

Safety First – Scenario Analysis under Basel II

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Abstract

In mid 2004, after a lengthy period of industry consultation, the Basel Committee finally released its definitive rules on capital charges for Operational Risk under Basel II. In its proposals for allowing banks to calculate regulatory capital using their own internal models, the Basel Committee backed away from its original quantitative emphasis, concentrating instead on ‘qualitative standards’ for Operational Risk Management (ORM) systems. A key element of the standards for accreditation to use an ‘own model’ or Advanced Measurement Approach (AMA) for calculating a capital charge for Operational Risk is the use of Scenario Analysis to identify low-probability, high-severity loss events. Unfortunately, other than specify that Scenario Analysis must be robust and methodical, the Basel Committee provided few clues as to what Scenario Analysis should cover in practice.

This paper proposes a structured approach to ‘Scenario Analysis’ for Basel II, based on concepts proven in other industries, specifically the concept of ‘Safety Management’ and in particular the “Bow-Tie Diagram”. After giving a brief introduction to the ‘Bow-Tie’ concept, the paper describes how such a concept may be used by banks and regulators to satisfy the requirements of Basel II and to improve Operational Risk management across the industry. An example of the use of the Bow-Tie technique is included for illustration.

Keywords

Basel II,
Operational Risk,
Advanced Measurement Approach,
Scenario Analysis,
SbAMA

Introduction

In June 2004, the Basel Committee released the ‘Revised Framework for the International Convergence of Capital Measurement and Capital Standards’, which specified the definitive rules on capital charges for Operational Risk under Basel II (Basel 2004). Under proposals for allowing “internationally active” banks to calculate regulatory capital using their own internal models – so called AMA (Advanced Measurement Approaches) - the Basel Committee backed away from dictating explicit methodologies for calculating operational risk capital charges¹ towards an approach that included both qualitative and quantitative components of an “Operational Risk Framework”.

In their final proposals, the Basel Committee stressed the importance of ‘qualitative standards’ for banks that wish to use an AMA for management of their operational risks². However, other than urge that an Operational Risk Management (ORM) system must be “conceptually sound and implemented with integrity”, the Basel Committee gave few clues as to what such a ‘system’ might look like. Part of the reason for this was to allow banks to create an “internal model” that would better fit their unique operations, people and processes. Certainly an internally evolved system is likely to have a higher level of acceptance than a “one size fits all” prescription.

Basel II does draw some boundaries though and states that any system developed must be “credible and appropriate”, “well reasoned”, “well documented” and “transparent and accessible”. In many cases, these terms are open to interpretation by banks and their regulators and generally seek a wider consensus.

As part of the on-going research called for by the Basel Committee, this paper considers some important questions raised in key parts of the Basel II proposals, specifically in regards to Scenario Analysis and the paper proposes mechanisms, proven in other industries, for attacking this problem.

After summarising the Basel II proposals on Operational Risk and Scenario Analysis, the paper provides an overview of analysis methods employed in safety conscious industries, such as airline maintenance and mining, and in particular expands the concept of the ‘Bow-Tie’ diagram.

The paper then argues that such a model could be a useful standard for conducting Scenario Analysis in the Basel II context and across the industry sector.

Finally, the paper provides an illustrative example of how such an approach could be developed.

¹ The Basel committee specified only that AMA models must be based on a 99.9th percentile confidence interval of a distribution constructed from internal and external loss data.

² Note that many of the same qualifying criteria also apply to the use of the Standardised Approach (SA) in calculating operational risk capital for Basel II.

Operational Risk Management under Basel II

The final Basel II proposals stipulated that an Operational Risk Management ‘system’ must be implemented by an independent operational risk management function responsible for developing and implementing “strategies, methodologies and risk reporting systems ... to identify, measure, monitor and control/mitigate operational risk” (Basel 2004).

To qualify to use the AMA approach to calculate operational risk capital under Basel II, a bank must meet stringent “qualitative standards”, in summary (Basel 2004, section 666):

- An independent operational risk management function.
- An operational risk measurement system that is closely integrated into the day-to-day risk management processes of the bank.
- Regular reporting of operational risk exposures to business units, senior management, and the Board, with procedures for appropriate action.
- The operational risk management system must be “well documented”.
- Regular reviews of the operational risk management processes/systems by internal and/or external auditors.
- Validation of the operational risk measurement system by external auditors and/or supervisory authorities, in particular, making sure that data flows and processes are transparent and accessible.

To qualify to use the AMA approach, Basel requires that a bank’s internal measurement system must “reasonably estimate unexpected losses based on the combined use” of four “fundamental elements” (Basel 2004 section 665):

1. Internal loss data;
2. Relevant external loss data;
3. Scenario Analysis, (the particular subject of this paper);
4. Bank-specific business environment and internal control factors.

The Basel Accord details a series of quantitative standards that will apply to operational risk capital calculations and questions the use of data alone to describe the more severe and rare extreme losses (Basel 2004 section 669):

“A bank needs to have a credible, transparent, well-documented and verifiable approach for weighting these fundamental elements in its overall operational risk measurement system. For example, there may be cases where estimates of the 99.9th percentile confidence interval based primarily on internal and external loss event data would be unreliable for business lines with a heavy-tailed loss distribution and a small number of observed losses.”

There is of course an open question as to how banks can ensure that the ORM systems are complete when capturing operational losses in their internal frameworks as well as how they should comply with some of the more subjective standards that will be tested by their local banking supervisors.

In the final proposals, the Basel committee specified more detailed criteria for each of four fundamental elements, in particular (Basel 2004, 675):

“A bank must use **scenario analysis of expert opinion** [authors’ emphasis] in conjunction with external data to evaluate its exposure to high-severity events. This approach draws on the knowledge of experienced business managers and risk management experts to derive reasoned assessments of plausible severe losses. Over time, such assessments need to be validated and re-assessed through comparison to actual loss experience to ensure their reasonableness.”

In addition to these requirements for calculating regulatory capital, Basel requires that (Basel 2004, 665):

“The bank’s measurement system must also be capable of supporting an allocation of economic capital for operational risk across business lines in a manner that creates incentives to improve business line operational risk management.”

This requirement implies that a firm must implement consistent approaches to estimating both regulatory and economic capital across the organization. In this context a consistent approach to Scenario Analysis would also apply where such efforts are representative of a transparent risk profile for extreme events that can be used to reserve capital and drive improvements.

Scenario Analysis under Basel II

The Basel committee is not itself a regulatory body but sets standards for local banking supervisors in each of the G10 countries. Since publication of the Basel II proposals, national banking regulators have been expanding the Basel II rules for local use. In particular, in late 2005, the Australian Prudential Regulatory Authority (APRA) published detailed “guidance notes” for Australian banks wishing to be accredited in the use of AMA (APRA 2005). This guidance covers all aspects of an AMA and, in particular, specifies more detail required for Scenario Analysis:

“Scenario analysis must be incorporated into a bank’s³ operational risk measurement system to evaluate the bank’s exposure to high-severity loss events. The bank must collect scenarios that draw upon the **knowledge of experienced business managers and risk management experts to derive reasoned assessments of plausible severe losses [authors’ emphasis]**.

The set of developed scenarios should be **comprehensive** and capture all material sources of operational risk **across all of a bank’s business activities and geographic locations**.

A bank’s process for building a **database of scenario-based events must be robust and methodical** and is required to be **applied consistently across the bank**.

A bank’s operational risk management framework must include **policies and procedures** that identify how scenario analysis will be incorporated into the operational risk measurement system.

Scenarios and their use in operational risk modelling must be **independently reviewed and validated**. Over time, scenarios must be re-assessed through comparison to actual loss experience to assess their reasonableness.”

These requirements, especially “comprehensive”, “robust”, “methodical” etc., argue strongly for a structured framework for Scenario Analysis that can be applied consistently across all business within a firm and across the industry.

³ Note that APRA uses the term ADI (Approved Depository Institution) to refer to its regulated entities mainly, but not exclusively, banks.

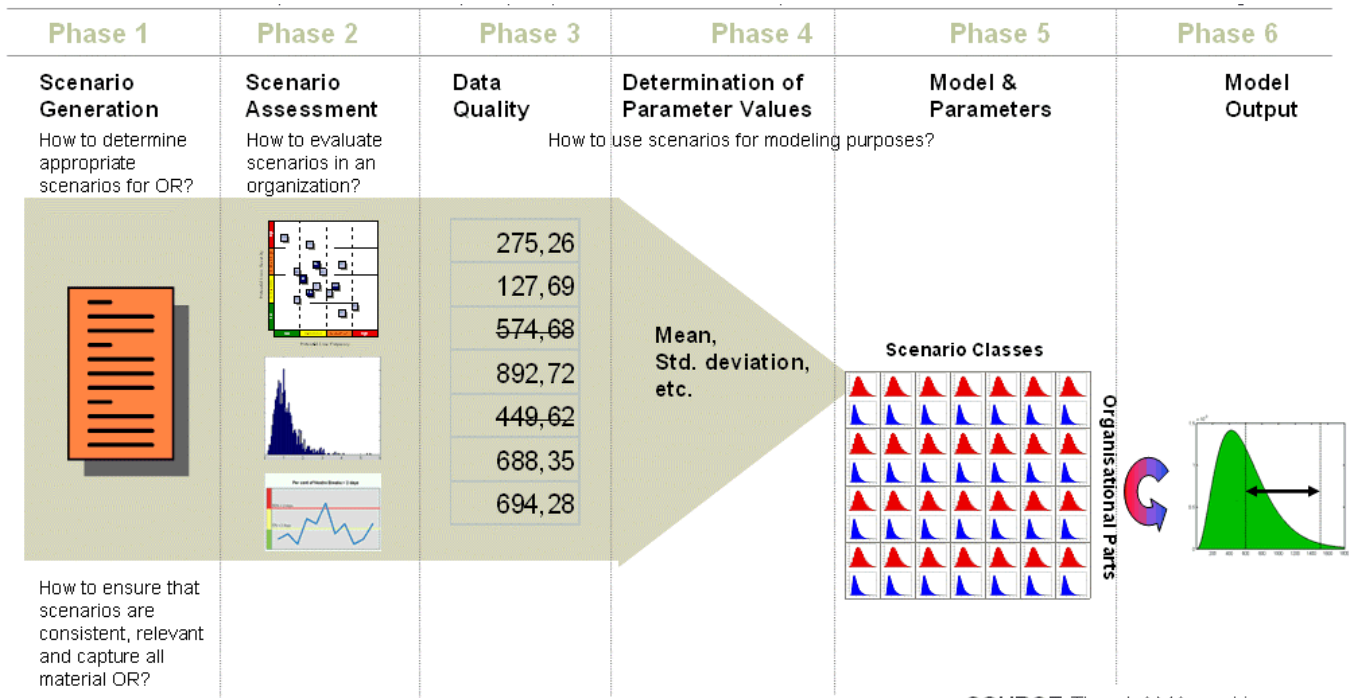
Scenario Based AMA

In 2003, a working group of internationally active banks identified the main steps in a so-called ‘scenario based AMA’ (sbAMA) process for calculating operational risk capital. The working group defined scenarios as “potential future events, [whose] evaluation involves answering two fundamental questions: firstly, what is the potential frequency of a particular scenario occurring and secondly, what is its potential loss severity?” There are several stages of a sbAMA lifecycle which have been outlined below (sbAMA 2003):

1. **Scenario Generation** – Identify plausible operational risk scenarios;
2. **Scenario Assessment** – Analyse and prioritise potential scenarios;
3. **Data Quality** – Review Assessment Factors, loss data (internal / external)
4. **Determination of Parameter Values** – Select and combine values in potential loss matrices;
5. **Model Parameters** – Typically use Monte Carlo simulation to “compound all individual distributions per scenario class and organizational units into an overall aggregated potential loss distribution”;
6. **Model Output** – Estimate economic or regulatory capital for the quantile we are interested in (e.g. 99.9% of Basel II) from the aggregated loss distribution values.

These phases can be summarised by the following diagram:

Figure 1 – sbAMA Phases of Deployment



SOURCE The sbAMA working group

The working group identified a number of benefits of a structured sbAMA process (sbAMA 2003):

“Scenario analysis is inherently forward looking and ... supports a proactive risk management culture ... The process of generating and assessing scenarios as well as evaluating the quality of the associated risk factors and control environment provides an important flow of [risk] management information. Any change(s) in the organisation’s risk profile should prompt a reassessment of the corresponding scenarios [and by implication economic capital allocation] ... [and thus] facilitates a progressive process of improvement in operational risk management... The close involvement of risk takers in all organisational parts increases the transparency of the process and [hence] contributes to meeting Basel II requirements.”

This paper follows the proposed sbAMA process, concentrating specifically on stages 2-6, i.e. Scenario Assessment and Model development and testing. The paper looks outside of Finance for tools that are used for risk assessment in other disciplines and argues that there are proven models/frameworks in other industries that can be used to provide a ‘robust and methodical’ basis for developing Scenario Analysis methods that are compliant with Basel II.

Time Dimension

Operational risk is concept that has proved surprisingly difficult to define⁴. It is a complex phenomenon that requires a number of ‘risk drivers’ and ‘control failures’ to be present and then be combined in the right mixture for a ‘Loss Event’ to occur. After the event occurs, its financial impact will grow, increasing in magnitude as it gathers momentum, ultimately leading to a Loss. Management of operational risk events and minimizing the losses that can result from them is difficult because at any “moment in time’ the complete picture is not available⁵.

In normal operations, loss events have the potential to be triggered at any time, when one or more causes happen, and evade the controls that are in place. Having been triggered, the magnitude of any loss that may occur will depend on how quickly the event is detected and the effectiveness of actions that are taken. Of course in most situations, controls do not fail and events do not occur but, if they do, losses are usually prevented by effective and prompt action.

It is important to note that banks group their risk management techniques/controls depending on where each type of event is at any moment in time. Some controls prevent events and others mitigate or transfer losses after the event has occurred.

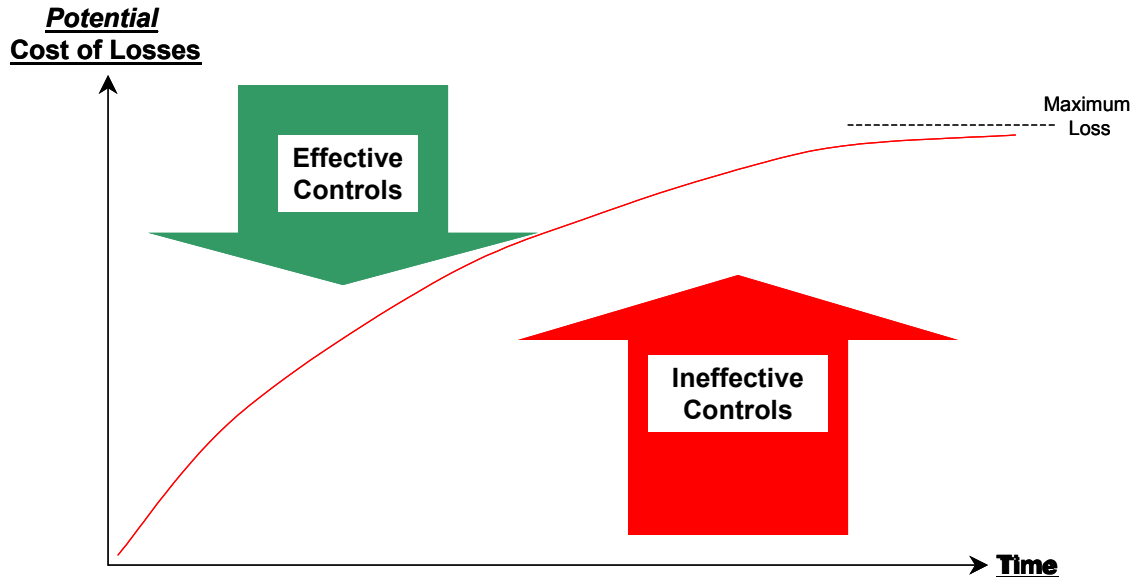
The likelihood of a particular loss event occurring is a mathematical function of the likelihood of the underlying causes occurring, reduced by the effectiveness of existing controls. The

⁴ Despite much discussion in the industry, Operational Risk has only been partially defined within Basel II, omitting strategic and reputational risks (BIS 2004)

⁵ In this respect, Operational Risk is very different to Market and Credit Risks. In modern banks using ‘mark to market’ accounting, Market Risk losses (and profits) are crystallised almost immediately when a ‘market event’ occurs, such as a change in asset prices; mitigating controls, such as hedges, will have an immediate off-setting impact. With Credit Risk, losses are crystallised instantaneously as, for example due to bankruptcy, an accounting write-down is absorbed; after the write-down ‘recoveries’ may over time reduce the maximum loss. With emerging products, products, such as ‘credit derivatives’, banks may eventually move to a more proactive management of potential credit losses over time.

magnitude of any loss that may be ‘crystallised’ is a function of the maximum loss that could occur, reduced by the effective of controls in place to mitigate that event. Figure 2 shows how the magnitude of the *potential* costs of losses grows over time as risky situations evolve, with effective controls reducing potential losses and ineffective controls amplifying them.

Figure 2 – Operational Event - Moment in Time



The remainder of this paper combines the approach to Scenario Analysis described above with a structured approach to managing risks, as they would evolve over time.

Safety Management

Operational Risk exists in all industries. In certain industries, however, such as airlines, mining and nuclear power generation, operational losses can be truly catastrophic, involving deaths, injury and widespread destruction. A recent example of such a disaster is the destruction of the Buncefield oil-depot in the UK (Buncefield 2006). In contrast, in the Finance industry the worst loss that can occur to a single firm may be its bankruptcy, as for example in the case of Barings (McConnell 1998). However, financial sector stability and the ability for banks in a jurisdiction to be able to transact, settle and clear transactions is of course always the concern of regulatory authorities.

In safety conscious industries, such as mining, risk/safety management is long established and well developed, often being taught as a post-graduate discipline, in its own right. While the terminology of safety management is slightly different to operational risk management [referring to ‘hazards’ rather than ‘risks’, and ‘containment’ rather than ‘mitigation’] its objectives are the same – the identification of potentially disastrous events and the reduction of the likelihood and impact of major events. This paper argues that the tools and techniques used in such safety conscious industries are applicable to the Finance industry and, in particular, to the Operational Risk Management as defined by Basel II.

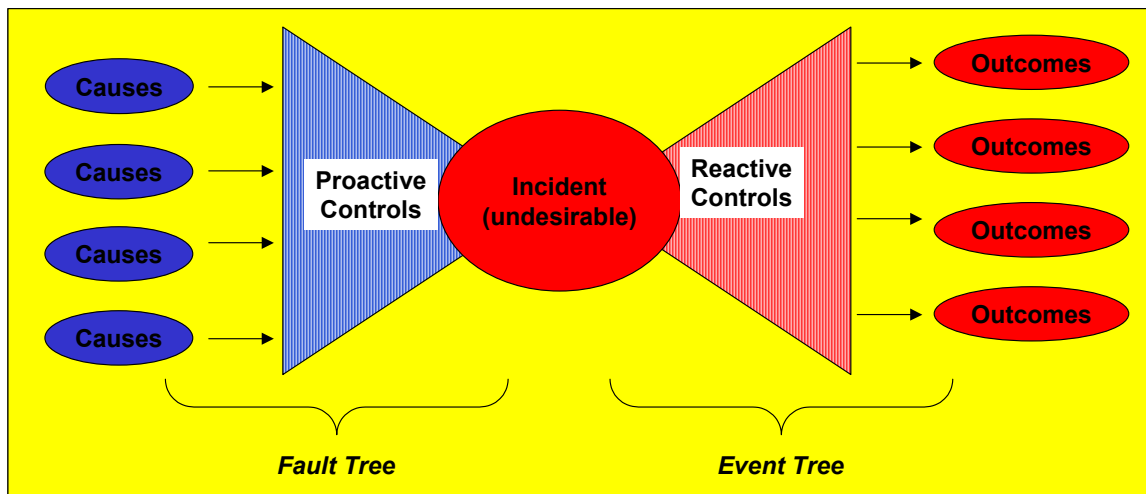
The Bow-Tie Diagram

In 2004, the US Federal Aviation Authority (FAA) mandated that its regulated entities employ a technique known as the ‘Bow-Tie Diagram’ as the main mechanism for “safety analyses” (FAST 2004). This technique is also recommended by other bodies responsible for safety in air traffic control (EuroControl 2004) and safety management in hazardous industries (Work Cover 2001).

Figure 3 illustrates the key components of a ‘Bow-Tie’ diagram:

- Causes: potential causes of an undesirable Incident⁶;
- Proactive Controls: actions taken to reduce the likelihood of an undesirable Incident occurring;
- Incident: an event that can cause undesirable Outcomes;
- Reactive Controls: actions taken to reduce the impact of an undesirable Incident; and
- Outcomes: potential results of an undesirable Incident.

Figure 3 – Bow-Tie Diagram



The left-hand side of the diagram is often called a ‘Fault Tree’, which is a detailed analysis of *the combination of causes* (‘faults’) that can possibly give rise to an undesirable incident, while the right hand side is often called an Event Tree, which is a detailed analysis of the Outcomes or Consequences of an undesirable Incident.

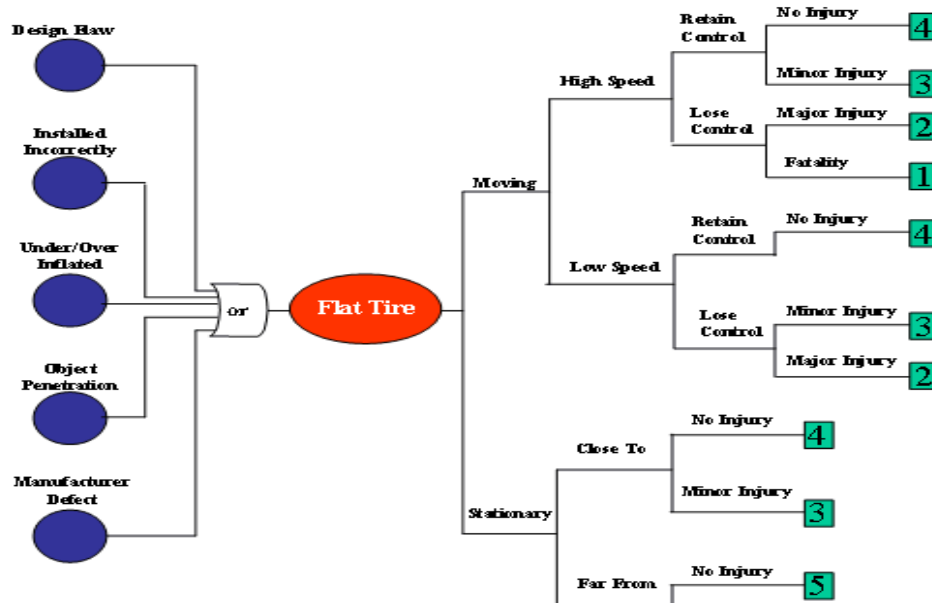
⁶ The Bow-Tie sequence is also termed: Hazard → Preventative Controls → Incident → Mitigating Controls → Consequences in some Safety Management areas.

In essence, the diagram attempts to answer the two ‘fundamental questions’ posed by the sbAMA working group: “what is the potential frequency of a particular scenario occurring [i.e. left side/Fault Tree] and secondly, what is its potential loss severity [i.e. right side/Event Tree]”?

In industrial applications, Bow-Tie analyses are most often employed to identify and assess the potentially disastrous impact of the failure of mechanical components, such as chemical containment vessels or airframe components.

Figure 4 is an example used by the FAA to illustrate the use of bow-tie analysis.

Figure 4 – Example of Use of a Bow-Tie Diagram



In this relatively simple example, there is the potentially disastrous incident of a flat tyre occurring during airplane take-off. The causes are identified on the left and, on the right, the conditions that give rise to various outcomes, some much worse than others. In practice, of course, a diagram would be much more complex than this one. Advantages of using the “bow tie” assessment are often identified as (e.g. Euro Control 2004):

- It provides a ‘common language’ for communication between independent risk managers and operational experts;
- The full range of Causes (i.e. ‘inherent risks’) and Proactive Controls (i.e. ‘residual risks’) can be shown and discussed;
- The combination and interaction of Causes and Proactive Controls can be clearly illustrated; and
- Likewise the full range of Outcomes (i.e. Losses in Basel terminology) and Reactive Controls can be illustrated and discussed.

In summary, the complex linkages between possible Causes and potential Outcomes can be made explicit and that assists in drawing a clear picture for the precise drivers that generate losses. Furthermore, if each stage of analysis, e.g. moving from left to right, is carried out by experts and then brought together into a coherent whole by independent risk analysts/moderators then such a process should qualify for being “robust and methodical” for Basel purposes.

Of course the bow-tie technique is not a panacea, it is merely a way of making risk management assumptions, analyses and conclusions **explicit**. It has known weaknesses, including:

- The quality of the final analysis will totally depend on the quality of the analysis process and the analysts and experts taking part: garbage in - garbage out;
- The technique does not help in uncovering underlying causes, merely in making their consequences explicit, there is therefore an earlier analysis step (i.e. Risk Identification) required;
- It is a ‘semi-quantitative’ methodology and hence requires an additional step of estimating the impact of each outcome numerically as required by Basel II, and
- It can be ‘gamed’ by staff members who may have a different agenda, so requires additional supporting information to be captured such as external data or other documented factors which can suffice as evidence.

A methodical approach to estimating risk in any Scenario Analysis exercise is extremely important as research shows that business managers (as with people in general) are not good at producing accurate estimates of risk, especially of low-probability, high-impact events. The relatively new discipline of Behavioural Finance, for which Kahneman and Tversky won the Nobel Prize in Economics in 2002 - though neither laureate was an economist! - describes how people do not estimate risks as would be predicted by classical finance theory.

Research in ‘risk perception’ shows⁷, for example, that people will invariably overestimate the likelihood of an event with which they have some familiarity rather than a completely alien one and will extrapolate from known situations to estimate an unknown one, invariably not making a large enough adjustment (i.e. will underestimate the risk). Furthermore, researchers have found that ‘experts’ are over confident in their ability to estimate accurately from small data samples. Nor does using a number of experts, rather than one, to estimate risks necessarily lead to a better estimation, as the well-known phenomenon of ‘groupthink’ can lead groups to make completely wrong, but agreed, conclusions.

The use of a Bow-Tie approach does not, of course, eliminate these problems, merely reduces the likelihood of error by segregating risk analysis into smaller, discrete, independent components and reducing cross-contamination between them. Of course it should be recognised, especially for low-probability events, small errors in one part may be amplified in others – a problem with all subjective techniques. Therefore a good taxonomy is required for homogenous loss data collection that can show when correlation factors are present for broad impacts that cross over from one risk classification into another.

⁷ Kahneman, Tversky and other researchers in the field, argued that rather than use the ‘expected utility’ rules of classical decision theory, people estimate risk using subjective ‘heuristics’ (or convenient ‘rules of thumb’)

Application of the Bow-Tie Diagram in Scenario Analysis

A Bow-Tie diagram is a graphical representation of a Scenario.

Having identified a ‘Scenario’, such as flat tyre in the FAA example, the situation can be analysed in a methodical manner, by experts, as follows:

- Identify potential Causes: using operational/business experts, risk managers and, if appropriate, external experts;
- Assess the effectiveness of Proactive and Reactive Controls: using independent internal/external auditors and risk managers;
- Identify and assess possible Outcomes: using operational/business experts, risk managers and, where possible, internal and external experience;
- Build a Bow-Tie model of the Scenario (i.e. Causes, Controls and Outcomes): using business and independent assessments and, where available, historical data and evaluate the range/distribution of potential Outcomes and their sensitivity to assumptions of the key parameters; and
- Refine the Model: based on business/risk management feedback and any additional analyses required.

In order to satisfy the requirements of Basel II, such a process would have to be judged:

- **Methodical:** with each component step performed to agreed procedures with well-defined separation of responsibilities;
- **Robust:** able to be replicated by different analysts and experts, producing results that are not too dissimilar;
- **Comprehensive and Consistent:** used in the same way across all business units;
- **Well-documented:** in a consistent fashion with sufficient detail; to permit
- **Independent Review and Validation:** by external and independent experts.

APRA (2005) requires that a firm should build a “database of scenario based events” that can be reviewed periodically and modified as business conditions change. The consistent use of a Bow-Tie technique should aid the development of such a database, allowing rational discussion between risk analysts and business managers to take place when discussing new initiatives, which is a major benefit of such an approach, overcoming a major hurdle in subjective assessment.

Since financial firms are subject to similar risks (although their individual control environment and consequent range of potential outcomes may vary significantly), there is the potential for

developing a database of scenarios that are applicable across the industry. For example, the loss of a shared industry service such as an Exchange or Clearing house. Such a ‘scenario’ is the same for all participating firms, but the impact may vary wildly, depending on: for example, transaction volumes, customer impact and the quality of their BCP (Business Continuity Planning).

For those institutions that are subject to Basel II regulation, it is suggested that the so-called Basel II Level 2 Event Type categorisation is a good starting point for identifying incidents for Scenario Analysis, if only because losses must be reported to regulators at this level, see Figure 5 for a subset of the Basel II event classifications⁸.

Figure 5 – Basel II Event types (Subset)

Event-Type Category (Level 1)	Definition	Categories (Level 2)	Activity Examples (Level 3)
Internal fraud	Losses due to acts of a type intended to defraud, misappropriate property or circumvent regulations, the law or company policy, excluding diversity / discrimination events, which involves at least one internal party	Unauthorised Activity	Transactions not reported (intentional) Transaction type unauthorised (w/monetary loss) Misrouting of position (intentional)
		Theft and Fraud	Fraud / credit fraud / worthless deposits Theft / extortion / embezzlement / robbery Misappropriation of assets Malicious destruction of assets Forgery Check kiting Smuggling Account take-over / impersonation / etc. Tax non-compliance / evasion (wilful) Bribes / kickbacks Insider trading (not on firm's account)
External fraud	Losses due to acts of a type intended to defraud, misappropriate property or circumvent the law, by a third party	Theft and Fraud	Theft/Robbery Forgery Check kiting
		Systems Security	Hacking damage Theft of information (w/monetary loss)
Employment Practices and Workplace Safety	Losses arising from acts inconsistent with employment, health or safety laws or agreements, from payment of personal injury claims, or from diversity / discrimination events	Employee Relations	Compensation, benefit, termination issues Organised labour activity
		Safe Environment	General liability (slip and fall, etc.) Employee health & safety rules events Workers compensation
		Diversity & Discrimination	All discrimination types

Likewise the so-called “Level 3” activities provide a good and granular starting point for identifying Causes for scenarios. For example in Figure 5 above, in looking at External Fraud (Event type Category Level 1), a suitable Scenario might be ‘Systems Security’ and ‘Causes’ (Category Level 2) might be ‘Hacking Damage’ and ‘Theft of Information’ (Activity Example Level 3).

⁸ For those firms not subject to Basel regulation, the event type classifications provide a good starting point, which may be augmented by other classifications specific to the industry.

- (d) The likelihood of an incident⁹, here Systems Security, will depend on the estimated frequency of multiple causes, reduced by the effectiveness of proactive controls, as estimated by observation and expert opinion. It should be noted the severity of an incident has not been considered at this stage, merely the likelihood of its occurrence. In this particular example, the expert judgement involved in estimating frequencies would be technical in nature, not necessarily considering, or even knowledgeable about, the range of outcomes of a particular incident.
- (e) Having recognised that an undesirable incident may occur, the potential outcomes can be estimated. As with the left side of the Bow-Tie diagram, the effectiveness of the right-sided ‘reactive controls’ can be estimated, by appropriately knowledgeable experts. Note that, in this particular example, these business-focussed reactive controls are qualitatively very different to the technical proactive controls. Estimates of some controls may be determined by experience, for example in this illustration, recovery rates can be estimated by of the firm’s or industry experience.
- (f) Eventually, the magnitude of the outcomes can be calculated by combining estimates of controls.

In cases such as that illustrated in the example above, the magnitude of outcomes/consequences would naturally be linked to the magnitudes of the individual transactions involved in an incident, i.e. the loss from a large transaction would almost certainly be greater than a smaller one, given similar controls¹⁰. In these cases, a Monte Carlo approach, which models the Bow-Tie, incorporating not only varying estimates of transaction size, but also estimates of underlying frequency and control effectiveness distributions, would create a distribution of potential losses from which the Basel II 99.9th percentile can be drawn. This type of approach is supported by regulators as it fits the type of parametric model required to generate the type of ‘Value at Risk’ estimates needed to calculate capital.

Basel II requires that models used in Scenario Analysis “need to be validated and re-assessed through comparison to actual loss experience to ensure their reasonableness” (Basel 2004, 675). In terms of the Bow-Tie model, this means using actual experience, such as the observed frequency of causes, along with estimates of control effectiveness to estimate (a range of) outcomes/losses. If the model is not a good predictor of losses, then its individual components and assumption must be reviewed and adjusted as required. Occasionally, new components, such as causes, controls or outcomes, may have to be added to the bow-tie model to improve its predictive capability.

Such a structured approach to Scenario Analysis, including estimates of and assumptions behind each component being documented in a structured fashion, should help to satisfy the Basel II criteria of being “methodical”, “robust” and “well documented”. If used in the same way across an organization such an approach meets the criteria of being “consistent” and “comprehensiveness”. A well-documented structured approach would also lend itself to

⁹ More properly, an estimation of a frequency distribution rather than precise frequency, e.g. between .001% and .004%

¹⁰ Loss values do not necessarily rise linearly with size of the underlying transactions, as additional ‘large value’ controls may be triggered.

regulators' requirements that the approach can be "independently reviewed and validated" (APRA 2005).

Further Research

As noted by the Basel Committee, there are extensive opportunities for research into the topic of Operational Risk Management, covering both quantitative and qualitative methodologies (Basel 2004). For this particular topic (i.e. Scenario Analysis) there are several potential areas of further research, in particular:

- Empirical research into and case studies on the approaches, methods and tools that are being adopted by banks for Scenario Analysis within Operational Risk Management.
- Research into the theories of Scenario Analysis and how banks might use those theories in complying with Basel II.
- Further consideration of the proposed approach, including:
 - (a) The applicability and deficiencies, if any, of Bow-Tie models to Operational Risk Management as defined by Basel II.
 - (b) The potential for using standardized Bow-Tie models across the industry.
 - (c) Consideration of how such models may be used for allocation of economic capital.
- Studies into technology aspects of Scenario Analysis in Operational Risk Management systems.

Summary

The final Basel II proposals are far from clear about precisely what banks are required to do to implement Operational Risk Management systems that will comply with the quantitative standards for using AMA approaches in calculating capital charges for Operational Risk. While this lack of clarity is a reflection of the paucity of research in the area, it leaves firms in the invidious position of trying to second-guess the meaning of subjective terms in Basel II, such as 'robust', 'methodical' and 'well-documented'. One topic that is particularly subjective is Scenario Analysis, or the use of 'expert judgement' to add to the set of data used in capital calculation.

The paper argues that there are well-developed techniques outside of Finance that may be applied to Scenario Analysis, as defined by Basel II, to help satisfy these somewhat subjective criteria. In particular the paper describes the Bow-Tie technique used in managing risk in safety conscious industries such as mining and air traffic control. The paper expands on the Bow-Tie diagram, how it may be used to satisfy Basel II and provides an illustration of how it might be employed.

Though still somewhat subjective, the use of a consistent and comprehensive approach to Scenario Analysis would not only allow regulators to compare the use of Scenario Analysis by banks across the industry (and to set criteria for compliance with regulatory requirements) but

would also allow firms to allocate economic capital according to rigorous Scenario Analysis of risks in its business lines.

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