Context:
In the case of a large diamond mining client: Developing a risk-adjusted valuation tool that allows for effective decision-making.

The situation
Our client is a large diamond mining operation in Botswana. The company was experiencing a bottleneck in the recovery of diamonds, which was resulting in a negative impact on the economic value of the mine.

Having identified <u>processing-throughput</u> as the primary cause of the bottleneck, engineers at the plant proposed a number of potential processing improvements. Five options were short-listed – each differing in terms of capital expenditure required to implement the proposed improvements.

What the client needed to do was establish as accurately as possible, which of the five options would deliver the highest value against the lowest risk.

The Challenge
According to the project engineer assessing the five options, the belief was that not all the projects would add the same amount of value and that each option introduced differing amounts of risk.

"We had no way of quantifying the potential risks in value terms, nor did we have any way of quantifying the amount of value that could be created", said one engineer. "This meant we couldn't off-set trade risk against value creation, which was what we really needed to do to make the correct decision" a colleague went on to add.

It was with the challenge of creating a tool that would more realistically measure risk than current methodologies, that the mine approached Cyest.

The Diagnosis
After analysing the problem, Cyest concluded it was necessary to find a way of modelling each alternative project's contribution using a risk-adjusted methodology.

Whilst a number of options – from qualitative risk and value assessment techniques, through to quantitative techniques – were explored, it was agreed that a quantitative technique would provide the most reliable and robust answers.

Before Cyest could even begin creating on a solution, some hard work lay ahead!

1. The process of value creation had to be modelled in a deterministic sense. The value creation process covers everything from mining the ore through extracting and selling the diamonds.

2. The parameters that could add risk to the project had to be identified. Thereafter, the ranges within which they could vary, had to be identified and these quantified parameters had to be included in the deterministic model.
3. A method had to be found that both varied the parameters within a 'range of uncertainty' and recorded the impact of this variation in terms of value – i.e. at this point the software would need to move from being deterministic to stochastic.

The Solution

The first step was for Cyest to become familiar with the mining operation and the five enhancement proposals that had been put forward. This was achieved in a series of collaborative workshops with senior management over a five week period.

Once consensus had been reached that the solution lay in a quantitative approach, a comprehensive list of factors that would determine both risk and value was drawn up. The important inputs to the value creation process and some of the outputs required from the model are illustrated below.

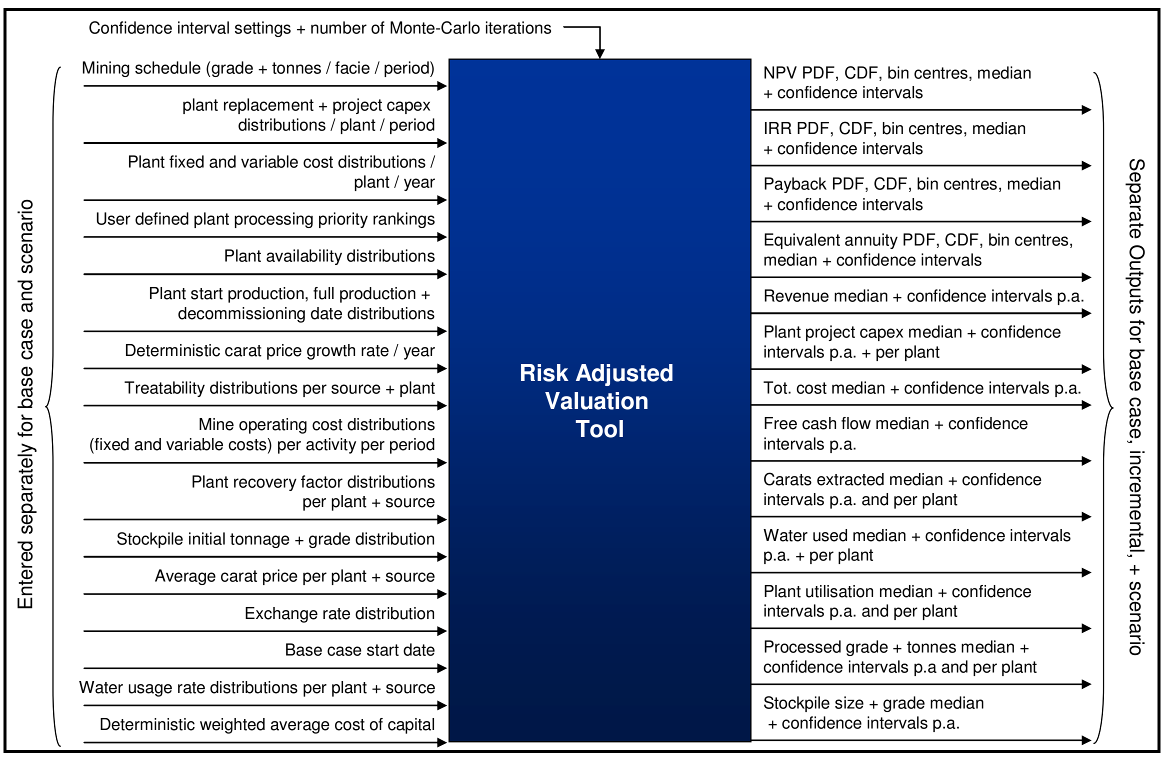

Figure 1: The basic inputs to and outputs required from the model.

There's nothing new about collating information to determine project value. Traditionally, a single 'crisp' input (an assumption of value and risk, based on experience, trends and projection), yields a single 'crisp' output in a deterministic way.

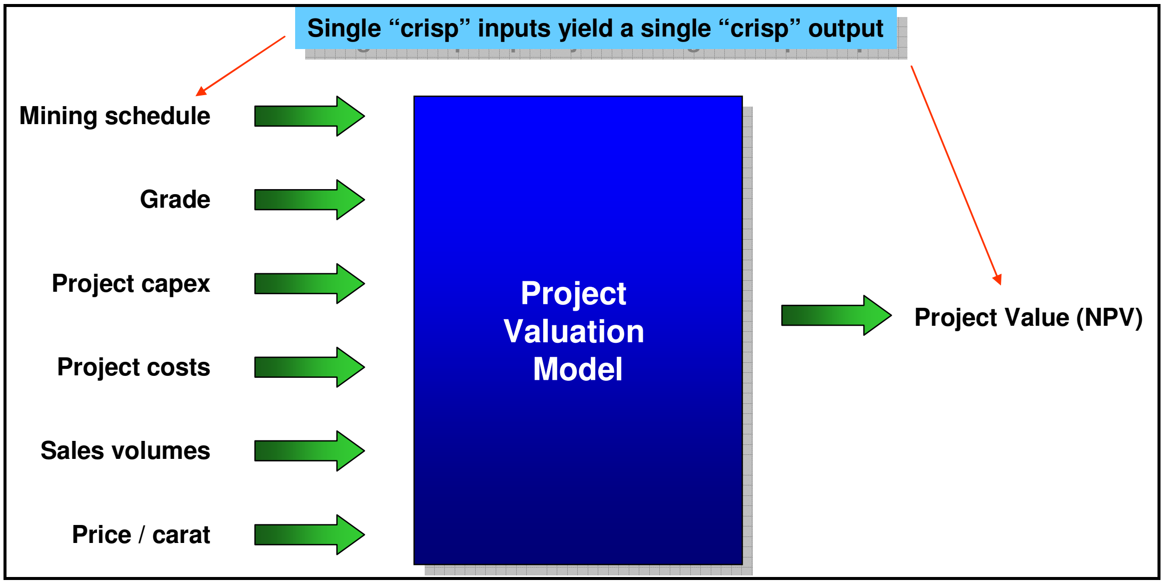

Figure 2: An illustration of the usual "crisp" project valuation models

In this type of model, the following assumptions are implicit:

1. Each input will have a value exactly as predicted when the project actually occurs.
2. The timing of each input (e.g. costs, tonnes mined or capex) will occur exactly as expected.
3. Given these 'crisp' inputs, the valuation model exactly reflects reality in the way it transforms the inputs into the project value.

In reality however, these assumptions **will be violated.** If, for example, the price per carat, mine operating costs or even quality of ore changes, the project value will be affected – whilst the exact measure of each measure is not readily predictable, it is however possible to map the probable distribution of values for each variable.

For this reason, Cyest believed it was imperative to run multiple, 'what if' scenarios where inputs and model parameters change slightly and the impact of each change on the project value is recorded.

Using a technique known as Monte-Carlo simulation, inputs take on a value within a pre-defined range according to an a-priori probability distribution. Each of the factors that contribute towards determining the project value is given a consensus-driven probability rating. 'Minimum', 'maximum' and 'most likely' values, as well as confidence in achieving the most likely are recorded (by way of investigative workshops with management) and result in a proper 'weighting' of values that are more or less likely to occur. This information is used to create a probability density function which clearly reflects the minimum, break-even, most likely and maximum Net Present Value (NPV).

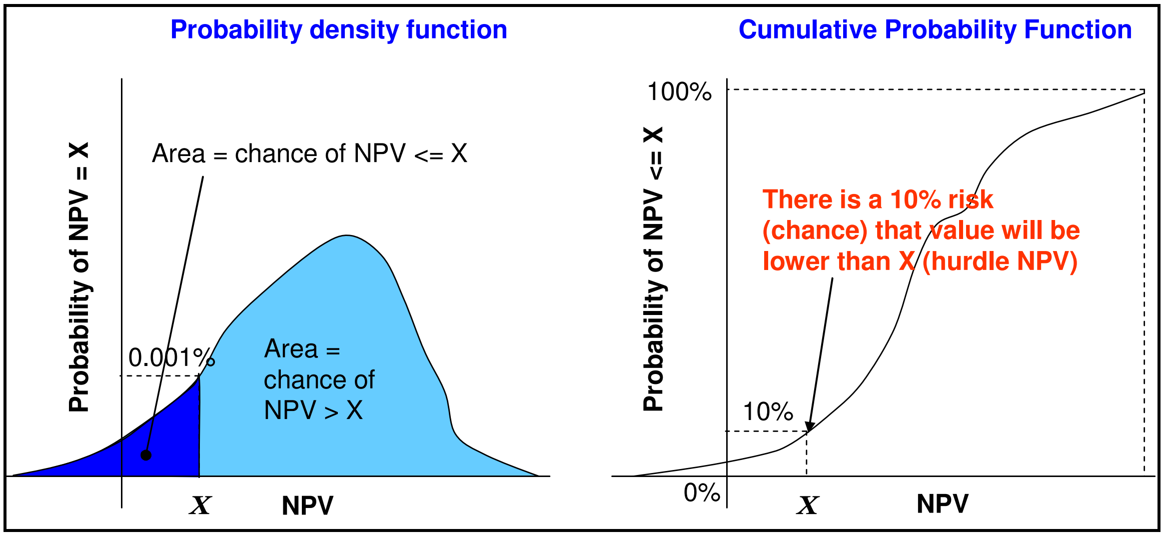

Figure 3: An illustration of net present value as viewed in a probability density function

Instead of a valuation model driven by exact 'crisp' inputs (and predictable deterministic outputs as a consequence), a model based on probability density is created. This more accurately reflects the uncertainty commonly experienced by management, and provides a truer indication of the sensitivity of outcomes (such as NPV, cash flow or IRR) to the inherent nature of uncertainty relating to each output.

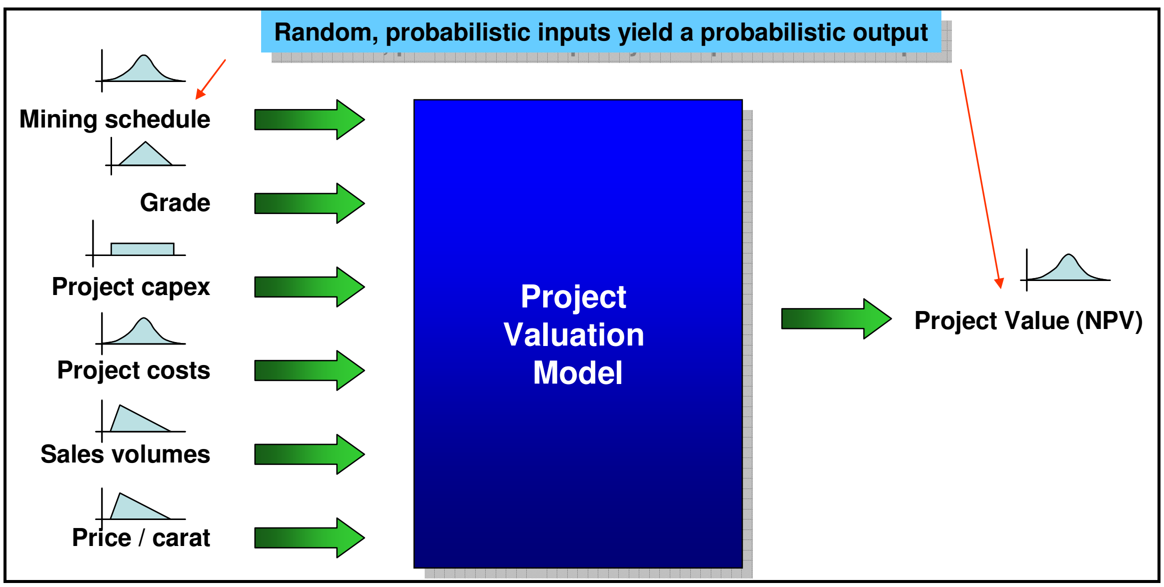

Figure 4: An illustration of how "crisp" inputs and outputs have been transformed to probabilistic inputs and outputs

The Software

Cyest developed a user-interface using Microsoft Excel to enable the mine to easily input data, variable parameters, weights and ratings within a designed framework for each of the five proposed solutions.

This data was then electronically committed to a Microsoft Access database which was analysed and processed using custom built software before being published back to the user in Microsoft Excel format. A customised reporting ‘dashboard’ was also built that made for seamless integration between Excel, the database and the processing software.

This methodology ensured that the mine engineers had access to information, but did not have to become ‘super-users’ of the programme. The basic software architecture is illustrated below.

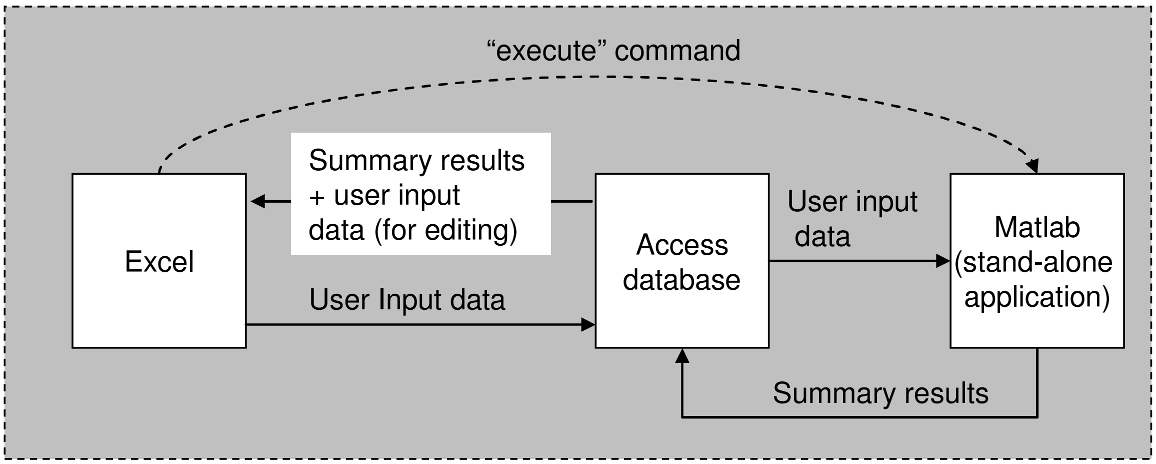

Figure 5: The basic software architecture, showing the link between the front-end (Excel), the database and the back-end processing software

The Outcome

Because each of the contributing factors in the five proposed solutions had been given a probability rating, the risk of each scenario could be more accurately measured against NPV.

This meant the project with the highest NPV and lowest risk could be more accurately determined and the mine was able to choose the most viable solution.

Moreover, given the nature of the model, it was easy to adjust the variables and regenerate results as and when new information was presented (i.e. as management gained a better understanding of the risk profile of a particular input, this information could be immediately reflected an improved probability function).

Going Forward

The importance of dealing with uncertainty encountered in the undertaking of any project in a systematic and applied way were clearly demonstrated. By understanding the complex factors that influence NPV and working within upper and lower parameters, risk can be quantified more realistically.

As a result of this exercise, the mine management was not only able to make an informed and insightful decision on a multi-year project, this methodology is now in the process of being adapted for use in their strategic planning.