A model for valuing an invention

How to value an invention or technical development occupies a lot of minds these days. As a physicist I learned ways of making numerical estimates in situations of uncertainty, and I have applied this type of thinking to the valuing problem. I have offered the following method a number of times on courses for professionals who do sale and licensing of technology. Many people have said that they find the approach valuable, and no one has yet pointed out a fundamental flaw. I have also been watching out for methods of valuing IP, and have been surprised not to see this one, so it may be new. One merit of the approach is that it might be used to persuade numerate scientists (or inventors or academics) that their brainchild is not nearly as valuable as they think.

Stage:-	Idea	Proof of principle	Product prototype	Product-ion setup	Market launch	Success
Cost	£1	£10	£100	£1,000	£1,000	-
Chance of proceeding	50%	50%	50%	50%	50%	-
Value	?	?	?	?	?	£50,000

Problem. What is the value of the initial idea in the case above? £50,000 is the total profit over the life of the product. How does the value change as the project progresses through the stages?

The Problem

The table sets out a typical problem for solution. Realistically the numbers would be multiplied by 1000, but it is easier to work with smaller numbers.

Our scientist spends £1 on coming up with an Idea. Let us assume that this comes out of departmental funds without formalities. He or she is then formally given £10 to prove the principle by developing a laboratory demonstration. Or possibly the £10 is not given: often promising ideas fail to attract funding. Even if the £10 is secured, proof of principle may not have prove as easy as it looks, and the project may fail. In the failure case the £1 and the £10 have been wasted and that particular project stops.

In the table I have assumed that the probability of securing the £10 is one in two, i.e. 50%. I have also assumed a 50% chance that the proof of principle task will be successful. If so, the next step well be to see if the thing can be made into a product prototype that could be market tested. I am invoking the well known "1-10-100 rule", which says that each stage in a technical development costs 10 times as much as the previous one, so our scientist now needs £100 from a funder or investor. Now it may be that the prototype proves to be unconvincing, or too expensive to make. Thus again there is a risk, which I have put at 50%, that the funded task may not be accomplished. We proceed to find funds for production setup and then for market launch, with a cost and a risk at each stage as shown.

Suppose that the market launch proves to be successful, and that the product proceeds to make £50,000 of profit over its life-cycle in the marketplace. Not bad for an idea that cost £1, but what was the idea worth? If we were trying to sell just the idea, what would be a fair price?

When I have asked classes to try to estimate the value of the invention before I show them the method, their answers vary from half the profit, i.e. £25 000, down to £1. You are invited to think about this before reading on. If you cannot work out an answer, please at least make a guess and write it down in the idea/value square in the table.

The Solution

Since the invention only has a 50% chance of attracting its first £10 of funding, the scientist would need to make two such inventions in order that, on average, one of them will be funded for the next stage. This one will then only have a 50% chance of

succeeding at that next stage. Thus to have one invention on average succeeding at the proof of principle stage, the scientist should start with 2 x 2 inventions, i.e. 4. To have an even chance of getting all the way to market success, and thus be qualified to share in the £50 000, the number of inventions that has to be made is 2 x 2 x 2 x 2 x 2, which comes to 32. Having to make 32 inventions will cost the inventor's department £32, which can be considered to be their stake in the enterprise.

How much has been staked in all? The number of proof of principle projects required is fewer by 50% as there is one less risk stage, so there need to be 16 of these, costing 16 x £10. In the same way, we need 8 production prototypes at £100, and then 4 production setups at £1000 each, and finally 2 market launches also at £1000 each. Of the two launched products one was a success and the other was ruined by, for example, a health and safety issue.

So how much has been invested in all?

$$32 \times £1 + 16 \times £10 + 8 \times £100 + 4 \times £1000 + 2 \times £1000,$$

which is

$$£32 + £160 + £800 + £4000 + £2000 = £6992.$$

If the invention is being sold on at the first stage, what it its fair value? I suggest that the answer is:

$$\frac{32}{6992} \times £50{,}000 = £229.$$

If you got within a factor of three of this, that is as good as right.

Discussion

Of course a university scientist, or more likely the person from their Vice-Chancellor's office, will claim that this is a paltry sum, but it can be pointed out that the return on their input is

$$\frac{£229}{£32} = 7.1 \text{ times},$$

Which is pretty good.

What if an inventor's auntie funded the proof of principle stage, and after its success wants to sell out? Her stake can be valued at 16 x £10, or £160, which is worth 160/6992 of the £50 000, or £1144.

In the Solution section above, we see set out the "weighted investments" assignable to all of the stages. The values of these stakes come out to:

£229, £1144, £5721, £28 604, £14 302

These are the numbers to put in the Value row in the table. You can easily show that every investor receives 7.1 times their investment.

Licensing

What if we are going to license for a royalty on future profits instead of selling for a lump sum? The royalty rate should surely be simply

$$\frac{32}{6992} = 0.46\%.$$

As readers will know, the great benefit of the royalty approach is that you do not need to estimate the eventual profits. Note that for accountancy reasons it is much wiser to base royalty on sale price. If profit is 10% of sales, then the royalty rate for the bare idea becomes 0.046%.

Risk and uncertainty

My proposal is that when they negotiate, seller and buyer should work to construct their own table, by striving to agree on the stages, investments and risks for their particular type of business. A value will then fall out mechanically.

We have been talking about risk. Risk is where you know the chances. In pharmaceuticals for example the costs and probabilities required to do this calculation are known from the hundreds of cases on the books. Uncertainty is where you do not know the risks. In web based companies there was almost no data at the time most deals were struck.

If buyer and seller can fill in some of the boxes with agreed figures and be content to guess wildly on the others, there will be some degree of improvement in ideas for valuation, or at least the argument will have shifted to more factual ground.

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The R&D Management Centre
Business skills for science and technology