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Abstract

This paper explores risk management of the construction of Sydney's Centrepoint building, and contrasts with risk management in financial services.

Designing and constructing buildings, bridges etc. requires engineers to balance conflicting interests, such as the trade-off between cost and resilience. It is a basic principle of engineering that an underlying structure must be consistent with the purpose of the structure. In engineering, good risk management does not operate in a silo, but is embedded in day-to-day processes, supporting business to achieve its primary goals.

Risk management is engrained into engineers' mindsets throughout every stage of the design and construction process. Engineers design and manage using a principles-based approach which allows them to respond efficiently and effectively to unforseen circumstance. In contrast, in financial services risk management is often seen as an adjunct to business processes and externally-imposed frameworks from regulators may encourage a compliance focus to risk management.

Key words: Risk Management, Risk Culture, Risk Appetite, Organisational Change, Actuarial

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1 Introduction

1.1 Risk return trade-off

Financial Services organisations have a goal of maximising returns for their stakeholders, whether they are shareholders or members of a mutual society. There are many ways in which an organisation can maximise their returns; however every opportunity has risks associated with it. Organisations are in the business of balancing risk and returns to optimise outcomes.

Financial services organisations have their own risk appetite and are typically reasonably risk averse. This risk aversion can be observed from an enterprise level down to the investment portfolios within business units in an organisation. The collapse of banking groups during the GFC have shown the effects on organisations where risks are not managed properly.

Part of the risk aversion of financial services organisations is driven by the needs of their investors and customers, in particular, the desire for the organisation's reputation to be safe and reliable.

Portfolio theory, as seen in Figure 1, provides an easy way to visualise the risk/return trade-off of risk averse investor. The higher the utility curve, the better it is for the investor. However, there are limited resources. The point at which the utility curve intersects with the set of attainable portfolios is the optimal portfolio mix for the investor.

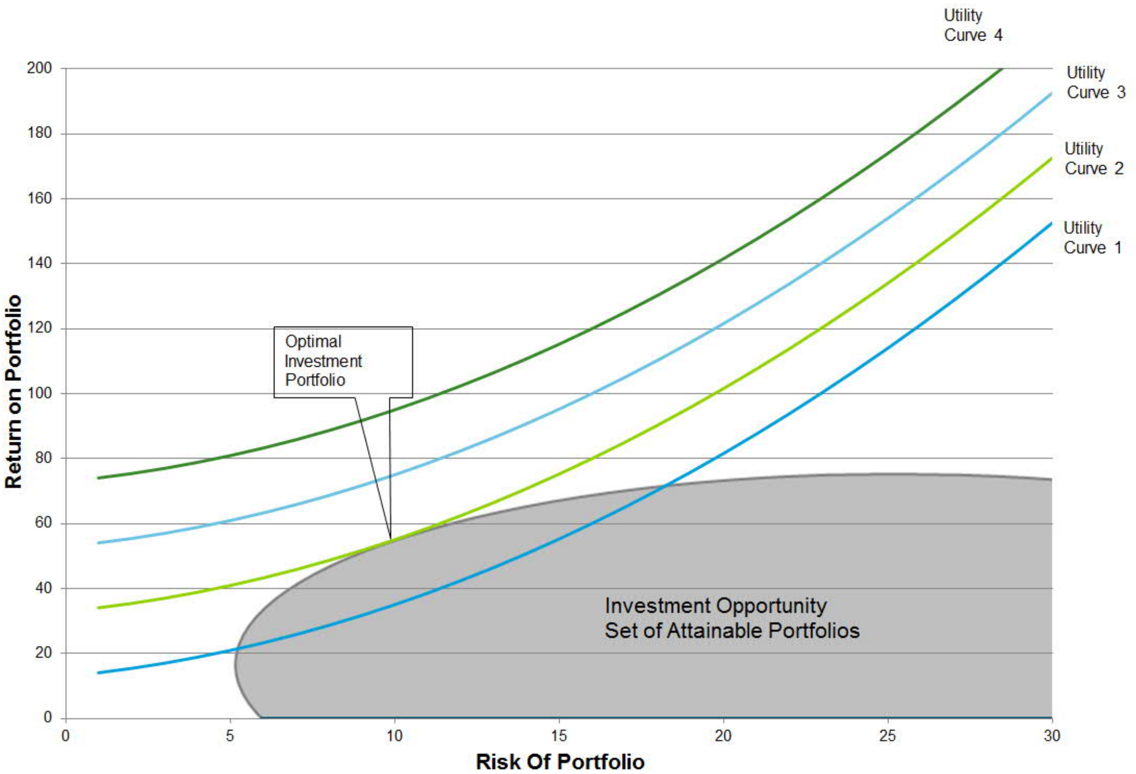

Figure 1 – the optimum portfolio for a risk averse investor

Risk is not unique to financial services. Risk is prevalent in every organisation and profession in varying degrees. In engineering, design and construction of buildings and bridges are exposed to potentially adverse consequences that are severe and far-reaching.

This paper seeks to draw parallels between risk management processes in the engineering and actuarial professions, and suggests that there are cross-sector learnings that can be distilled.

1.2 Risk and Engineering

Risk management is embedded into the psyche of the engineering profession. Catastrophic outcomes including fatalities may result from a failure to mitigate risks properly.

Engineers design and manage projects so that they can easily adapt to changes in design or scope or desired outcomes. The resultant nimble and fluid operating model enhances the outcomes of their work.

The management of risks in the engineering field covers the full spectrum of the design, construction and operation of the associated elements. The initial design process incorporates contingencies and scenario/stress testing, which is partly mandated by design standards. Prior to any construction or fabrication of major designs, the engineer ensures that a full independent verification process is completed. During construction and for higher risk elements, they continually monitor and make adjustments to ensure the actual performance is in line with the expected performance.

An example of the application of risk management in engineering can be observed through the risk management steps taken during the redevelopment of the Centrepoint Tower in Sydney. This project was visible and high risk for the design engineers both in terms of reputation and safety.

1.3 Actuaries and Engineers. Actuaries versus Engineers?

Actuaries can be considered the structural engineers of the financial services industry. Actuaries design, model, create, identify and mitigate risks, just like engineers.

Through a high level exploration of the redevelopment project of the Sydney Centrepoint Tower and other engineering projects, this paper aims to showcase engineering risk management techniques and process, and draws applicable learnings for the financial services industry.

The paper is structured in a manner that focuses on the key phases of the redevelopment of the Centrepoint Tower, from the original design through to the finished product, and distils the learnings at each stage. We will consider topics such as regulation, efficient modelling and external review, real time monitoring, risk management frameworks and risk culture, many of which are interlinked.

2 Foundation & framework: regulation versus innovation

2.1 Engineering

The success of any engineering project is hinged on a solid plan that deals with any issues and risks that may eventuate during the life of a project. For the redevelopment of the Centrepoint Tower, the foundation of the project started with a careful selection of the team to carry out the project. The winning team included members of the original building design team. These members had 30 years of experience working on the building.

In setting up the risk management framework for the redevelopment, significant efforts were placed on understanding the existing behaviour to ensure that there was no change in the overall building behaviour during the redevelopment.

A difference with the financial services sector is that there are no separate risk management standards developed by a regulatory body that engineers have to comply with irrespective of the design of the building. There are design guidelines that apply to engineers which are not mandatory if they are not applicable to the specific circumstances of the building. Engineers are encouraged to think outside the box in creating design solutions. They are not constrained by the guidelines and can create unique solutions.

2.2 Possible implications for financial services

With the release of CPS 220 Risk Management by the Australian Prudential Regulation Authority (APRA) the level of risk management overview has increased. CPS 220 has enshrined the requirement of a Chief Risk Officer and an adequately detailed, board owned, risk management framework. The risk management framework must cover a significant amount of information across each organisation's business operations. The new standards set out the type of risks to review and the requirements for managing these.

In contrast, engineering regulations are more principles-based and allow for innovative designs. One common use of innovative design is in relation to the compliance of new buildings to the fire safety code. The standard requires set distances from exits and points of choice [1] within a new building. However, these are based upon generic assumptions of a typical building, the occupants and its use. For an atypical building, a fire engineer can optimise the design of buildings by modelling the speed of evacuation, available fire sources and the potential speed of the spread of the fire. There is implicit understanding that actual structures are too diverse to be covered by one-size-fits-all standards.

[1] A point of choice is a position along the typical evacuation route at which a person has a choice to which emergency exit (e.g. fire stair) that they can take. This is important so that if there is a fire blocking an exit that a person can access another exit quickly and easily.

During the redevelopment of the Centrepoint Tower, the Australian standards did not adequately address some of the new structural situations that were created by the changes to main structure. By utilising internationally accepted design standards and thoroughly peer reviewed design models, engineers were able to gain comfort that the new layout was structurally adequate.

The design of innovative products in financial services is analogous to the redevelopment of the Centrepoint Tower. By having a standard that is open to be challenged, and supported by a thorough risk management framework, innovation can be fostered.

> By not being constrained by prescriptive standards, financial services organisations may be able create more efficient and innovative solutions to meet challenging problems.

Product design has major implications for the profitability of financial services companies. There have been failures of innovative products in the past where the risks were not truly appreciated, or otherwise ignored.

The challenge for actuaries is to help create innovative products, while minimising the risks associated with them. A key part of this is creating the right skillsets and experience in a product design team. Actuaries have a deep understanding of the numbers behind products; however, a product design team should also include a cross-section of the business, with actuaries working closely with non-actuaries. There needs to be a firm understanding of how the products are perceived by customers and the perceived risks of the product. This will enable validation of sales or volumes assumptions used in modelling. Where relevant the integrated team should also include input from claims professionals. These professionals will have a deep understanding of the behaviour of the prospective policyholders and how the design of the product affects the behaviour, and in turn drive claims assumptions. Constant monitoring and refinement is to be encouraged – actual experience invariably differs from expectations. We will further examine the topic of collaboration in Section 6 of this paper.

3 Design Modelling & Capital Requirements

3.1 Engineering

In engineering, there is generally an independent design verifier for high risk projects. This person or organisation would typically be engaged by the project owner (Westfield for the redevelopment of Centrepoint Tower). These verifiers complete an independent design of the elements. This process enables an optimal solution to be completed, with rigorous review of contentious issues.

Due to the risks associated with the redevelopment of the Centrepoint Tower, especially as a result of the design challenges that required solutions outside the Australian Standards, an independent design verifier was engaged on the project. As part of the redevelopment, a significant amount of the building's lateral stability elements (i.e. walls) were removed to allow joining the existing building with the new surrounding buildings. This created a significant risk around the ongoing performance of the final building as well as the short term stability during the construction of the new elements.

The performance of the existing structure was modelled and reviewed using Strand7, a finite element analysis software package. Through an in-depth review of the existing buildings performance, e.g. highly stressed elements in Figure 3 , the original design drawings and design changes carried out over the lifetime of the building, a computerised model of the structure was created and refined.

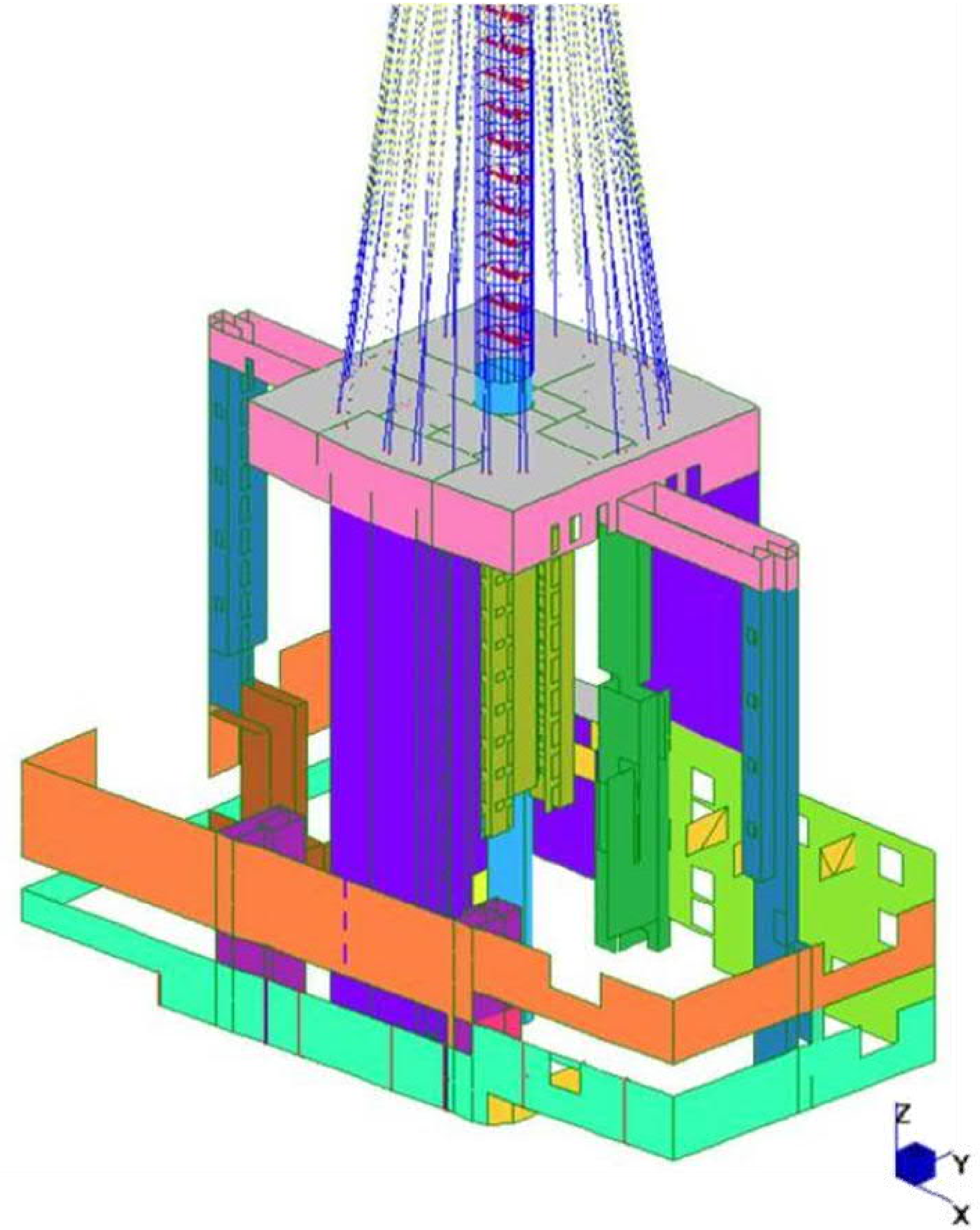

Figure 2 - Existing Condition Model (source – Hyder Consulting)

This existing condition model (Figure 2 and Figure 3) was used as the basis in which to review and design any structural changes to the building. At the same time that the main design firm was creating this model, the independent verifiers created their own model of the structure. Throughout this process, although both design teams' assumptions were globally equivalent, modelling differences brought out potential design issues. Through the refining of both models and the discussion on the optimal assumptions, the two models were created and were found to be globally equivalent. This enabled a higher level of comfort when designing areas that are critical to the overall performance of the building, particularly the circular core of the tower.

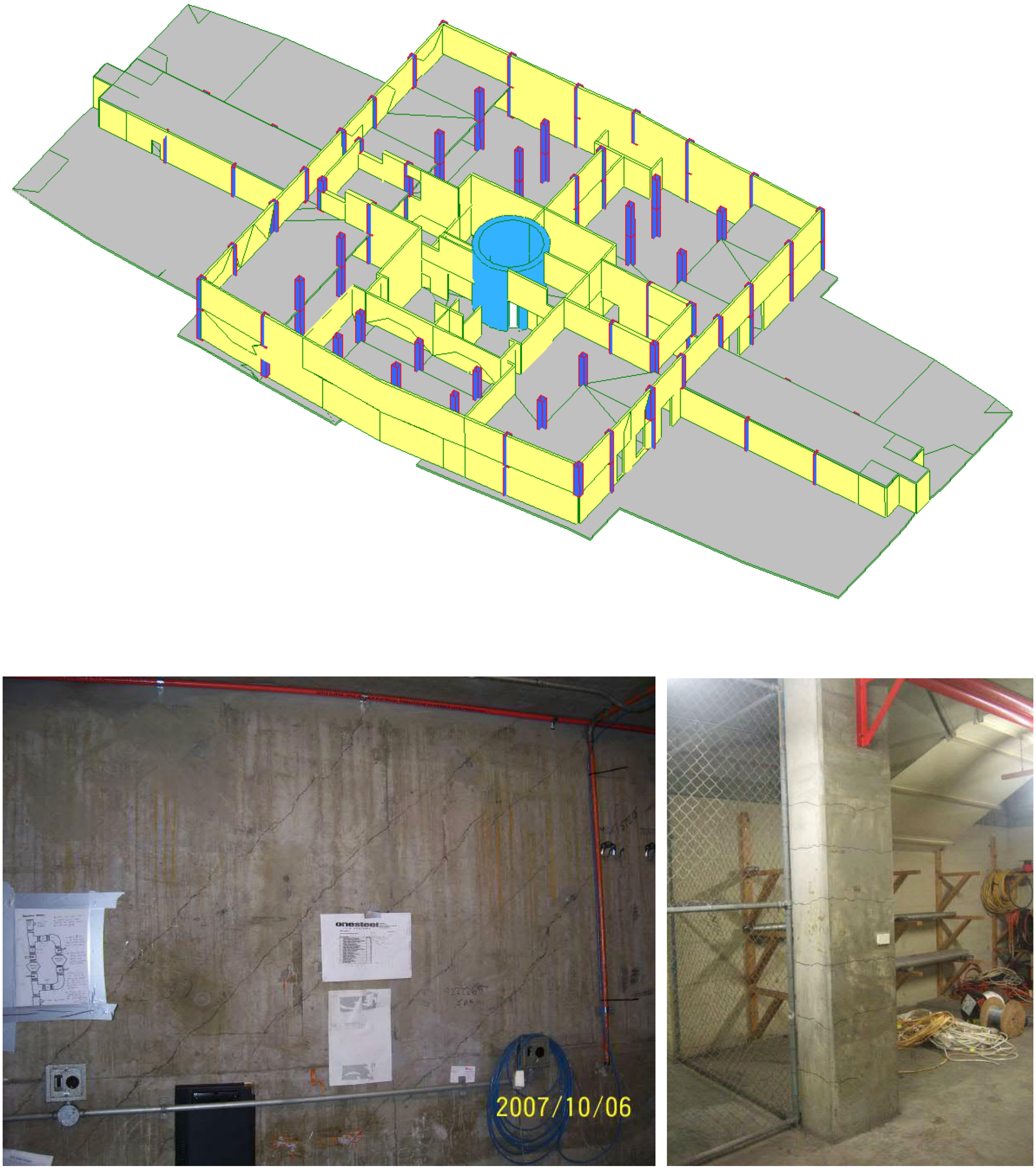

Figure 3 – Highly stressed wall (left) and column in tension (right) at upper levels (top) (source – Hyder Consulting)

By bringing in an independent verifier, a thorough review was able to be conducted. As the verifier was aware of the risks, and sought to minimise their exposure to these risks, a more robust design was made.

3.2 Possible implications for financial services

The release of the new solvency and capital adequacy standards Life and General Insurance Capital (LAGIC) has brought to the forefront the prescribed requirements of capital, aligning general insurance and life insurance capital requirements.

Capital requirements are externally imposed and becoming increasingly complex. Whilst there is recognition that companies can build their own internal capital model, the approval process may lead to homogeneity of the models. This contrasts with engineering whereby risk management intrinsically allows for differences in design and shape of buildings, and does not adopt a "one-size-fits-all" approach.

With robust modelling of the interaction of risks within an organisation, a level of capital that is lower than the regulatory requirement may be deemed appropriate.

> Robust modelling in conjunction with efficient risk management systems may lead to specific capital requirements.

To complete this will require a rigorous process that fully appreciates the complexities of the organisation and the industry as a whole. This is where the role of an independent verifier would provide the regulator comfort without the regulator having to conduct its own independent modelling of every financial services organisation.

Independent review of models in engineering is analogous to the current actuarial peer review process. The resilience of financial services organisations is modelled through the projection of future cash flows under various circumstances. The current capital models used by insurers are generally designed and built in-house. If two independent capital models that are different in nature and complexity indicate a similar level of capital is required, it may be shown that a different level of capital is required to cover the potential risks to a business than what is indicated by the regulator's prescribed model. This is consistent with an engineer completing a design of a structural element with a reduced level of structure to the design code, whilst the building is still structurally adequate and has a level of safety factors built in.

4 Scenario & Stress Testing

4.1 Engineering

Engineers have had significant experience in stress testing the behaviour of their designs. For structural engineers, a significant amount of real life scenario and stress testing has been completed over hundreds of years to appreciate the real life behaviour of structural elements. A major component of the stress testing in engineering is the testing of the individual elements. Each component of a structure will have had an equivalent element tested to failure at one point. For instance, a structural beam will be bent to failure, or a piece of reinforcement will be pulled until failure. Through the testing, a good understanding of the performance of the element is gained, from the normal range of loads, through high level loads and all the way to failure.

For general structures and standard loading, combining all of this information is sufficient to gain comfort. However, when dynamic loads such as earthquakes are considered, the interaction between all of the elements becomes important. As a result, researchers have built full scale shake tables to test full buildings and bridges as can be seen in Figure 4.

Figure 4 – Six story timber building on shake table (credit: Colorado State University)

For the Centrepoint Tower, testing included a load test to failure of the concrete in major structural elements. This was completed by extracting concrete samples on-site and testing these in a specialist's lab. The performance of the existing building was also taken into account where designing new elements.

4.2 Possible implications for financial services

For in-depth modelling to be carried out, there needs to be a better understanding of potential future scenarios. A big driver of the capital adequacy requirements, as noted in the new LAGIC standards, is around the combination of individual stresses on the whole organisation after considering each individual component, whether insurance risk, asset risk, asset concentration risk or operational risk. There is an allowance for a diversification benefit in the form of a prescribed formula.

The complexity of financial institutions varies tremendously between small and large companies. A simplified aggregation benefit formula may not adequately account for such differences. The engineering profession considers scale naturally - what works in one site does not necessarily work everywhere. Other complexities are also considered when models are scaled up to real-life dimensions.

Engineers use the result of small scale testing across all components of a system to build an understanding of the whole system. The interaction of the elements becomes very important. This is where testing of large components for the interaction is required. For financial services organisations, the interactions of the individual elements need to be explored. This can help understand the effects of a new product, or new pricing strategy on the entire company. To complete this optimally, the understanding of historical experience as well as the specific testing is vital.

> The understanding of the interaction between individual risk elements of an organisation is imperative to understanding the overall risks to the business.

In engineering, full scale tests based on a set of failure assumptions and a design load are carried out for complex projects. Likewise, financial services organisations in Australia are encouraged to also consider reverse testing (ie stress to failure). This is already carried out in some countries overseas. In reverse stress testing, scenarios that threaten the survival of the financial organisation are considered. This is intended to overcome any false sense of security that might arise from regular stress testing where manageable impacts are identified. It also helps identify organisations to explore more fully the vulnerabilities and tail risks and improve contingency planning as appropriate management actions can be identified.

5 Continual monitoring of Actual vs Expected performance : Agility

5.1 Engineering

For complex and high risk elements of an engineering project, continual monitoring is important. When the Centrepoint Tower was redeveloped, there was a range of measures undertaken to understand the performance of the building and minimise the risks associated with the construction works, as demonstrated in Figure 5 and Figure 6.

The process around the monitoring of the redevelopment was as follows:

- A computer model was created, modelling the behaviour of the structure in its original condition. This behaviour included the effects of a wide variety of pressures on the structure including wind and heat.

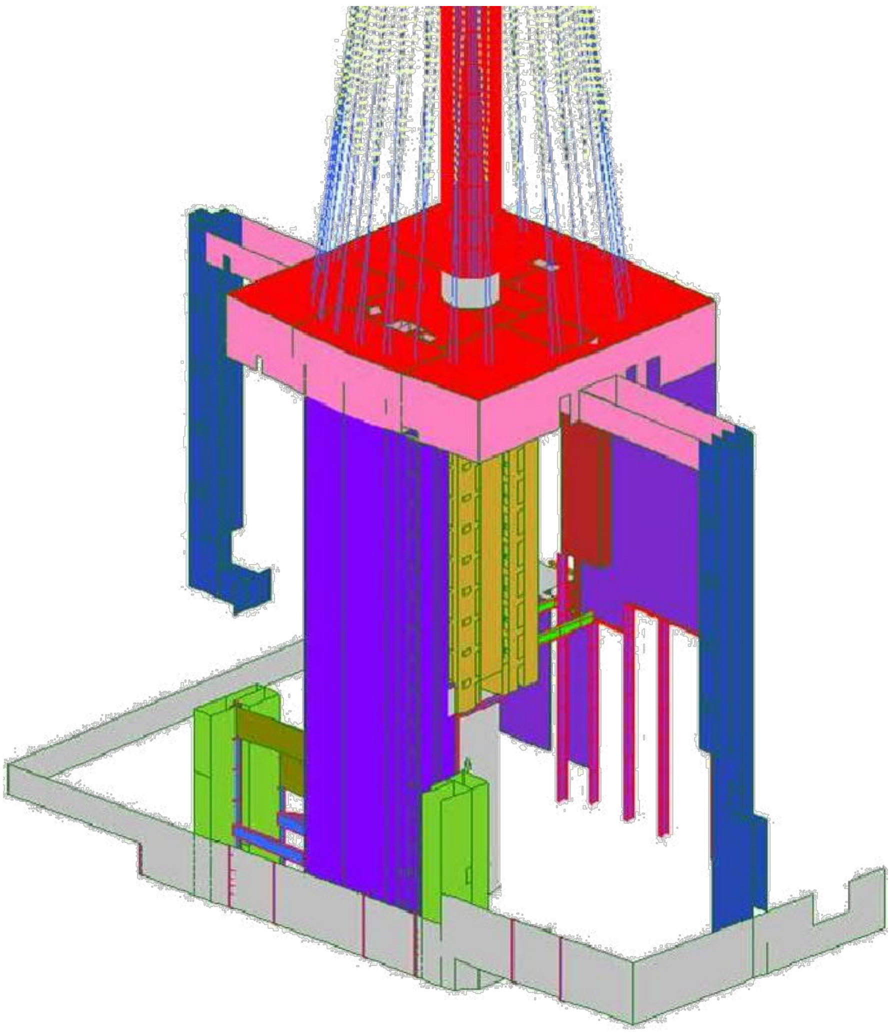

Figure 5 - Final Model of Structural Elements

- A series of monitors were placed upon certain areas of the tower and its supports. These enabled accurate real-time positioning of the structure.

- A series of models were created based upon the major construction milestones of the redevelopment. These models allowed the expected deflections of the tower to be calculated based upon the series of loadings.
- A system was put in place so that at all times the performance of the tower was monitored.

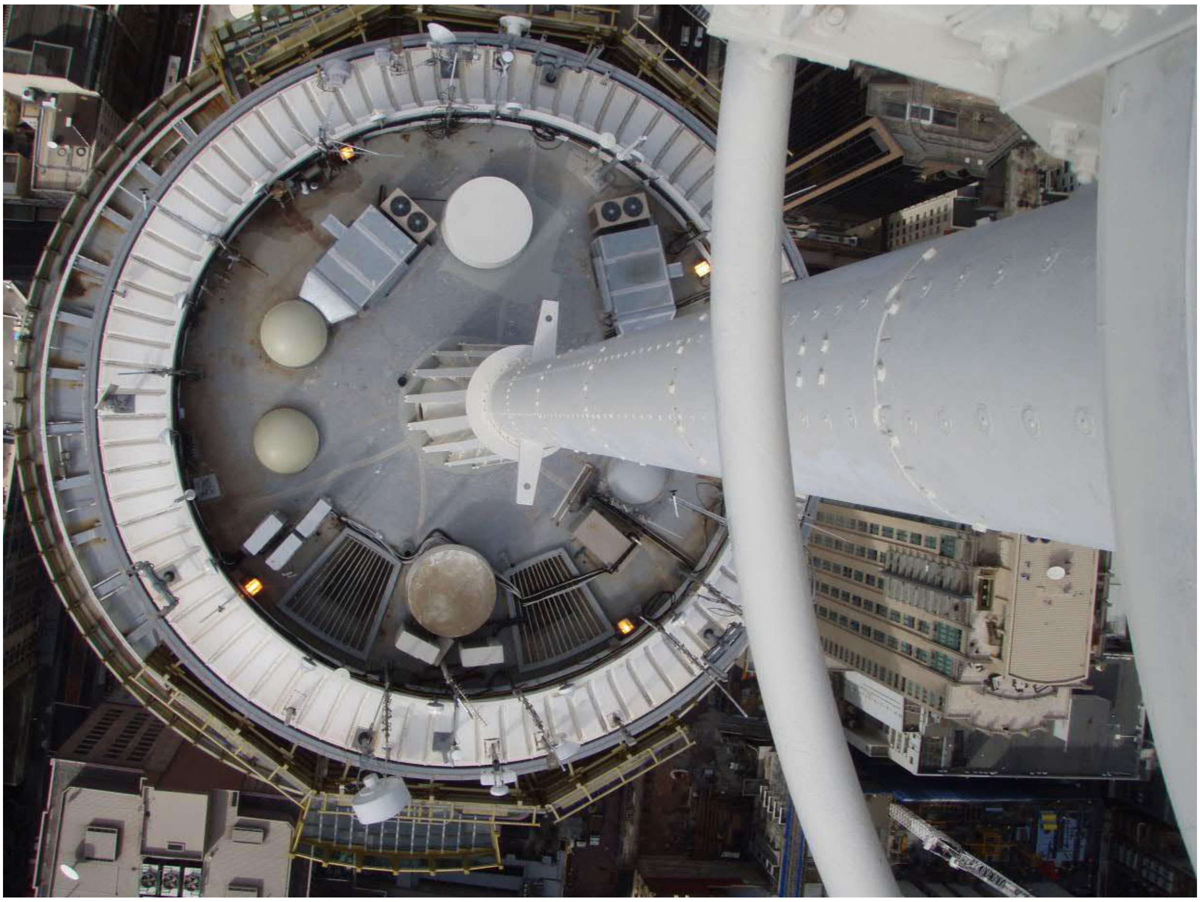

Figure 6 - The Turret of Centrepoint Tower where monitoring was placed during construction

Real time monitoring of performance is particularly useful when accurate expected performance is known. This level of monitoring enabled the project team to gain a better understanding of the behaviour of the structure. It also provided comfort to the users of the structure knowing that it was performing as expected.

Another method of continual monitoring was seen during the construction of the Burj Khalifa in Dubai. The Burj is the tallest building in the world, standing at 828m high, breaking numerous records during its construction. Due to the size of the building and the lack of precedence, great care was taken during construction to understand its ongoing performance. Much like the stepped models and continual monitoring used at the Centrepoint Tower, the Burj was continually monitored. In addition to this, the design team also made use of the tower cranes that were operating onsite. At certain times, the design team used the tower cranes to excite movement in the tower. With the monitoring devices in place they could understand the movement of the tower and therefore the load paths. This enabled them to adjust certain design aspects during the construction to optimise the building and ensure its safety.

The engineers were able to update design of major infrastructure based upon real time monitoring. They were also able to confirm the performance of their buildings based upon the measurements.

5.2 Possible implications for financial services

Engineers have an acute awareness of the limitations of models: no model can fully reflect reality. In econometrics, however, there is an implicit assumption that modelling reflects reality and the unreality of assumptions is often ignored. Monitoring actual performance against modelled outcomes is crucial. Not only will it help revise assumptions, it will shed light on whether modifications need to be made to the model.

In insurance firms, experience analysis and/or valuation of the business is conducted regularly, often quarterly. The valuation process takes a significant amount of time and the results and drivers of change may not be known for weeks after the valuation date. Dependent on the timing of the valuation, months could have elapsed after a change in the business has happened. Given our assumptions are based on actual historic performance, a delayed view of the performance may hamper our ability to form expectations well, be they expected number of claims or lapse rates or expected returns, and respond to changes in experience.

With a better understanding of the actual composition of an insurance portfolio as well as the experience of the claims in real time, an insurer would be able to better manage their risk profile and the associated capital required around their portfolio. This would enable an organisation to adjust pricing, underwriting, policy terms and conditions and sales incentives to manage those risks.

To give a straight forward example, if an insurer is selling too many funeral insurance policies to young people, a nimble insurer would be able to change incentives or remuneration to sales agents such that it is not attractive to sell to these groups to ensure a balanced risk portfolio. Likewise, pilot campaigns can also be tested more regularly to ascertain the effectiveness of the campaign and price elasticity of a product. Similarly, real time monitoring can also help “shock lapses” to be identified more quickly, whether from premium increase, bad publicity in the press, or adviser churn.

Real time monitoring could also be useful for resource and staff allocation. For instance, with up-to-date understanding of applications at different stages, resources can be allocated to support the sales team that is servicing most sales at the appropriate time. It can also help identify at an early stage whether the insurer is selected against.

Insurers overseas are aiming for real-time monitoring and comparison with expected assumptions, similar to the way the structural performance of the Centrepoint Tower was monitored in real-time. Real time monitoring of capital position is optimal, and has been achieved by Bermudian insurers in particular. However the insurance industry's reliance on complex black box capital models which are separate from a company's financial systems makes real-time capital modelling difficult. Most organisations currently have IT systems that are inflexible and that render organisations unable to respond to change swiftly. Organisations that can overcome IT issues have a competitive advantage.

> To profit from the knowledge of real time data and monitoring, an organisation must have a nimble and agile target operating model that quickly adapts to future unforeseen circumstances.

There have already been many changes in the financial services sector – including digitisation, "cloud" based infrastructure etc. Like the engineering field, there will continue to be many changes in the future. It is impossible to predict the future accurately, the key to success, however, will be the ability to respond to the future. Therefore, organisations that succeed in the midst of change will need to be nimble and agile.

6 Collaboration & Design of risk management frameworks

6.1 Engineering

Structural engineers are great at creating structurally optimal buildings, based upon the design guide of the architects. However, when too much responsibility is given to either the engineer or the architect, it results in a poor solution. The Centrepoint Tower in Sydney is one extreme. It was heavily designed by a structural engineer. It is a practical structure, but it is arguably not the most pleasing to the eye. At the other end of the spectrum is Sydney Opera House. It is a beautiful building designed by Jørn Utzon, however it was almost impossible to build. It was finally completed 10 years late and 14 times over budget[2].

Figure 7 - Sydney Opera House (Left), Sydney Centrepoint Tower (Right) (source: WikiCommons)

A risk management framework needs to be a happy medium between the two professions, creative and structural. A visually appealing framework may not have the information needed to manage risks. On the other hand, a framework that can manage all the risks may be so confusing to the users that it is not used.

Generally engineers and architects know their place in the design of buildings. When they work in harmony, great buildings can be created. In such a way actuaries need to work with the business to create a risk management frame work that not only enables risks to be managed, but is also intuitive to use and practically able to be implemented.

[2] http://en.wikipedia.org/wiki/Sydney_Opera_House

6.2 Possible implications for financial services

To be successful, the risk management framework should be designed and implemented through a process of collaboration with other professions. This will enable the risk management framework to be comprehensive enough to cover the risks of a business, but also detailed in a way to ensure that it is used by the organisation as a whole. Just as engineers and architects respect each other's strengths, actuaries, claims, sales, marketing staff need to collaborate to generate the most optimal solution to business problems, taking into account risk and return.

This, however, does not mean that a well-structured risk management framework will alleviate all the risks of a business. The ownership of risks and the risk profile of the employees will play a significant role in the success of an organisation in managing their risks.

> Risk appetites are set at the enterprise level by an organisation, but they need to be cascaded and managed in a meaningful way at an individual level.

Although organisations as a whole have a goal to maximise returns while minimising risk, the individuals within the organisation may choose to pursue their own personal interests. This can be seen in the failure of organisations to manage their internal staff risks in companies such as:

- Barings Bank's £827m trading loss;
- Société Générale's €4.9b trading loss;
- Commonwealth Bank's mismanagement of $300m of investors' funds.

On each of these occasions, individuals created a method to bypass the risk management frameworks of their respective employers. It is clear that even the risk management requirements enforced upon financial services organisations cannot guarantee against fraudulent actions of an individual(s). Fraud is a substantial but separate topic and will not be covered in this paper.

A more granular example of collaboration is how the knowledge of the claims team could be fed back into actuarial team and in turn influence pricing and underwriting. For instance, an analysis of how actual claims experience compare to underwriting questions will enable an assessment of the effectiveness of underwriting questions in risk selection. Similarly, claims handlers often input a lot of information of claimants in free text field. This information is valuable but hard to analyse and therefore often lost. Much value can be derived from these for enhanced understanding and management of the portfolio by non-claims teams.

7 Culture

7.1 Engineering

The risk culture within engineering organisations is imperative to the success and safety of buildings everywhere. Although engineers are generally risk averse in their designs, the culture within an organisation is important to the overall performance of projects.

A successful construction project is one that is completed on time, within budget, with a product that functions as proposed and will structurally perform. To achieve this requires a sound risk culture and great communication among the differing design teams.

During the redesign of the Centrepoint Tower, there was a great collaborative culture amongst the full design team. To find the optimal solution for the project required a constant flow of information amongst the team.

This iterative process, or control cycle, was centred on finding the optimal safe solution. A design was put forward and then reviewed by the team to ensure that the design met the requirements of the relevant design standards. In the process of completing the review, the teams also looked for a better way to complete the design. Teams also modified the layouts and structure in order to gain a more robust and economical solution.

This process gave the engineers comfort that their concerns were met when the design was not optimal for them, while at the same time gave the architects and client the comfort that the design was adequate and the best possible outcome.

7.2 Possible implications for financial services

The myriad of failed financial services organisations in history demonstrate the importance of risk culture in organisations. Hubris and lack of accountability can cause significant damage to the organisation's profitability and reputation. Culture is amorphous, difficult to change and certainly not "created" overnight. Cultural transformation in an organisation is best achieved in collaboration with other professionals such as human capital experts. Actuaries alone, albeit how ambitious, are unlikely to achieve the same level of results which arise through collaborative efforts.

In financial services, risk management is often seen as a compliance exercise, at the periphery rather than at the centre of business operations. Risk management is at times considered by the business as acting like a brake on new ventures and new ideas. This is in stark contrast to the engineering profession where risk management is embedded in its processes. It is central to what engineers do, rather than something extraneous.

A relatively concrete manifestation of risk culture is the process in which new projects are approved in organisations and the level of communications and upward information flow from business units to management. Typically large projects are run by project managers who are not subject matter experts. They then obtain sign-offs from different business heads and inform management once all sign-offs are received and a green light is given to proceed with implementation.

One of the challenges from business unit's perspectives is that there are inadequate resources and time to give a full, unqualified sign-off. A typical result is business units are pressured to give sign-offs and make compromises such as testing simpler cases or not test the full extent of interactions. A sign-off may then be given with a large number of caveats about aspects that are not yet tested. However during the process of collation of all the sign-offs, the qualifications are not escalated and management is therefore not made aware of how uncomfortable the business units may be of the proposed project, nor is management fully across some of the risks that the business units are concerned about. The sign-off process is at times relegated to a compliance exercise. Vital risk information is therefore "lost" or disregarded and management has no access to them.

> By better collaboration with all the relevant parties, management are placed in a position to make the most appropriate decisions for the business.

One of the possibilities to improve the information flow between business units and management might be the introduction of a "scaled sign-off". This means that in addition to the qualifications that business units provide, a range can also be provided of the level of comfort or confidence they have towards the project risks, say from 1 to 5 (1 being least comfortable and 5 being most comfortable). A low score can therefore prompt management to look into the qualifications provided by certain business units as part of the sign-off. This snapshot of comfort level could lessen the disconnect in information flow and be a mechanism to encourage discussion around issues with management in a timely manner and serve as a starting point to promote a stronger risk aware culture.

8 Concluding remarks

We describe in this paper, through the redevelopment of the Centrepoint Tower, that there are a number of learnings that financial services sector can draw from engineers in risk management.

A clear mandate for financial services organisations to succeed in the future is to be nimble and adaptive. This is the only way organisations can future-proof themselves. Organisations need to better understand and manage risks and be prepared for the unexpected.

By considering real time monitoring of experience and responding with changes where appropriate, ensuring information flow is smooth throughout the organisation and collaborating with different professionals, organisations can optimise the way they operate and potentially reduce the required amount of held capital. The success of these measures will be underpinned by a strong risk culture.