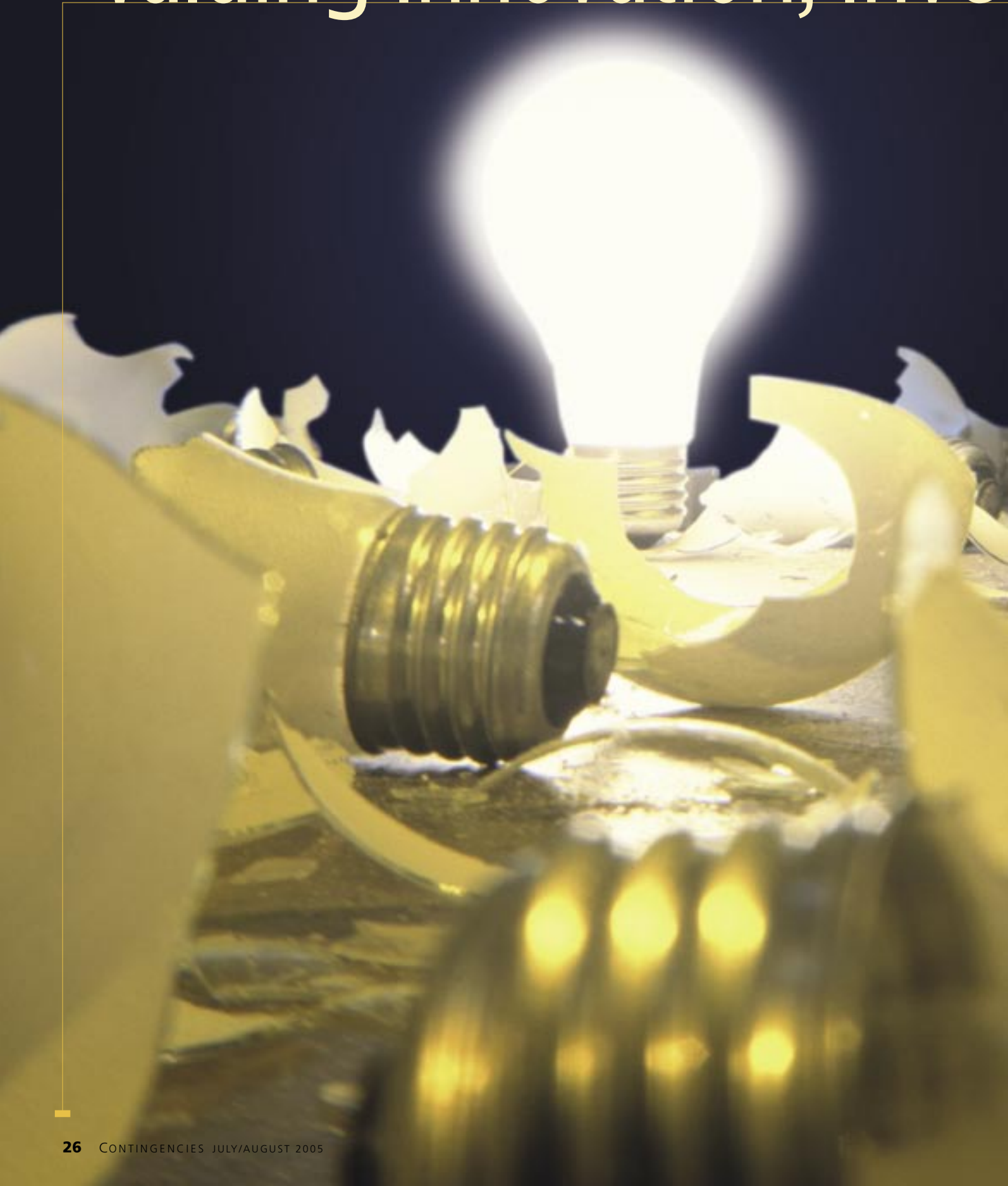


# Valuing Innovation, Inve



# vention, and Patents

It's the intersection where uncertainty and financial risk meet innovation—the perfect place for an actuary

By Tom Bakos

INNOVATION TAKES ONE INTO THE UNKNOWN, uncertain world of the future. If done for more than just intellectual curiosity—with some idea of fame, commercial success, and ultimate fortune—it will most definitely involve some financial risk. A casual “nothing ventured, nothing gained” may be the way an inventor stepping into this uncertain future acknowledges the financial risk associated with this decision.

But think of it: A future world that involves uncertainty, financial risk, and the concept of value is our world, the world of the actuary. Perhaps actuaries can help these inventors make reasoned rather than casual decisions about how, where, and when to invest their financial capital and pioneer a new and innovative application of actuarial talent along the way. There might even be a place for financial economics in all of this. Wouldn't that be exciting?

Financial economics is the branch of economics concerned with risk in financial markets and the financing of companies. A text recently published by the Actuarial Foundation, *Financial Economics with Applications to Insurance, Investments and Pensions*, and other texts actuarial candidates may remember from the Society of Actuaries syllabus, provide a background and detail on how financial economic theory can be applied to understand and manage financial risk.

Financial economics concentrates on *money*, the most typical measure of value. It considers in its formulations: the *timing* of money transactions; the uncertainty surrounding the future receipt of money; the agreements one makes (options) or perhaps unknowingly enters into regarding *the future transfer of money*; and, of course, *information* about future monetary value. Anyone who has studied the subject knows the names Fisher Black, Myron Scholes, and Robert Merton, who pioneered option pricing theory beginning in the early 1970s.

But perhaps we are getting ahead of ourselves. Before we can apply any mathematical value theory to innovation, invention, and patents, we first must understand exactly what it is we're dealing with. An invention, by its very nature, is unique. Therefore, unlike a stock, bond, or money market security, to which financial economic theory is most often applied, invention is not traded in a market of equals. A particular invention has a value that is inherent, either present or not present, by virtue of its design. An invention's value is based on the invention's potential for commercial application and the acceptance by consumers of what the invention has to offer.

## The Value of Innovation

Let's define "innovation" as a process of enlightenment that leads, ultimately, to invention. Some people are involved in innovation, some are not. To be seriously involved in innovation a person needs to be attuned to the problems encountered in the industry in which he or she works. Inventors are the ones who devote time and effort to finding new solutions or better solutions to the problems they encounter.

The time and effort required to solve problems is called research and development (R&D). The cost of R&D can be expressed in dollars. While innovation almost always requires research to solve problems and development to implement those solutions, occasionally innovation may be stimulated by a flash of insight. But even when this happens, some significant effort may be required to persuade others of your brilliance. R&D dollars, therefore, fund innovation and make it work.

The payoff for R&D expenditure is innovation and invention. Commercially successful inventions justify the R&D dollars spent to find them. But R&D dollars are also burned in useless activities that lead nowhere and produce nothing of commercial value. The value of innovation is the net of the value of the commercially successful inventions produced by that innovation over total R&D costs measured in money. In formulating value calculations for innovative processes, actuaries can think of innovation as a contingent event, uncertain with respect to its occurrence, timing, or severity. With respect to innovation, however, the money impact of the "severity" of innovation is a positive.

Competitive intelligence is used by others to find out how someone else has solved their problems. For many, it's an alternative to research and innovation. In an absolutely free market, the R&D costs of innovation need to be weighed against the costs of finding solutions through competitive intelligence. Until recently, the insurance market has thrived in this free market approach to innovation. Patents, however, have already closed this open door in other industries and are finding greater application in the insurance industry.

The value of innovation seems well recognized given the number of products advertised as new and improved. The value of innovation in the abstract is muddled, of course, by including apparent innovation in the formulas. In any event, the value of true innovation is more reasonably considered with reference to the value of the inventions it produces.

## The Value of Invention

An invention is a solution to a problem. Successful solutions to problems that need to be solved can be worth a lot. When an invention becomes worth something, and how much it's worth, depend on the nature of the invention and the problem it's solving.

Actuarial experience studies, for example, matching inventions to commercial success (or failure) might show what Buckminster Fuller learned through personal experience in his 50 years as an inventor: There is a lag between invention and a

commercial or industrial application. He refers to this lag as a gestation period and quotes a two-year period for electronics inventions, five for invention in aerodynamics, 10 for automobiles, and so on up to 50 for invention in the area of single-family dwellings, one of his specialties.

The 50-year gestation period for single-family home innovation was, no doubt, influenced by Bucky's experience with his geodesic dome house, which he invented in the late 1940s and which has not, even yet, really caught on. If Bucky had lived beyond July 1983, he may have lengthened his gestation period estimate for single-family home innovation.

An important consideration in evaluating the value of an invention is this lag between when an invention is revealed and its commercial application. Clearly, any deferral of the financially rewarding commercial application of an invention will result in "time value" considerations. A number of reasons can explain the lag.

First, while the application of the invention may seem obvious to the inventor, others may need persuading. Change is difficult to sell, and an invention may simply be ahead of its time. The invention may be solving a problem people don't yet know they have.

For example, while I would never think of leaving my home today without my cell phone, 10 years ago I could not imagine needing one. Today, I'm so convinced my cell phone is solving problems that I rarely leave home without it and become a little stressed if I forget. I often return to get it.

Second, if the invention is an entirely new and better solution to a problem that already has solutions, its value must be measured against the cost of implementing it in favor of those other solutions.

For example, a way of producing steel more cheaply may be found using new technologies that would be uneconomical to introduce into older, established steel plants. The new technologies are more easily applied in new startups since startups have nothing invested in older technologies. For startups, the newer, inventive technologies are more efficient and will provide a competitive advantage against the established steel producers.

New, innovative, more efficient technologies may be difficult to introduce into established processes because of the foregone cost of the older infrastructure that the established plants would have to abandon. These costs would still need to be amortized in the prices they charge using the new technology. Therefore the same competitive advantage wouldn't be realized. Conversion to new technologies may only be economically practical after the older solutions have worn out and been paid off.

Therefore, the cost to implement an inventive solution in the commercial market is an important offset to its value. This cost is a factor driving the implementation lag and may often drive a generation-skipping approach to implementing a new invention.

For example, I moved from Windows 98 to Windows XP, skipping the iterations in between. Nor do I upgrade my computer every time a new processor type comes to market. Economics is the reason for these decisions.

Third, a new invention may require even more new invention to realize its full potential. For example, it would have been difficult to foresee the full value of the laser in the late 1950s when its operation was first described. Today, billions of lasers exist in all types of devices, medicine, manufacturing processes, construction industries, military systems, communication systems, consumer electronics, and pointing devices.

So, placing a value on invention is often a highly subjective process. And as we look more closely at the process, we can see that it has all of the elements actuaries look for: It's deviously varied, it usually requires that assumptions be made, and it often involves risk and uncertainty.

Clearly, also, an understanding of the value of an invention can be refined over time as products enabled by the invention are introduced into commercial markets and their success or failure can be objectively measured. Gathering these data would be the equivalent of doing an experience study. These studies might also be able to provide a clearer assessment of the subtle value that a reputation for innovation and invention brings to a company or brand.

Although an invention doesn't need or require a patent to be a success, a patent can enhance the value of an invention. While an unpatented invention can be commercialized, a patented invention's commercialization possibilities are enhanced. When the inventor might not have the resources to capitalize on every opportunity, licensing the use of the invention to others provides revenue through royalty payments that would be lost if the invention were easily copied and unprotected.

While it's true that an inventor may benefit from the head-start advantage of being first to market with the new technology of the invention, some skeptics may wonder why others don't also embrace the new technology. Therefore, licensing the invention to others allows the inventor to control competition to the inventor's advantage, enhances the perceived value of the invention by introducing competition, and brings in additional revenue through royalties.

### The Value of a Patent

A patent can be used to protect the value of the intellectual property one creates. So, while an invention itself has value, a *patented* invention may have even greater value because of the *intellectual property rights* a patent provides. In essence, a patent gives the patent owner the right to exclude others from making, using, or selling the invention. In exchange for this exclusivity (generally limited to 20 years), the inventor must reveal how the invention works.

The holder of a patent on a potentially commercially successful invention owns valuable intellectual property (IP). The rights to the IP created by the patent can be licensed or sold. So even if the patent owner doesn't choose to directly commercialize the underlying invention, the patent itself can have market value. In fact, companies are cropping up that either acquire the patents of others or become product development shops whose sole product is invention.

Intellectual Ventures, for example, is a 5-year-old company (reported on in *Newsweek*, Nov. 22, 2004—see website: <http://www.intellectualventures.com> for more information) that does nothing but invest in pure invention. This invention is coordinated through its internal team and retained advisers. They, of course, protect the intellectual property they create through expenditure of their R&D dollars with patents. In effect, they manufacture nothing but patented inventions.

■ *Breadth and quality.* Patents, of course, are individually unique. While they can be and are categorized by type, the quality of any individual patent application or issued patent depends on the insight and ability of the inventor to see and understand the full range and applicability of his or her invention.

The offset to granting limited exclusivity to the inventor is requiring the inventor to disclose precisely how the invention works. The purpose of this is to enlighten other inventors who may make improvements or find better solutions, and thereby advance the sciences for the betterment of all. An inventor who focuses narrowly on the problem being solved may draft a patent application that provides only narrow protection and opens a door for others. Even if a patent is issued, the invention might miss obvious elements that a broader view would have included. A broader outlook equates to greater potential value and a higher quality patent.

■ *The cost offset.* The decision to patent an invention is not itself without risks and costs. The accompanying chart, *Life Cycle of a Patented Invention*, highlights the steps in the process of acquiring and keeping a patent. The decision required at each step is highlighted, along with the implied cost associated with that decision. Future value should always be a consideration in the decision to move forward or to abandon the patenting process.

Depending on where one is in the invention development process and the resources available, this value determination may be highly subjective and implied or very detailed and objective. For example, if third parties need to be influenced to make a financial contribution or investment to further the development and implementation of the invention, a business plan may require a more reasoned and supported value determination.

The value determination for a single patent may be highly subjective for inventions that involve entirely new areas of commerce versus inventions that are improvements on an existing invention with demonstrated commercial value. It's important to recognize that a U.S. patent provides protection for 20 years. Therefore, a decision to seek a patent on an invention that has an anticipated lag of 20 years or so could prove to be financially unsound, regardless of the perceived value of the underlying invention.

In addition, patent protection is granted on a country by country basis. Although some coordination is provided through the Patent Cooperation Treaty (PCT) and the European Patent Office (EPO), which provides a uniform, centralized patent granting system for its 30 member countries, foreign patent filing costs can add significantly to the overall cost of seeking patent protection.

■ *Patent valuation approaches.* As a patented invention is developed and tested commercially, uncertainty about future profitability is removed and more analytic valuation methods can be employed.

Before being tested in the market, however, two alternative approaches can be applied to value patents. The *macroeconomic* approach relies on large numbers of patents being filed in an industry or industry segment, which, in their totality, make a contribution to the gross domestic product (GDP) of the industry segment. This GDP value can be measured in terms of money. Then, the value of a particular company's patent portfolio, or the average value of a patent in its portfolio, can be estimated using this experience data.

This method, of course, is based on averages and relies on similarities in the patents being analyzed. Essentially, it's a portfolio valuation. The average value of a patent in the portfolio, even though it can be calculated, would probably have little relationship to the actual value of any individual patent in the portfolio, some of which would be worthless and some of which would be very valuable.

A second approach adapts *option pricing theory*—as developed by Black, Scholes, Merton, and others—to value what are known as the real options considered to be a part of a patent. In its historical beginnings, option pricing theory generally focused on *financial* options that address the purchase or sale of an underlying *financial* asset, such as a stock. For example, a call option on a stock confers a right to buy that stock for a predetermined price at a specified future time.

A *real* option is defined as an option on a nonfinancial asset. A patent, for example, has been thought of in terms of a call option or a series of call options on the future commercialization of the underlying invention, that is, on the commercialization of the technology embodied in the patent. It's not a financial option, since it doesn't involve a financial asset or the right to receive money directly.

■ *Patent value volatility.* As already noted, early in a patented invention's existence there will likely be uncertainty regarding the future commercial value of the intellectual property a patent defines. However, as the patent application and, ultimately, the issued patent progresses through its life cycle, the *variance or volatility* of the underlying invention's future returns diminishes. Commercial survival breeds success and future profitability.

Of course, the inverse is also a possibility; commercial failures along the way can be used to predict the growing worthlessness of a patented invention.

Either way, this creates some problems in applying option pricing theory, which tends to assume a constant volatility during an option's term. However, while these problems can be solved, valuing a patented invention using option pricing theory is complicated and expensive. The detailed knowledge required to predict cash flows resulting from any particular invention, which are derived solely from the patent and not the underlying invention itself, requires highly detailed knowledge

**35 U.S.C. 284 Damages.** Upon finding for the claimant the court shall award the claimant damages adequate to compensate for the infringement but in no event less than a reasonable royalty for the use made of the invention by the infringer, together with interest and costs as fixed by the court.

When the damages are not found by a jury, the court shall assess them. In either event, the court may increase the damages up to three times the amount found or assessed. Increased damages under this paragraph shall not apply to provisional rights under Section 154(d) of this title.

The court may receive expert testimony as an aid to the determination of damages or of what royalty would be reasonable under the circumstances.

about markets, demand for the invention, and non-infringing competition, which is probably unique to each invention.

### Patent Infringement Damage Calculations

A successful patent infringement lawsuit is a clear indicator of the value of a patent. It also indicates how difficult a patent value calculation can be. Typically, determining patent infringement damages, which is a form of valuing a patent, is so complicated that it usually isn't even begun until after a court has established infringement.

Damages for patent infringement are covered in general terms by the patent statute. (See box.) This statute establishes a minimum value for damages equal to a reasonable royalty for the use of the invention made by the infringer. So one approach to doing a damage calculation is to calculate a reasonable royalty.

Established royalties can be used for this determination, but there may often be no existing royalty patterns. This is possible if the patent hasn't been licensed or if the infringement falls outside the range of licenses typically granted for the use of the invention. Plant patents, for example, are associated with seeds genetically modified to provide some cultivation advantage.

Seeds, of course, are self-replicating, so owners of plant patents may license their seed to farmers for a single planting. The seeds, which are either the product of a harvest (e.g., corn) or are a byproduct of the harvest (e.g., cotton), are intended to be

sold commercially as a product or destroyed and not saved, or sold for replanting in a following season. Farmers sign a license agreement and pay a royalty when they buy seed that has been genetically altered to provide a cultivation advantage.

If the license is violated, the patent is infringed. If confirmed by a court, one would be faced with determining reasonable royalties for a license agreement for using the invention in a way the owner of the patent would never allow. One method for doing this involves imagining a hypothetical negotiation between the patentee and the infringer, assuming that both are willing participants. This hypothetical exercise could be an excellent application of modeling approaches used by actuaries in pricing contingent risk.

Often, deciding what is a reasonable royalty focuses on whether the infringer would be able or willing to pay the implied royalty amount. That is, could the infringer make a profit from the use of the invention if the royalty were a cost element he had to consider in pricing? This, perhaps, can be related to reinsurance pricing models in which a reinsurer's pricing needs to strike a balance between its and the direct writer's profitability requirements.

Reasonable royalty, however, is usually the fallback. Typically, courts interpret damages to mean *lost profits* as a result of the infringement but no less than a reasonable royalty. Lost profits result when the infringer takes business away from the rightful patent owner that the patent owner would have gotten absent the infringement. This approach requires a demonstration that the patent owner could have met the additional demand and that there is an absence of acceptable noninfringing substitutes. In addition, of course, the patent owner's profits on the lost sales need to be established.

A kicker in the calculation of lost profits is the concept of *price erosion*. A patent gives the patent owner the right to exclude others from making, using, or selling his invention and therefore allows the patent owner to control the market and set prices. Of course, this must be done reasonably, in line with what the market for the product will bear.

An infringer, on the other hand, may be able to offer a product based on the invention more cheaply because, for example, the infringer has no research and development costs to amortize. Therefore, the infringer's participation in the market may force the patent owner to reduce prices below levels it would otherwise have charged in order to remain competitive. This price erosion effect can be considered in a lost-profit damage calculation.

Lost-profit calculations might also include a third element known as the *entire market rule*. This rule may be applied if a patented invention is sold in conjunction with non-patented elements or products, such that the sale of the patented invention is somehow interrelated with the sale and profits from the non-patented product.

In one case, a patented paper towel dispenser installed at little or no cost was deemed to be the primary driver of the sale

of paper towels. Therefore, the sales of paper towels, a non-patented product, could be used to determine damages associated with the infringement of the patented paper towel dispenser. Since there was very little profit derived from the sale of the dispenser, damages would have otherwise been small.

### Risk and Uncertainty

For all of the types of valuation discussed here, risk or uncertainty is an implied element. Risk and uncertainty evolve as each stage—innovation to invention to patent—is passed and as a patented invention proves itself in the market or fails to attain commercial success. Value determinations along the way depend on an understanding of these risks and the alternatives presented by the uncertainty.

It seems that actuaries are well qualified to adapt their understanding of how risk works and how uncertainty and time affect the financial value of innovation, invention, and patents. This expertise can be applied in building models that calculate or demonstrate the value of invention in general and the value of specific patented inventions.

TOM BAKOS is a consulting actuary in Ridgway, Colo. He can be reached at [Tbakos@BakosEnterprises.com](mailto:Tbakos@BakosEnterprises.com).

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