Agenda

1. History of Scenarios as Management Tools
   i. Strategic Risk Scenarios
   ii. Stress Test Scenarios
   iii. View from Cambridge Centre for Risk Studies

2. Case Studies of Use of CCRS Cat Stress Test Scenarios

3. Best Practice in Using Scenarios in Insurance Decision-Making
History of Scenarios as Management Tools

i. Strategic Risk Scenarios

Scenario Planning: Scenarios for strategic business risk
- Shell scenario planning since 1970s, describes future ways of the world working
- “Scenario planning is a disciplined method for imagining possible futures…” to be “better positioned to take advantage of the unexpected opportunities”
  
P Schoemaker, Sloan Management Review 1995

Strategic risk scenarios are plausible but extreme narratives used in corporate planning
- Bring challenge to BAU: “Is my organisation fit for the futures?”
- Relies on Imagineering
- Typically not probabilistic
- Further methodology needed to quantify impacts, make decisions

Devil is in the detail
History of Scenarios as Management Tools

ii. Stress Test Scenarios

- **Stress Tests are plausible but extreme narratives (scenarios)**
  - What damage will a shock do to my business?
    - Imagineeering
  - Challenge to quantify impact
    - Typically not probabilistic
    - Qualitative tail risk analysis

- **Regulatory stress tests in banks**
  - Standard in Compliance
  - Study weakness but not test fatality
    - In individual banks
    - In aggregate (system)
    - Weather a worse-than-expected outcome vs. a CCAR Adverse Scenario

Timeline of Bank Stress Testing

- **Early 1990s**
  - Banks begin small-scale stress tests of their trading activities.
- **1996**
  - Market risk amendment to the Basel Capital Accord.
- **1999**
  - IMF and World Bank launch the Financial Sector Assessment Program (FSAP).
- **Early 2000s**
  - National central banks and supervisory authorities begin to develop their own independent bank stress tests.
- **2004**
  - Basel II introduces requirement for credit risk stress testing by banks.
- **Feb. 2009**
  - Federal Reserve begins the Supervisory Capital Assessment Program (SCAP).
- **May 2009**
  - Committee of European Banking Supervisors (CEBS) begins inaugural EU-wide stress test.
- **2011**
  - Federal Reserve begins Comprehensive Capital Analysis and Review (CCAR) programme which incorporates an annual bank stress test.
- **2014**
History of Scenarios as Management Tools

ii. Stress Test Scenarios - Subtypes

- **Reverse** stress tests for corporates and financial services: When would my organisation fail?
  - In what kind of situation, beyond what level of severity?
    - Imagineeering required
    - Quantifying impact is the main challenge
    - Typically not probabilistic

- **Coherent** stress tests
  - Narrative describes/quantifies all parts of system moving at the same time (correlated change)
  - e.g. *counterfactual* scenarios drawing on historical events
History of Scenarios as Management Tools

ii. Stress Test Scenarios - Subtypes

- **Catastrophe stress tests for insurance tail risk assessment**
  - Pre 1992, qualitatively severe stress tests used by insurance firms to check ability to survive a shock
    - C.f., CCAR Severely Adverse scenario
  - Hurricane Andrew led to many bankruptcies and consolidation in US insurance industry
  - This ushered in *probabilistic* analysis of tail events: What is chance of exceeding any given level of loss?
    - Exceedance, e.g., expected loss from 1-in-100 year event
      - C.f., 1% Value-at-Risk
  - Few insurance bankruptcies since 1992 even though pay-outs for large events
Qualitative goal of risk assessment: How big/bad could a plausible disaster be?

1. Selection of stress test
   i. Taxonomy of stress test types
   ii. Knowledge: history, science, theory of each

2. Severity of stress test
   i. Severity metrics and units
   ii. Constraints or physics of shock

3. Severity of impact on system at risk
   i. Map of Loss Process including constraints
   ii. Expert elicitation on level of Conditional Impacts

4. Building the scenario
   i. Narrative including Footprint, Timeline, Quantified Direct Impacts and Variants
   ii. Model (quantify) indirect impacts and variants

5. Probabilistic analysis of Threats
Agenda

1. Scenarios as Management Tools: Selective Survey

2. Case Studies of Use of CCRS Cat Stress Test Scenarios
   #1: Multiline Global Insurer Testing Risk Appetite
   #2: Global Reinsurer Explores Non-Standard Threat
   #3: Regulatory Request to Global Insurer
   #4: London Insurer Assesses Emerging Threat
   #5: UK Reinsurer Explores Expanding Its Cover
   #6: Risk Modeller brings Cyber Cat Models to Market

3. Best Practice in Using Scenarios in Insurance Decision-Making
Case Study #1: Multiline Global Insurer Testing its Risk Appetite

Objective

- Explore impact on claims pay-outs and investment portfolios from emerging risks: cyber, war, and pandemic

CRS Research Application

- Produce stress test scenarios for emergent risks
  - Plausible but extreme events – qualitative tail risk
  - Assess insurance claims
  - Assess investment portfolio
- Explore risk consequences of diverse threat types
  - Geopolitical Conflict: risk $\bigcirc$ (\(\Rightarrow\) Inflation$\uparrow$)
  - Human Diseases: risk $\uparrow$
  - Cyber Technology Catastrophe: risk $\uparrow$

Impact

- Risk appetite adjustments, e.g., for total exposure in Healthcare and Mortality
- Regular stress tests include emergent risk scenarios
Case Study #2: Global Reinsurer Exploring Impact of Non-Standard Threat on Pay-Outs in Different Lines

### Objective
- Provide general analysis of triggers and consequences of social unrest events from a reinsurance perspective

### CRS Research Application
- Produce stress test scenario for social unrest
  - Plausible but extreme event
  - Asses policy liabilities by insurance line

### Impact
- More comprehensive management information to risk function

<table>
<thead>
<tr>
<th>Class</th>
<th>Line of Business</th>
<th>Property Line/Owner</th>
<th>Personal Contents</th>
<th>Commercial Combined</th>
<th>Construction &amp; Engineering</th>
<th>Commercial Facultative</th>
<th>Binding Authorities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Casualty</td>
<td>Workers Compensation</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Directors &amp; Officers</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Financial Lines</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>General Liability</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Healthcare Liability</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Professional Lines</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Professional Liability</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Auto</td>
<td>Personal Lines</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Commercial &amp; Fleet</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Marine &amp; Specie</td>
<td>Cargo</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Marine Hull</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Marine Liability</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Specie</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Aerospace</td>
<td>Airline</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Airport</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Aviation Products</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>General Aviation Space</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Energy</td>
<td>Downstream</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Energy Liability</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Offshore Energy &amp; Power</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Upstream</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Specialty</td>
<td>Accident &amp; Health</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Aquaculture Insurance</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Contingency – Film &amp; Event</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Equine Insurance</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Excess &amp; Surplus</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Life Insurance</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Livestock</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 5: Estimated impact of a social unrest scenario on claims patterns from different lines of insurance.
Case Study #3: Regulatory Request to Global Insurer

Objective

- Insurer asked by regulator to report its exposure to a non-standard natural catastrophe

CRS Research Application

- Produce stress test scenario for solar storm
  - Plausible but extreme event
  - Assess policy liabilities by insurance line

Impact

- Reporting to regulator and internal management
Case Study #4: London Insurer Assesses Emerging Threat

Objective

- Underwriter seeks assessment of “silent” exposure to cyber disaster
  - New loss process: cyber induced physical damage
  - Not excluded in existing Marine and Aviation policies

CRS Research Application

- Produce stress test scenario for cyber threats
  - Plausible but extreme events
  - Assess policy liabilities

Impact

- Review policy wording for clarity around cyber coverage
Case Study #5: UK Reinsurer Explores Feasibility of Expanding Its Cover

Objective

- Reinsurer investigating of expanding terrorism cover for emerging risk
  - New area combines cyber catastrophe with terrorism

CRS Research Application

- Produce stress test scenarios for cyber terror threats
  - Plausible but extreme attack
  - Assess property damage

Impact

- Seeking to include cyber terrorism, causing physical damage, in coverage scheme
## Case Study #6: Risk Modeller brings Cyber Cat Models to Market

### Objective
- Help insurance clients manage accumulation risk to their cyber products

### CRS Research Application
- Exposure Data Schema
- Accumulation Scenarios: Initially 5 models for affirmative cyber cover
  - Assess accumulation to plausible but extreme cyber attacks

### Impact
- Release of first cyber accumulation model in market

<table>
<thead>
<tr>
<th>Information Technology</th>
<th>Operations Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Business Loss Processes</strong></td>
<td><strong>Cyber-Physical Loss Scenarios</strong></td>
</tr>
<tr>
<td>Data Exfiltration ('Leakomania')</td>
<td>Cyber Attack on <strong>US Power Generation</strong> ('Business Blackout')</td>
</tr>
<tr>
<td>Denial of Service Attack ('Mass DDoS')</td>
<td>Cyber Attack on <strong>UK Power Distribution</strong> ('Integrated Infrastructure')</td>
</tr>
<tr>
<td>Cloud Service Provider Failure ('Cloud Compromise')</td>
<td>Cyber attack on <strong>Commercial Office Buildings</strong> ('Laptop batteries fire induction')</td>
</tr>
<tr>
<td>Financial Theft ('Cyber Heist')</td>
<td>Cyber attack on <strong>Marine Cargo Port</strong> ('Port Management System')</td>
</tr>
<tr>
<td>Contagious Malware ('Extortion Spree')</td>
<td>Cyber Attack on <strong>Industrial Chemical Plant</strong> ('ICS Attack')</td>
</tr>
<tr>
<td>Software Vulnerability ('Sybil Logic Bomb')</td>
<td>Cyber Attack on <strong>Oil Rigs</strong> ('Phishing-Triggered Explosions')</td>
</tr>
</tbody>
</table>

### Exposure Data Schema

<table>
<thead>
<tr>
<th>2017 Cyber Risk Landscape</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accumulation Scenarios</strong></td>
</tr>
<tr>
<td>Cloud Service Provider Failure ('Cloud Compromise')</td>
</tr>
<tr>
<td>Contagious Malware ('Extortion Spree')</td>
</tr>
<tr>
<td>Financial Theft ('Cyber Heist')</td>
</tr>
<tr>
<td>Software Vulnerability ('Sybil Logic Bomb')</td>
</tr>
</tbody>
</table>
Agenda

1. Scenarios as Management Tools: Selective Survey
2. Case Studies of Use of CCRS Cat Stress Test Scenarios
3. Best Practice in Using Scenarios in Insurance Decision-Making
   I. Risk Management for an Insurer
   II. Insurance as a Service
I. Risk Management for an Insurer
   – Overriding principle is *comparability or ranking of all threats*.

II. Insurance as a Service
   – Propose goal of *quantifying loss or damage for each of comprehensive set of threats to insurance clients*. 
I. Risk Management for an Insurer

Overriding principle is comparability or ranking of all threats. To achieve this with scenarios we recommend developing:

- **Comprehensive or universal taxonomy of risk types**
  - e.g., Cambridge Taxonomy of Threats
  - Taxonomy visibly frames what is relevant, excludes the rest

- **Definition of System at Risk**
  - The system is the unit of analysis
  - Metrics of impact are defined

- **Qualitative Tail Risk Analysis**
  - Plausible but extreme threat scenarios using a clear and repeatable methodology
  - Use operations of System at Risk and understanding of wider environment to bound outcomes
  - Translate threat characteristics to impacts on System

- **Probabilistic Tail Risk Analysis is a significant next step**
II. Insurance as a Service

Propose goal of quantifying loss or damage for each of comprehensive set of threats to insurance clients.

To achieve this with scenarios we recommend developing impact analytics:

- **Modelled Scenarios:**
  - Industrialise scenario building in models and software
    - Generate a library of many modelled scenarios
  - Estimate probability or frequency of each threat scenario

- **Modelled Systems at Risk, aka Insurance Clients**
  - Identify taxonomy of Systems at Risk, e.g., corporations in sectors
  - Model a loss process, on type of System, for each threat
  - The above are informed by learning and outputs from Stage 1

- **Probabilistic Risk Assessment**, including
  - Estimate *average impact of each threat* per unit time
  - Estimate *tail risk* for a given return period
  - *Gap analysis*: Where does insurance promise the best value?