Latest Innovations in Emerging Risk Assessment

WHAT CAUSES ORGANISATIONAL FAILURE?

Identifying, assessing, understanding and mitigating emerging risks are some of the most difficult tasks in risk management. Yet, they are essential in order to develop a resilient organisation that can adapt to an evolving environment. When we look at the causes of why organisations suffer large, unexpected losses and those that ultimately fail, it is typically not the result of the risks they are aware of and actively manage, but rather the ones that they either haven't seen before or are novel in some way. History is littered with examples where combinations of multiple causal events interacted in unexpected ways to produce catastrophic losses. You only need to look at the history of rogue traders to evidence this.

When such risks manifest themselves, it becomes clear with 20:20 hindsight what characteristics the risks have and how they might be classified. However, before this point, these risks are essentially emerging risks, characterised by being things that you don't fully understand, that may be material, and for which the likelihood, severity and timing are uncertain. Understanding them properly is, thus, really an exercise in understanding the uncertainty in how they may evolve dynamically over time.

Emerging risk assessment is an important part of the ICAAP process, which requires organisations to undertake stress testing and scenario analysis in order to understand and better manage the risks it is facing. However, to date most organisations tend to focus on a relatively small number of single risk factor stresses or simple scenarios that they already know and are easy to quantify. As a consequence, there is typically a disconnect between these and the risk scenarios that actually drive material losses and organisational failure. In order to bridge this gap, organisations are now starting to look at enhancing ways to systematically and meaningfully incorporate emerging risk assessment into this process.

AN EVOLUTIONARY APPROACH TO EMERGING RISKS

Are so called 'black swan' risks really unpredictable? From an evolutionary perspective, a black swan should not be a surprise – but an orange swan with purple dots would be. Risks bear considerable similarities to organisms: they exist in a particular environment; they change over time; and they have uncertain outcomes. The evolution of risk is partly determined by the uncertain nature of risks, partly by the environment and partly by human behaviours.

In order to identify emerging risks, a risk DNA methodology has been developed that uses phylogenetic approaches developed for biological and language evolution. It provides insight into the lineage, pace and characteristics of the evolution of risks. It cuts across organisation boundaries and disciplines; looks at risks for what they are, at an almost fundamental level; and then groups them accordingly. By adapting phylogenetic analysis, it is possible to determine an enterprise risk DNA map, which can unlock some surprising insights into risk behaviour.

Phylogenetics not only indicates the similarities and differences between species, but also illustrates their evolutionary relationships. There are three major methods and algorithms employed to construct phylogenetic trees: distance matrix, maximum likelihood and maximum parsimony. The parsimony principle favours the tree with the least evolutionary changes. Methods based on the principle of maximum parsimony are by far the most widely used because they are the most logical and intuitive to apply. A detailed methodology of the phylogenetic techniques is given in 2012 Clark Prize winning paper, available from the Institute and Faculty of Actuaries' website[1].

The outputs from phylogenetic analysis are tree-like shapes, often called 'evolution trees', 'phylogenetic trees' or 'cladograms'. An evolutionary tree is essentially a connected graph that is composed of nodes, which represent species (risks) and branches. A risk tree is studied from left to right. As we move to the right, the tree branches to indicate points where the risk characteristics are evolving. Figure 1 (p29) shows a section of a tree with two legs representing risks A & B, 'lost intellectual property rights' and 'claims infringement of intellectual property rights', respectively. The risk characteristics are indicated by the numbers on the branches: 22 – 'inadequate legal framework'; 7 – 'crime' and 25 – 'human error or incompetence'. This tree shows there was an earlier risk with hazard 22 from which emerged the two new risks, A & B, with additional characteristics, 7 and 25 respectively.

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Figure 1: *(right)* **shows a section of a tree with two risks. The characteristics are indicated by the numbers on the branches: 22 – 'inadequate legal framework'; 7 – 'crime' and 25 – 'human error / incompetence'.**

There are many patterns formed within the trees which indicate where evolution is most likely, thus helping with the monitoring and prioritisation of emerging risk management. Some of the more common patterns are shown in Table 1 below:

Figure 1

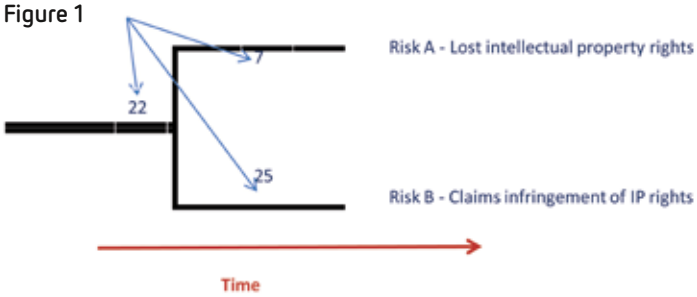


Table 1: Patterns in evolution trees

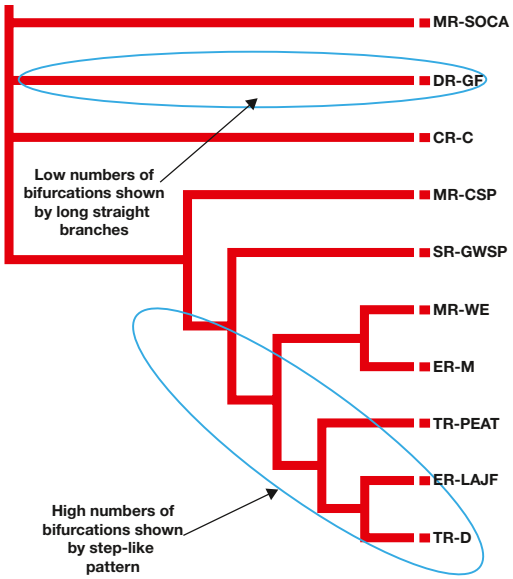
CHARACTERISTIC / EXAMPLE EVOLUTION TREE

LOW BIFURCATION:

Low numbers of bifurcations, shown by long straight branches, indicate areas of limited emergence. These areas are stable and independent from other risks. They possess few characteristics and can be more easily tracked.

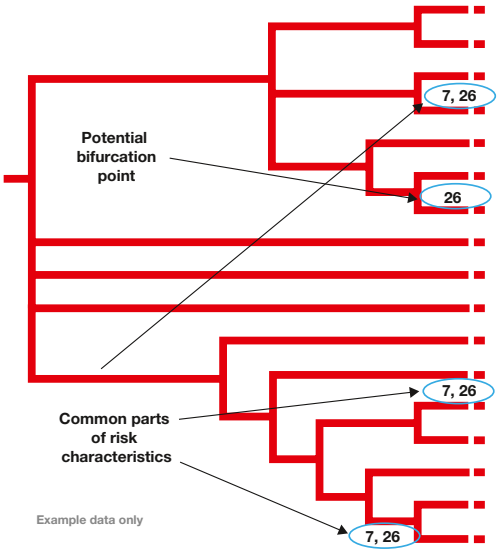
HIGH BIFURCATION:

High numbers of bifurcations indicate areas of high complexity where risks are more likely to evolve from. This is shown by many branches on the evolutionary tree. Character patterns in these highly active regions can often be identified, creating an early warning system.



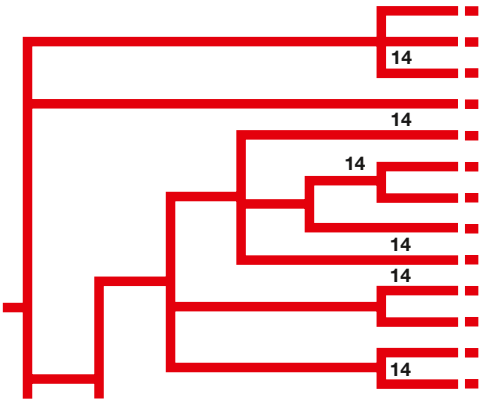
PATTERNS:

Pattern spotting between sets. As an example, pairs of common characteristics appearing in multiple locations can be used to identify potential locations for emerging risks. The emerging risks occur where one of the pair of characteristics exist. It is possible that these single characteristic locations may evolve into the common pair. Pair spotting (and other character pattern spotting) can be used to make predictions or construct scenarios about future risks.



SUDDEN CHARACTER EMERGENCE:

The same character in multiple risk locations indicates something is changing fast. If characteristic '14' was 'government', for example, why is it suddenly affecting so many risks and what will the consequences of this be?



CASE STUDY

In order to demonstrate this technique, we have applied it to operational losses associated with derivatives. We have leveraged the work produced by Thomas Coleman who mapped a range of relevant characteristics to a number of major derivative loss events. The loss events are shown in Figure 2.

We have taken this mapping data at face value from *A Practical Guide to Risk Management*, with the exception of aggregating some of the finer levels of granularity on the security type. These characteristics are somewhat subjective, and clearly it would be possible to define additional characteristics, but they are sufficient for our purposes to demonstrate this technique. Figure 3-4 shows the evolutionary tree for this data and the 14 different characteristics used.

Each branch in the tree ends in a specific loss event. Each branching point is defined by a split in the characteristics as identified by the numbers that are common to all members of the sub-branches. The first thing that is noticeable in this tree is the division into three major clades or groups:

- normal activity gone wrong (characteristic No. 4);
- fraudulent activity (characteristic No. 1); and
- collection of "simple" events characterised by the use of a range of derivatives (characteristic No. 14).

These can be considered the fundamental, or most systemic, risk elements. So, for example, the presence or absence of the fraud characteristic defines the first major break in lineage and forms the largest fraud clade. At the bottom of the tree is the derivatives clade which shows very little evolutionary process. These events can be considered to be relatively stable and unchanging in nature. These are the crocodiles of the risk world – they have reached their evolutionary peak and show little sign of emergent behaviour.

In contrast, there are two areas in the fraud clade that show significant evolution through a large number of bifurcations in characteristics. They can be considered to be highly evolving risk events. These types of events should be studied in detail, as companies with similar characteristics to these events are more likely to be subject to emerging risk. Furthermore, we would generally expect to see increased complexity in the new risks that evolve in these highly active areas.

Figure 2: Selection of Large Derivative Trading Losses (2011 USD equivalent figures)

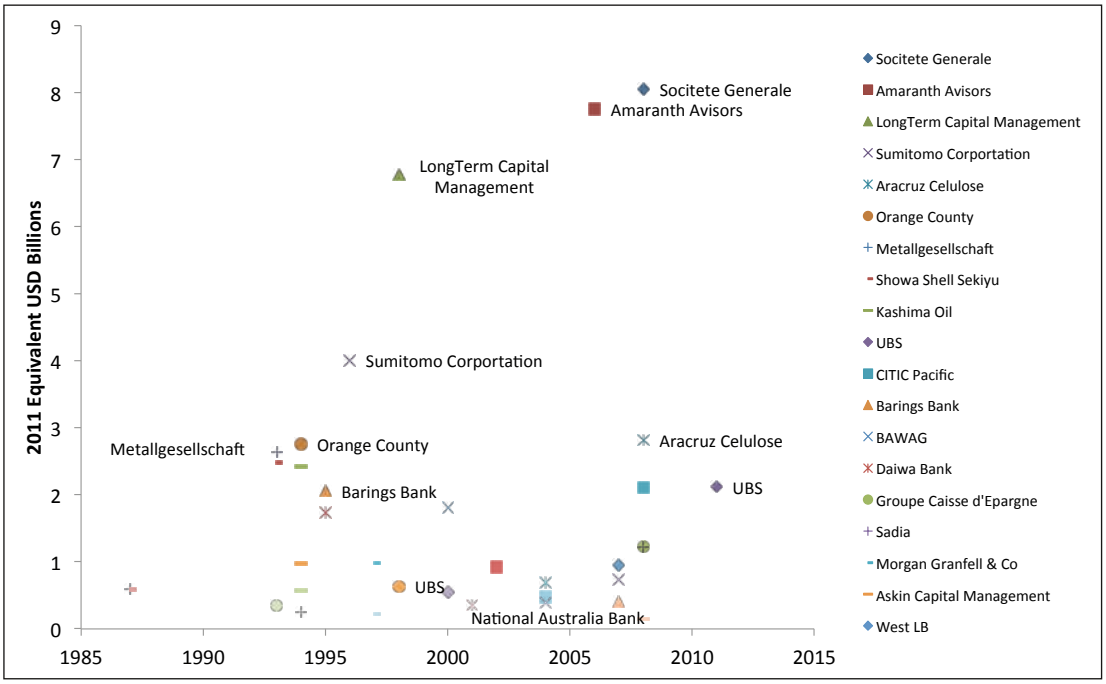
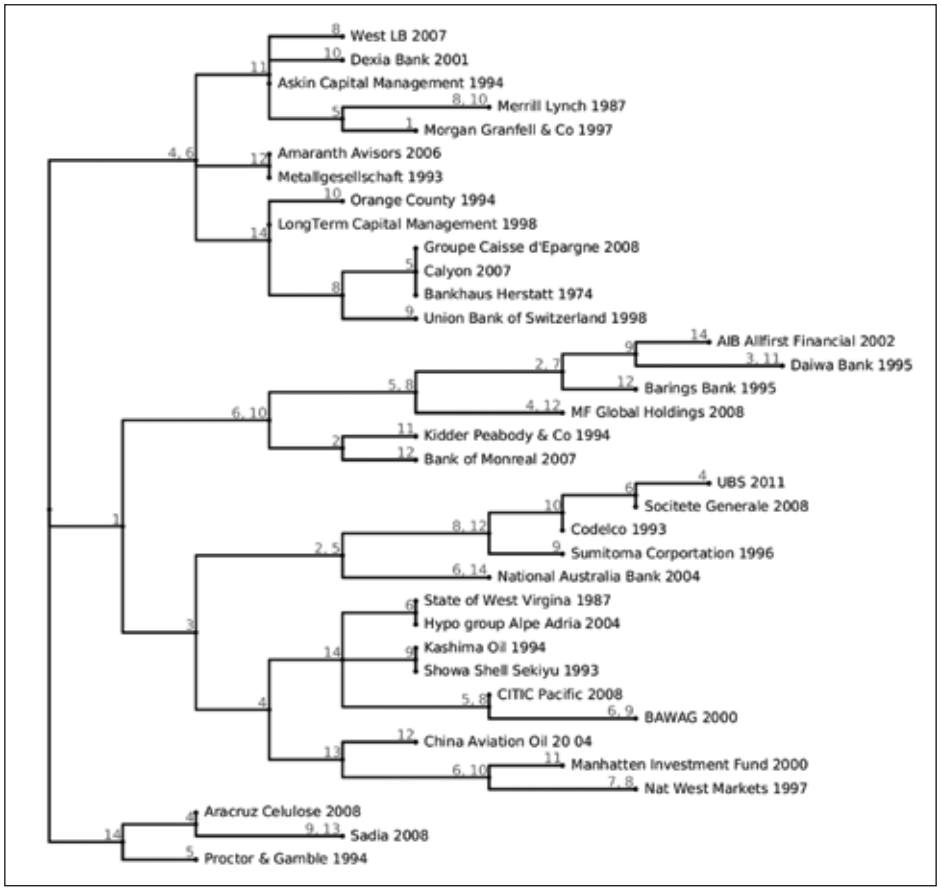


Figure 3-4: Evolutionary tree of Large Derivative Loss Events[2] and Characteristics



Characteristics that appear frequently are more likely to appear in the future. The sequence of characteristics can also be important, as some characteristics tend to occur towards the end of branches rather than at the beginning. For example, characteristic 9 (Long-term accumulated losses in excess of three years) always occurs at the end of a branch structure, indicating that it could readily jump across to another branch to define a new emerging risk characteristic.

We have highlighted bifurcations involving characteristic number 8 (Lax management/Control problem). This is a very common characteristic, as it is evident in almost all branches/events. In many cases, it is also evolving jointly along with a number of other characteristics such as:

- 10: Single person;
- 5: Trading in excess of limits;
- 12: Physicals; and
- 7: Failure to segregate functions.

Characteristics 8 and 5 (trading in excess of limits) in particular seem to be very closely related in evolutionary terms. Note that this seems somewhat logical in hindsight, but we arrived at this conclusion through an objective analysis based purely upon a rich classification dataset. This could be very important information, as it provides clues as to what characteristics emerging risk events might have in the future. From this, we can then ask more focused questions such as:

- What would the next West LB (very top) or NatWest Markets (near bottom) events look like, if they evolved to contain a 5 characteristic (trading in excess of limits) as they already have an 8 characteristic?
- What would this event possibly look like if it happened at my organisation?

IMPLICATIONS

Firstly, risk can be viewed as an evolutionary process that gives rise to emerging risks. This will be the case whenever the underlying system involves human behaviours or is a complex adaptive system. Investigating the evolving characteristics of risk events in the past can provide insight into our understanding of how emerging risks might occur in the future.

Secondly, it is important to capture multiple characteristics of risk events, both in terms of realised historic events, as well as forward looking events. Valuable information may be lost if risks are forced to be assigned to only single categories or characteristics, which may be the case if risk register software constraints exist, if a prescriptive risk classification framework is narrowly defined, or if the emerging risk identification approach is biased from the outset to focus on single processes or risk silos. The quality and completeness of loss data collection and classification processes become critical activities in the emerging risk process.

Thirdly, the risk taxonomy can be determined objectively from the data, rather than being defined prescriptively in an ex-ante sense. Risk taxonomies are almost always defined on the latter basis, resulting in linear structures, which is only appropriate in rare situations whenever system complexity is low. However, humans tend to overly simplify situations where there is complexity, losing valuable information in the process. By defining the risk taxonomy objectively through this framework, we are able to map the interrelationships and connectivity between different risk branches, to gain insight into how risk events are truly related.

This is closely related to the discussion on the boundary between risk classes. Whilst it is a natural human response to try to carve everything up neatly into independent risk silos, with risks such as operational risk, it is not quite as appropriate to do so because of the high degree of interaction with other risk types. The Société Générale rogue trading event is a good example here, as there are clearly elements of market risk, operational risk and liquidity risk involved in the generation of the final loss amount.

The final implication is that the above framework provides a structured way of addressing emerging risk. It is another lens through which we can possibly gain insight into future emerging risk events that we haven't yet seen and when we are not sure exactly what we should be looking for.

CONCLUSION

Taking into account the unique evolutionary history of an enterprise's risk system, it is possible to determine the likely future trajectories or emergence of new and evolving risks. The evolutionary tree shows what the parent risk is and when a risk characteristic combines or separates to form a new lineage or emerging risk. This allows focused scenarios to be developed for the ICAAP of how emerging risks could evolve both within and between risk classes, hence allowing for early intervention, and thus, the enhancement of organisational resilience. Lastly, the analysis provides a unique and powerful way of classifying risks that is independent of traditional organisational boundaries and structures. This can aid effectiveness and efficiencies in managing risks and allocating risk-related resources or capital. A

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The full version of this paper was presented at the 2013 Actuaries Summit and can be downloadedfrom http://www.actuaries.asn.au/SUM2013/Program/Media.aspx

[1] http://www.actuaries.org.uk/research-and-resources/documents/review-use-complex-systems-applied-risk-appetite-and-emerging-ris-0

[2] Cladograms produced using Evolutionary Risk Analysis software available from www.systemicconsult.com