced, even if the touch screen remained the main interface of future iPhones. That replacement could be - and was - captured in the valuation of the firm but could not be ascribed to the current array of technologies in Apple's portfolio.

The other limitation in valuing the technology itself came from the influence of complementary intangible assets. Steve Jobs described the device as "an iPod, a phone and [an] internet communicator". By 2007, the iPod already had a cult following and accounted for close to half of Apple's revenue. Jobs' choice of words is revealing, since he was presenting the new device as a derivation of Apple's most popular product, relying on the latter's aura and on the company's brand.

In retrospect, the launch of the iPhone presented a strong technological continuity with the iPod. Additionally, it relied on the Apple brand's "umbrella". Considering these elements, did the iPhone-specific technologies deserve to have the residual cash flows ascribed to them, thus giving them the leveraged upside of any significant success?

Investor insight on technological innovation

Technology often provides an irresistible lure to investors, underpinning good investment “stories”.¹¹ The tension between “stories” and “numbers” in the investment process has been well documented.¹²

The expectation of a profitable investment in technology, and therefore the valuation of that technology, habitually rests on several features. An in-depth understanding and disclosure of these features is crucial in making the valuation of technology “more tangible”.

- Conferring a strategic advantage in a potentially large market. This is especially true in the case of network effects and holds even if the technology is a non-rival good and market share “leaks” to competitors. The emergence of competitors precipitates adoption and accelerates the growth of the market.
- Creating a lasting cost advantage in an existing and/or growing market. This is typically captured through the estimated remaining useful life (RUL) or an estimate of the attrition rate of the technology.
- Imposing switching costs for customers.
- Requiring little reinvestment, regardless of whether the outlays are expensed or capitalised.

The evaluation of these important variables is complicated by the fact that technology can be contained in a registered right (eg, a patent), be unregistered (eg, a trade secret), or straddle both.

At one end of this spectrum, a patent has a very visible and predictable “cliff”; at the other end, the technology may be kept as a trade secret. Sometimes, the existence of the technology itself is a secret. Part of the technology, as noted above, was not Apple’s and could be licensed in. The integration of these available technologies and standards accrued to other intangible assets such as human capital.

Using IVS for value measurement

The International Valuation Standards (IVS) provide a framework for the valuation of technology, regardless of the purpose of the valuation. Application of the IVS and the valuation of technology assets is complex and requires substantial professional judgment, expertise, and analysis. A valuer may pick from three approaches, selecting the one(s) that is(are) most appropriate in the circumstances.

Market approach

Under the market approach, the value of an intangible asset is determined by reference to market activity. The specificity and the opacity of technology make relevant comparisons difficult. For this reason, the application of the market approach for valuing single technological assets (as opposed to technology businesses) is quite rare.

11. “We relate to and remember stories better than we do numbers, but storytelling can lead us into fantasyland quickly,” (Damodaran, A. (2017). Narrative and numbers: the value of stories in business. Columbia Business School. <https://doi.org/10.7312/damo18048>)

12. Shiller, R. J. (2017). Narrative economics. *American Economic Review*, 107(4), 967-1004.



Cost approach

The cost approach can be used when the technology is commoditised and does not confer a differentiated advantage. In that case, two main methods are applied: replacement cost method or reproduction method.

In their more advanced forms, these methods require the determination of an opportunity cost and/or of an “appropriate” profit mark-up. In effect, the cost method allows an analysis of the efficiency of the historical outlays incurred, and of the extent of entrepreneurial profit commensurate with risk.

Income approach

While the cost approach is mostly retrospective, the income approach is forward-looking and requires financial projections capturing the earnings power of the technology being valued.

The Apple example shows that several intangible assets and technologies can be entwined together in a product. The valuation professional should therefore determine whether the technology being valued is the main value driver or a secondary input.

When technology is not the main (or “Principal Income Generating”) asset, the relief from royalty method (RFR) is often appropriate. The RFR method discounts hypothetical royalty payments corresponding to the use of the technology. The royalty percentage is a function of the nature of the technology being licensed, but also considers specific contractual terms such as exclusivity, geographical reach, and duration. Since the royalty rate is a fixed percentage (e.g., 5% of sales), the value of the technology is a linear function of the revenues generated.

While the principle of the RFR method is quite simple, the determination of an appropriate royalty rate can prove challenging in practice. Databases containing royalty rate data from prior transactions present their own challenges and often fail to include important terms of licence deals. The alternative to using data from previous transactions is to derive a “fundamental” royalty rate. Such rates attempt to apportion the risks and rewards for both the licensor and the licensee from the economics rents to be extracted from the transaction.

Conversely, when the technology is the main value driver of a bundle of assets, the excess earnings method is often appropriate.

The excess earnings method subtracts contributory asset charges (CACs) for all the other assets necessary to generate the firm’s earnings stream.

By construction, the excess earnings method will yield more volatile results than those of the RFR. By imputing residual cash flows to the technology, the method’s result is more leveraged to any marginal change.

We note that certain professional organisations¹³ are exploring an increasingly nuanced framework for the delineation of principal assets and therefore the allocation of value through the choice of the valuation method.

13. AICPA (2022, September 15). Working draft of Business Combinations Accounting and Valuation Guide [AICPA \(2022, September 15\). Working draft of Business Combinations Accounting and Valuation Guide](#)



Valuation of technology for Transfer Pricing

The increasing complexity of technology has also been reflected in the valuation for the purposes of Transfer Pricing (TP). Both the US and the OECD have recently updated their rules and guidelines in these matters.

In this context, the valuation of technology is done on an “arm’s-length” pricing basis, considering “realistic alternatives” rather than a fair market value/fair value basis.

The RFR method for financial valuation is broadly equivalent to the comparable uncontrolled transaction (CUT) method in transfer pricing.

However, some significant differences remain:

- Transfer pricing valuations are less concerned with the identification of specific assets than the bundling of intangible assets into portfolios for the apportionment of earnings.
- Routine returns for other assets are derived from returns earned by comparable companies, rather than contributory asset charges.
- Cash flows are generally calculated on a pre-tax basis in the US, while financial reporting valuations deduct taxes before discounting cash flows.

The differences in these methodologies create the possibility of either unanticipated tax frictions or differences that will remain the object of scrutiny.





Conclusion and next steps

The discussion around the valuation of technology informs standard-setters and other stakeholders about a class of assets that has profoundly altered our economies and our way of life. The acceleration in the pace of technological change has raised the stakes for developing robust intangible asset valuation techniques.

As discussed, technology is one of the most complex intangible assets to value. Nonetheless, some clear trends emerge:

- The investment in technology allows for a high dispersion in possible outcomes for its creators and investors. These outcomes include failure.
- Any specific technology lies on a technological continuum between its predecessors and yet-to-be-invented future iterations.
- Capturing the unit economics underpinning the valuation of the technology requires overcoming the natural opacity in its characteristics.
- The deployment of technology generally interacts with other intangible assets: it relies on human capital, brand and customer relationships, and simultaneously adds to those assets.

The complex characteristics of technology suggest that best practices for its valuation will continue to evolve.

These characteristics also emphasise the need for robust professional competence in the conduct of such valuations. These requirements are in line with the IVSC's stated objectives of producing high-quality standards and promoting competency amongst valuation professionals.

Throughout this series of papers, we have visited the challenges and opportunities posed by the valuation of the principal categories of intangible asset classes. Forthcoming papers will continue the review of specific intangible assets and examine how these assets interact together.



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